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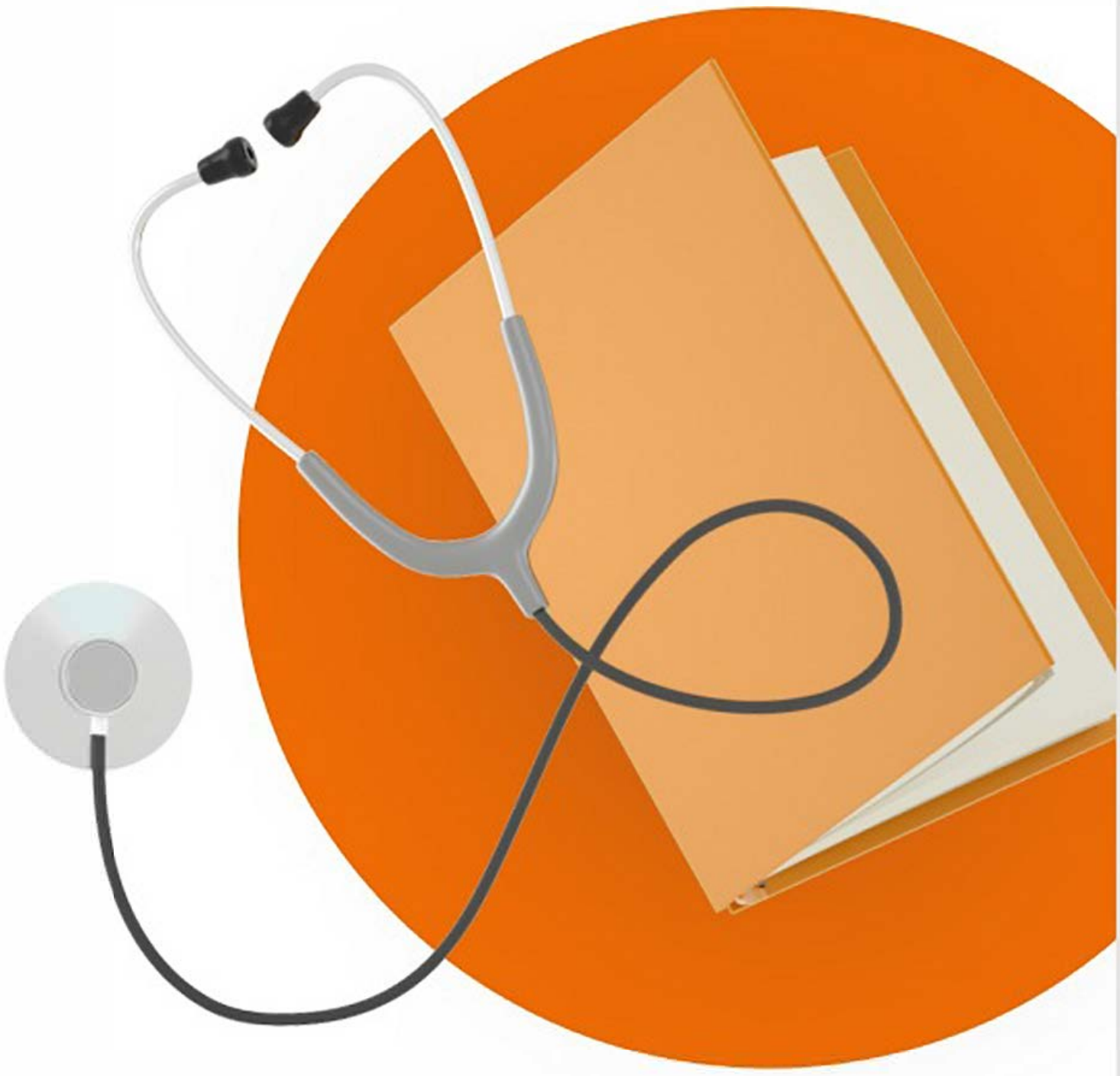

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Strides in Development of Medical Education

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Strides Dev Med Educ. 2026; 23(1):e93306. doi 10.22062/sdme.2023.93306

Editorial

From Metric Compliance to Disciplinary Leadership: Strategic Roadmaps in Medical and Pharmaceutical Higher Education

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Keywords: Medical Education; Strategic Planning; Scientometrics; Higher Education Administration; Disciplinary Leadership; Iran

Introduction

Global biomedical research governance has decisively moved beyond raw publication counts and superficial impact factors toward structural maturity, disciplinary balance, and tangible clinical outcomes (1, 2). For developing health systems and regional academic centers, international prestige cannot be sustained through peripheral, uncoordinated participation in global citation streams. Instead, institutional excellence requires targeted leadership within specialized niches that directly address population disease burdens and healthcare delivery priorities (3, 4). In medical and pharmaceutical education, this paradigm shift necessitates rigorous scientometric roadmaps that move beyond passive descriptive metrics to guide resource allocation, curriculum modernization, and translational research (5).

Addressing this strategic need in this issue of *Strides in Development of Medical Education* (SDME), Khazaeli et al. (6) delineate an empirical roadmap across thirteen specialized pharmaceutical disciplines. Supported by the Academy of Medical Sciences of the I.R. Iran, their investigation establishes a tripartite classification—Flagship, Pioneer, and Emerging tiers—based on Scopus productivity parameters alongside national infrastructure assessments. While the authors present a comprehensive institutional inventory, the critical imperative for educational leaders lies in critically interpreting these bibliometric tiers: transforming academic research productivity into measurable health system capacity and patient safety outcomes. Their work moves the discourse from reactive metric compliance to proactive, evidence-based strategic steering (7).

Decoding the Tiered Taxonomy: Lessons for Medical Education

By integrating Scopus-based scientometrics with national capacity data, Khazaeli et al. (2026) categorized thirteen pharmaceutical disciplines into three tiers. However, from a health-systems perspective, these tiers must not be viewed merely as bibliometric ranks, but as functional levers directly influencing clinical care, patient safety, and drug policy:

Flagship Groups (e.g., Pharmacology, Pharmaceutics, Pharmaceutical Biotechnology): Established research productivity in these domains directly underpins national self-reliance in biological therapeutics, rational antimicrobial dosing, and advanced delivery systems, mitigating critical drug shortages and therapy failures.

Pioneer Groups (e.g., Clinical Pharmacy, Pharmaceutical Nanotechnology, Traditional Pharmacy, Drug Control): These groups represent the frontline of patient safety and quality assurance. For

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instance, advancing the strategic footprint of Clinical Pharmacy directly correlates with reduced inpatient Adverse Drug Events (ADEs) and optimized polypharmacy management, while standardized Drug Control and evidence-informed Traditional Pharmacy curb counterfeit products and mitigate toxic botanical-drug interactions in primary healthcare.

Emerging Groups (e.g., Drug Economics & Management, Nuclear Pharmacy): Far from peripheral, targeted capacity building in pharmacoeconomics provides health ministries with essential Cost-Effectiveness Analyses (CEAs), ensuring that scarce healthcare budgets are allocated to high-yield therapies rather than low-value pharmaceutical expenditure.

Thus, applying this taxonomy prevents the pitfall of pursuing publication metrics disconnected from disease burden, aligning academic output with measurable clinical endpoints.

Bibliometric Implications and the Path Forward

From the perspective of global scholarly communication and disciplinary prominence, publishing foundational policy research serves two vital functions:

Thematic Anchoring: It positions the journal at the nexus of contemporary debates regarding research governance, science policy, and higher education reform. By curating such analyses, the journal contributes to the broader scholarly ecosystem, fostering nuanced discussions on how academic research outputs can be better aligned with national health mandates and societal needs.

Actionable Knowledge Translation: It facilitates the essential transition from abstract scientometric data to concrete administrative decision-making. By offering an empirical framework—such as the one proposed here—to university deans, curriculum planners, and policymakers, the journal fulfills its commitment to serving as a platform for evidence-based institutional stewardship and strategic academic development.

As we navigate the complexities of academic integrity, AI integration, and shifting global health demands, the medical education community must transition from scattered scholarship to orchestrated scientific leadership. The roadmap proposed by Khazaeli and colleagues suggests that achieving disciplinary Leadership depends on disciplined tier-specific planning, structural alignment, and strategic institutional stewardship.

Conclusion

Achieving sustainable disciplinary leadership and clinical relevance in medical and pharmaceutical higher education requires moving beyond indiscriminate resource allocation toward disciplined, tier-differentiated governance. To operationalize scientometric roadmaps into institutional excellence, educational leaders and curriculum planners must implement three actionable strategies:

Tier-Aligned Resource Allocation and Faculty Recruitment: University deans and department heads should tailor budgeting, infrastructure investments, and faculty recruitment to the specific developmental stage of each discipline—prioritizing translational capacity in Flagship fields, patient-safety integration in Pioneer areas, and health-economic justification in Emerging domains.

Competency-Based Curriculum Redesign: Medical and pharmaceutical curriculum committees must embed empirical metrics directly into academic programs—such as incorporating adverse drug event (ADE) mitigation and polypharmacy management into clinical pharmacy training, and health technology assessment (HTA) principles into pharmacoeconomics curricula.

Evidence-Based Strategic Steering: Institutional policymakers should leverage scientometric taxonomies not merely for compliance or ranking purposes, but as dynamic monitoring tools to align faculty research outputs with national health burdens, therapeutic self-reliance, and patient safety outcomes.

Acknowledgements: Editorial Independence

To maintain strict editorial independence and adhere to COPE and ICMJE guidelines on in-house submissions:

- Both Dr. Payam Khazaeli (Editor-in-Chief of SDME) and Dr. Sara Shafian (Associate Editor of SDME) completely recused themselves from the peer review, editorial evaluation, and decision-making processes regarding this editorial and the related empirical study.

- The evaluation, peer review, and final acceptance of this manuscript were overseen independently by an

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Review Article

Enhancing Student Engagement in Physiology Education through Flipped Classrooms, Gamification, and Visualization: A Narrative Review

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Abstract

Background: Learning physiology is a crucial aspect of medical education, focusing on the study of normal human body functions as the fundamental knowledge required for every physician. However, studying physiology poses significant challenges, including the need for active learning, loss of motivation, and lack of student engagement.

Objectives: This study explores the impact of flipped classrooms, gamification, and visualization teaching methods on student engagement in physiology education.

Methods: This review integrates insights from studies published between 2020 and 2024, highlights the complementary strengths of these methods, and offers a roadmap for educators to create dynamic and engaging learning environments tailored to modern medical education.

Results: Nine published articles were included to provide an understanding of modern methods and their impact. The flipped classroom approach is a strategy to encourage active learning, but it can also increase students' workload. Incorporating game elements into the learning process can create a more enjoyable environment and enhance students' motivation to learn. Physiology is a complex subject with abstract concepts; therefore, visualization methods can simplify these concepts and ultimately support students' learning processes.

Conclusion: No single superior teaching or learning method is available. Educators and students must adapt their approaches to suit the specific needs of the classes and individuals.

Keywords: Flipped Classroom; Gamification; Physiology Education; Student Engagement; Visualization

Background

Medical education is a challenging path toward becoming a doctor (1). During this process, medical students are required to be lifelong learners and continuously update their knowledge (2). According to the Cambridge Dictionary, learning involves knowledge acquisition (3). Bloom's taxonomy divides learning into six levels, starting from the lowest: remembering, understanding, applying, analyzing, evaluating, and creating (4). The higher the level of Bloom's taxonomy, the more proficient a person is at mastering the subject (5).

Physiology is a complex but essential branch of knowledge in the medical field. Physiology studies the normal functions of living organisms, including their parts and all the biological processes occurring within them (6). Previous studies have demonstrated that physiology is often considered difficult to understand (7). Medical students need active engagement in the learning process to master the basics of physiology effectively (8).

Student engagement refers to the attention and effort devoted to learning performance and reflects the motivation to learn (9). Previous studies have revealed a significant relationship between student engagement

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and learning outcomes (6, 10, 11). Factors that influence student engagement in learning include active participation in class, the relationship between teachers and students, active and collaborative learning, and a conducive educational environment (6).

Despite the growing awareness of its significance, strategies to enhance student engagement in physiology education are inconsistent and often inadequately evaluated. Therefore, conducting a well-designed study in this area is crucial for generating reliable evidence for constructive andragogical approaches. Rigorous research is essential to ensure that interventions address the barriers students face, leading to optimal learning outcomes and efficient educational resources. A carefully structured study helps identify gaps in existing methods and fosters the development of innovative approaches. Without such evidence, efforts to improve engagement may remain fragmented, unsystematic, and less impactful.

Objectives

Several teaching methods can enhance student engagement. This review explores the relationship between flipped classrooms, gamification, and visualization teaching methods and student engagement in human physiology education. It synthesizes the existing research and compares the most efficacious teaching methods for enhancing student participation and understanding in human physiology courses.

Methods

This narrative review was conducted to synthesize recent evidence on strategies to enhance student engagement in physiology education. Literature search was performed in PubMed and Google Scholar using the following keywords: "*student engagement*," "*study method*," and "*physiology*." Boolean operators were applied (e.g., *"student engagement" AND "study method" AND "physiology"*), with filters set for publication period (2020-2024) and language (English).

PubMed was selected because it provides comprehensive biomedical coverage, and Google Scholar was included to capture additional peer-reviewed educational studies. Other databases, such as Scopus, Web of Science, and ERIC, were not prioritized because of their substantial overlap with records retrieved from PubMed and Google Scholar, as well as subscription limitations. For the scope of this narrative review, the combination of PubMed and Google Scholar was considered adequate for identifying the most relevant studies, resulting in the inclusion of nine articles in the final synthesis.

The selection process comprised two stages: (1) screening titles and abstracts to remove duplicates and irrelevant articles; (2) full-text review of potentially eligible studies. Two reviewers independently conducted the screening and data extraction. Discrepancies were resolved through discussion until a consensus was reached.

The data were extracted and reviewed for each article. The inclusion criteria were as follows: (1) original research published in peer-reviewed international journals, (2) written in English, and (3) explicitly examining student engagement in physiology education. The exclusion criteria were as follows: (1) reviews, conference abstracts, editorials, and studies not directly related to physiology or student engagement; (2) not written in English; and (3) full text not available.

The initial search identified 543 and 345 articles in PubMed and Google Scholar, respectively. After removing duplicates and irrelevant records, 38 articles remained for full-text review. Of these, nine met the inclusion criteria and were included in the final synthesis. Although the number of included studies was relatively small, it reflects a limited but emerging body of literature that focuses on student engagement strategies in physiology education. The overall study selection process is illustrated in Figure 1.

Data were extracted using a structured matrix that included the study design, participants, teaching methods, and key findings. The synthesis followed a thematic narrative approach, grouping the results into three main categories: the flipped classroom, gamification, and visualization.

Results

Nine studies were included in this narrative review. Table 1 summarizes the articles examined in this review. Each row in the table represents an individual study, detailing its methodology, population, and key findings. This overview enables readers to swiftly grasp the diversity of approaches explored in the literature and their specific impacts on student engagement in physiology education. Lu et al. (2023) asked whether a flipped classroom would improve exam performance compared with traditional teacher-centered lectures.

Their findings confirmed that students in the flipped classroom achieved significantly higher usual performance and final exam scores, directly answering the study question (12). Similarly, Ganfornina et al. (2023) investigated whether flipped classrooms could enhance intrinsic motivation and learning outcomes in neurophysiology. The results showed higher final grades

and improved learning perceptions, supporting the effectiveness of this approach (13). Anderson et al. (2023) explored whether the different delivery modes (online, hybrid, and in-person) of flipped teaching during the COVID-19 pandemic affected performance. Interestingly, hybrid flipped formats were linked to lower exam scores—while the flipped model can be beneficial, contextual factors such as modality and external stressors are crucial (14).

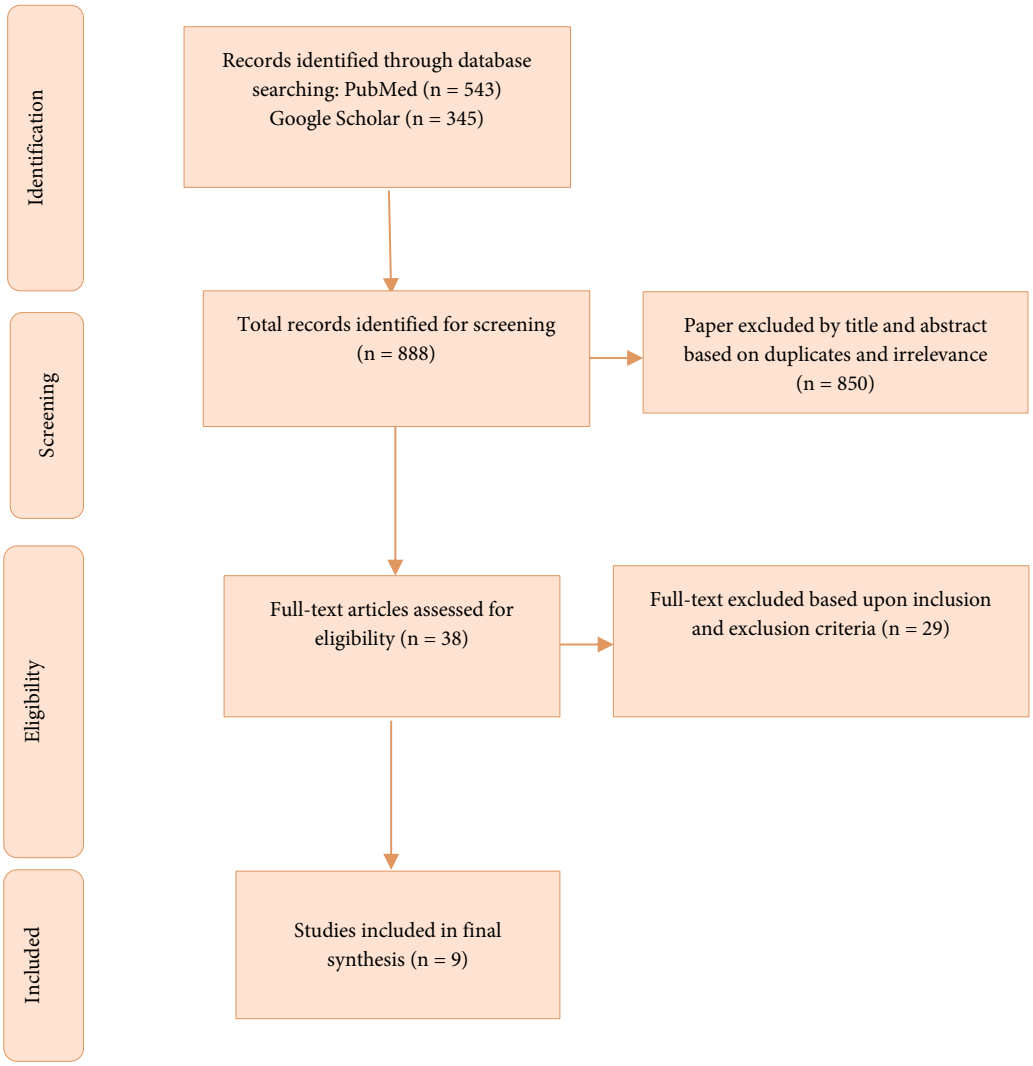

Figure 1. Flowchart of the study selection process showing the identification, screening, eligibility, and inclusion stages

Table 1. Summary of Studies Included in This Review

Study Author (Year)	Method	Participants	Findings
Lu et al. (2023) (12)	Student-centered flipped classroom compared to traditional teaching class in physiology education	131 2nd year medical students	This research showed that students' usual performance and final exam scores in the flipped classroom were significantly higher than those in the traditional teaching class.
Ganfornina et al. (2023) (13)	Flipped classroom compared to standard teaching group in neurophysiology learning, focusing on students' intrinsic motivation and performance	891 (standard) vs. 962 (flipped) 2nd year medical students	This study compared the final grades between the standard teaching group and the flipped classroom group. The flipped classroom teaching method group reports a significant increase in final exam scores. Furthermore, flipped classrooms have shown a benefit in creating a positive perception and understanding.

Study Author (Year)	Method	Participants	Findings
Anderson et al. (2023) (14)	Flipped classroom during the COVID-19 pandemic in teaching Clinical Physiology 1 and 2. The lesson was delivered online, hybrid, or in person, and the exam scores were compared between groups.	45 2nd year medical students	Students who received a hybrid modality flipped classroom during the COVID-19 pandemic were associated with lower exam scores.
Hennekes et al. (2021) (15)	The PEGASUS Games (Physical Exam, Gross Anatomy, Physiology and UltraSound Games) for preclinical medical education	20 1st year medical students	This research compared the learning outcomes of the game group and the non-game group after learning neck and thyroid material. The game group showed better performance than the non-game group.
Bawazeer et al. (2023) (17)	A cross sectional study on students' engagement using interactive polls (Kahoot, Mentimeter, Blackboard) in teaching physiology, pathology, and pharmacology during COVID-19 Pandemic	184 3rd and 4th year medical students	This research demonstrates the impact of using interactive polls on increasing student engagement by creating an enjoyable learning atmosphere.
Roberts et al. (2024) (16)	Codenames board game for the physiology classroom, requiring, at minimum, a simple list of vocabulary terms	74 1st year medical students	The study's findings reveal that participating in this activity increased students' active involvement and encouraged them to engage in high-level integrative thinking, irrespective of their grade level.
Subbiramaniyan et al. (2021) (18)	A meme-based approach for enhancing student engagement and learning in renal physiology	280 2nd year medical students	This research indicates that memes can enhance student engagement by increasing enjoyment in learning and simplifying complex concepts.
Su et al. (2023) (19)	Effectiveness of the "Hand as Foot" teaching method using a randomized controlled trial in human physiology education	84 health management students	The "Hand as Foot" teaching method demonstrated strengths in engaging students and aiding comprehension.
Keba et al. (2024) (20)	Using Word Cloud with Mentimeter as a formative assessment classroom technique in physiology	150 1st year medical students	The word cloud provides formative evaluation and helps monitor student understanding in the classroom.

Hennekes et al. (2021) investigated whether incorporating the PEGASUS Games into preclinical education enhanced outcomes in anatomy and physiology. Their results confirmed that students exposed to the game showed superior learning performance (15). Roberts et al. (2024) asked whether a board game ("Codenames") could increase engagement and higher-order thinking in physiology classes. The findings revealed that this gamified activity promoted active involvement and encouraged integrative thinking, addressing the study's central question (16). Bawazeer et al. (2023) evaluated whether interactive polls (Kahoot, Mentimeter, Blackboard) could sustain engagement during a pandemic. This study demonstrated a positive effect, showing that digital gamified polling created an enjoyable learning atmosphere and enhanced interaction (17).

Subbiramaniyan et al. (2021) explored whether memes could improve the engagement and comprehension of renal physiology. Their study confirmed that memes increased enjoyment and simplified complex topics, directly answering the research question (18). Su et al. (2023) investigated the effectiveness of the "Hand as Foot" method as a visual analogy for physiology education. A randomized trial demonstrated that this technique significantly improved understanding and engagement, validating the research aim (19).

Keba et al. (2024) assessed whether word clouds generated via Mentimeter could serve as a formative assessment and engagement tool. The results showed that this technique effectively monitored the learning progress while enhancing classroom participation (20), answering the study question.

Conventional lectures are teacher-centered and often limit student interaction and long-term retention. The flipped classroom shifts the focus to active, student-centered learning with pre-class preparation and in-class discussions, resulting in improved understanding and problem-solving, but may increase student workload. Gamification stands out for transforming learning into enjoyable and motivating experiences through elements such as games and competitions, fostering engagement, autonomy, and positive

emotions. Visualization methods, including memes, hand gestures, and creative digital tools, simplify complex physiological concepts, making learning more accessible and memorable. The flipped classroom, in combination with gamification and visualization techniques, has emerged as the most efficacious approach. It offers the deepest engagement, enhanced learning motivation, and better retention, as it is well-structured and tailored to student needs.

This review addresses three study questions concerning flipped classrooms, gamification, and visualization in physiology education. Flipped classrooms have been shown to enhance engagement and learning outcomes by fostering active, student-centered participation, with most studies reporting higher exam scores and more positive learning perceptions than traditional lectures. Nevertheless, outcomes could vary depending on the delivery modality. Gamification methods, including serious games, board games, and interactive digital polls, consistently increase student motivation, enjoyment, and higher-order thinking, confirming their value in sustaining participation. Visualization techniques, such as memes, hand gestures, and word clouds, effectively simplify complex physiological concepts and promote comprehension while maintaining student interest. Overall, the evidence indicates that all three methods improve engagement in different but complementary ways. In particular, flipped classrooms, in combination with gamification and visualization, have been considered the most comprehensive approach for enhancing participation and understanding in human physiology courses.

Discussion

Physiology requires students to possess an understanding beyond mere memorization (21, 22). Students must integrate complex concepts to develop a strong scientific foundation. Mastering physiology is a crucial bridge connecting preclinical and clinical learning in medicine. Fatima et al. present several challenges and obstacles in studying physiology, including concept integration (84%), the use of active learning methods (81.7%), and the role of educators in answering student questions (88.4%) (23). Challenges in studying physiology can be addressed through engagement and the active involvement of students in learning (24).

Educators and students must contribute toward fostering student engagement (9). Reinke et al. state that educators are responsible for creating learning environments and experiences that promote active learning and facilitate social interaction in the classroom (6). Educators must package learning such that students develop interest and spend more time studying. Conventional teaching methods that emphasize teacher-centered lectures are no longer relevant to the evolving needs of university students (25). Conventional learning, which limits the interactions between students and teachers and among students (26), must be replaced with other teaching methods that enhance student engagement.

The flipped classroom is a student-centered learning method that has been proven to increase student engagement (27, 28). In its implementation, students must prepare themselves before class begins by reading materials or watching prerecorded videos (29). Learning instructions are provided to the students before the class starts. During in-class meetings, the learning process focuses on group discussions, case-based studies, debates, and short presentations (13). Hadad et al. (2025) substantiate the significant decay of physiological knowledge over time, demonstrating the most significant loss in the gastrointestinal system while noting a positive retention only in endocrinology among fourth-year students. These findings underscore the critical necessity of implementing active learning strategies—the flipped classroom, gamification, and visualization methods—as they are directly focused on reinforcing long-term memory and counteracting the Ebbinghaus forgetting curve (30). Lu et al. investigated the impact of the flipped classroom on physiology education. This study was conducted with 131 respondents divided into six classes and randomly assigned to receive conventional and flipped classroom instruction. The findings showed a significant difference in final exam scores between the groups, with the flipped classroom outperforming the conventional teaching class ($p < 0.05$). The number of students in the flipped classroom group who failed the final exam was also lower than in the conventional group. Notably, 77.58% of the respondents agreed that the flipped classroom improved their understanding, 86.21% mentioned that it enhanced their independent learning skills, and 70% stated that it improved their problem-solving skills (12).

Interactive activities built into the teaching and learning processes are created because time is allocated for students to be first exposed to new concepts and materials. The flipped classroom promotes active, cooperative, collaborative, and problem-based learning (12). Existing research has proven that flipped classrooms are beneficial for increasing student

engagement (12, 29, 31). However, despite its many advantages, the flipped classroom may add to the burden and cause some students to feel overly anxious and lose motivation to study because of the limited pre-class independent study time (12, 13).

Ganfornina et al. attempted to address the increased workload arising from the flipped classroom learning method by eliminating pre- and in-class assessments (13). This approach emphasizes the students' internal motivations for learning. Ganfornina et al. investigated the application of the flipped classroom in neurophysiology education. Neurophysiology content was delivered at the end of the physiology curriculum and is a challenging subject. This study compared the final grades of groups that received traditional and flipped classroom instruction. Printed student workbooks and study guides were provided before class began. During the class sessions, the instructor implemented doubt-solving activities, group discussions, debates on important topics, and brief presentations linking the learning material to clinical aspects. The classes concluded with challenge questions and take-home messages. The results showed that the group taught using the flipped classroom method demonstrated better memory retention ($p < 0.009$). Additionally, the flipped classroom approach was helpful in understanding crucial neurophysiological concepts ($p = 0.048$). The students in the flipped classroom group achieved higher exam scores (13).

Students in large classes are more likely to skip sessions and focus solely on studying for exams (32). This habit drives students to adopt a test-oriented learning approach, ultimately leading to poor long-term material retention. The flipped classroom teaching method offers a solution by fostering active learning, which promotes the longer retention of information in the brain (33). According to Ganfornina et al., there is no universally perfect teaching or learning method; each student must identify the approach that best aligns with their intrinsic motivation (13). It also highlights the importance of educators preparing concise, effective, and practical materials to ensure that the flipped classroom model is accessible and beneficial to all students, including those hesitant to embrace this teaching method (13).

Anderson et al. examined the impact of using a hybrid flipped classroom model during the covid-19 pandemic and found that it decreased academic performance compared to groups attending either entirely in-person or fully online classes (14). Students perceived the hybrid flipped classroom to offer no significant advantages over traditional teaching methods. In-class sessions emphasize active learning by engaging in group discussions and problem-solving activities. However, some students reported discomfort with active learning because of the uncertainty of correct answers, even though the instructors ultimately clarified this. The hybrid format also limited the instructors' ability to effectively evaluate small-group discussions, and the mixed presence of in-person and online participants further reduced the effectiveness of the flipped classroom approach. Despite these challenges, some students recognized that active learning improved their critical thinking skills (14).

Gamification is a teaching method that leverages the fun of playing and connects it with the learning process. This approach can make the learning environment enjoyable and ultimately increase students' attention. In addition to the learning environment, enhancing student engagement requires attention to active learning, social interaction in learning, and collaboration. Traditional classes deliver materials to one or several separate classes, causing students to struggle integrating the overall material. Gamification can help students integrate materials and create fun learning environments, ultimately sparking active learning.

The benefits of gamification in education, as researched by Waluyo et al., include the addition of game elements such as points, badges, and goals, which create a positive learning environment and foster positive emotions (34). This approach has been shown to reduce anxiety and increase student motivation to learn (34). A pleasant learning atmosphere encourages students to participate actively in the learning process (35). Additionally, gamification fosters autonomy, competence, and relatedness, contributing to intrinsic and extrinsic motivation, as seen in tools such as Kahoot and Quizlet. Gamification's ability to create enjoyable and engaging environments has consistently been linked to improved student performance and participation (35, 36).

Hennekes et al. conducted a study comparing learning outcomes between groups taught using gamification and those taught using conventional methods in the context of neck and thyroid education. The gamified group engaged in three different games: "ball toss," "taboo," and "pin the tail," all played in groups with the objective of helping students retrieve information from their memory. The non-gamified group received traditional instructions. The results showed that the gamified group achieved higher

immediate post-test scores, increased learning motivation, and improved social interactions (15).

Roberts et al. presented data on the use of games in physiology education. Seventy-four respondents were divided into small groups and allowed to play the educational games. The games used in this study were designed to achieve higher levels of Bloom's taxonomy through interleaving, recall, and teamwork. Respondents stated that using games gave them a new perspective on learning, made them more interested, and enabled them to integrate the topics they studied (16). Gamification has the potential to increase student engagement in physiology teaching. An increase in student engagement primarily occurs through the creation of a fun learning environment. However, educators must design games that enhance students' analytical and evaluative skills to reach higher levels of Bloom's taxonomy. Designing games must be tailored to various aspects, including the characteristics of the students, while considering the type of game player (37).

Classroom interactions are important for enhancing student engagement. The interaction between students and instructors in conventional classrooms during Q&A sessions is sometimes not optimal because students tend to be shy about asking questions and fear making mistakes in front of their peers. An alternative for fostering this interaction is online polling. Applications, such as Kahoot and Mentimeter can be used to increase student engagement. Research conducted at King Saud bin Abdulaziz University during the COVID-19 pandemic revealed the benefits of online polling in increasing engagement among physiology students. Online polling can facilitate interactions between educators and students. Most respondents agreed that they were comfortable using online polling services.

Additionally, online polling improved grades, and 88.9% of the respondents agreed to use online polling again, even for other subjects. The increase in grades observed in previous research may be relevant to retrieval theory. A retrieval technique is one way to achieve deep learning by first attempting to recall materials without referring to other sources. Retrieval is an active learning strategy (17).

Using creative learning media allows for longer retention of new knowledge in the brain. Memes are a means of communication that combine elements of pop culture, and are usually used for online conversations. Using media, such as memes, creates a combination of enjoyable textual and visual materials (38-40). Making memes requires analyzing and integrating material, which is beneficial for achieving higher levels of Bloom's taxonomy (41). The benefits of memes in increasing student engagement in physiology education have been observed in a study by Subbiramaniyan et al. This study involved 146 students studying renal physiology who created a meme. A total of 44% of students stated that using memes was enjoyable and could relieve stress. Notably, 38% of the students felt that memes made information easier to remember than conventional text forms. Thirty% of students stated that memes could simplify complex concepts and make the material easier to understand (18).

Learning media are not limited to presentation slides, textbooks, or two-dimensional images. Conventional learning media lack the ability to visualize materials. Using virtual reality (VR), augmented reality (AR), or mixed reality (MR) allows more visual teaching and helps students understand abstract concepts (42, 43). However, the use of advanced technology incurs significant costs and is not available in all areas. Intelligent visualization alternatives use hand gestures. Hand-as-foot is a teaching method that uses hand gestures to simulate anatomical structures and functions. Using hands-in visualization can help students understand complex physiology. A randomized study by Su and Zhao examined the effect of the Hand as Foot on physiology education. Eighty-four respondents were divided into two groups: traditional and experimental. Renal physiology was studied in both groups. The results showed that the group taught using the hand-as-the-foot method had higher engagement levels, better understanding, and better recall than the conventional group (19).

The hand as a foot can increase student engagement. This aligns with the method's ability to create a conducive learning environment. Educators practice hand gestures while delivering material, followed by students, initiating active student engagement and fostering interactions between teachers and students. Another benefit of the hand as a foot-teaching method is the simplification of complex materials, which increases students' learning motivation. However, Su and Zhao conducted their study on only one topic: renal physiology. Further research is required to determine whether the foot-teaching method can be applied to other physiological areas (19).

Evaluation is a critical aspect of the learning process and can be summative or formative. Quick assessments conducted after delivering the material, known as formative evaluations, help determine whether a class understands the presented content. Through formative evaluation, educators can adapt

their teaching methods to be more relevant and aligned with student needs. Research by Keba et al. revealed that using word clouds with Mentimeter provides rapid visualization of students' understanding in class following lessons. This approach is an effective formative evaluation that offers valuable insights into enhancing learning processes (20).

A summary of this review is presented in Figure 2. The flipped classroom encourages active learning by combining independent studies with clear study guidance before class, such as reading materials or watching prerecorded instructional videos. Educators should focus on activities that develop problem-solving, discussion, and critical thinking skills during class rather than relying on traditional lectures. However, the increased workload associated with flipped classrooms can lead to a loss of motivation among students. Therefore, educators must be attentive to student conditions and design well-structured curricula.

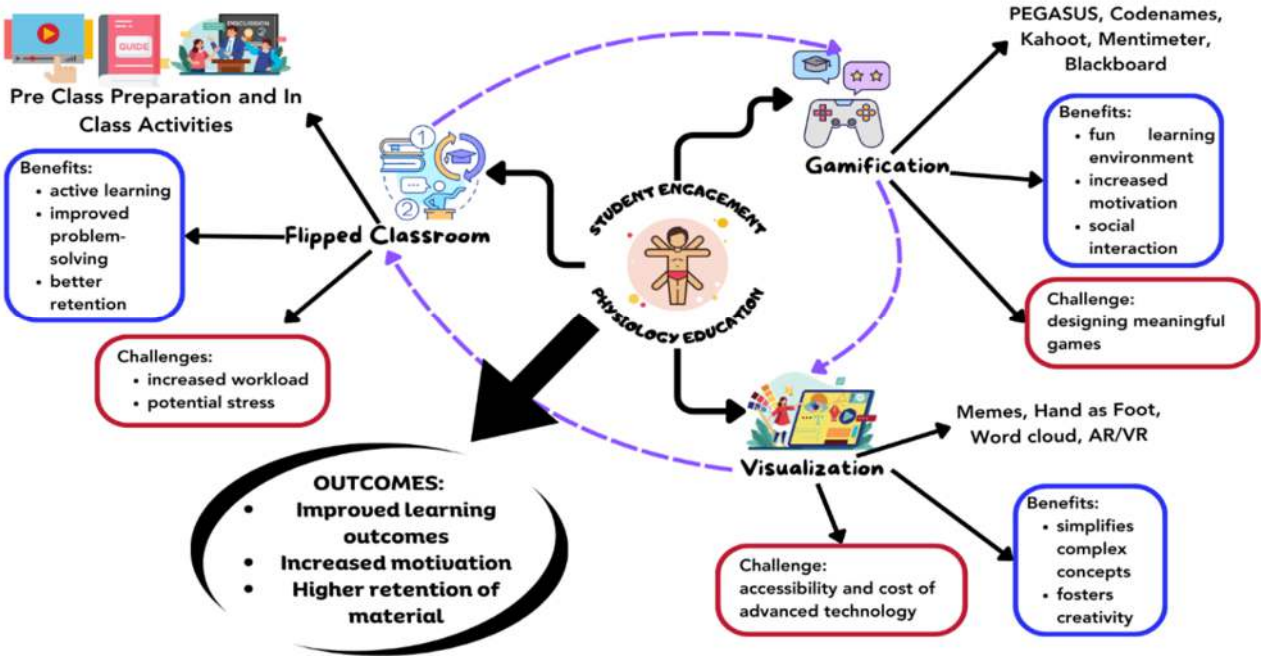

Figure 2. Student Engagement in Physiology Education from Different Teaching Methods and Their Outcomes

Combining gamification and visualization with the flipped classroom model can create a more enjoyable classroom atmosphere and enhance interactions between students, teachers, and peers. Learning activities packaged as games can evoke positive emotions and reduce student stress, which has a positive impact on increasing student engagement. Educators should also ensure that games are tailored to suit the characteristics of students, which creates a challenge in designing meaningful games. Visualization methods like "hand as foot" or memes can simplify complex and abstract material, making it easier for students to understand. Every learning process should be evaluated to create a dynamic learning environment that meets the needs of the class. Tools such as word clouds can be used for formative assessment, providing quick visual feedback on students' understanding and helping educators refine their teaching strategies for better outcomes. These innovative methods are expected to improve student engagement by improving learning outcomes, increasing motivation, and attaining higher material retention.These innovative methods are expected to enhance student engagement by improving learning outcomes, increasing motivation, and promoting material retention. Nonetheless, this study has several limitations. First, the review included only a few studies (n = 9), which may have restricted the generalizability of the findings. Second, the search strategy was limited to two databases and did not include ERIC, potentially leading to the omission of relevant studies. Third, there was considerable heterogeneity among the included studies in terms of the study design, population, and outcome measures, which may have affected the comparability of the results. Finally, a formal quality assessment of the primary studies was not conducted, which may have limited the ability to evaluate the strength of the evidence.

Conclusion

Physiology is challenging because of its complex concepts and the need for a deep understanding. The key to a student's success in mastering these complex concepts lies in active learning, which promotes the longer retention of information in the brain.

Modern teaching methods provide educators with diverse tools to address the varying learning styles and classroom dynamics. The integration of flipped classrooms, gamification, and visualization represents a shift toward more interactive and student-centered teaching approaches in physiology education. By leveraging these methods, educators can design adaptable strategies that align with the evolving demands of modern medical education, ensuring a more engaging and effective learning environment for students. Future research should involve larger multi-institutional studies and incorporate dedicated educational databases to enhance the generalizability of the findings. Additionally, direct comparisons among different innovative teaching methods are required to identify the most effective strategies for specific physiological topics and student cohorts.

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Review Article

Tools for Assessment of Teamwork Skills of Health Professions Teachers: A Scoping Review

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Abstract

Background: Teamwork skills are crucial in HPE for fostering effective teaching and learning environments. While several tools assess teamwork in various educational settings, few are designed to assess the teamwork skills of educators within HPE.

Objectives: This scoping review aimed to identify and map tools used to assess teamwork skills among teachers in Health Professions Education (HPE), with a focus on the tools' characteristics, including assessed domains and applicability in academic settings.

Methods: A scoping review was conducted following Arksey and O'Malley's framework, updated by Levac et al. We searched Google Scholar, PubMed, and PakMedinet for studies using tools to assess teamwork in academic or clinical settings. Inclusion criteria focused on studies that mapped the characteristics and domains of teamwork tools. Data were charted and summarised to highlight their applicability in educational settings.

Results: Thirteen studies met the inclusion criteria. One tool, TeamQ, was designed for clinical teaching teams, while others were aimed at students, interprofessional teams, or general academic settings. Commonly assessed domains included communication, leadership, collaboration, and problem-solving. Most tools were self-assessment-based and showed varied applicability across educational contexts.

Conclusion: This review identifies several tools for assessing teamwork in educational contexts. However, there is a significant gap in tools designed specifically for assessing the teamwork skills of HPE educators. Future research should focus on developing such tools to measure teamwork behaviours in academic settings.

Keywords: Assessment Tools; Faculty Development; Health Professions Education; Teamwork Skills; Teacher Evaluation

Background

In today's rapidly evolving world, characterised by advanced technology, increased interconnectedness, and growing workplace complexity, teamwork has become an indispensable component for success in any field. In Health Professions Education (HPE), the importance of teamwork extends beyond clinical care to include the educational processes involved in training the future health professionals (1). Studies in academic and healthcare settings have consistently demonstrated the positive impact of teamwork on patient outcomes, error reduction and the development of supportive learning environments (2, 3). As interdisciplinary and team-based work environments become increasingly common, the role of teachers in modelling and fostering effective teamwork has gained importance (4).

Among the general competencies proposed for healthcare settings, teamwork is widely recognised as a key non-technical skill essential for enhancing communication, problem-solving, decision-making, and overall performance. Professional bodies and international organisations, such as the WHO, have emphasised the integration of teamwork into both clinical and educational contexts (5). Moreover, health professions curricula are increasingly placing more emphasis on collaborative learning models such as team-based learning and inter-professional education, where facilitation and participation in teamwork is central to effective teaching practice (4).

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Thus, teachers should themselves be competent at teamwork to role model required behaviours, give students the support they need, help them develop positive relationships with colleagues, and assist in developing team-based models of care (6). Identifying, nurturing, and evaluating these competencies in health professions educators are, therefore, crucial to preserving the quality and impact of education and care, underscoring the need for assessment of their teamwork skills.

Various professional fields have successfully developed and tested instruments to measure teamwork competencies (7). However, despite the growing recognition of teamwork as an essential competency, there is a lack of comprehensive guides on the tools available for assessing teamwork skills, specifically in HPE teachers. Although several tools exist to measure teamwork competencies, these tools differ in format, scope and applicability, making it challenging for teachers and administrators to choose an appropriate assessment tool.

Objectives

To address this gap, the present study conducts a scoping review of existing tools used to measure teamwork skills among teachers of health professions education. By systematically mapping existing instruments and summarising their key characteristics, we aim to provide a comprehensive guide for educators, researchers, and institutional administrators seeking to enhance teamwork skills in educational settings. This scoping review specifically addresses the following questions:

- What tools are available for assessing teamwork skills among teachers of health professions education?
- What are the key characteristics of these tools, including the teamwork domains assessed, target population, and context of use in academic settings?

Methods

Study Design: We conducted a scoping review in accordance with Arksey and O'Malley's framework (8), updated by Levac et al. (9), and reported the findings in line with the PRISMA-ScR guidelines for scoping review (10). The framework is particularly suitable for mapping the breadth of existing literature and understanding the range of tools and methodologies available for assessing teamwork skills in health professional educators. The purpose of this scoping review was to map and summarise the characteristics of tools used to assess teamwork skills among HPE teachers. A scoping study approach was adopted due to the broad nature of the research question and the wide variety of study designs involved.

The following five stages of scoping review, which Arksey and O'Malley's framework (8) suggested, were followed:

Stage 1: Identifying the research questions/aims

Stage 2: Identifying relevant studies

Stage 3: Study selection

Stage 4: Charting the data

Stage 5: Collating, summarizing and reporting the results

The optional expert consultation, which is the sixth stage suggested by Levac et al. (9), was not undertaken as the co-authors of this study are experienced medical education researchers and adequately fulfilled this role (11).

Stage 1: Identifying the research questions

We developed the research questions for this scoping review to guide the mapping and summarising of available tools for assessing teamwork skills in teachers of Health Professions Education (HPE). These questions were designed to identify tools, summarise their characteristics, and understand the contexts in which they are applied. The research questions, as presented in the Introduction, focus on:

1. Identifying available tools for assessing teamwork skills in HPE educators.
2. Examining the key characteristics of these tools, including the teamwork domains assessed, target population, and context of use in academic settings.

Stage 2: Identifying relevant studies

An extensive review of related articles was performed in Google Scholar, PubMed, and PakMedinet electronic databases up to January 2025. The search was conducted in English and included no date limitations to identify as many relevant studies as possible. The search strategy was developed by the first author and the co-authors (medical education specialists). It was further refined to ensure the inclusion of studies relevant to our research question.

In order to increase the thoroughness of the search, we also sought further literature through grey literature sources such as Research Gate, university repositories for dissertations, and institutional reports. This enabled the inclusion of studies that may not have been published in a peer-reviewed journal. In addition, the snowballing technique was used by manually reviewing the reference list of included studies for further relevant studies that were not retrieved in the database search.

The database-specific search strategies were developed using a combination of free-text keywords

and MeSH (Medical Subject Headings) terms. The search was adapted for each database to maximise the retrieval of relevant studies. The main search terms used were "teamwork skills", "teachers", "health professions education", "assessment tools", and variations of these terms. Boolean operators (AND, OR, NOT) were used to combine the keywords. The detailed search strategy for each database is shown in Table 1 and 2.

Table 1. Articles Found on Literature Search

Keywords/Search Term	Articles Found			Records Retrieved
	Google Scholar	PUBMED	PakMediNet	
Teamwork AND Teamwork Skills (Construct Search)	231,000	2,823	7	233,830
Teachers (Population Search)	338,000	41,788	388	338,388
Teachers of Health Professions Education (OR Medical Education) (Population Search)	17,800	12,149	41	29,990
Teamwork Skills Assessment Tool (OR Instrument OR Scale) (Instrument Search)	31,700	129	0	31,829
#1 AND # 2	22,100	78	0	22,178
#1 AND # 2 AND #3	16,800	7	0	16,807
#1 AND # 2 AND #3 AND #4	2,450	0	0	2,450
				675,470

Note: Searches were conducted across Google Scholar, PubMed, and PakMediNet using combinations of Medical Subject Headings (MeSH) and free-text terms. #1 to #4 denote sequential Boolean combinations of search blocks (construct, population, instrument). Total records retrieved across all database searches equal 675,470.

Table 2. Articles Found on Literature Search

Source	Search approach	Limits applied	Records identified
Google Scholar (Research Gate, university repositories for dissertations, and institutional reports)	Same keyword combinations; first 200 results screened	Title/abstract screening only	1
Snowballing	Reference lists of included studies	Not applicable	2
TOTAL			3

Note: Grey literature was searched via targeted institutional repositories, ResearchGate, and academic search engines (screening the first 200 results per query), supplemented by manual backward/forward citation snowballing of included studies. Total records identified equal 3.

Initially, the search was limited to tools that assess teamwork skills in teachers of health professions education. However, through this search strategy, only one teamwork skills assessment tool was identified, which was used to assess teamwork skills in teachers of health professions education. Given the limited availability of tools specifically designed to assess teamwork skills in teachers of health professions education, the scope was subsequently broadened to include tools applied in adjacent educational settings (e.g., students, interprofessional education, and non-HPE teachers and academic settings). This broadening enabled us to identify additional tools applicable to both HPE and non-HPE teaching in assessing teamwork skills. This approach is in coherence with the scoping review methodology, which prioritises breadth of coverage to identify gaps in the literature (9).

In order to increase the thoroughness of the search, we also sought further literature through grey literature sources such as Research Gate, university repositories for dissertations, and institutional reports. This enabled the inclusion of studies that may not have been published in a peer-reviewed journal. In addition, the reference list of included studies was manually reviewed for further relevant studies that were not retrieved in the database search.

Stage 3: Study selection

The studies were included or excluded based on the following criteria:

Inclusion

- Studies with a focus on tools assessing teamwork skills among teachers in the health professions, in both the academic and clinical teaching environments.
- Studies involving the use of teamwork assessment tools in HPE for non-teachers (e.g., students, Inter-professional education, etc.) and tools used in academic settings other than HPE.
- Studies that provided general characteristics of teamwork assessment tools, such as teamwork domains assessed, context of use, target population, and applicability in educational settings.

Exclusion

- Commentaries, conceptual papers, and conference proceedings.
- Non-peer-reviewed studies
- Studies in languages other than English.

After the search, studies were screened in two stages:

Phase 1: Title and abstract screening to exclude irrelevant studies. Articles unrelated to the assessment of teamwork skills in health professions education were excluded.

Phase 2: Full-text screening to confirm that the studies met the inclusion criteria. We included studies that focused on the mapping of available tools to measure teamwork skills in teachers of health professions education, with a particular emphasis on characteristics like domains, context, and applicability.

The selection was performed independently by two reviewers. Discrepancies were resolved through discussion between the reviewers. A PRISMA flow diagram was constructed to illustrate the selection of studies, as shown in Figure 1.

Stage 4: Charting the Data

Data were extracted from the included studies using a standardised data extraction sheet. We captured the following data: tool name, author, year of publication, country of origin, details of the target population and sample size, tool type (e.g., self-assessment, peer assessment, team assessment), domains of teamwork skills assessed, number of items, validated or not, and context of use in educational settings.

Two reviewers independently extracted data from all eligible studies, and discrepancies were resolved by consensus.

As recommended by Khalil et al. (12), the results are predominantly displayed in Table 3 outlines the attributes of the teamwork skills assessment tools, comparison of their key characteristics, including the domains assessed and the contexts in which they are applied. In instances where a tool was employed across various studies, these studies are presented collectively.

Stage 5: Collating, summarizing and reporting the results

In this stage, we organised and summarised the data extracted from the included studies in a structured format in order to respond to the research questions of this scoping review.

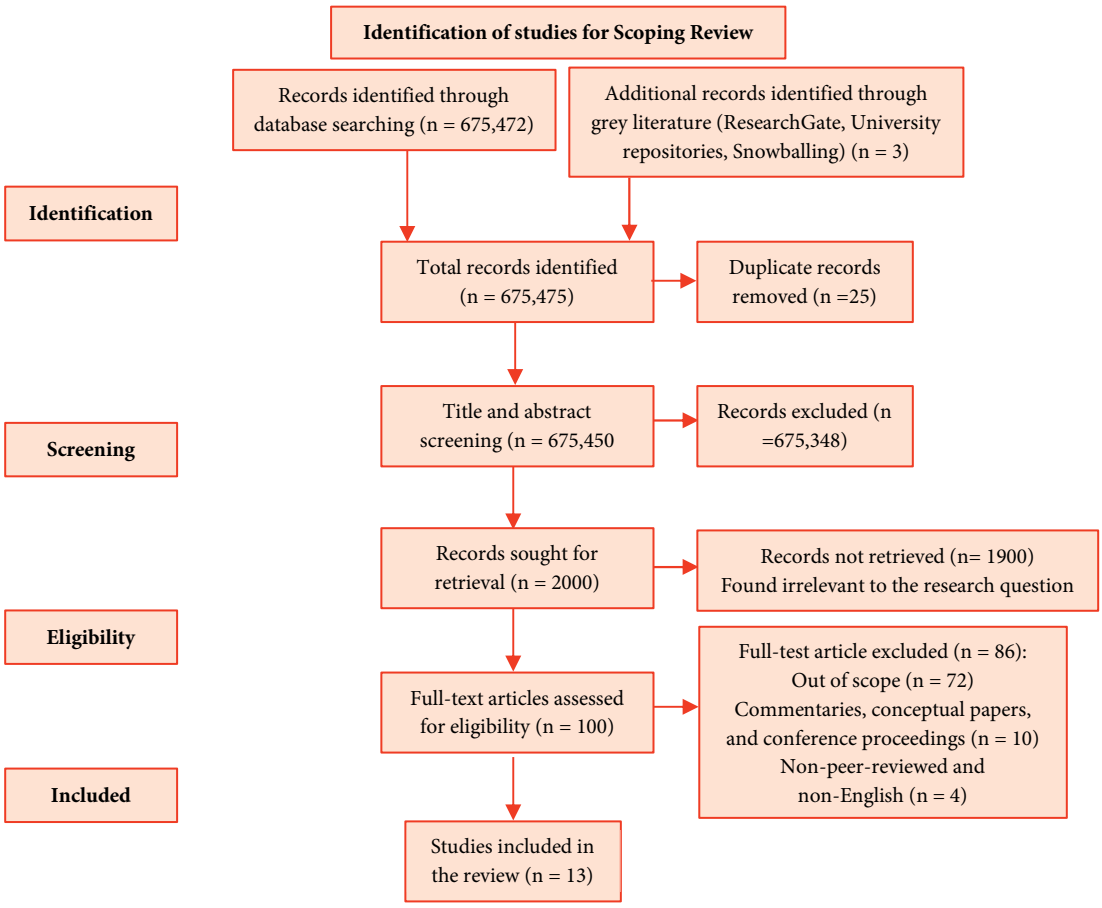

Figure 1. PRISMA flow diagram of the study selection for the scoping review

Collating the Data: Data were summarised systematically using tables to present the essential characteristics of each teamwork assessment tool. For each tool, the following information is provided: tool name, author(s), year of publication, country of origin, population examined (including sample size), domains of teamwork skills assessed, number of items in the tool, validation status, and context of use in educational settings. These descriptors were extracted during data charting and grouped into relevant categories, which also made convenient comparisons between tools in terms of dimensions.

Summarizing the Data: Following data extraction, we synthesised the summary of findings by considering the most salient features of each tool. This overview underscored the types of teamwork competencies measured by the tools, the populations to which they were applied, and whether the tools are validated or not. The summary process provided us with the opportunity to examine the field of teamwork skills assessment in health professions education, identifying trends, gaps, and common problems.

Reporting the Results: The findings were narratively presented in accordance with the review's research questions. Instruments were reviewed with regard to the dimensions of teamwork measured, their applicability across educational contexts, and the populations for which they were developed. The results were presented in the form of tables for easy comparison and better perception. The report ensured that results were transparent, structured, and provided unambiguous direction for educators, researchers, and decision-makers in health professions education.

Results

Search selection: The initial literature search, conducted in January 2025, identified 675,472 records across academic databases (Google Scholar, PubMed, etc.) and 3 records from a grey literature search (ResearchGate, University repositories, and snowballing). The search terms included variations and combinations of "teamwork skills, "teachers", "health professions education," and "assessment tools". After removing duplicates, 675,472 references remained. Title and abstract screening reduced the number of references to 2000, and a further 1900 were eliminated as found irrelevant to the research questions, resulting in 100 articles for full-text screening. 86 studies were further excluded as out of scope, after applying the inclusion and exclusion criteria. This ultimately resulted in 13 studies being included. The PRISMA flowchart for the study is presented in Figure 1.

The regional location of the studies was primarily from North America, 53.8% (n = 7), followed by Europe, 23.1% (n = 3), East Asia, 15.4% (n = 2), and South Asia, 7.7% (n = 1). The first research article on teamwork skills assessment tools was written in 1992. The number of publications grew post-2018: 2 publications in 2018, 3 in 2019, 3 in 2020, and 5 in 2021 Table 3.

Most of the included studies were articles or innovations, 76.9% (n = 10), while 23.1% were perspectives (n = 3). 38.5% of studies targeted undergraduate medical education (UME) (n = 5), 23.1% graduate medical education (GME) (n = 3), and 15.4% continuing professional development (CPD) (n = 2). The remaining studies (23.1%, n = 3) were conducted across multiple levels of education (UME, GME, CPD).

Characteristics of the included tools: The 13 studies included in this scoping review employed various tools to evaluate teamwork skills in the field of health professions education and academic settings other than HPE. These tools assessed key teamwork domains such as communication, collaboration, leadership, and problem-solving, which are essential for effective teamwork in health professions education (13).

Variation across study populations was also evident, with some tools addressing students (69.23%, n = 9), teachers (23.07%, n = 3), and some interdisciplinary teams (7.69%, n = 1), as shown in Figure 2. Among the 13 tools, seven (53.8%) were used in HPE, and six (46.1%) were applied in academic settings outside HPE (Figure 3).

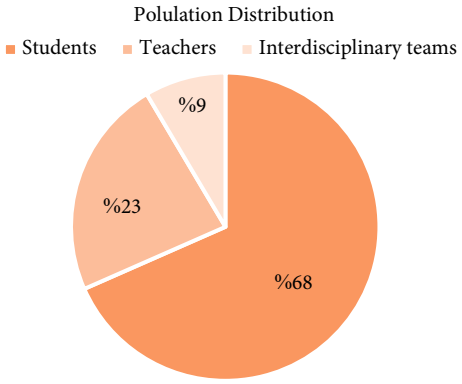

Figure 2. Distribution of populations being studied in the selected tools

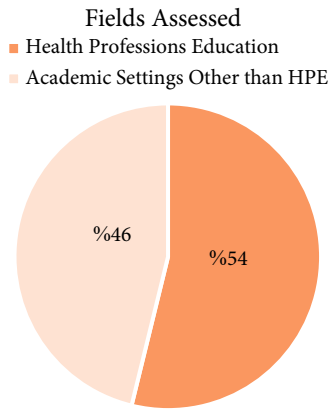

Figure 3. Fields assessed in the selected tools

The sample sizes in the included studies also varied, ranging from 100 to 1,351 participants. For example, the Comprehensive Assessment of Team-Member Effectiveness (CATME) (14) tool included 1,351 students across different academic years, and the Individual Teamwork Observation and Feedback Tool (iTOFT) (15) involved 108 students and 85 assessors.

These tools were mainly self-assessment tools (69.2%, n = 9), followed by team-based assessment (23.1%, n = 3), and peer assessment (15.4%, n = 2), as shown in Table 3. The Comprehensive Assessment of Team-Member Effectiveness (CATME) (14) and Teamwork Skills Questionnaire (TSQ) (16) were used as both self-assessment and peer-assessment tools.

The validation status of these tools also varied. Out of 13 tools assessed, 12 reported validity evidence, including well-known instruments such as CATME, TSQ, and T-TPQ. However, one tool, the Teamwork Baseline Assessment Tool (TBAT), did not provide any validity evidence.

Instruments such as TBAT (17) and TSQ (16) assessed skills related to teamwork behaviours and group goal setting. In general, the tools covered a broad range of teamwork domains, such as coordination, conflict resolution, and problem-solving, which indicates their applicability across different educational and professional settings. CATME (14) emphasised team contribution, task management, and interpersonal communication. TAS (18) focused on teamwork and task management in healthcare, based on shared-situation awareness, whereas iTOFT (15) addressed decision-making and patient safety.

The tools included in the review assessed a variety of domains related to teamwork skills. The most common domains among these tools are communication, collaboration, and leadership. TeamQ (19) and T-TPQ (20) evaluated constructs such as team leadership, communication, and mutual support. A concise summary of the key features of the included teamwork assessment tools is presented in Table 4, while detailed tool characteristics are provided in Table 3.

Table 4. Summary of the key features of the included teamwork assessment tools

Key Features	Summary
Target population	Students (n=9), teachers (n=3), mixed (n=1)
Educational context	HPE (n=7), non-HPE academic settings (n=6)
Tool type	Self-assessment (n=9), team-based (n=3), peer assessment (n=1)
Common teamwork domains	Communication, collaboration, leadership, problem-solving
Validation status	Majority validated (13 tools); one tool unvalidated
HPE Teacher-specific tools	One tool (TeamQ) (20) is designed explicitly for HPE teachers.

Note: Data are synthesized from the 13 included assessment tools. Tool-type counts may overlap, as certain instruments (e.g., CATME) serve multiple assessment modes (self-, team-, and peer-assessment). HPE: Health Professions Education

Questionnaire content: The number of items of the teamwork assessment tools varied from 10 to 54, with most tools (69.2%, n = 9) consisting of 15 to 30 items. For example, TeamQ (19) had the most significant number of items (54 items) across a variety of teamwork domains. On the other hand, instruments such as TeamSTEPPS T-TPQ (20) and CATME (14) contain 35 items that address basic domains, for example, leadership and cooperation. These tools primarily focused on behaviours and team interactions, with only a few exploring more abstract domains, such as "team vision" and "belief in multidisciplinary patient care" (measured by TeamQ (19)).

Results of syntheses: This scoping review identified a variety of tools designed to assess teamwork skills, particularly in health professions education (HPE). The

most commonly evaluated domains across the tools included communication, collaboration, leadership, and problem-solving. Notably, tools like CATME and T-TPQ focused on task-related competencies, such as decision-making, interpersonal communication, and coordination. In contrast, TeamQ incorporated more abstract constructs, including team vision and belief in multidisciplinary patient care, which are crucial for clinical teaching teams. However, a gap was identified in the availability of tools explicitly tailored for assessing teamwork in HPE teachers, as many tools focus on students or clinical teams, rather than teachers in academic settings.

Discussion

This scoping review aimed to identify tools that measure the teamwork skills of teachers working in Health Professions Education (HPE). Collaborative teamwork is increasingly recognised as a core competency in both healthcare and education, particularly within interprofessional education contexts (21-22). Successful teamwork in the educational setting, where teachers play a crucial role in promoting collaborative learning, can have a profoundly positive impact on student achievement and the preparation of future health professionals who will practice in teams in clinical settings (23). Although teamwork has been recognised as important in teaching settings and at the bedside, the results of our study show a severe underdevelopment of tools for measuring teamwork among teachers of HPE.

At the first stage of the search, instruments specifically evaluating teamwork skills in health professions education teachers were identified. However, the search identified only one validated instrument, TeamQ (19), which focuses on the teamwork skills of clinical teachers in teams, particularly those working with residents. This instrument, while suitable for clinical teaching environments, has a limited scope in non-clinical teaching situations, such as those involving educators in basic sciences or other theoretical disciplines of health professions education, like Health Management.

Realising the limited number of studies pertaining to teachers of HPE, the search was broadened to encompass instruments applied in broader academic settings, such as the evaluation of teamwork in students, inter-professional education, and teachers working in other educational programs. This broader search uncovered further tools that, although not developed explicitly for teachers of HPE, offered valuable insights into assessing teamwork skills in an educational context. Notable among these instruments were those measuring teamwork skills in interprofessional education (IPE) and among learners participating in team-based learning, such as the Teamwork Assessment Scale (TAS) (18) and the Comprehensive Assessment of Team-Member Effectiveness (CATME) (14). Importantly, although these tools were not originally developed for teachers of health professions education, their domains and constructs were interpreted in this review specifically in relation to the teamwork demands faced by HPE educators.

The review revealed that the most frequently measured domains of teamwork in the included tools were communication, collaboration, leadership, and problem-solving. These domains are critical to clinical and educational settings, as effective collaborative teamwork can impact patient outcomes and learning in health professions education (24). The prominence of these domains aligns with the growing importance of interprofessional education (IPE) and collaborative learning within HPE curricula, in which working in teams is not only an essential skill to learn but also a behaviour that teachers must model (25, 26). However, tools such as CATME (14) and TeamSTEPPS T-TPQ (20), which primarily measure teamwork skills in clinical settings, may not fully encompass all domains of teamwork required for didactic settings. These tools are commonly used for measuring students' teams and do not directly address the collaboration and teamwork required by teachers in academic settings.

One of the areas found lacking in this review is that most of the tools focus on the perception of teamwork rather than on actual behaviours that should characterise these teams. Instruments such as the T-TPQ (20) or TeamQ (19) measure the perceptions of students or clinical teams regarding teamwork; however, they do not directly assess actual teamwork behaviours in educational settings. This is a substantial limitation, as tools relying exclusively on perception may not provide actionable findings to improve teamwork behaviours (27). For example, a teacher might believe they are an effective team player, but unless there is an objective way to measure actual collaborative behaviours, it is hard to determine what areas to work on for improvement. Thus, there is a clear need for tools that focus on assessing observable teamwork behaviours (e.g., collaborative planning, coordination, and problem-solving) rather than relying solely on subjective perceptions alone (28).

Overall, the findings of this scoping review indicate that, while numerous tools exist for measuring

teamwork skills in health professions education, there is a notable gap in the literature for the tools designed for self-assessing teamwork skills among teachers of health professions education.

Implications for Research: Future research in Health Professions Education should prioritise the development of a teamwork skills assessment tool explicitly designed for HPE teachers, rather than adapting tools developed for students or clinical teams. Such instruments should focus both on self-assessment and observable teamwork behaviours relevant to academic and clinical teaching roles, including collaboration, coordination, and collective decision-making within teaching teams.

Establishing robust validity evidence will be essential, particularly content and construct validity grounded in HPE faculty expertise. Additionally, longitudinal research is needed to examine how teamwork assessment influences faculty development, students' educational outcomes, and educational culture within HPE institutions.

Implications for Practice: For Health Professions Education institutions, the findings of this review indicate that few tools are currently suitable for directly assessing teamwork skills among HPE teachers. In the absence of educator-specific instruments, existing teamwork assessment tools may be cautiously adapted for formative use within faculty development programs, interprofessional education initiatives, and team-based teaching environments.

These tools may be used diagnostically to support reflective discussions on teamwork competencies among teaching teams; however, institutions should avoid employing student-focused or clinically oriented instruments for high-stakes evaluation of teachers. Until validated, HPE teacher–specific tools are developed, teamwork skills assessment for teachers of HPE should be embedded within developmental, non-punitive frameworks that support professional growth, collaboration, and educational quality improvement.

Strengths and Limitations: One of the key strengths of this review is its comprehensive search strategy, which not only focused on tools for assessing teamwork in teachers of HPE but also expanded to include broader academic settings, including tools for students and interprofessional teams. This allowed for a more comprehensive understanding of the existing tools available to assess teamwork in HPE. Additionally, the inclusion of both published and grey literature helped ensure that the review captured a diverse range of tools and methodologies.

However, there are some limitations. While most included tools reported some validity evidence, this review did not critically appraise or synthesise the quality, type, or robustness of the psychometric properties. This was a deliberate methodological decision aligned with scoping review guidance, which prioritises mapping the extent and nature of available evidence rather than evaluating measurement quality. Consequently, conclusions regarding the comparative psychometric strength of the identified tools cannot be drawn, and future systematic reviews using formal appraisal frameworks are warranted.

Additionally, the search was limited to three databases due to institutional access constraints, as this review was conducted as part of a thesis project. Although this approach aligns with scoping review methodology, future reviews should include databases such as Scopus, Web of Science, ERIC, and PsycINFO to enhance comprehensiveness. The exclusion of non-English language studies may have led to the omission of relevant tools developed outside of English-speaking regions. Further research should address this gap by ensuring that studies from non-English-speaking regions are included in future reviews.

Conclusion

In conclusion, we provide a thorough overview of the available tools for assessing teamwork skills in health professions education. While several tools are available for assessing teamwork skills in students, clinical settings, and IPE, there remains a significant gap in tools tailored specifically for teachers working in the academic environment of HPE. The findings suggest the need for further research to develop instruments that can measure both perceived and actual teamwork behaviours among teachers. Incorporating these tools into faculty development programs will enhance teamwork competencies and improve the overall quality of health professions education, ultimately benefiting both educators and students.

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Table 3. Characteristics of the tools used in the included studies

Tool Name	Author	Country of origin	Target population & Sample size	Tool Type (Self, Peer, or Team assessment)	Domains of TWS assessed & Total No. of Items	Context of use
Teamwork Baseline Assessment Tool (TBAT)	Karunaratne N, et al.	Australia	• Students Sample size not mentioned	Self-Assessment	• Growth Mindsets • Reactions to Challenging Teamwork Scenarios • Ideal Team Player Attributes (being cooperative, proactive, and supportive) Total Items: 34 + 3 open-ended Questions	HPE
individual Teamwork Observation and Feedback Tool (iTOFT)	Thistlethwaite et al.	Developed by a consortium of seven universities from Australia, Canada, and the UK	• Students and novice health professionals • 108 students and 85 assessors	Self-Assessment	• Shared decision making • Working in a team • Leadership • Patient safety Total Items: 18	HPE (Interprofessional teams)
Teamwork Assessment Scale (TAS)	Kiesewetter & Fischer	Germany	• Students • 100	Team-Assessment	• Task-related Collaborative Behaviours • Team Adjustment Behaviours • Coordination • Collaboration • Information Exchange Total Items: 17	HPE (simulation-based-ward rounds)
Team Q	Slootweg et al.	Netherlands	• Teachers • 929 clinical teachers from 114 teaching teams	Team-Assessment	• Team leadership • Team communication • Team task reflexivity • Team vision • Task orientation • Team mental model • Belief in multidisciplinary patient care teams for better outcomes • Residents' empowerment • Feedback culture • Decision-making • Engaging residents Total Items: 54	HPE (postgraduate training program)
TeamUP rubric	Hastie et al.	Australia	• Students • 8 midwifery focus groups • 14 health and business focus groups	Self-Assessment	• Fostering a Team Climate • Project Planning • Facilitating Teams • Managing Conflict • Quality Individual Contribution Total Items: 35	HPE + business academics

Tool Name	Author	Country of origin	Target population & Sample size	Tool Type (Self, Peer, or Team assessment)	Domains of TWS assessed & Total No. of Items	Context of use
TeamSTEPPS Teamwork Perceptions Questionnaire (T-TPQ)	Battles & King	USA	• Military and civilian healthcare providers. • 495	Self-Assessment	• Leadership • Mutual Support • Situation Monitoring • Communication • Team Structure Total Items: 35	HPE (healthcare providers)
Comprehensive Assessment of Team-Member Effectiveness (CATME)	OHLAND	USA	• Students • 1,351	Both self and team, as peer assessment	• Contributing to the Team's Work • Interacting with Teammates • Keeping the Team on Track • Expecting Quality • Having Relevant Knowledge, Skills, and Abilities Total Items: 12	HPE (interprofessional program)
Teacher Collaboration Skills Scale' (TCSS)	Basık & Dayı	Turkey	• Teachers • 513	Team-Assessment	• Dialogue • Decision making • Action • Evaluation Total Items: 25	Non-HPE academic program (for special needs students)
Teamwork Skills Scale (TSS)	Romero-Díaz et al.	Spain	• Students • 2,722	Self-Assessment	• Teamwork Behavior • Teamwork Importance Rating • Teamwork capability perception Total Items: 10	Non-HPE academic program (Vocational training)
Teamwork Competency Scale (TCS)	Hebles et al.	Chile	• Students • 802	Self-Assessment	• Group goal setting • Planning and coordination • Conflict management • Problem-solving • Communication • Collective efficacy • Performance monitoring • Supportive behavior • Learning orientation Total Items: 30	Non-HPE academic program (undergraduate program)
Teamwork Skill Assessment	Varela & Mead	USA	• Students • 349	Self-Assessment	• Transition process • Action process • Interpersonal process Total Items: 35	Non-HPE academic program (Business)

Tool Name	Author	Country of origin	Target population & Sample size	Tool Type (Self, Peer, or Team assessment)	Domains of TWS assessed & Total No. of Items	Context of use
Teamwork Skills Inventory (TSI)	Strom & Strom	USA	• Students • 303	Self-Assessment	• Attending to teamwork • Seeking and sharing information • Communicating with teammates • Thinking critically and creatively • Getting along with teammates Total Items: 25	Non-HPE academic program (high school and university)
Teamwork Skills Questionnaire (TSQ)	O'Neil et al.	USA	• Students • 615 students • Teachers • 202 teachers	Self-Assessment	• Communication • Coordination • Leadership • Decision • Making Adaptability • Interpersonal Skills Total items: 36	Non-HPE academic program (social sciences and school)

Note: Tools are listed in order of publication/inclusion. Total items reflect closed-ended psychometric questions excluding qualitative/open-ended items. HPE: Health Professions Education; Non-HPE: Educational settings outside health professions (e.g., general university, vocational, high school).

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Review Article

A Concept Synthesis of Talent in Medical Sciences: A Multi-Attribute Talent Model

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Abstract

Background: Talented individuals are particularly important nowadays due to their potential abilities, creativity, and high initiative toward scientific progress. Due to the passage of time and conducting studies on the concept of talent by researchers, this concept has been observed in the last few decades generally, partially, or in combination with other concepts.

Objectives: The present research aimed to provide a more comprehensive understanding of the concept of talent and its adjacent substructures and abstract structures.

Methods: Concept synthesis in this study was implemented using the stages of the Walker-Avant approach in 2024. After extensive searching on scientific databases of Magiran, SID, Medlib, Iran Doc, Scopus, PubMed, Science Direct, Cochrane, Web of Science, Google Scholar, Eric and using keywords related to the article, resulting in approximately 706 items. After reviewing the articles based on their titles and related content, and given the theoretical data saturation and using 82 articles, analytical concepts and definitions were collected and categorized, and the model was finally presented.

Results: According to the findings, after categorizing and narrowing down the categories and considering the literature review, the present study's multi-attribute talent model was obtained (a model comprising of stages: acquisition of competency, accomplishment leading to achievement, and culmination into talent") that concept of talent were synthesized with more complete and precise definitions.

Conclusion: According to the research findings in the present model, talent encompasses high levels of achievement and performance defined by expertise, giftedness, and individual characteristic (such as grit, perseverance, and commitment) based on acquiring competencies and higher-order thinking rooted in intelligence and aptitude within a specific dimension. Finally, based on the available reviews, limited studies were obtained regarding talent models, in which concepts had been used interchangeably, and talent had been assessed limitedly, which we tried to resolve this issue in the current model.

Keywords: Talent; Giftedness; Intelligence; Aptitude; Achievement

Background

Investing in human resources, particularly talented individuals, is crucial in today's world because they possess high potential, creativity, and initiative toward scientific progress.

Talent concept

Numerous and sometimes different definitions of talent have been proposed in different articles (1).

Some researchers build their framework for conceptualizing talent based on objective or subjective approaches. The objective approach views talent as individuals' characteristics, including natural ability, mastery, commitment, and fit (1).

According to Gagné, talent is the superior mastery of systematically developed abilities or skills (2). Williams (2000) suggests that individuals who consistently

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demonstrate high competency in a broad spectrum of activities and situations, in a specialized field, or in a narrow area of expertise (i.e., in potential situations) are considered talented (3). Ulrich defines talent as competency (knowledge, skills, and values required for current and future occupations, and the appropriate skill, place, occupation, and time) × commitment (willingness to engage in an activity) × engagement (finding meaning and purpose in their activities) (4).

Aptitude concept

Achievements typically serve as aptitude; for instance, reading skills are crucial aptitudes for academic learning. Aptitude indeed encompasses most cognitive structures, such as abilities or success. Furthermore, aptitude is not always positive; for example, some individuals tend to cause accidents or some may be good liars. Lastly, and most importantly, context or conditions can influence aptitude (5).

Giftedness concept

Moreover, the term "giftedness", one of the terms hidden in talent, is defined by Renzoli as a clever individual who may not have a very high intelligence quotient (IQ) but stands out due to nurturing other qualities, such as task commitment, above-average abilities, and creativity (6). In addition, Gagné (2011) describes giftedness as possessing and utilizing salient innate abilities, known as aptitude, that place an individual among the top 10% of their peers in at least one ability dimension (7).

Creating a deemed concept is a mental process in which a mental structure is created and its related opinions are formed based on experience. Consequently, the ultimate outcome of the process establishes criteria for identifying concepts and perceptions existing in a particular scenario, resulting in a shared understanding and influential communication. In the process of dissemination of scientific theories, the development of concepts and the establishment of deemed concepts are pivotal stages. During the synthesis stage, the concepts concerning the intended phenomenon are exclusive, precise, and clearly defined (8). Due to the passage of time and conducting studies on the concept of talent by researchers, this concept has been observed in the last few decades generally, partially, or in combination with other concepts.

A literature review even in texts related to health and medical sciences shows that talent, aptitude, and giftedness are often used interchangeably, and there is no single definition of the aforementioned concepts in studies (5).

Objectives

The present research aimed to provide a more comprehensive explanation and clarification of the concept of talent and its adjacent substructures and abstract structures (Such as aptitude and giftedness concept) using the Walker-Avant concept synthesis approach in 2024.

Methods

Concept Synthesis Stages in the present study

According to Walker-Avant concept synthesis approach:

- "We will discuss the steps of concept synthesis sequentially but, as in most of the strategies, they are really iterative. That is, you do not always progress from step to step but may cycle through steps several times or go back and forth between steps.
- During the time you are becoming theoretically saturated, begin to classify the data you acquire. The system of classification need not be rigorous. Indeed, it is better if the system stays fairly loose at this stage.
- While you are classifying the data, look for clusters of phenomena that seem to relate closely to each other or overlap considerably and combine them.
- The new concept has been reduced as much as possible, a name should be chosen for it that accurately describes it and that facilitates communication about it. Once the concept is named, the next step is to verify the new concept empirically and modify it as necessary.
- Verification involves a return to literature, field studies, data collection, and colleagues to discover if the concept is empirically supported.
- The new concept should then be described in a theoretical definition that includes its defining attributes.
- Finally, determine, if possible, where the new concept fits into existing theory in the area."

Walker-Avant asserted that the process of conceptual synthesis method can be done in an iterative process and there is no need to follow step by step (9).

In this research, we utilized a literary approach for concept synthesis because the preferred and practical approach to assessing the concept of talent.

Search Strategy

This study suggests that the goal of this process is to reach theoretical saturation. To this purpose, we need to get totally acquainted with our field of interest by utilizing various sources, including reviewing the literature and case studies. All of these sources offer

potential sources of usable data.

In this study, articles and books were collected by searching the electronic databases of Magiran, Iranmedex, SID, Medlib, IranDoc, Scopus, PubMed, Science Direct, Cochrane, Web of Science, Google Scholar, Eric and using keywords General Intelligence, Intelligence, IQ, Aptitude, Effort, Supporting context, context, Competency, Atitude, Mindset, HOTS, High performance/ Achievement, Performance, Grit, Perseverance, Commitment, Expertise, Giftedness, Talent related to the title, No time limit. Boolean operators (AND, OR, NOT) were used appropriately to construct the search query. Examples of English search queries included as follows: ((IQ OR Giftedness OR Aptitude) AND Talent)

Inclusion and exclusion criteria

The inclusion criteria for articles included full-text articles published in English and Persian and the exclusion criteria included articles in languages other than English and Persian and duplicates resulting in a total of 706 documents.

After reviewing and examining the abstracts and content of the texts and removing duplicates, 82 articles that covered the subject of the study and were available in full text, including research and review articles, were selected (Figure 1).

The Figure 1 depicts the flowchart of the search strategy and a diagram for the paper's selection. After reviewing the documents in the Table 1 presents an abstract of a review of articles that have examined concepts and definitions related to talent.

Data Extraction

In this stage, while categorizing the data, we integrated a cluster of phenomena apparently closely related or considerably overlapped.

Choosing a name for the cluster that accurately described the phenomenon and facilitated communication regarding it: After narrowing down the new concept as much as possible, a name was chosen for it that accurately described it and facilitated communication regarding it (Table 2).

Results

From the 82 articles obtained in the concept synthesis process, the method of identifying factors that are related to the focal concept (talent) and related sub-constructs such as competency, high performance, exceptional personal characteristics in the conceptual model was used. Finally, all related concepts and related sub-constructs were integrated into our model.

After categorizing and narrowing down the categories, and according to reviewing the texts for the second time, the following multi-attribute talent model was obtained (Figure 2).

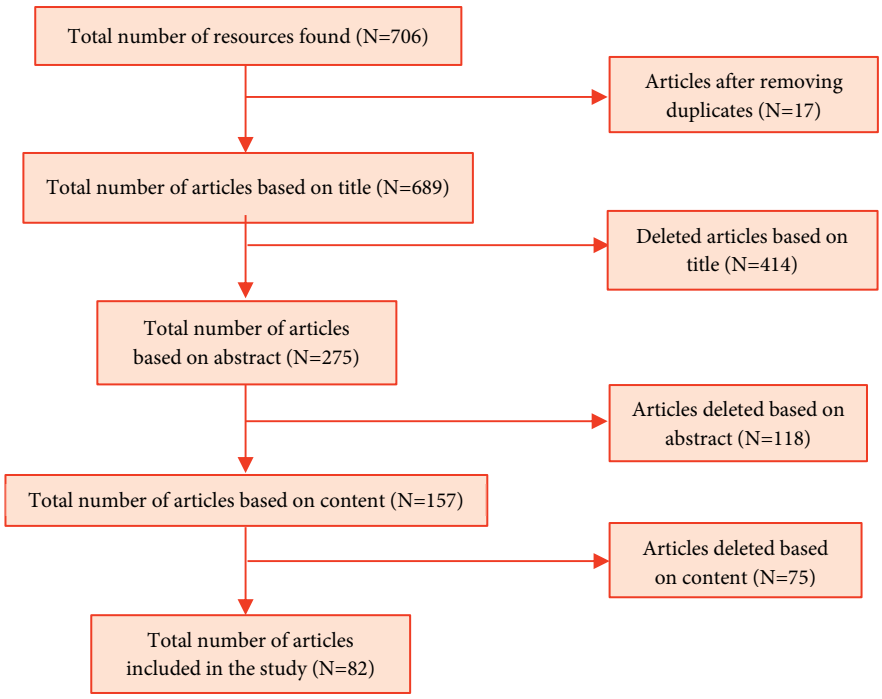

Figure 1. The flowchart illustrates the search strategy

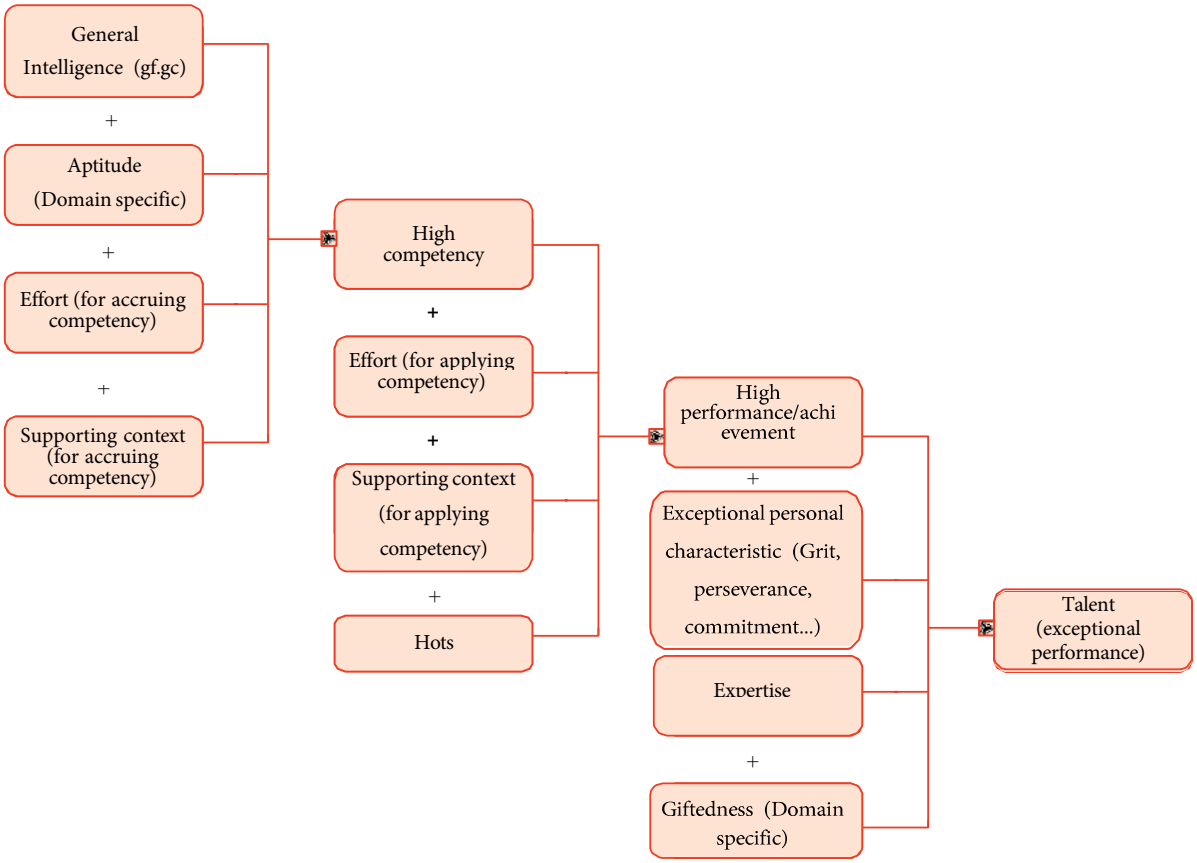

Figure 2. Multi Attribute Talent Model

In the present model Talent encompasses high levels of achievement and performance defined by expertise, giftedness, and individual characteristics (such as grit, perseverance, and commitment) based on acquiring competencies and higher-order thinking based on intelligence and aptitude in a certain dimension

Definition of the Multi-Attribute Talent Model

In the initial stage, the multi-attribute talent model encompasses acquiring high competencies based on general intelligence (fluid and crystallized intelligence) and aptitude in a specific dimension, which can be achieved via effort and the necessary supporting context for acquiring these competencies. In the middle stage, high achievements and performances resulting from the high competencies acquired in the previous stage plus higher-order thinking (productive and critical thinking) and effort and the necessary supporting context for applying competencies are accomplished. In the final stage, these high achievements and performances, combined with expertise, giftedness, and exceptional individual characteristics (such as grit, perseverance, and commitment), can culminate in talent. Some of the above factors, such as higher-order thinking, personality traits, expertise, and grit, are not specific to the middle and final stages, and the individual may have already attained them at a lower level in the previous stage.

Theoretical Definitions in the Multi-Attribute Talent Model

- *General Intelligence*

General intelligence in the multi-attribute talent model involves general mental ability for reasoning, abstract thinking, problems-solving, planning, and learning in various dimensions, which is associated with working memory, mental processing speed, general knowledge, and visual and verbal perception. In other words, general intelligence comprises fluid (non-verbal) and crystallized (verbal) intelligence.

- *Aptitude*

Aptitude refers to an individual's abilities and capacities to acquire knowledge and skills in a specific dimension that are defined under the influence of a context or conditions.

- *Effort*

Effort for Acquiring Competency: It refers to a mental or practical, optional or compulsory, intermittent or continuous activity to achieve something in attaining advancement and acquiring competency.

Effort for Applying Competency: It refers to a mental or practical, optional or compulsory, intermittent or continuous activity to achieve something in attaining

advancement and acquiring competency with doubled effort in applying abilities and skills to attain achievement.

Table 2. Choosing a name for the clusters

	Intelligence
Concepts related to mental high capacity	IQ
	Giftedness
	Smart
	Fluid Intelligence
	Crystallize Intelligence
	Aptitude
	Linguistic Aptitude
	Auditory Aptitude
	Inductive reasoning Aptitude
	Numerical Aptitude
	Physical Aptitude
	Artistic Aptitude
	Analytical Aptitude
	Genius
	Grit
	Effort
	Persistence
Concepts related to exceptional personal characteristics	Commitment
	Creativity
	Motivation
	EI
	Skill
	HOTS
Concepts related to competency	Ability
	Natural ability
	Non intellective ability
	Expertise
	Achievement
Concepts related to the norm of high performance	High Achievement
	Performance
	High Performance

Effort for Applying Competency: It refers to a mental or practical, optional or compulsory, intermittent or continuous activity to achieve something in attaining advancement and acquiring competency with doubled effort in applying abilities and skills to attain achievement.

- *Supportive Context*

Supporting Context for Acquiring Competency: The supporting context for acquiring competency in this model refers to the situation or conditions accompanying particular theoretical, practical, and ethical training, and also nurturing and growth opportunities together with more appropriate facilities (such as more capable teachers, stronger laboratory and infrastructure equipment, etc.), culminating in acquiring competency.

Supporting Context for Applying Competency: The supporting context for applying competency in this model refers to a situation or condition of the acquired competency together with its development and expansion and access to a higher degree of freedom of action, which is focused on a specific field. It also comprises unique training based on the enrichment and acceleration of educational content and training focused on future occupational performance.

- *Competency*

In the multi-attribute talent model, high competency is defined as the ability to engage in an activity involving a set of knowledge related to implicit knowledge and expertise based on experience and cognitive, practical, social, and technical skills, as well as perceptual ability, in the related profession in individuals with general intelligence that possess aptitude in a particular dimension and make efforts to acquire competency according to their supporting context.

- *Higher-Order Thinking Skills (HOTS)*

HOTS are defined as the ability to apply knowledge, skills, and values in creating meaning and reflection in reasoning, thinking, problem-solving, decision-making, innovation, and inducing new things.

- *High Achievement/Performance*

High achievement or performance in this model refers to the individual's best effort within the existing supporting context to acquire high competency by using higher-order thinking (such as productive thinking, critical thinking, and problem-solving).

- *Grit*

Grit includes perseverance, willpower, continuous determination, working hard despite challenges, maintaining effort and interest, and enthusiasm over time despite experiencing failures and tough times.

- *Perseverance*

Perseverance in the multi-attribute talent model refers to a permanent vigor to achieve goals and improve skills and performance via effort, making an individual dedicate herself/himself to an activity in the long run by being purposeful, disciplined, enthusiastic, and interested.

- *Commitment*

Commitment refers to the willingness to focus and invest energy in a specific area or in solving a problem, giving rise to achieving high levels of goals, productivity, and performance.

- *Expertise*

Expertise refers to an acquired ongoing process consisting of acquiring and stabilizing a collection of

specialized knowledge and skills in a field until reaching mastery over time (depending on the available type of field).

- *Giftedness*

Giftedness refers to the salient inherent and mental abilities in one or more particular dimensions that can be elevated under the influence of the environment and learning.

- *Talent*

Talent encompasses high levels of achievement and performance defined by expertise, giftedness, and individual characteristics (such as grit, perseverance, and commitment) based on acquiring competencies and higher-order thinking based on intelligence and aptitude in a certain dimension.

Discussion

According to the researchers' investigations, unfortunately, limited studies have been conducted on talent models involving the following two cases, each of which is explained separately.

The Differential Model of Giftedness and Talent (DMGT)

By presenting the DMGT, Gagné laid the foundation for the education of special systems across the world, from Australia to Canada. In his latest model, Gagné defined giftedness as an inherent and non-acquired phenomenon, with a hereditary structure consisting of the individual's natural abilities, among the top 10% of peers. Moreover, Gagné posits that two types of mental and physical abilities contribute to giftedness. The four mental abilities include intellectual ability (such as general intelligence, fluid intelligence, crystallized intelligence, and verbal, numerical, spatial memory), creativity, social ability, and perceptual ability (such as visual, auditory, olfactory, taste, and tactile). Physical abilities also include muscular abilities (strength, speed, and endurance) and motor control abilities (such as speed of reflexes, balance, and coordination). Furthermore, he described talent as upper-than-average abilities, skills, and performance compared to other individuals that are diverse and are shaped based on considerations and under environmental and educational conditions. From Gagné's perspective, the basic types of talent include academic, technical, scientific and technological, artistic, social services, trade and business, games, and kinetic and athletic talents. Thus, giftedness turns into talent through a development process influenced by individual factors (including motivation, awareness, will, and personality traits), environmental factors (including individuals, society, etc.), and chance (7).

The criticism of Gagné's DMGT model

The criticism raised about Gagné's DMGT is that he has taken concepts such as giftedness and aptitude as synonyms, since he regards giftedness as salient inherent abilities, called talent, which, according to his model, is more indicative of talent than giftedness, while based on existing evidence, these two concepts are entirely independent of each other. Moreover, given this confusion of concepts in his model, he has divided the dimensions of giftedness so that it may be said that he has limited the dimensions to some specific fields.

The second model that was obtained: The Talent Unlimited Model

In this model, Taylor (1986) introduced the multiple talent approach. Accordingly, each individual has a unique brain talent that needs to be nurtured, and the knowledge accumulation capability is only one of the various types of talent. Taylor developed the "totem pole (a timber or stick on which the motifs of the protective animals of various Indian tribes have been engraved) for the multiple talent" in identifying and fostering all human capacities via educational programs. In this pole, he suggests the academic talent and five types of talent, consisting of productive thinking talent, decision-making talent, planning talent, communication talent, and forecasting talent. Accordingly, every individual is considered to have a unique pattern of strengths in one or more fields and a unique growth curve in each field of talent. Thus, the development of the individual's generality by searching for talents and their fostering is profitable for both the individual and the society. He believes that if this approach is employed in education, it will culminate in the success of a large number of students inside and outside the school. Taylor also claims that 9 out of 10 children will be upper than average in at least one of these fields of talent (68).

The criticism of Taylor model

The model developed by Taylor, despite its name, i.e., the talent unlimited model, has categorized talent into specific fields. Also, since he believes that every individual possesses talent, it can be inferred that Taylor has used talent instead of the word aptitude.

Conclusion

In this section, the primary focus has been on examining the concept of talent from a theoretical and profound perspective. It is a concept that was necessary to be dealt with due to the numerous meanings and

concepts hidden in it, and it was essential that the position of numerous and significant concepts, such as intelligence, giftedness, aptitude, and talent, be explained as much as possible. Overall, in the present study intelligence can be known as the general mental ability, and giftedness can be regarded as salient inherent and mental abilities in one or more specific dimensions that bring an innate gift to the mind. On the other hand, aptitude refers to specific abilities, such as artistic, creative, intellectual, or athletic abilities and fosters in certain areas that are valued and rewarded by society and require many practices and efforts in a specific supporting context to acquire a high level of competency and, subsequently, high performance. It is worth noting that exceptional personality traits, such as grit, commitment, perseverance, and endurance, as well as acquisition and acquired stabilization of specialized knowledge and skills in one or more fields permanently over time are particularly important in achieving talent. Finally, based on the available reviews, limited studies were obtained regarding talent models, in which concepts had been used interchangeably, and talent had been assessed limitedly, which we tried to resolve this issue in the current model. Apart from distinguishing between the concepts of giftedness, intelligence, and talent, other related concepts that contribute to talent development, such as acquiring competency and expertise, need to be taken into account in the light of higher-order thinking. Limitations of the present study include of the unavailable to access the full text of some articles related to the research topic was, unfortunately, beyond the control of the researchers. Also, the choice of language of the articles (only English and Persian) also led to the neglect of articles related to other languages.

The present study can help organizations and institutions that deal with talented individuals to have a clearer and more precise definition of the term talent and to be able to make the best select among these people. Also, the present study can help in designing the curriculum of educational institutions at different levels (any type of educational institution, including all schools, especially gifted schools and universities). In addition, it is recommended that researchers in the fields of education and management take advantage of the findings of the synthesis of the present concept, which has led to further clarification of this concept, and design a measurable tool or tools that are effective in policymaking. Also, other researchers in the fields of medical sciences can explore the relative weight of each attribute in the model.

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Table 1. Concepts related to talent in the articles

Sternberg, Robert J, 2006 (12)	F. Lohman D, 2005 (5)	Ulrich, D., & Smallwood, N, 2012 (4)	Williams, M, 2000 (3)	Silzer R. F,Church A.H ,2010 (11)	Gagné, F, 2000 (10)	Gallardo-Gallardo E, Dries N, F. González-Cruz T, 2013 (1)	
							Genius
✓							Creativity
							Innovation
							Expertise
	✓						Persistence
							Grit
							Commitment
							Performance
							Achievement
							Achievement motivation
							Extrinsic motivation
							Intrinsic motivation
							Motivation
							Effort
							competency
							Skill
							Attitude
							Analytical Aptitude
							Artistic Aptitude
							Physical Aptitude
							Numerical Aptitude
							Inductive reasoning Aptitude
							Auditory Aptitude
							Linguistic Aptitude
	✓						Aptitude
							Wisdom
							Smart
							Intellect
							Emotional Intelligence(EI)
							Fixed Mindset
							Growth mindset
							Giftedness
							Intelligent Quotient(IQ)
							Crystallize Intelligence
							Fluid Intelligence
							Intelligence
							Non intellective ability
							Natural ability
				✓	✓		Ability
		✓	✓		✓	✓	Talent

Table 1. Concepts related to talent in the articles (continue)

Bashant J, 2014 (19)	Heckhausen, H, 1967 (18)	Singh K,2011(17)	Glynn S.M, Brickman P, Armstrong N, 2011 (16)	Yin Cheng, Viv and Mo, 2001 (15)	Kesim, M, 2009 (14)	Wang, A. Y, 2011 (13)	
							Genius
				✓	✓	✓	Creativity
							Innovation
							Expertise
							Persistence
✓							Grit
							Commitment
							Performance
			✓				Achievement
	✓	✓					Achievement motivation
		✓	✓				Extrinsic motivation
		✓	✓				Intrinsic motivation
		✓	✓				Motivation
							Effort
							competency
							Skill
			✓				Attitude
							Analytical Aptitude
							Artistic Aptitude
							Physical Aptitude
							Numerical Aptitude
							Inductive reasoning Aptitude
							Auditory Aptitude
							Linguistic Aptitude
							Aptitude
							Wisdom
							Smart
							Intellect
							Emotional Intelligence(EI)
							Fixed Mindset
							Growth mindset
							Giftedness
							Intelligent Quotient(IQ)
							Crystallize Intelligence
							Fluid Intelligence
							Intelligence
							Non intellective ability
							Natural ability
							Ability
							Talent

Table 1. Concepts related to talent in the articles (continue)

Schmid S and X. Bogner F,2015 (26)	Dweck C. S, Chui C, & HongY, 1995 (25)	Oxford University Press, Effort, 2015 (24)	Jeremiah J, 2017 (23)	Goodwin B, B. Miller K, 2013 (22)	Brooks N and Seipel S. J, 2018 (21)	Duckworth A. L, 2016 (20)	
							Genius
							Creativity
							Innovation
							Expertise
							Persistence
			✓	✓	✓	✓	Grit
							Commitment
✓							Performance
✓							Achievement
							Achievement motivation
							Extrinsic motivation
							Intrinsic motivation
✓				✓			Motivation
✓	✓	✓					Effort
							competency
							Skill
							Attitude
							Analytical Aptitude
							Artistic Aptitude
							Physical Aptitude
							Numerical Aptitude
							Inductive reasoning Aptitude
							Auditory Aptitude
							Linguistic Aptitude
							Aptitude
							Wisdom
							Smart
							Intellect
							Emotional Intelligence(EI)
							Fixed Mindset
							Growth mindset
							Giftedness
							Intelligent Quotient(IQ)
							Crystallize Intelligence
							Fluid Intelligence
							Intelligence
							Non intellective ability
							Natural ability
							Ability
✓							Talent

Table 1. Concepts related to talent in the articles (continue)

Genius							
Creativity	✓				✓	✓	
Innovation				✓			
Expertise							
Persistence							✓
Grit							
Commitment	✓						
Performance						✓	✓
Achievement							
Achievement motivation							
Extrinsic motivation							
Intrinsic motivation							
Motivation							
Effort						✓	✓
competency							
Skill						✓	
Attitude							
Analytical Aptitude						✓	
Artistic Aptitude							
Physical Aptitude							
Numerical Aptitude							
Inductive reasoning Aptitude							
Auditory Aptitude							
Linguistic Aptitude							
Aptitude							
Wisdom							
Smart					✓	✓	
Intellect							
Emotional Intelligence(EI)							
Fixed Mindset		✓	✓		✓	✓	
Growth mindset							
Giftedness							
Intelligent Quotient(IQ)	✓						
Crystallize Intelligence							
Fluid Intelligence						✓	✓
Intelligence						✓	✓
Non intellective ability					✓		✓
Natural ability							
Ability							
Talent	✓						✓
	Renzulli, 2000 (6)	Gardner H, 2011 (32)	Kanesan P, Fauzan N,2019 (31)	Taylor SP, 2017 (30)	J. Sternberg R, 2003 (29)	Dasta M, Shokri O, Pakdaman s, Fathabadi j, 2020 (28)	Kent P, 2017 (27)

Table 1. Concepts related to talent in the articles (continue)

McClelland D. C, 1958 (38)	Krause O, 2005 (37)	Neely A, Gregory M, Platts K, 1995 (36)	European Foundation for Quality Management(EFQM), 2003 (35)	Yazdani S, Akbari Farmad S, Farajpour A,2018 (34)	Guy M, Doris S, 2009 (33)	
						Genius
						Creativity
						Innovation
						Expertise
						Persistence
						Grit
						Commitment
	✓	✓	✓	✓	✓	Performance
						Achievement
✓						Achievement motivation
						Extrinsic motivation
						Intrinsic motivation
						Motivation
						Effort
		✓			✓	competency
		✓			✓	Skill
						Attitude
						Analytical Aptitude
						Artistic Aptitude
						Physical Aptitude
						Numerical Aptitude
						Inductive reasoning Aptitude
						Auditory Aptitude
						Linguistic Aptitude
						Aptitude
						Wisdom
						Smart
						Intellect
						Emotional Intelligence(EI)
						Fixed Mindset
						Growth mindset
						Giftedness
						Intelligent Quotient(IQ)
						Crystallize Intelligence
						Fluid Intelligence
						Intelligence
						Non intellective ability
						Natural ability
						Ability
						Talent

Table 1. Concepts related to talent in the articles (continue)

Zhang K, Shi J, Wang F, et al, 2022 (45)	Kaya F, Juntune J, Stough L. 2015 (44)	Vargas-Sánchez A, Plaza-Mejía M.Á, Porras-Bueno N, 2016 (43)	Breivik G, 2016 (42)	T. Linse C, 2006 (41)	Ki Fudyartanta, Psikologi Umum, 2001 (40)	Knapp B, 1963 (39)	
							Genius
							Creativity
							Innovation
							Expertise
							Persistence
							Grit
							Commitment
						✓	Performance
	✓						Achievement
							Achievement motivation
							Extrinsic motivation
							Intrinsic motivation
							Motivation
							Effort
							competency
			✓		✓	✓	Skill
							Attitude
							Analytical Aptitude
							Artistic Aptitude
							Physical Aptitude
							Numerical Aptitude
							Inductive reasoning Aptitude
							Auditory Aptitude
							Linguistic Aptitude
							Aptitude
✓							Wisdom
							Smart
							Intellect
							Emotional Intelligence(EI)
							Fixed Mindset
							Growth mindset
							Giftedness
	✓						Intelligent Quotient(IQ)
							Crystallize Intelligence
	✓						Fluid Intelligence
	✓						Intelligence
	✓						Non intellective ability
							Natural ability
							Ability
				✓		✓	Talent

Table 1. Concepts related to talent in the articles (continue)

Zhang K, Shi J, Wang F, Ferrari M, 2022 (50)	Glynn S.M, Brickman P, Armstrong N, Taasoobshirazi G, 2011(51)	Al-Shabatat AM, 2013 (50)	Gagné F, 2011 (7)	Gagné F, 2007 (49)	Parliament, 2012 (48)	Meyer k. 2021 (47)	Gones W, 2016 (46)	
								Genius
		✓						Creativity
								Innovation
		✓						Expertise
								Persistence
								Grit
								Commitment
		✓	✓			✓		Performance
		✓		✓		✓		Achievement
								Achievement motivation
	✓							Extrinsic motivation
	✓							Intrinsic motivation
	✓	✓		✓				Motivation
								Effort
								competency
		✓		✓				Skill
								Attitude
								Analytical Aptitude
								Artistic Aptitude
								Physical Aptitude
								Numerical Aptitude
								Inductive reasoning Aptitude
								Auditory Aptitude
								Linguistic Aptitude
				✓				Aptitude
✓								Wisdom
							✓	Smart
								Intellect
								Emotional Intelligence(EI)
								Fixed Mindset
								Growth mindset
		✓		✓				Giftedness
		✓	✓	✓				Intelligent Quotient(IQ)
								Crystallize Intelligence
								Fluid Intelligence
		✓						Intelligence
		✓						Non intellective ability
			✓	✓				Natural ability
		✓				✓		Ability
		✓	✓	✓	✓	✓		Talent

Table 1. Concepts related to talent in the articles (continue)

Koukab S.R, Zubia S.A, 2015 (57)	Lynch M, 2022 (56)	Hochanadel A, Finamore D, 2015 (55)	Cochrane A, Simmering V, Green CS, 2019 (54)	Horn J. L,Cattell R. B, 1966 (53)	Boyatzis RE, 2008 (52)	
✓						Genius
✓						Creativity
						Innovation
						Expertise
			✓			Persistence
		✓				Grit
						Commitment
						Performance
✓		✓				Achievement
						Achievement motivation
						Extrinsic motivation
						Intrinsic motivation
						Motivation
✓		✓				Effort
					✓	competency
✓						Skill
						Attitude
	✓					Analytical Aptitude
	✓					Artistic Aptitude
	✓					Physical Aptitude
	✓					Numerical Aptitude
	✓					Inductive reasoning Aptitude
	✓					Auditory Aptitude
	✓					Linguistic Aptitude
						Aptitude
						Wisdom
						Smart
						Intellect
						Emotional Intelligence(EI)
		✓				Fixed Mindset
		✓				Growth mindset
						Giftedness
✓		✓				Intelligent Quotient(IQ)
				✓		Crystallize Intelligence
			✓	✓		Fluid Intelligence
✓		✓				Intelligence
						Non intellective ability
						Natural ability
		✓				Ability
✓						Talent

Table 1. Concepts related to talent in the articles (continue)

	Genius	Creativity	Innovation	Expertise	Persistence	Grit	Commitment	Performance	Achievement	Achievement motivation	Extrinsic motivation	Intrinsic motivation	Motivation	Effort	competency	Skill	Attitude	Analytical Aptitude	Artistic Aptitude	Physical Aptitude	Numerical Aptitude	Inductive reasoning Aptitude	Auditory Aptitude	Linguistic Aptitude	Aptitude	Wisdom	Smart	Intellect	Emotional Intelligence(EI)	Fixed Mindset	Growth mindset	Giftedness	Intelligent Quotient(IQ)	Crystallize Intelligence	Fluid Intelligence	Intelligence	Non intellective ability	Natural ability	Ability	Talent
Boume L.E, Kole J.A, Healy AF, 2014 (58)				✓				✓																															✓	
Britannica, 2022 (59)																																	✓							
Perlovs ky L.I, 2001 (60)																												✓												
Becker H.S. 1960 (61)							✓																																	
Nurhidayah, 2017 (62)																																							✓	
Schumpeter, J.A, 1934 (63)			✓																																					
OECD/Eurostat, 2005 (64)			✓																																					

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		✓																																					National Audit Office (NAO), 2009 (65)
		✓																																					Confederation of British Industry (CBI), 2008 (66)
		✓																																					NESTA, 2012 (67)

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Review Article

Artificial Intelligence in Personalized Medical Education: A Systematic Review of Applications, Benefits, and Challenges

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Abstract

Background: Medical education, due to its increasing complexity, requires innovative and effective approaches, with artificial intelligence (AI) emerging as a leading tool. AI facilitates the personalisation of learning by adapting educational processes to individual student needs.

Objectives: This study aims to systematically examine the role of artificial intelligence in personalising medical education by identifying its main applications, pedagogical benefits, and implementation challenges, and by proposing evidence-based recommendations for optimising AI-driven instructional strategies.

Methods: A systematic review was conducted by searching five major databases PubMed, Scopus, IEEE, Web of Science, and Google Scholar up to March 2025. Relevant keywords included "artificial intelligence," "personalized learning," "adaptive learning," "machine learning," "deep learning," "natural language processing," and "medical education." In total, 70 articles were initially identified, and after screening and applying inclusion and exclusion criteria, 32 studies focusing on the application of artificial intelligence in medical education were selected for analysis.

Results: Findings indicated that AI enhances learning quality through personalized feedback, adaptive learning pathways, and interactive educational simulations. AI can also assess students' strengths and weaknesses, recommend appropriate educational resources, and promote self-directed learning. However, challenges such as implementation costs, data security concerns, and user resistance to adopting new technologies were identified as major barriers.

Conclusion: AI holds significant potential for enhancing the quality of medical education and personalizing the learning experience. To fully harness this technology, it is crucial to address existing challenges and develop human-AI hybrid models. Future research should focus on improving technical infrastructure and increasing user acceptance.

Keywords: Personalized Learning; Machine Learning; Artificial Intelligence; Education; Medical

Background

Medical education, as a complex and dynamic process, faces challenges such as the vast volume of educational content, substantial individual differences among students, and escalating expectations for improved learning quality (1). Traditional models of medical education, which primarily rely on uniform and group-based methods, are often limited in addressing the diverse and personalized needs of learners (2). These shortcomings have drawn increasing attention to the development of personalized learning approaches, which leverage data analysis and the identification of

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individual characteristics and needs to adapt content and learning processes to each learner's unique circumstances (3).

The integration of artificial intelligence (AI) into medical education has garnered widespread interest from researchers and policymakers in recent years, owing to its capabilities in machine learning, big data analytics, and intelligent content generation (1, 4). This technology enables the design of adaptive learning environments, assessment of educational progress, and provision of immediate feedback, thereby rendering learning experiences more dynamic and precise (5). However, a critical review of the literature reveals that many prior studies have either focused on general education or merely described AI applications in medical education, without comprehensive and systematic evaluations of this technology's impact on learning quality and clinical competencies (1, 3). These studies are often confined to specific tools or small populations, with limited attention to implementation challenges, ethical considerations, data security, or algorithmic biases (6).

Furthermore, many of these investigations are outdated in methodology or timing, emphasizing the introduction of applications rather than assessments of real-world effectiveness on a large scale (7). One prominent gap in the literature is the scarcity of comprehensive reviews on AI's role in continuing medical education (CME) and domains beyond initial academic training (8). These gaps, particularly in the analysis of personalized quality and educational outcomes within clinical settings and healthcare systems across different countries, have largely been overlooked (7). Such deficiencies underscore the need for empirical and systematic evidence on AI's benefits, limitations, and challenges in medical education (9).

This study aims to address the research question: What roles, benefits, and challenges does AI have in personalized medical education, and what research gaps exist in this field? Through a systematic review and critical analysis of existing studies, it examines AI applications across various levels of medical education, including CME, while focusing on benefits and implementation barriers. This research contributes to a deeper understanding of the technology's potential and limitations, laying the groundwork for evidence-based policymaking and enhancements in educational infrastructure.

Objectives

This study aims to systematically examine the role of artificial intelligence in personalising medical education by identifying its main applications, pedagogical benefits, and implementation challenges, and by proposing evidence-based recommendations for optimising AI-driven instructional strategies.

Methods

This systematic review was conducted to identify, evaluate, and synthesize evidence on the applications, benefits, and challenges of artificial intelligence in personalized medical education. The study was designed and reported in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines (10), ensuring transparency and reproducibility.

Systematic Literature Search: A comprehensive literature search without geographical restrictions was conducted up to March 2025 across four primary databases PubMed (for biomedical and health sciences coverage), Scopus (for interdisciplinary education and technology indexing), IEEE Xplore (for AI and engineering advancements), and Web of Science (for high-impact peer-reviewed publications) selected for their complementary strengths in capturing the multidisciplinary nature of AI in medical education, ensuring depth, quality, and minimal overlap. Google Scholar was used as a supplementary tool to identify additional articles and gray literature not indexed elsewhere, with the search limited to these five resources to prioritize efficiency, reproducibility, and practical constraints such as time and access, as preliminary scoping indicated sufficient coverage without needing further databases like EMBASE or ERIC Keywords including:

"Artificial Intelligence," "Personalized Learning," "Medical Education," "Health Sciences Education," "Adaptive Learning," "Individualized Learning," "Machine Learning," "Deep Learning," "Neural Networks," And "Natural Language Processing."

These keywords were combined using Boolean operators as follows:

("Artificial Intelligence" OR "Deep Learning" OR "Neural Networks" OR "Natural Language Processing") AND ("Personalized Learning" OR "Individualized Learning" OR "Adaptive Learning" OR "Personalized Education") AND ("Medical Education" OR "Health Sciences Education")

Given the rapid evolution of artificial intelligence in medical education, the search was limited to studies published from 2010 onwards. After removing duplicates, a total of 70 articles were identified.

Inclusion and Exclusion Criteria

Studies were included if they:

Addressed the direct or indirect application of artificial intelligence (including machine learning, deep learning, neural networks, or natural language processing) in medical or health sciences education.

Covered any stage of medical education (undergraduate, postgraduate, specialist training, or continuing medical education).

Were published as full-text articles in English or Persian and were accessible.

The following studies were excluded:

Articles primarily focused outside the field of medical education (n = 8).

Purely descriptive or cross-sectional studies without a clear emphasis on artificial intelligence or those with only superficial references to it (n = 5).

Letters to the editor, conference abstracts without full text, editorials, and commentaries.

Studies published in languages other than English or Persian, or those without accessible full text.

As illustrated in Figure 1, the inclusion and exclusion process are depicted step-by-step, showing the identification, screening, eligibility assessment, and final selection of 32 studies.

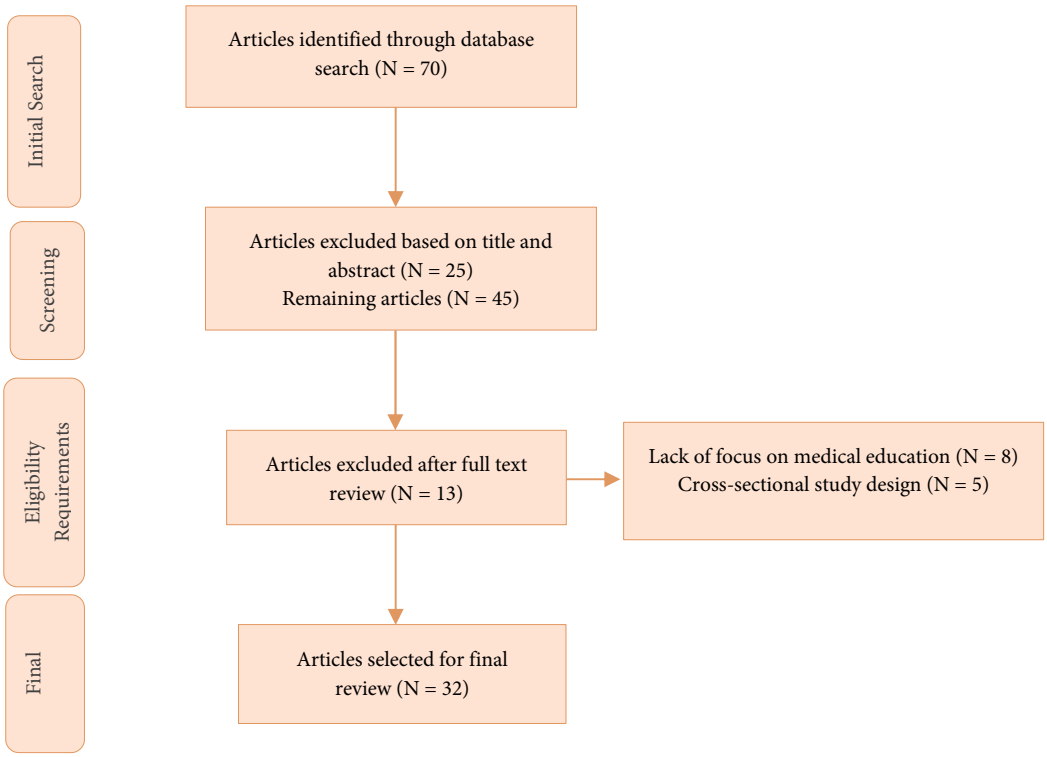

Figure 1. Study Stages Diagram

Screening and Study Selection: Initially, two independent reviewers screened the titles and abstracts based on the inclusion and exclusion criteria. In cases of uncertainty, full-text reviews were conducted to determine eligibility. Discrepancies were resolved through discussion and consensus. Ultimately, 32 articles were included in the final analysis.

Data Extraction and Analysis: The data extraction process was conducted using a standardized form by two independent reviewers to ensure the comprehensiveness and impartiality of data collection. For each included article, essential information was extracted, including the author(s) and year of publication, study design, type of artificial intelligence application, educational outcomes (such as learning improvement, increased engagement, or enhanced self-regulation), and any reported challenges or limitations.

To enhance transparency, any discrepancies between reviewers were discussed in joint meetings until consensus was reached.

Data Analysis: A thematic content analysis approach was employed to analyze the extracted data. The process entailed the following steps:

- First, the key findings of each article were coded into concise statements or phrases;
- Next, similar and related codes were grouped into major themes (such as "Personalized Feedback," "Adaptive Assessment," "Data Security Challenges," etc.);

- Finally, each major theme was organized and interpreted based on the commonalities or differences observed across the reviewed studies.

Application and Outcomes of the AMSTAR and CASP Tools

a) Quality Assessment of Systematic Reviews (AMSTAR): The AMSTAR tool, comprising 11 key criteria including clarity of the research question, comprehensiveness of the search, identification of gray literature, appraisal of primary study quality, methods for data synthesis, and assessment of publication bias—was applied. In this study, each systematic review was independently scored by two reviewers for all AMSTAR items, with possible responses being "Yes," "No," "Can't Answer," or "Not Applicable." Studies scoring above 7 out of 11 were considered high quality; the most common weaknesses were a lack of transparency in study selection and inadequate assessment of publication bias.

b) Quality Assessment of Quantitative Studies (CASP): The CASP checklist for quantitative studies covers issues such as clarity of the research question, appropriateness of methodology, adequacy of sample size, consideration of selection bias, control of confounding variables, transparency of statistical analysis, and comprehensive reporting of results. Each domain was rated as "Yes," "No," or "Partially." The majority of quantitative studies received a score above 7 out of 10, with the main weaknesses noted in reporting of selection bias and limited explanation of findings.

c) Quality Assessment of Qualitative Studies (CASP Qualitative): For qualitative studies, the CASP Qualitative checklist assessed aspects such as clarity of the research aim, adequacy of data analysis, credibility of findings, and inclusion of trustworthiness criteria (e.g., confirmability and transferability). Most qualitative studies achieved acceptable scores, although some demonstrated weaknesses in providing analytic detail or justifying the credibility of their findings.

Discrepancy Resolution Procedure: In cases where there were inconsistencies in the quality scores assigned by the two reviewers, disagreements were resolved through discussion and, if necessary, consultation with a third researcher in order to maximize objectivity and accuracy. The results of the quality and risk of bias assessments were directly integrated into the synthesis and interpretation of the systematic review findings.

Data Extraction: Data from the selected studies were systematically extracted based on predefined inclusion criteria.

The extracted variables included (1) the author and publication year, (2) the key concept or focus of each study, (3) the specific AI applications used, and (4) the main research findings, including any reported implementation challenges. These data collectively informed the thematic synthesis of AI applications in personalized medical education and are summarized in Table 1.

Results

A total of 32 articles were reviewed, covering an approximate ten-year period (2015–2025). As illustrated in Figure 2, the majority of publications appeared in recent years (2023–2025), reflecting a gradual increase in research interest toward the application of artificial intelligence and personalized learning in medical education. This trend appears to be driven by factors such as technological advancements, the acceleration of digital education during the COVID-19 pandemic, and a global shift toward personalized approaches in teaching and learning.

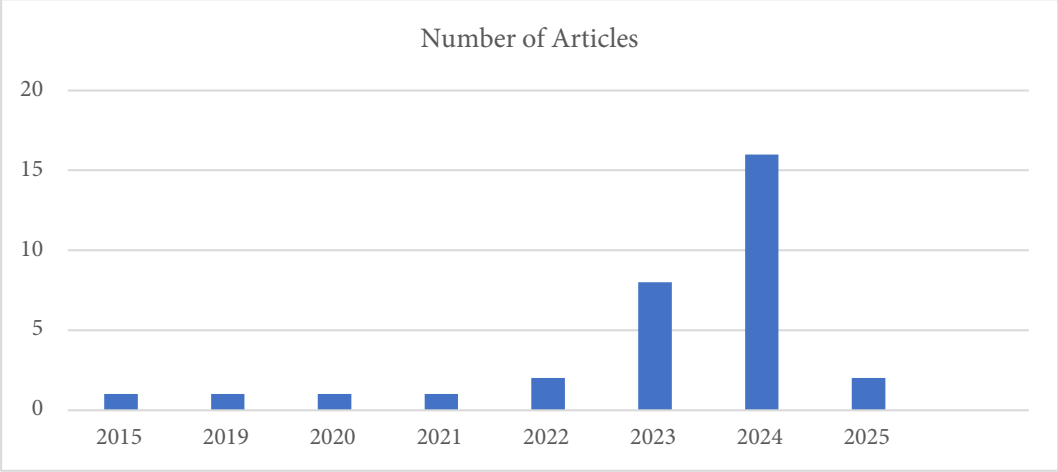

Figure 2. Annual Distribution of Included Articles

However, while the quantitative growth of studies in recent years is evident, this temporal concentration introduces certain limitations in interpreting the results of the systematic review. Notably, many of the recent articles are primarily focused on preliminary investigations, short-term interventions, or pilot implementations of AI tools, with limited evidence available on their long-term effectiveness or sustained impact in real-world educational environments. Therefore, when considering the progression of research in this field, it is essential to assess not only the contextual drivers but also the quality and depth of evaluation in these studies, and to identify gaps in comprehensive or longitudinal investigations.

The geographical distribution of the reviewed articles reflects a broad global interest in AI-driven personalized learning within medical education. As depicted in Figure 3, approximately half of the studies were conducted in Asian countries—including China and India highlighting the region's leading role in developing and applying AI innovations in medical education. The Americas (23.5%) and Europe (20.6%) each contributed a substantial share of the literature, underscoring significant engagement in these regions as well. The "Others" category, comprising countries in Oceania and Africa (5.8%), although smaller in proportion, indicates a growing interest in this field.

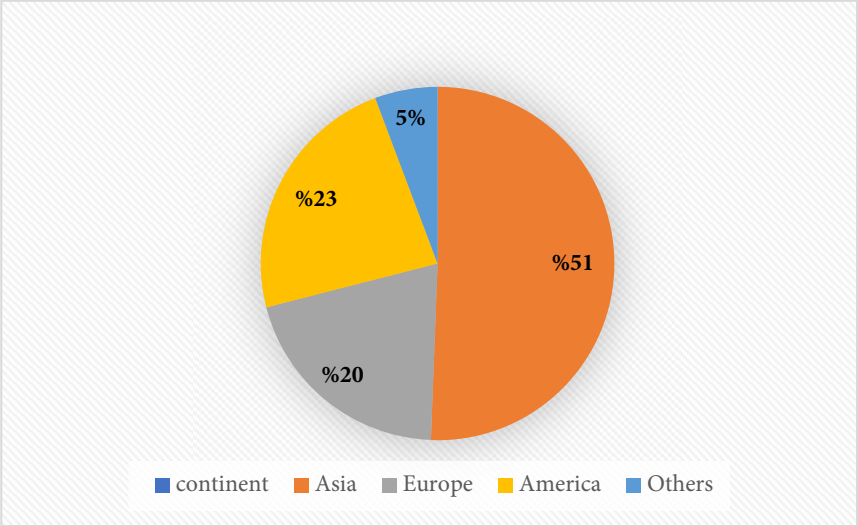

Figure 3. Geographical Origins of Included Studies

The predominance of publications from Asia, along with meaningful contributions from Europe and the Americas, may reflect differences in technological infrastructure, resource availability, and research capacity across regions, which could influence both the generalizability of findings and the extent of practical adoption.

Applications of Artificial Intelligence in Personalized Medical Education

Findings from the reviewed studies, as presented in Table 2, indicate that the applications of artificial intelligence (AI) in personalized medical education can be categorized into nine conceptual domains, including adaptive learning, assessment, self-regulated learning, and decision-support systems. Among these, adaptive learning pathways, real-time feedback, and personalized assessments were the most frequently reported applications, as highlighted in studies such as Johnson and Lee (2022), Deng et al. (2024), and Triola et al. (2023).

These findings can be meaningfully interpreted through the lens of the Self-Regulated Learning (SRL) theory, which emphasizes core processes such as goal-setting, self-monitoring, and metacognitive feedback. Within this framework, AI-enabled tools—such as adaptive instructional sequences, intelligent feedback systems, and personalized assessments—are considered mechanisms that promote learner autonomy and motivation by facilitating dynamic, self-directed learning processes (42, 43).

However, several recurring challenges were noted, including inconsistent feedback quality, infrastructural limitations, and misalignment with traditional assessment frameworks. Therefore, successful implementation of AI in medical education requires alignment with pedagogical theories, access to high-quality data, and dynamic interaction between human educators and intelligent systems.

The Role of Artificial Intelligence in Transforming Medical Curricula for Personalized Education

Among the studies reviewed, only four explicitly addressed the role of artificial intelligence (AI) in transforming medical curricula for personalized education. Although limited in number, these studies highlight AI's potential to design dynamic learning pathways tailored to individual student characteristics. However, the effective realization of this potential requires integration with human pedagogical expertise.

Table 2. The Role of Artificial Intelligence in Personalized Learning

Thematic Domain	Specific Application	Description and Educational Role	Challenges/Limitations	Reference(s)
Adaptive Learning	Personalized Learning Pathways	Customizing educational content based on individual learning style, pace, and needs.	Requires complex, data-driven adaptive algorithms.	Almansour et al. (2024), Ruberto et al. (2021), Sanati et al. (2024), Deng et al. (2024), Gupta et al. (2020)
Performance Analytics	Real-time Feedback & Performance Analysis	Immediate feedback based on student performance to support adaptive instruction.	Quality may vary; difficulty detecting conceptual misunderstandings.	Rabie et al. (2023), Sriram et al. (2025), Domrös et al. (2024)
Resource Recommendation	Targeted Content Suggestions	AI-powered recommendation of articles, videos, and materials tailored to progress.	Risk of redundancy or misaligned resources.	Halkiopoulos et al. (2024), Xu et al. (2024) kiopoulos et al. (2024)
Behavioral & Cognitive Analysis	Learning Interaction Tracking	Monitoring engagement patterns to optimize instructional design.	Requires advanced behavior analytics and interpretation.	Bhutoria et al. (2022), Saxena et al. (2023)
Decision Support	Learner Guidance Systems	Assisting students in selecting next steps or learning goals based on data.	Recommendations can be mechanical and context-insensitive.	Almansour et al. (2024), Sanati et al. (2024), Sajja et al. (2024)
Learning Gap Detection	Strengths & Weaknesses Identification	Detecting content areas where students need reinforcement.	Potential inaccuracy when data is incomplete or biased.	Thompson et al. (2025), Naseer et al. (2024)
Self-Regulated Learning	Independent Learning Support	Guiding learners to manage their own educational goals and processes.	Limited motivation and interaction in fully automated systems.	Denny et al. (2015), Murtaza et al. (2022)
AI-Driven Assessment	Personalized Testing	Generating quizzes aligned with students' progress and needs.	Infrastructural barriers in traditional, paper-based testing environments.	Santhosh et al. (2024), Sajja et al. (2024)
Experiential Simulation	AI-Based Clinical Simulations	Simulating clinical scenarios using AI and VR to build practical skills.	Costly infrastructure; challenges in real-world skill transfer.	Ruberto et al. (2021), Chowdhury et al. (2024), Castellano et al. (2024)

Table 3 presents an analytical comparison of the complementary roles of human educators and AI systems across five key dimensions: emotional interaction, curriculum development, feedback mechanisms, learning focus, and decision support. The findings indicate that AI demonstrates strong capabilities in data analysis and real-time feedback delivery, but it remains irreplaceable in domains requiring empathy, ethical judgment, and human-centered communication.

Studies such as those by Deng et al. (2024) and Triola et al. (2023) emphasize that a hybrid model combining human and AI strengths produces the most effective outcomes in medical education. Nonetheless, challenges such as algorithmic transparency, faculty readiness, and alignment with traditional curricula continue to hinder the full implementation of such an approach.

Current Applications of Artificial Intelligence in Medical Education

Review of the studies indicates that a majority of articles (20 out of 32) focus on the application of

artificial intelligence (AI) in learning and knowledge development. One of the primary motivations for integrating AI in this domain is its capacity to deliver immediate and targeted feedback to students, which plays a crucial role in identifying knowledge gaps and enhancing academic performance. However, the quality of AI-generated feedback remains inconsistent, as it often depends on predefined models and limited data sources.

Table 3. Comparative Roles of Human and AI Educators in Personalized Medical Education

Role	Human Educator	AI Educator	Studies
Emotional Interaction	Provides empathy, value-driven guidance	Focuses on analytical and adaptive feedback	Deng et al. (2024), Ruberto et al. (2021)
Curriculum Development	Designs flexible, student-focused curricula	Tailors learning paths based on detailed data analysis	Almansour et al. (2024), Ezzaim et al. (2023)
Feedback Mechanism	Offers qualitative, experience-based feedback	Provides instant, precise, and data-driven feedback	Rabie et al. (2023), Domrös et al. (2024)
Learning Focus	Prioritizes broader educational objectives and mentoring	Optimizes micro-learning and personalization	Triola et al. (2023), Saxena et al. (2023)
Decision Support	Supports nuanced, context-driven decisions in learning	Provides algorithm-based, data-driven suggestions for improvement	Almansour et al. (2024), Sajja et al. (2024)

Furthermore, AI applications are predominantly concentrated in undergraduate medical education, with considerably fewer implementations in continuing medical education (CME), residency programs, or fellowship training. This disparity is largely attributed to the lack of structured curricula in professional training and the inherent challenges in providing context-specific content for AI algorithms.

In the domain of assessment and evaluation, only 4 out of 32 reviewed articles explicitly address the use of AI. The primary barrier to wider adoption in this area is the insufficient digital infrastructure for examination processes, as many assessments in medical education are still conducted offline using paper-based formats (Table 4).

Table 4. Overview of current applications of artificial intelligence in medical education identified

Focus and Advantages of Use	Supporting Studies	Key Findings
Curriculum		
Comprehensive Curriculum Analysis	Deng et al. (2024); Triola et al. (2023); Ruberto et al. (2021); Ezzaim et al. (2023)	Improved curriculum alignment, integration of competencies, early risk detection, and gap identification.
Learning		
Customization of Content to Individual Needs	Rabie et al. (2023); Deng et al. (2024); Ahmed et al. (2023); Almansour et al. (2024); Ezzaim et al. (2023); Triola et al. (2023)	Adaptive content tailoring, personalized pathways, targeted feedback, and topic relevance improvement.
Development of Adaptive Simulation Environments	Ruberto et al. (2021); Deng et al. (2024); Triola et al. (2023); Ahmed et al. (2023); Chowdhury et al. (2024)	Real-time case adjustments, enriched scenario diversity, and improved interactive learning.
Patient Safety	Saxena et al. (2023); Deng et al. (2024); Triola et al. (2023)	Better diagnostic accuracy, reduced errors via multilingual support, and early identification of high-risk situations.
Reduced Need for Direct Faculty Supervision	Ruberto et al. (2021); Ahmed et al. (2023); Saxena et al. (2023)	Lower instructor workload through automated feedback, content generation, and translation support.
Evaluation		
Adaptive Feedback Systems	Rabie et al. (2023); Murtaza et al. (2022); Sajja et al. (2024); Domrös et al. (2024)	Personalized, targeted, and real-time feedback improving engagement and self-reflection.
Feedback Quality Enhancement	Ruberto et al. (2021); Saxena et al. (2023); Deng et al. (2024)	Increased clarity, precision, and speed of feedback
Cost Reduction	Ahmed et al. (2023); Deng et al. (2024); Ruberto et al. (2021); Saxena et al. (2023)	Savings from automated content, reusable simulations, and reduced translation/training costs.

Challenges of Implementing AI in Personalized Medical Education

Despite the high potential of artificial intelligence (AI) to enhance learning processes in personalized medical education, research findings reveal that its implementation is challenged by multiple, complex barriers. These challenges are not limited to technical issues or financial costs; they also encompass concerns related to algorithmic stability, data bias, decision-making transparency, human-machine interaction, and trust in AI technologies.

For instance, technical limitations go beyond the need for advanced infrastructure; they include the inability of algorithms to accommodate diverse learning styles and the difficulty in modeling learner behaviors over time.

Similarly, data security is not merely a regulatory concern—it directly influences students' trust in AI-based systems and their willingness to engage with them in educational settings.

Moreover, the use of incomplete or biased data can result in inaccurate feedback and misdirected learning, particularly in contexts involving adaptive testing models. Without transparent mechanisms for data quality control, the educational credibility of such systems may be significantly undermined.

Another critical issue is resistance to emerging technologies, which can stem from user unfamiliarity, previous negative experiences, or broader cultural hesitancies toward digital innovation. In this regard, instructors play a pivotal role in fostering a culture of acceptance and guiding the effective integration of AI tools into learning environments.

Finally, the absence of robust theoretical frameworks presents a major barrier to the systematic design and evaluation of intelligent educational systems. Without models such as the Unified Theory of Acceptance and Use of Technology (UTAUT) (44) or self-regulated learning frameworks (42), the implementation of AI risks remaining superficial and disconnected from deeper pedagogical principles(Table 5).

Table 5. Challenges of Using Artificial Intelligence in Personalized Learning

Key Aspect	Definition	Supporting Studies
Technical Challenges	Implementation of AI-based personalized systems demands significant financial investment, technical infrastructure, and interdisciplinary expertise.	Ruberto et al. (2021); Triola et al. (2023); Ezzaim et al. (2023)
Security and Privacy	Protecting personal data and ensuring compliance with privacy regulations are essential to building trust in AI-driven systems.	Alsharif et al. (2022); Deng et al. (2024)
Incomplete or Inaccurate Data	Low-quality data, poor generalizations, or biased training sets may result in ineffective learning recommendations.	Rabie et al. (2023); Ahmed et al. (2023)
Resistance to Emerging Technologies	User skepticism, lack of familiarity, and low digital literacy may hinder the adoption of AI-based tools in education.	Johnson & Lee (2022); Saxena et al. (2023)
Risks in AI-Based Assessment	Errors in adaptive testing systems or flawed feedback mechanisms may negatively affect student performance.	Chen et al. (2022); Triola et al. (2023)
Diversity in Learning Styles	AI systems struggle to account for varied and evolving learning styles, requiring continuous model refinement.	Deng et al. (2024); Ahmed et al. (2023)

Discussion

The findings of this systematic review indicate that artificial intelligence (AI), as an emerging approach in medical education, has attracted increasing attention, particularly in the context of facilitating personalized learning. However, critical appraisal of the existing literature demonstrates that the outcomes and effectiveness of AI in this domain are significantly influenced by several variables, including implementation conditions, educational structures, and learner-specific factors. Accordingly, it is not feasible to assume uniform or definitive effectiveness of AI across all educational contexts.

For example, although AI is frequently depicted as a neutral and efficient tool in the literature, empirical evidence challenges this assumption. The study by Kung et al. (2023) found that while automated feedback systems may hold promise for clinical training, they often lack the nuanced understanding required for complex clinical decision-making, and in some cases, may even foster ineffective or misguided learning strategies (45). This finding contrasts with optimistic perspectives that portray AI as inherently flawless and precise, and highlights the necessity for qualitative evaluation of AI feedback and its alignment with real-world educational contexts.

Similarly, the study by Georgieva et al. (2023) confirmed the added value of AI-based simulations in strengthening students' procedural confidence but revealed a critical limitation: such systems, contrary to

expectations, are less effective in developing essential "soft skills" such as effective communication and ethical judgment (46). This not only exposes the weaknesses of current AI systems but also underscores the tension between technical capabilities (e.g., rapid, data-driven feedback) and human-centered educational imperatives (such as interpersonal and ethical competencies). As such, the exclusive reliance on intelligent tools is insufficient for comprehensively enhancing clinical competencies compared to traditional or blended educational approaches.

Despite the considerable potential of AI for content personalization and resource recommendation, the relative inability of AI systems to accurately interpret nuanced individual learner differences remains a challenge. Sarkar et al. (2024) demonstrated that learners with lower levels of digital literacy received less adaptive or personalized content recommendations (47); this contradicts claims that AI inherently promotes educational equity and suggests that without consideration for learners' individual prerequisites, pre-existing inequalities may even be exacerbated.

With respect to user-related barriers, contrary to the prevailing notion that resistance is merely a psychological issue or solely the result of insufficient training, a more nuanced analysis by Ali (2022) indicates that AI acceptance is shaped by a complex interplay of digital literacy, institutional trust, and perceived usefulness of the technology (9). Therefore, in contrast to research that frames technical training as sufficient for user acceptance, Ali's findings emphasize the necessity of structural, institutional, and multi-dimensional approaches to address resistance to AI adoption.

Another notable gap identified in the literature—also highlighted in this review—is the predominant focus of most studies on undergraduate medical education, with less attention paid to the role of AI in specialized and continuing education. While most research centers on general medical students, Charow et al. (2021), as a key exception, illustrate the potential of AI in advancing professional development for healthcare providers, emphasizing that realizing this potential depends on identifying and addressing fundamental infrastructural and cultural barrier (7).This perspective is notably distinct from the majority of studies, which either overlook these aspects or focus solely on technical obstacles.

Finally, the lack of robust theoretical and conceptual frameworks, such as Self-Regulated Learning (SRL) models or the Unified Theory of Acceptance and Use of Technology (UTAUT), stands out as a significant barrier to the systematic development and evaluation of AI interventions. As demonstrated by Chun et al. (2022), interventions grounded in theoretical frameworks are more effective in promoting learner autonomy and reflective learning (42). This stands in contrast to studies lacking such frameworks, which often yield less generalizable or less impactful results.

Overall, while the current literature highlights the high potential of AI in medical education, comparative and critical analysis indicates that successful implementation and realization of its benefits depend on learner-centered design, the quality of training data, intelligent integration with human educators, and the establishment of explicit theoretical foundations.

This study is subject to several limitations. First, the scope of the literature search and access to resources was limited; although comprehensive searches were conducted across four major databases, the exclusion of some sources and the lack of access to the full text of certain articles may have resulted in the omission of potentially relevant evidence. Second, conceptual and definitional heterogeneity among the included studies complicated direct comparison and generalizability of findings. Third, while quality assessments and risk of bias evaluations were executed independently and rigorously, the complete elimination of publication or selection bias cannot be guaranteed. Finally, most of the studies included in this review focused on short-term interventions or academic settings, with insufficient evidence available from real-world or long-term educational contexts.

Conclusion

Artificial intelligence holds considerable potential to improve the quality and personalization of medical education, yet challenges related to ethics, costs, and access continue to limit its comprehensive implementation. The results of this review underscore that optimal use of AI requires attention to evidence-based policies, adequate infrastructure, and frameworks that address algorithmic bias and educational equity.

In line with the findings and limitations of this study, it is suggested that future research focus on:

- Longitudinal evaluations of AI's impact in practical, real-world medical education settings;
- The development and validation of context-appropriate theoretical models for analyzing AI integration in diverse educational environments;
- Examination of strategies that may reduce digital inequities and expand access to AI-based learning tools;
- Further investigation of ethical aspects, including privacy and algorithm transparency;

- Comprehensive assessment of user experience and acceptance among students and educators, with consideration for cultural and institutional differences.

Such research directions may contribute to a more responsible and effective use of AI in medical education.

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Table 1. Summary of Included Studies on AI Applications in Personalized Medical Education

Author and Year	Title	Key Concept of Research	Applications Used	Research Results
Rabie et al. (2023) (11)	The Role of Artificial Intelligence and Personalized Education in Medical Curriculum	Feedback	AI-based performance monitoring	Improved clinical feedback and learner awareness; noted low-quality feedback and inconsistent implementation.
Sriram et al. (2025) (12)	Artificial Intelligence in Medical Education: Transforming Learning, Personalized Training, and Assessment	Real-time Feedback	Immediate assessment support	Enhanced learner engagement; no specific limitations mentioned.
Almansour et al. (2024) (13)	Generative Artificial Intelligence and the Personalization of Health Professional Education	Adaptive Learning; Personalized learning paths	Generative AI for customized content creation; adaptive learning algorithms; AI-based learner guidance systems	Increased retention, autonomy, and learner motivation; improved access to educational resources; challenges include high infrastructure cost, data privacy concerns, algorithmic bias risk, content validation issues, and faculty training needs
Santhosh et al (2024) (14)	Integration of Machine Learning and Deep Learning in Medical and Healthcare Education	Assessment	Simulation and decision-making support	Improved diagnostic accuracy, enhanced clinical decision-making skills; adoption inconsistent across institutions; challenges include infrastructure variability and faculty expertise gaps.
Ezzaim et al. (2023) (15)	AI-Based Learning Style Detection in Adaptive Learning Systems	AI-driven automatic learning style detection	Application of Decision Trees and Artificial Neural Networks for learning style detection (Felder–Silverman model)	Improved learning adaptation; prevalent Felder–Silverman model; challenges with learner self-awareness and traditional methods
Ruberto et al. (2021) (16)	The future of simulation-based medical education: Adaptive simulation utilizing a deep multitask neural network	Adaptive AI-driven simulation with real-time virtual patient adjustments	Virtual patient models	Enhanced experiential learning; high cost and technical limitations reported.
Denny et al (2015) (17)	Using Natural Language Processing to Provide Personalized Learning Opportunities	AI-powered self-regulated learning	NLP tools to analyze trainee clinical notes and identify competencies & learning gaps	Supported self-directed study; high accuracy in competency detection; learner engagement and motivation varied
Halkiopoulos et al. (2024) (18)	Leveraging AI in e-learning: Personalized learning and adaptive assessment through cognitive neuropsychology—A systematic analysis	Recommendation	Educational content matching system adapting learning materials to learner's cognitive level	Matched learners' levels; redundancy and misalignment occasionally noted.
Bhutoria et al(2022) (19)	Personalized Education and Artificial Intelligence in the United States, China, and India: A Systematic Review Using a Human-in-the-Loop Model	Analytics	Behavioral tracking	Improved time management; data interpretation complexity noted.

Author and Year	Title	Key Concept of Research	Applications Used	Research Results
Sanati et al. (2024) (20)	Developing an AI-Based Platform for Personalized Learning in Neurology Education for Medical Students	Clinical Reasoning	AI-assisted diagnostic support in neurology	Improved diagnostic accuracy and speed; highlighted need for standardized, high-quality neurological data.
Triola et al. (2023) (21)	Precision Medical Education	Ethics & Data-Driven Personalization	Longitudinal learning analytics and AI-assisted monitoring for equity, transparency, and ethical compliance	Defined PME framework; highlighted need for robust ethical guidelines, data governance, and institutional policy development
Duong et al. (2019) (22)	Artificial intelligence for precision education in radiology. The British journal of radiology	Vision & AI-Enhanced Learning	AI-driven adaptive learning systems for radiology training, image analysis, and personalized feedback	Potential to personalize radiology education; highlighted need for high-quality, accessible datasets; discussed challenges in AI implementation and trainee buy-in.
Rane et al. (2023) (23)	Education 4.0 and 5.0: Integrating artificial intelligence (AI) for personalized and adaptive learning	Customization	Topic-based AI personalization, adaptive learning pathways, and real-time feedback tools	Improved learning personalization and balanced workload; noted requirements for robust infrastructure, teacher readiness, and quality training datasets.
Thompson et al. (2025) (24)	Artificial Intelligence Use in Medical Education: Best Practices and Future Directions	Best practices	AI in exam prep, surgical training feedback, and academic writing support	Enhanced access and personalization; highlighted ethical risks and need for regulation.
Deng et al. (2024) (25)	Strategies for Optimizing Personalized Learning Pathways with Artificial Intelligence Assistance	Adaptive learning	AI-driven patient simulations with real-time feedback	Improved personalization and clinical decision practice; noted high infrastructure requirements.
Naseer et al. (2024) (26)	Integrating deep learning techniques for personalized learning pathways in higher education	Engagement	AI-powered monitoring dashboards	Higher engagement linked to retention; highlighted privacy and data security concerns
Chowdhury et al. (2024) (27)	Medical Education Technology: Past, Present, and Future	EdTech evolution	AI-assisted adaptive learning, simulation tools, and digital assessment platforms	Improved access, engagement, and skill acquisition; personalization limited in niche or specialized subjects.
Sajja et al. (2024) (28)	Artificial Intelligence-Enabled Intelligent Assistant for Personalized Learning	Assessment	Dynamic AI-generated formative quizzes	Improved feedback accuracy and learning alignment; emphasized need for rigorous content validation.
Saxena et al. (2023) (29)	Precision, Personalization, and Progress in Medical Education	Translation	AI-based multilingual support systems	Improved accessibility; noted inconsistencies in translating medical terminology.
Nikhil et al. (2025) (30)	A Comprehensive Study on AI-Enhanced Personalized Learning in STEM Courses	Cognitive load	AI-sequenced learning modules	Reduced learner burden and improved stepwise progress; faculty resistance due to retraining needs.
Murtaza et al. (2022) (31)	AI-Based Personalized E-Learning Systems: Issues, Challenges, and Solutions	Feedback	Learner modeling, adaptive assessments, and targeted feedback modules	Improved engagement, retention, and course completion; noted feedback delays, high implementation costs, and privacy concerns.

Author and Year	Title	Key Concept of Research	Applications Used	Research Results
Gupta al. (2020) (32)	Use of an Adaptive E-Learning Platform as a Formative Assessment Tool in the Cardiovascular System Course Component of an MBBS Program	Adaptive learning	AI-driven adaptive e-learning platform with personalized quizzes and feedback	Improved student engagement and knowledge retention; significant gains on post-test scores compared to baseline; students reported positive perceptions of personalization and feedback accuracy.
Castellano et al. (2024) (33)	Empowering Human Anatomy Education Through Gamification and AI	Gamification + AI-assisted adaptive feedback	Gamified learning platform with AI-based progress tracking and interactive quizzes	Higher course completion rates, improved post-test knowledge and spatial understanding; some students perceived gamification as superficial or time-consuming
Xie et al. (2024) (34)	Investigating the impact of innovative AI chatbot on post-pandemic medical education and clinical assistance: a comprehensive analysis	AI chatbot for clinical & educational support	Intelligent Q&A, clinical case role-play, rapid resource retrieval	Better access to content, improved clinical problem-solving; issues with complex queries
Riedel et al. (2023) (35)	ChatGPT's performance in German OB/GYN exams–paving the way for AI-enhanced medical education and clinical practice	AI performance evaluation	Answering OB/GYN exam questions	Moderate accuracy; good on simple theory, weaker on complex/local guideline items
Ahmed et al. (2023) (36)	Utilization of ChatGPT in medical education: applications and implications for curriculum enhancement	Curriculum enhancement	Content generation, exam question creation, clinical role-play	Greater learner satisfaction, faster content prep; accuracy and ethics concerns
Xu et al. (2024) (37)	Opportunities, Challenges, and Future Directions of Large Language Models in Education	LLM potential & challenges	Content generation, Q&A, clinical dialogue simulation	Faster content access, supports self-directed learning; accuracy, privacy, oversight issues
Wu et al. (2024) (38)	Embracing ChatGPT for medical education: exploring its impact on doctors and medical students	AI-powered medical learning	Simulated clinical dialogues, intelligent tutoring, PBL/TBL integration, automated Q&A	Enhanced clinical reasoning, decision-making, and content accessibility; ethical/data privacy concerns, need for balance with human interaction
Rani et al. (2024) (39)	Perception of Medical Students and Faculty Regarding the Use of Artificial Intelligence (AI) in Medical Education: A Cross-Sectional Study.	User perceptions of AI-driven personalization	Adaptive simulations, AI-based adaptive assessment, chatbot content delivery	High acceptance; better personalization & engagement; concerns on privacy, accuracy, over-reliance
Thompson et al. (2025) (24)	Artificial Intelligence Use in Medical Education: Best Practices and Future Directions	Personalized learning	AI-based weakness detection, adaptive quizzes, targeted resources	+18% mastery, faster remediation; risks: dependency, privacy issues
Domrös et al. (2024) (40)	Medical Education: Considerations for a Successful Integration of Learning with and learning about AI	Human–AI feedback integration	AI-assisted oral feedback in OSCE and communication training	Improved verbal performance feedback and learner self-reflection; limitations included reduced perceived personal interaction and need for instructor mediation
As' ad et al. (2024) (41)	Generative Artificial Intelligence (AI), and Healthcare Agents: A Proof of Concept and Dual-Layer Approach	Intelligent tutoring; generative AI agents	Dual-layer AI system for adaptive clinical tutoring and conversational support	Feasibility shown for personalized content delivery, higher engagement; challenges include data privacy, integration complexity, need for validation

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Review Article

Does the Use of Virtual Reality Affect the Performance of Undergraduate Nursing Students? A Scoping Review

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Abstract

Background: Virtual reality-based educational software is a valuable tool and strategy that can effectively address challenges in nursing education.

Objectives: This scoping review aimed to determine the impact of virtual reality on the clinical skills and performance of undergraduate nursing students. The review was conducted in 2025.

Methods: Articles were retrieved by searching relevant keywords in databases such as PubMed, Scopus, Web of Science, Springer, ERIC, PsycINFO, CINAHL, EMBASE, SID, and Magiran. After applying the inclusion criteria and quality indicators, seven papers were selected from an initial pool of 158. Data extraction was conducted using a standardized form, and the collected data were then summarized and reported.

Results: Four randomized controlled trials, two quasi-experimental and, an experimental pretest-posttest studies indicated that using virtual reality as a supplementary tool can improve nursing students' performance in various clinical skills. These skills included tracheostomy and skin care, preoperative fire safety, intravenous catheter insertion, Foley catheter care, documentation during disasters, care for pregnant patients, and other related competencies.

Conclusion: The authors recommend further research on virtual reality-based techniques grounded in learning theories and used as a supplement to face-to-face training. Such approaches could ultimately enhance patient safety.

Keywords: Virtual Reality; Undergraduate Nursing Students; Clinical Skills; Performance

Background

The use of computers to educate nursing students is at the forefront of contemporary educational approaches. Nursing professors constantly face challenges, including maintaining patient safety and boosting students' self-confidence. Addressing these challenges is essential for enhancing the competence and clinical performance of nursing students (1). Nurse educators also consistently encounter difficulties in bridging the gap between theoretical knowledge and clinical practice (2, 3). Evidence-based practice could help reduce this gap. Furthermore, rapid changes in science and technology, the rising prevalence of chronic diseases, the growing preference for home care, shorter hospital stays, and the unique characteristics of third-millennium students are among the factors complicating nursing education (4, 5). On the other hand, the global nursing shortage and the pressure to enroll more students have created significant challenges for nursing schools, such as insufficient manpower, limited educational space and time, and inadequate resources. Many nursing professionals believe substantial changes are needed in nursing education (6).

Virtual Reality Simulation (VRS) is currently one of the most important approaches used in nursing education (7). VRS is a computer-aided training program that generates images and objects in a three-dimensional environment, creating a sense of immersion for the user. Through this simulation, users can immerse themselves in a virtual world where they interact with objects and people as if they were in reality (8). The learner interacts realistically within a computer-based, three-dimensional setting. While traditionally used for gaming and entertainment, this technology is now rapidly being adopted in aviation, military, and

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medical education (9). Two main types of virtual reality have been introduced. The first is desktop-based virtual reality, accessed through a computer screen, keyboard, mouse, touchscreen, or joystick. The second type involves immersive virtual tours, which allow users to explore, shop, and visit locations in a virtual world. This form of virtual reality can be displayed on large screens or through stereoscopic units, and its use in training is increasing (10, 11).

The use of simulation- and virtual reality-based educational software as a valuable strategy and tool is effective in addressing challenges in nursing education. Simulation-based training software creates a virtual clinical environment that allows nursing students to interact with virtual patients. This provides opportunities to practice nursing care while enhancing psychomotor skills and evidence-based decision-making (12). When designing virtual reality environments, pedagogical approaches based on cognitivism, constructivism, and behaviorism must be considered (13). By utilizing virtual reality techniques, students can improve their active participation and problem-solving skills. In this context, applying the principles of constructivist theory, such as providing prompt feedback, is crucial (14). The design of virtual reality environments often integrates educational principles like collaborative learning, active learning, teacher-student interaction, feedback, and task timing. These models also account for student characteristics (e.g., age, prior knowledge) and curriculum, as well as design features such as learning objectives, realism, guidelines, evaluation, and instructor review of simulation scenarios. Therefore, virtual reality can play a significant role in promoting students' self-confidence (15, 16). Using virtual reality also enhances students' critical thinking skills. This technique allows students to learn important procedures without risking harm to actual patients. They can train in procedures such as intravenous line insertion, wound care, and phlebotomy. Additionally, they can use three-dimensional anatomical models for patient assessment and follow-up (17). This educational approach enables students to practice skills repeatedly, thereby reinforcing learning (18). Furthermore, VRS allows nurse educators to create realistic clinical environments for students in a safe setting, enabling them to learn care procedures while ensuring patient safety (19). In today's digital world, VRS not only helps students master their curriculum but also enhances their digital literacy and computer skills (20). In a study by Jason and Forsyth, Virtual Reality Simulation (VRS) was reported to reduce learners' anxiety, improve the accuracy of client care, and enhance clinical competence. It also helped update trainers' knowledge and reduce their anxiety. This review highlights how nursing schools employ this innovative technology and suggests its implementation can help bridge the gap between theory and clinical practice, ultimately improving nursing students' learning and promoting safe patient care (21). Other advantages of this approach include its flexibility, allowing education to occur anytime and anywhere (22). Perhaps one of the greatest advantages of VRS is the ability to manipulate the learning environment through features like magnification, highlighting, and tagging. Additional key benefits include interactive tests and quizzes, opportunities for peer learning, and the absence of geographical limitations in disseminating information (6). The feasibility of simultaneous learning for multiple learners worldwide in a virtual hospital, combined with the exchange of information and experiences without time or space constraints, provides unique learning opportunities for medical and nursing students (23).

Objectives

Recognizing the importance of effective teaching methods in nursing and the positive impact of simulation-based education, this scoping review aims to evaluate the effect of virtual reality (VR) on the clinical skills and performance of undergraduate nursing students. By conducting a comprehensive review of the literature and explicitly defining the components of the PICO framework, this study seeks to formulate and address the central research question. Specifically, we aim to determine how VR-based educational interventions (P: nursing students; I: virtual reality; C: traditional teaching methods such as lectures, demonstrations, or simulation without VR; O: clinical performance) influence the development of nursing students' clinical competencies.

Accordingly, our primary research question is:

"Among nursing students, how does virtual reality–based education, compared with conventional teaching approaches, affect their clinical performance across various nursing procedures and skills?"

Methods

Design: No single research paradigm was applied in this scoping review. The researchers employed both positivist approaches to describe and explain the assessment methods used, and constructivist

approaches to clarify the theoretical frameworks that influenced the choice of assessments (24).

Search strategy: This scoping review was conducted without time restrictions, and the literature search was performed up to the end of 2024. International databases (ERIC, PsycINFO, CINAHL, EMBASE, PubMed, ScienceDirect, Scopus, Web of Science) and national Iranian databases (SID, Magiran) were searched. An example of the search strategy used in some databases is shown in Table 1. Keywords included "smart glass," "virtual clinical education," "nursing student," "performance," "skill," "training," "education," "clinical education," "nurse*," "bachelor of science," "undergraduate," "undergraduate nursing student," and "ability." Boolean operators (AND, OR) were applied. All search results, including titles and abstracts, were imported into EndNote 7 software. Articles in Persian and English that focused on populations other than nursing students were removed.

Table 1. The search strategy in some databases

Database	Search Strategy
PubMed	((((((("virtual reality*"[Title] AND "performance*"[Title]) OR "practice*"[Title] OR "skill*"[Title] OR "enhance"[Title]) AND "nurs*"[Title/Abstract]) OR "Virtual Clinical Education"[Title/Abstract] OR "Google glass"[Title/Abstract]) AND "student"[Title]) OR "learner"[Title] OR "Outcome learning"[Title])
Scopus	(TITLE("Virtual*" OR "Virtual Reality*" OR "VR") AND (TITLE("Performance*" OR "Learner" OR "Outcome" OR "Outcome learning*")) AND TITLE("nurs*"))
Web of Science	(TI=("performance*" OR "practice*" OR "Outcome") AND TI=("VR" OR "Virtual reality" OR "Virtual reality simulation") AND TI=("Learner" OR "Outcome learning") AND TI=("Nursing student"))
SpringerLink	("virtual reality" OR "virtual clinical education" OR "augmented reality") AND ("nursing student" OR "nursing education") AND ("performance" OR "clinical skill" OR "competence")
ERIC	(("virtual reality" OR "online simulation" OR "virtual clinical training") AND ("nursing student" OR "undergraduate nursing") AND ("performance" OR "learning outcomes" OR "skill development"))
PsycINFO	(("virtual reality" OR "simulation training") AND ("nursing student" OR "healthcare education") AND ("performance" OR "clinical competence" OR "skill acquisition"))
CINAHL	(("virtual reality" OR "virtual simulation" OR "smart glass") AND ("nursing student" OR "undergraduate nursing") AND ("clinical skill" OR "performance" OR "competency"))
EMBASE	('virtual reality'/exp OR 'augmented reality'/exp) AND ('nursing student'/exp OR 'nursing education') AND ('performance'/exp OR 'clinical skill'/exp OR 'competence'/exp)
SID	("توانمندی" OR "مهارت بالینی" OR "عملکرد") AND ("دانشجوی پرستاری") AND ("آموزش بالینی مجازی" OR "واقعیت مجازی")
Magiran	("مهارت بالینی") AND ("دانشجوی پرستاری") AND ("شبیه‌سازی بالینی" OR "آموزش مجازی" OR "واقعیت مجازی" OR "آموزش بالینی" OR "عملکرد")

Inclusion and Exclusion Criteria: Original Persian and English studies published in peer-reviewed journals with full-text availability were included. Letters, gray literature, review articles, commentaries, editorials, and conference proceedings were excluded.

This review evaluated the performance of nursing students without restrictions on the type of skill or clinical specialty.

Search Outcome: Initially, 158 articles were retrieved from the databases. After removing duplicates (n = 32) and ineligible records flagged by automation tools (n = 20), 106 records remained for title and abstract screening. Of these, 13 records were excluded, leaving 93 reports sought for retrieval, of which 25 full texts could not be retrieved. Consequently, 68 reports were assessed for eligibility. Applying the 11 quality indicators developed by Buckley et al. (2009)—which evaluate study design, methods, analysis, results, and conclusions—led to the exclusion of 61 studies due to low methodological quality (score < 7), such as insufficient ethical considerations, incomplete attrition data, or mismatch between objectives and results. Ultimately, 7 high-quality studies met all inclusion criteria (score ≥ 7) and were included in the final review (Figure 1, Tables 2 and 3).

Data extraction: All authors were involved in extracting and classifying information. The extracted data included author(s)/year of publication, country of origin, study aim, design, sample and study population, data collection methods, and methods of analysis (Table 3).

Table 2. Quality indicators for included studies (42)

Quality Indicator	Detail
Research Question	Is the research question or hypothesis clearly stated?
Study Subjects	Is the subject group appropriate for the study (considering number, characteristics, selection process, and homogeneity)?
Data Collection Methods	Are the methods used (qualitative or quantitative) reliable and valid for the research question and context?
Completeness of Data	Is subject attrition reported? Is the attrition rate less than 50%? For questionnaire-based studies, is the response rate adequate?
Control for Confounding	Have potential confounding factors or variables been controlled, removed, or accounted for where possible?
Analysis of Results	Are the statistical or other analytical methods used appropriate for the study?
Conclusions	Do the data clearly justify the conclusions drawn?
Reproducibility	Is the study described in sufficient detail to be reproduced by other researchers?
Prospective Design	Is the study prospective (looking forward in time) rather than retrospective (looking backward)?
Ethical Issues	Were all relevant ethical issues appropriately addressed?
Triangulation	Were the results supported by data from more than one source or method?

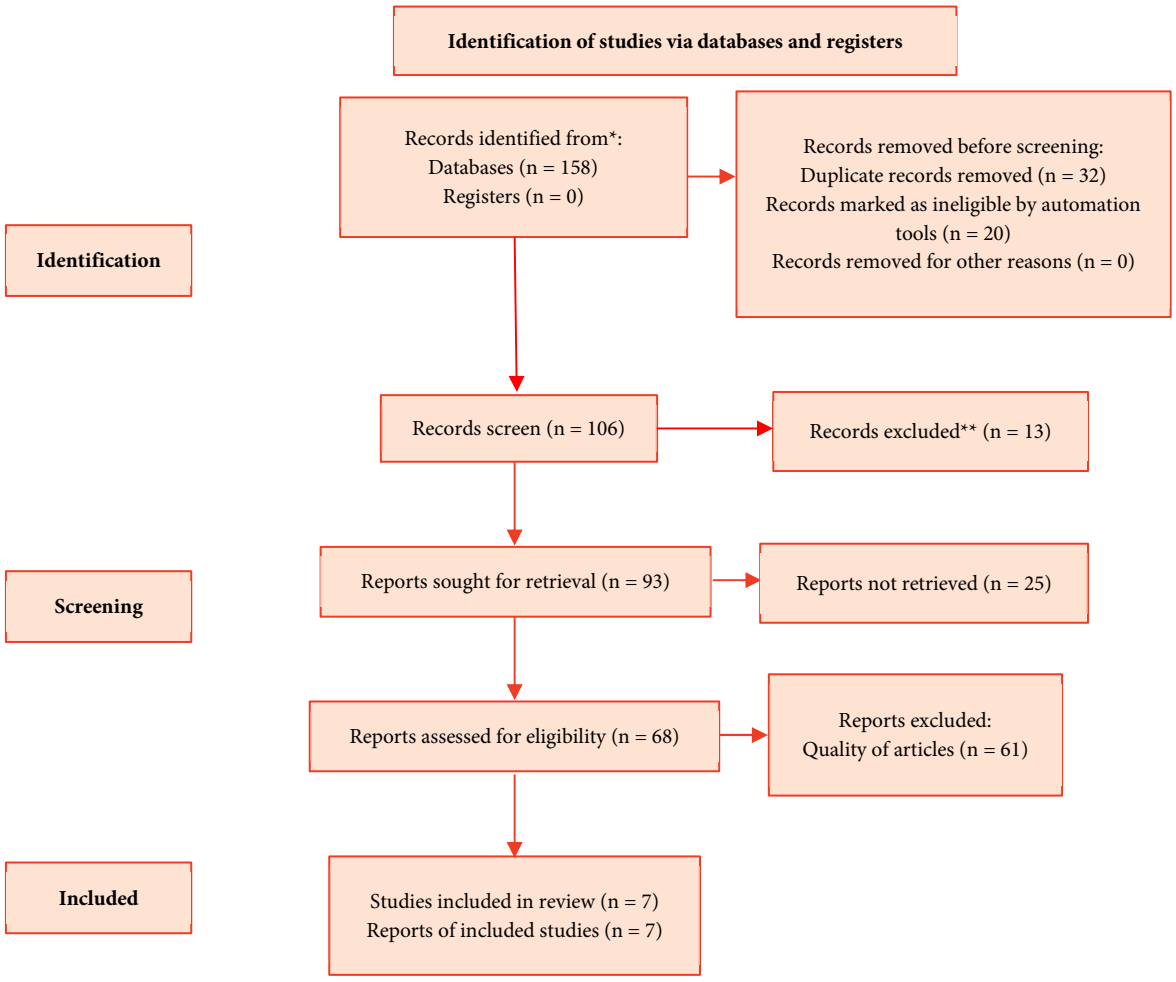

Figure 1. The paper selection process

Table 3. Summary of included nursing studies for the effectiveness of Virtual Reality on Skill and Performance

Author /year/ country	Aim	Design	Comparison (Control) group	Sample and study population	Data collection	Method of analysis
Bayram and Caliskan (2019)/Turkey	Determining the effect of a game-based virtual reality phone application on tracheostomy care education for nursing students.	Single-blind randomized controlled trial	Theoretical class and demonstration on the mannequin	N=86 First-year nursing students	Informative features form, A tracheostomy care knowledge test and skill checklists, and a performance assessment form OSCE	Descriptive Nonparametric tests
Jung et al./ (2012)/Korea	Confirmed the educational effectiveness of practical exercises (PE) using intravenous (IV) simulators incorporating virtual reality (VR)/haptics (based on the sense of touch) device technologies.	A randomized controlled trial	Conventional arm model	N :114 First- year nursing students	Personal information, basic knowledge measurement, trait and state anxiety measurement, training materials, and effectiveness of training.	Descriptive Nonparametric tests (Mann–Whitney U test), Paired t-test, one-way ANOVA
Smith et al./ (2018)/USA	To assess two levels of immersive virtual reality simulation (VRS) to teach the skill of decontamination.	Quasi experimental design/Focus group	Written instructions	N=197 Senior baccalaureate nursing students	Decontamination Checklist/ Interview and focus group	Descriptive/ Repeated measures/ Qualitative analysis techniques
Smith and Hamilton/ (2015)/USA	To evaluate the effectiveness of VR simulation as a teaching strategy for preparation of students for successful performance and validation of Foley catheter insertion by generic associate degree nursing (ADN) students.	Randomized Control Trial	Instructions in a classroom setting	N=20 Nursing student with Fundamental Course	Demographic Questionnaire Log Sheets Skills Evaluation Tool Visual Analog Perceived Preparedness Scale	Descriptive statistics Independent-samples t- test Pearson correlations
Ismailoglu, Zaybak. (2018)/Turkey	Compare the effects of using a VIS with a plastic arm model for teaching IV catheter insertion skills to nursing students.	A Randomized controlled quasi-experimental study	Plastic arm model	N= 65 2nd. -year students	Personal Information Form Intravenous Catheterization Knowledge Assessment Form Intravenous Catheterization Skill Checklist Visual Analog Scale The Fear Symptoms Scale	Data were analyzed using IBM SPSS version 18
Rossler et al./ (2019)/USA(Texas)	The effectiveness of the Virtual Electrosurgery Skill Trainer (VEST) on OR fire safety skills among prelicensure nursing students	An experimental pretest-posttest (Pilot study)	Traditional programmatic education	N=20 Enrolled in the perioperative nursing elective course	Perioperative Performance Evaluation Tool 10-item researcher-made tool to test knowledge level	Descriptive Wilcoxon test
Chang et al./ (2022)/Taiwan	An exploratory study using social learning theory embedded in SVVR for childbirth education training is presented; moreover, the learning performances of nursing students who participated in SVVR classroom learning and those who learned with the traditional approach were compared	A quasi experimental	Traditional programmatic education	N=30 Care for pregnant women	Spherical Video-based Virtual Reality (SVVR)	Data were analyzed using IBM SPSS Statistics version 18 Descriptive Wilcoxon test

Results

Initially, 158 articles were identified from the following databases: PubMed (43), Scopus (20), Web of Science (44), PsycINFO (20), ERIC (4), EMBASE (3), and CINAHL (12).

Study Characteristics: This scoping review included Seven studies examining the impact of virtual reality on the skills and performance of nursing students. No studies were conducted in Iran.

The studies originated from Turkey (2), the United States (3), Taiwan (1), and Korea (1). Among these Seven studies, four were randomized controlled trials, and two were quasi-experimental.

Sample sizes ranged from 20 to 197 participants, totaling 532 individuals. All studies were single-blind and conducted between 2011 and 2022. They focused on topics such as tracheostomy care, fire safety, intravenous catheter insertion, IV injection, disaster documentation, care for pregnant women, and Foley catheter care.

Virtual reality simulator specifications

- In the study by Bayram & Caliskan (2019), a video demonstrating tracheostomy care based on a researcher-developed checklist was created. An offline, game-based virtual reality application for Android phones was then developed using CS6 and Adobe Flash CC. The game featured a nurse character guiding the student through suctioning and caring for the patient character Mr. Melek's tracheostomy in six steps over ten minutes. Upon completion, students could save and send their progress to the researchers (25).
- In the study by Rössler et al. (2019), the virtual reality simulation was designed in four sections: (a) learning objectives, (b) a replicated operating room environment, (c) a human patient simulator portraying a surgical patient, and (d) a simulated fire source. Participants were introduced step-by-step to the role of an operating room nurse and had to complete each stage correctly to proceed (26).
- The Virtual Intravenous Simulator (VIS), used by Ismailoglu and Zaybak (2018), is a VR-based simulator designed to enhance psychomotor skills for intravenous catheter insertion. It incorporates a haptic device simulating a patient's arm with a valve for needle insertion. A sensor system detects movements and translates them into a 3D computer environment. The simulator offers various clinical scenarios with different vascular structures (27).
- The simulator in the study by Jung et al. also used a haptic device to provide tactile resistance during vein puncture within a 3D image viewed through polarized glasses. The skin and vein pathway were displayed on a monitor, allowing learners to experience needle insertion. It demonstrated anatomical features, complications, injection techniques, and intravenous therapy (28).
- In the study by Smith et al. (2018), a virtual reality simulator introduced students to the use of Personal Protective Equipment (PPE) in the emergency department via a ten-minute scenario developed using the Unity 3D game engine. Models and characters were designed in Autodesk Maya. Students could explore the virtual emergency unit using a VR headset and select equipment by pressing a button on a manual controller (29).
- In the study by Smith and Hamilton, a virtual reality simulator was designed to train students in Foley catheter insertion. Learners performed urinary catheterization step-by-step on screen. If an error occurred, an alert sound prompted them to return to and correct the step. The simulator was operated using a mouse (30).
- The study by Chang et al. (2022) aimed to enhance nursing students' preparedness to care for pregnant women and support safe childbirth processes using virtual reality (31).

Performance outcomes

- Bayram et al. (2019) reported statistically significant differences favoring the VRS group in scores for tracheostomy tube suctioning ($p = 0.017$) and peristomal skin care ($p = 0.003$). They recommended VRS for teaching these skills but suggested future studies include longer follow-up periods (25).
- Rössler et al. (2019) found a statistically significant difference in students' performance skills related to an emergency fire scenario and the PASS technique (Pull, Aim, Squeeze, Sweep) between the intervention and control groups ($p = 0.001$). The authors recommended VRS for beginner students in both academic and clinical courses. They noted limitations including optional participation and unaccounted-for prior VR experience (26).
- Ismailoglu and Zaybak (2018) reported a statistically significant difference in mean psychomotor skill scores (experimental: 45.18 vs. control: 20.44, $p < 0.001$) on the simulator. However, no significant

difference was found in subsequent clinical psychomotor skill scores ($p = 0.841$). They recommended VIS for teaching IV insertion but suggested future research assess skills in real clinical settings (27).

- Jung et al. compared three groups: Conventional Arm Model, VR/Haptic IV Simulator, and IV Arm + IV Simulator. While no significant difference was found in overall performance scores, a statistically significant difference was observed in procedure duration ($p = 0.007$), with the IV Arm + IV Simulator group being fastest. The authors recommended combining VR with hands-on skill lab training. Limitations included insufficient training time and unaddressed cultural heterogeneity (28).
- Smith et al. (2018) did not find a statistically significant difference in overall performance between groups in a disaster documentation scenario. However, women in the VR group completed documentation faster than men ($p = 0.007$). Performance scores declined in all groups at six months post-intervention. The authors recommended VR for teaching disaster preparedness, noting limited generalizability (29).
- Smith and Hamilton (2015) found no statistically significant difference between the VR and control groups for Foley catheter care. However, mean scores showed a positive trend for the VR group, and the mean procedure time was shorter in the intervention group (125 ± 66.08 seconds vs. 182.50 ± 71.92 seconds). The authors suggested VR could be a supplementary learning tool (30).
- Chang et al. (2022) reported that students learning through Spherical Video-based Virtual Reality (SVVR) demonstrated higher learning motivation and satisfaction compared to traditional instruction, highlighting its potential for childbirth education (31).

Discussion

This review examined the effect of virtual reality simulation (VRS) on the skills and performance of nursing students. Some of the included studies confirmed the positive impact of VRS on performance, while others, despite not reporting statistically significant results, recommended its use due to advantages such as reduced procedure time, opportunities for repeated practice, safe training for invasive procedures, maintained patient safety, and increased student satisfaction.

Supporting findings come from other fields. Kundhal and Grantcharov (2009) found medical students trained with VRS for laparoscopic procedures completed tasks significantly faster ($p < 0.05$) (32). Janse et al. (2013) noted benefits of VRS for medical students inexperienced in hysterectomy (33). Konge et al. (2013) observed significant improvement in respiratory physicians' ability to diagnose lymph nodes using VRS, recommending its use before clinical practice (34, 35). Conversely, Andersen et al. (2016) found no significant difference in performance for mastoidectomy simulation ($p = 0.22$) (36).

In anatomy education, Gorski et al. (2016) reported that a 3D VR application (KOMVR) improved engineering students' understanding of human anatomy and reduced wait times for learning resources (37). Ekstrand et al. (2018) found medical students who watched a 3D neuroanatomy video achieved higher knowledge scores (38). Soltun et al. (2019) demonstrated that 360-degree VR significantly increased knowledge and motivation in medical students (39). Gopal et al. (2018) found a VR learning system (VR4MAX) significantly improved medical students' bronchoscopy skills and knowledge (40). In contrast, Blumstein et al. (2020) found no significant knowledge difference between VR and standard teaching for tibial surgery techniques, calling for further research with larger samples and validated measures (41).

Limitations: Although the search strategy was extensive, some studies may have been missed. The full texts of two articles were unavailable; requests sent to the authors received no response, leading to their exclusion. This review was limited to English and Persian publications, potentially omitting relevant studies in other languages.

Conclusion

The use of virtual reality (VR) technology in nursing education is becoming increasingly prominent. Undergraduate students, particularly those from the millennial generation, often show less inclination toward traditional classroom attendance and rigid schedules. Consequently, virtual learning can serve as a valuable educational tool for this population. VR technology is particularly beneficial for teaching clinical skills and enhancing performance. Given the practice- and repetition-oriented nature of nursing, hands-on clinical experience remains essential alongside

theoretical knowledge. Compared to traditional methods, VR offers a promising strategy to mitigate risks in nursing education. By integrating VR as a supplement to hands-on training in skill labs and clinical settings, educators can enhance student learning while maintaining patient safety and effectively preparing competent professional nurses.

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Conflict of interests: There is no conflict of interest.

Ethical approval: This systematic review was conducted in accordance with the ethical principles of secondary research and was approved by the Research Ethics Committee of Tehran University of Medical Sciences (Ethics Code: IR.TUMS.MEDICINE.REC.1399.159). As a review of published literature, this study adhered to the principles of academic integrity through proper citation and accurate reporting of primary findings. The review process followed PRISMA guidelines to ensure transparency and reproducibility, and two independent reviewers screened the studies and assessed their quality to minimize bias.

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Review Article

The Role of Holding Medical Students' National Scientific Olympiads in Medical Education Enhancement: A Narrative Review of Student and Faculty Perspectives

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Abstract

Background: Improving medical education involves various aspects, one of which is increasing student empowerment. The purpose of organizing scientific Olympiads is to prepare medical students to solve problems in a competitive environment.

Objectives: Therefore, this study examines the role of scientific Olympiads in improving medical education.

Methods: In this review, relevant articles were identified through an internet search of international databases, including PubMed, Scopus, and Web of Science, as well as Persian databases such as SID and Magiran. The search employed a combination of keywords such as 'Medical education,' 'Scientific Olympiad,' 'Medical students,' etc. A total of 47 studies were obtained. After excluding 38 studies that did not meet the inclusion criteria, the remaining 9 studies were reviewed.

Results: After reviewing the articles, the views of students and faculty were assessed. Overall, the views were categorized into two parts: positive and negative. Some of the positive views included improving problem-solving skills, reasoning, and creativity, developing relationships between universities and students, and creating a healthy academic competition environment. Negative views included uninterested students, memorizing some questions, and a disproportionate volume of resources concerning study opportunities, among others.

Conclusion: The results showed that holding scientific Olympiads for medical students in the country can improve medical education. The overall performance of scientific Olympiads was satisfactory from the perspective of students and faculty. On the other hand, paying attention to weaknesses and attempting to eliminate them may be a suitable approach to achieving the goals of medical education.

Keywords: Scientific Olympiad; Medical Students; Medical Education

Background

The primary goal of medical education is to train skilled health professionals with sufficient and up-to-date knowledge, who prioritize patient care over their own interests and are committed to maintaining and continually developing their expertise throughout their careers (1). To achieve this important goal, medical universities play a key role (2). Achieving the goals of medical education requires strong, visionary leadership that responds effectively to both internal and external challenges. This leadership should effectively guide our current students on their path to a medical career. Achieving this requires ongoing review and enhancement of medical education, actively addressing its shortcomings (3, 4).

Improving medical education encompasses various aspects, one of the most fundamental approaches being the increase in student empowerment (5). Student empowerment, as a motivation-based construct, refers to learners finding meaningful tasks, feeling competent

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to perform them, and perceiving that their efforts have an impact within the learning (6). No one can deny the importance of universities in identifying, nurturing, and guiding students' scientific talents. Although educational methods in the past provided students with information and concepts in a theoretical manner, today, the analysis, prioritization, and organization of new knowledge —essential for critical thinking and effective learning —have become more important (7). Additionally, enhancing skills such as decision-making, problem-solving, clinical reasoning, practical skills, and integrating existing knowledge will increase students' competence and help achieve the goals of medical education (8-10). Since medical students are the intellectual capital of a society and play an essential role in improving health, supporting superior talents and creating opportunities for their growth are among the most important tasks of educational institutions, and the use of talents can bring about significant changes in scientific, social, and economic fields (11-13).

Numerous studies show that friendly competitions provide strong motivation for students and help improve their performance (14-16). Creating a healthy, competitive environment in medical science education is an effective approach to guide students toward a full understanding of the concepts presented. It also encourages students to refer to relevant articles and participate in group learning, both of which are essential for promoting the competence of medical science students (15).

Science Olympiad is an event that provides a competitive environment for student groups from medical universities across the country (17). In general, the purpose of holding science Olympiads at the national and international levels is to compensate for the weaknesses in the education system. Therefore, these Olympiads aim to identify creative and innovative talents by conducting tests and, by optimally utilizing the elite, provide the necessary platform for the progress and development of society (18). The Science Olympiad has a history spanning 80 years. Russia was the first country to hold science Olympiads (19).

In Iran's healthcare system, the initial idea of holding a student scientific Olympiad in medical sciences was proposed in 2000 at Isfahan University of Medical Sciences. The first Olympiad was held at the same institution for undergraduate and professional doctorate students of medicine in 2009. Subsequent Olympiads were held in Shiraz, Tehran, Tabriz, and Kerman, respectively (20, 21). The purpose of holding the Olympiad for university students in our healthcare system is to prepare groups of medical science students to solve problems in a competitive environment, which can be effective in maintaining and promoting community health. Therefore, efforts to develop problem-solving and reasoning skills, emphasize critical and creative thinking, focus on the goals of the healthcare system, and encourage teamwork are among the primary objectives of the Olympiad (20).

It seems that holding a national festival like the Olympiad can encourage medical science students to go beyond routine studies and may potentially fill some educational gaps in health system education (22).

Objectives

Therefore, this study reviews the role of holding scientific Olympiads for medical science students in promoting medical education from the perspectives of both students and faculty.

Methods

This study is a narrative review that aims to investigate the role of scientific Olympiads for medical students in the country in improving medical education from the perspectives of students and faculty. To identify relevant articles, an internet search was conducted between 2009 and 2024 (in other words, from 2009 to the present, when the scientific Olympiads of medical students began) in the international databases PubMed, Scopus, and Web of Science, and the Persian databases SID, Magiran, and the scientific search engine Google Scholar, using a combination of the keywords in Table 1.

Table 1. Search keywords

Word	Search keywords	
	English	Persian
Medical Education	Medical education, education promotion, and education development	آموزش پزشکی، ارتقای آموش، توسعه آموزش
Scientific Olympiad	Olympiad, scientific Olympiad, medical Olympiad, national Olympiad, scientific competition	المپیاد، المپیاد علمی، المپیاد پزشکی، المپیاد ملی، رقابت علمی
Medical students	Medical students, undergraduate students	دانشجویان علوم پزشکی، دانشجویان درحال تحصیل
Iran	Iran, Iranian	ایران، ایرانی

Studies were included if they focused on medical students' scientific Olympiads, presented perspectives from students or faculty, and were available in full-text format in either English or Persian. Studies were excluded if they were irrelevant, duplicate records, letters to the editor, or lacked sufficient methodological detail. A total of 47 studies were retrieved, of which 38 was excluded because they did not meet the predefined eligibility criteria. A large proportion of retrieved studies were not directly focused on scientific Olympiads or did not provide perspectives from students or faculty relevant to the Olympiad context. Several articles were excluded because they were duplicates or not available in full text. Due to the limited number of studies in this field and the unique nature of the Olympiad exam in the country, all 9 remaining articles, including descriptive studies, case reports, qualitative studies, and action research, were included and reviewed.

Results

After reviewing the full texts of the articles, the perspectives of students and faculty on the role of scientific Olympiads for medical sciences students in the country's universities were examined. The details and results of these studies are presented in Table 2. Among the 9 articles, there were 4 qualitative studies, 2 case reports, 2 cross-sectional studies, and 1 action research project. The temporal distribution of the studies indicates that most articles were conducted in the early years of these scientific Olympiads for medical sciences students. Most studies primarily examined the students' perspectives, while only 3 studies also considered the faculty's perspectives. We categorized participants' views into two sections: positive views and negative views, which will be explained below.

Table 2. Characteristics and results of the articles reviewed in the study, in order of publication year

Author/Year	Type of study	Study objective	Students/Faculty Views on the Olympiad
Adibi et al. 2011 (21)	Action research	Expressing experience in designing, holding, and evaluating Olympiads	Although 94% of students believed the Olympiad differed from regular university exams, around 60% were satisfied with its overall quality, and 72% encouraged their peers to participate. Nonetheless, they suggested that to maintain its quality, an independent institution, preferably outside the Ministry of Health, should conduct annual and long-term evaluations to measure goal achievement.
Amini et al. 2011 (7)	Case report	Describing the experience of holding the country's second National Medical Sciences Olympiad	Ninety-five-point four percent of students were satisfied with participating in the Olympiad, 97.2% believed problem-solving skills should be part of the university curriculum, 87.4% felt the Olympiad enhanced their scientific thinking and problem-solving abilities, and 85.2% said it motivated them to pursue greater career success.
Hadizadeh et al. 2011 (23)	Case report	Expressing experiences gained in the process of holding the Olympiad	Most students (98%) reported that the test was different from typical university tests and that the skills required for the test were not taught at university (88%). They believed that the test measured creativity, problem-solving, and reasoning (52%).
Amini et al. 2012 (24)	Cross-sectional	Details of the clinical reasoning test in the Olympiad and participants' satisfaction with it	Most students believed that the Clinical Reasoning Test was a useful test for assessing competence. More than 50% of them reported that success in this test required clinical competence, teamwork, and problem-solving ability. Therefore, it could increase students' willingness to participate in group work and be beneficial.
Ghojazadeh et al. 2015 (25)	Qualitative	Assessing the opinions of Olympiad experts regarding the necessities, costs, achievements, obstacles, and solutions for holding effective Olympiads.	Experts described the Olympiad's core philosophy as improving health sector performance, enhancing inter-university collaboration, fostering competition, and stimulating student creativity. However, most participants felt its achievements didn't justify the costs. Key obstacles included poor communication between universities, a lack of support, low faculty motivation, student disinterest, and limited facilities.
Hazrati et al. 2015 (26)	Qualitative	Analyzing students' opinions on strengths and weaknesses, and their suggestions for better holding of the Medical Science Olympiad exams in the country	Most participants were satisfied with the exam execution and the provided services. They criticized the memorization-based questions and preferred analytical and argumentative formats. Suggestions included enhancing topic specificity, increasing subject diversity in laboratory sciences, and comparing students with similar grades to foster healthy competition.

Author/Year	Type of study	Study objective	Students/Faculty Views on the Olympiad
Nasrollahpour-Shirvani et al. 2015 (27)	Cross-sectional	Investigating the level of satisfaction of national candidates with the quality of holding the Fifth Scientific Olympiad	National candidates reported the highest satisfaction with the relevance of the questions to their field and the distinctiveness of the test content compared to typical university exams. The lowest satisfaction was with the ratio of introduced resources to study opportunity and the Olympiad's effectiveness in enhancing skills for other careers or interdisciplinary fields.
Azami-Aghdash et al. 2016 (28)	Qualitative	Evaluating the views of faculty members regarding the mission and performance of the Medical Sciences Olympiad	Most participants (79%) had a positive view of the Olympiad. Faculty members highlighted their strengths in promoting reasoning, teamwork, and academic collaboration. Key weaknesses included limited question authorship, low motivation for participation, and lack of innovative output from descriptive tests.
Hajinezhad et al. 2021 (17)	Qualitative	Explanation of issues related to the Iranian Medical Students' Scientific Olympiad program	Students, faculty, and officials believe the Olympiad can foster inter-university scientific exchange and enhance educational practices in medical schools. However, without proper implementation and resolution of previous issues, it may burden the health system without offering real benefits.

Positive viewpoints: Overall, the majority of students in all studies were satisfied with the organization and quality of the Olympiads. One study stated that most students would recommend this exam to their friends. Four studies reported that the Olympiad improves students' problem-solving skills. Improved reasoning in the learning process of students during this exam was reported in three studies. Other notable skills mentioned in the studies included creativity, scientific thinking, and teamwork. Creating motivation in students for greater success in their future professional lives was another positive viewpoint. Additionally, the necessity and main philosophy of holding Olympiads, as stated by experts, were to improve the performance of the health sector, expand mutual relations between universities, develop scientific competition, and stimulate students' creativity. One study stated that, from the perspective of the majority of participants, the achievements of holding these Olympiads are insignificant compared to their costs. In one study, most students stated that the clinical reasoning exam of the Olympiad is a useful test for assessing competence. In two studies, the important strength of this exam was identified as the development of relationships between universities and students. Increasing students' motivation and creating a healthy scientific competition environment were also among the positive viewpoints mentioned in the reviewed studies.

Negative perspectives: One study reported that, from the perspective of most students (88%), the skills required for this exam are not taught at the university. The most significant obstacles identified in one study were the lack of effective communication between universities, inadequate support for hosting these Olympiads, low faculty motivation, unenthusiastic students, and insufficient resources and facilities. Although increasing reasoning and problem-solving skills was mentioned as one of the strengths of the Olympiad in numerous studies, in one study, students objected to the rote memorization aspect of some of the questions and stated that the questions should be designed in a reasoned and analytical manner. The disproportionate volume of resources allocated compared to the study opportunity, as well as the low effectiveness of the Olympiad in developing and enhancing students' skills in other professional or interdisciplinary fields, were also reported. Considering that improving students' educational skills and ultimately improving the performance of the health sector were among the goals and positive points, one study stated that if this exam is not implemented correctly and the problems of previous periods are not solved, it will not help the health system and can impose significant costs on the system.

Key findings from the studies indicate that the Medical Sciences Olympiad is widely viewed as a valuable initiative that enhances students' problem-solving and teamwork skills while fostering academic creativity. However, challenges such as high costs, reliance on memorization-based questions, and weak institutional support hinder its full potential. To maximize impact, experts recommend independent oversight, diversified assessments, and stronger collaboration between universities and faculty.

Discussion

This review study was conducted to investigate the role of holding scientific Olympiads for medical

students in enhancing medical education from the perspectives of both students and faculty. The results showed that most students and faculty were satisfied with the overall performance of the scientific Olympiads. We divided participants' views into two parts: positive views and negative views.

As mentioned in previous sections, a key goal of medical education is to train skilled and competent personnel (1). Achieving this requires empowering students and providing them with up-to-date education. Factors affecting competence development in medical students include enhancing skills such as problem-solving, critical thinking, creativity, and clinical reasoning (7, 8). Cotrer et al. (2013) stated that clinical reasoning is a vital skill for all physicians, regardless of their specialty, and helping trainees develop effective clinical reasoning is a primary goal of medical education (29). Since the promotion of clinical reasoning, problem-solving, critical thinking, and teamwork has been identified as a major strength of scientific Olympiads, as indicated by positive perceptions from reviewed studies, it can be concluded that these exams are likely effective in meeting medical education goals and enhancing their development. Similarly, a 2016 study by Eguchi reported that competitions like the Olympiad challenge students' reasoning, creativity, and problem-based learning skills, while also fostering collaboration and teamwork (30). Another beneficial aspect of the Olympiad is the creation of a healthy, scientific, competitive environment. Lei et al. (2016) also noted that establishing such an environment in medical education helps students understand concepts more comprehensively. This setting encourages participation in group learning, which is critical for improving competence (14).

Additionally, Olympiads offer opportunities to strengthen relationships between universities and students, positively impacting students' learning experiences (31). In 2016, Kulbago et al. emphasized that the interplay between competition and cooperation is essential during the Olympiad, and interactions within and between teams help students develop their social and life skills in addition to knowledge (32). Lastly, motivating students to achieve greater success in their future careers was also viewed positively. In 2024, Pattipeilohy et al. noted that Indonesia's National Science Olympiad positively impacted the quality of education, potentially preparing young Indonesians to face future global challenges by boosting motivation, developing critical and analytical skills, raising educational standards, identifying talents, and fostering networks and collaborations (33). Conversely, although many studies suggest that the Olympiad enhances reasoning and problem-solving skills, some students have objected to memorizing certain questions and suggested that questions should be framed in an argumentative and analytical manner. Therefore, improving question quality could better empower students in reasoning and problem-solving (34). It's worth noting that this issue has been previously discussed, and as the quality of Olympiad questions evolves annually, recent data should be examined. Another concern raised was the lack of training in Olympiad-relevant skills at universities. Since skills such as problem-solving, reasoning, critical thinking, and teamwork are promoted through the Olympiad and are vital for the development of medical education, emphasizing these skills within university programs could positively influence policy and educational planning.

Furthermore, low motivation among faculty and students' lack of interest are significant barriers. Strategies aimed at increasing motivation could greatly enhance engagement with scientific Olympiads (35-36). For instance, Vahedi et al. (2016) identified continuing higher education and becoming faculty members as key motivations for students participating in the Olympiad. Focusing on these motivations could encourage greater student participation (37). Similarly, in 2023, Moradi et al. pointed out that both material and non-material rewards can significantly motivate Olympiad participants (38). Although many participants felt that the benefits gained from Olympiads are modest relative to their costs, some believed that improperly conducted Olympiads, coupled with unresolved course issues, could harm the health system and lead to unnecessary expenses. In 2010, Campbell et al. highlighted the importance of finding cost-effective ways to develop student talent amid rising education costs (39). Finally, the excessive volume of resources presented as study material was identified as another obstacle to achieving Olympiad goals. Qaedamini et al. (2023) reported that the overwhelming nature of lesson content can deter improvements in educational quality (40). Therefore, considering the resource volume in relation to students' available time is crucial for enhancing the quality of Olympiad assessments and medical education overall.

This study has several limitations that should be acknowledged. First, due to the narrative review methodology and strict inclusion/exclusion criteria, only a limited number of studies (n=9) met the eligibility criteria for full review, which may restrict the breadth of

the synthesized evidence. Second, the included studies exhibited considerable heterogeneity in design, methodology, and outcome measures (ranging from qualitative faculty/student perceptions to quantitative surveys), precluding a formal meta-analysis. Third, potential publication and language bias cannot be entirely ruled out, as the search was restricted to specific English and Persian databases. Future systematic reviews employing broader search strategies and quantitative synthesis are recommended to further evaluate the long-term impacts of medical student Olympiads.

Conclusion

Results showed that holding scientific Olympiads for medical students in the country can be beneficial for improving medical education. The overall performance of scientific Olympiads was satisfactory from the perspective of students and faculty. According to the study, hosting Olympiads can enhance education by developing skills such as reasoning, problem-solving, and critical thinking, fostering a healthy competitive environment, and boosting student motivation. On the other hand, paying attention to the weaknesses and trying to eliminate them can probably be a suitable approach to achieving the goals of medical education.

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Review Article

Conflict Management Competencies for Surgical Residents: A Scoping Review

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Abstract

Background: Conflict is prevalent in surgical clinical environments due to hierarchical cultures, communication challenges, and professional differences. Such conflicts adversely affect healthcare professionals, team performance, and patient safety. Despite their importance, conflict management competencies are often overlooked in surgical residency training.

Objectives: This review aims to identify the essential competencies in conflict management required of surgical residents.

Methods: A scoping review was conducted following Arksey and O'Malley's five-stage framework. Comprehensive literature searches were performed across multiple national and international databases from January 2011 to March 20, 2024. Data extraction adhered to PRISMA-ScR guidelines, and inductive content analysis was used to synthesize findings.

Results: Of 9,252 retrieved articles, 35 met the inclusion criteria. Three main categories emerged: (1) Educational Approaches, including experiential learning methods such as simulations and role-playing; (2) Conflict Management Competencies, emphasizing critical skills such as emotional regulation, negotiation, communication, empathy, role clarity, and collaborative problem-solving; and (3) Contextual Factors influencing conflicts, including hierarchical structures, cultural diversity, and institutional dynamics.

Conclusion: Conflict in clinical settings is a multifaceted issue influenced by individual skills, pedagogical methods, and systemic factors. Effective conflict management requires integrated educational programs, combined with organizational culture reforms that promote transparent communication and equitable power dynamics. Embedding conflict management training within competency-based medical education frameworks is essential to prepare surgical residents better and improve patient care outcomes.

Keywords: Conflict Management; Surgical Residents; Competency-Based Medical Education; non-Technical Skills

Background

The operating room's hierarchical culture and leadership expectations contribute to negative emotions and communication challenges (1). Conflict in surgical teams is common and can negatively impact healthcare professionals, team effectiveness, and patient safety (2). Conflict in surgical environments can arise from a range of factors, including individual differences, communication styles, and professional hierarchies (3). Surgical residents face significant interpersonal conflicts within healthcare teams. These conflicts contribute to stress, burnout, and job dissatisfaction among healthcare professionals (4). Surgical resident training programs often overlook soft skills like conflict management, despite their importance in healthcare settings (5). Recent research highlights the critical need to incorporate conflict management and communication training into surgical residency programs, addressing a longstanding gap in curricula that have traditionally focused on clinical and technical competencies (6). Conflict management competencies are essential in various contexts, including

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organizational performance, local governance, and educational settings (7).

While conflict management is recognized as an essential competency across diverse settings, the surgical environment—with its steep hierarchies, high-pressure operative dynamics, and interprofessional teamwork—creates a particularly unique and critical area for focused study (8). Competency-based medical education (CBME) represents a paradigm shift in medical training, centering on learners' ability to demonstrate essential competencies rather than advancing based on time spent in training. This model prioritizes integrating theoretical knowledge with clinical practice, ensuring that students develop practical, evidence-based skills in real-world settings (9). Clive Chappell et al. (10) and Nazik Hammad (11) emphasize the importance of competency-based education in designing training programs that accurately diagnose educational needs and improve the applicability of learning. Despite some studies in the field of conflict in healthcare settings, especially in nursing and health management (12-14), given the complexity of the surgical environment and the critical role of teamwork in achieving successful treatment outcomes, identifying and developing competencies in conflict management for surgical residents is an undeniable necessity (10). However, there has been limited targeted and coherent research on the specific roles, challenges, and competencies required of surgical residents in managing conflict. This review focused on surgical residents because conflict dynamics in surgical training are shaped by unique factors, including steep hierarchies, high-pressure operative environments, and multidisciplinary team interactions. These conditions differ significantly from other residency programs (2). The study aims to map conflict management competencies essential for surgical residents in clinical settings. Findings provide valuable insights for researchers, educators, and policymakers to enhance surgical education and professional performance.

Objectives

This review aims to identify the essential competencies in conflict management required of surgical residents.

Methods

Scoping reviews are designed to map the existing body of literature on a broad topic area, offering an overview of potentially extensive and diverse research (11). This scoping review was conducted following Arksey and O'Malley's (11) iterative five-stage framework, as outlined Figure 1.

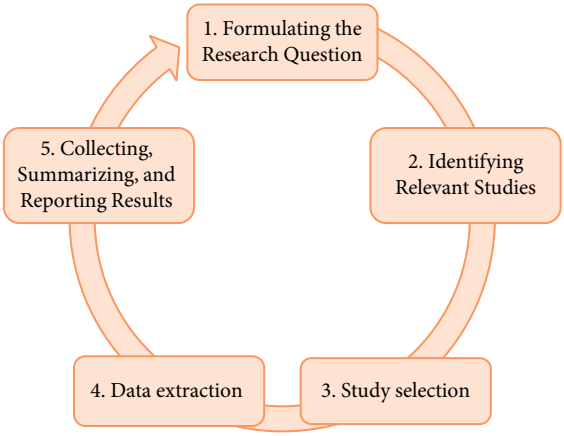

Figure 1. Steps in Conducting the Study

1. Identifying the Research Question

The research question was developed using the PCC framework (Population, Concept, and Context), as follows:

Population: Surgical residents

Concept: Conflict management competencies

Context: Clinical environment

This structured approach ensured the scope of the review remained focused and clinically relevant, addressing the specific needs of surgical trainees who encounter conflict in real-world healthcare contexts.

The main research question was as follows:

What are the required competencies for clinical conflict management in surgical residents?

The specific questions are:

1. Which conflict management competencies are essential for surgical residents in the clinical setting?

2. What strategies are effective for teaching and developing conflict management competencies in the clinical setting?

3. What contextual factors (e.g., cultural, institutional, hierarchical) influence conflict situations and their resolution in a clinical setting?

2. Identifying Relevant Studies

A comprehensive search strategy was developed using MeSH and standardized keywords to ensure broad and accurate retrieval across databases. Searches were conducted in both national (SID, Magiran, Irandoc, Civilica) and international databases (PubMed, Scopus, Web of Science, ProQuest, ERIC, EBSCO, Emerald, and Google Scholar). All retrieved records were screened using predefined eligibility criteria to include only studies involving surgical residents, with keywords summarized in Table 1.

Table 1. Keywords and Search Terms used in this study

Concept 1: Conflict management		Concept 2: Competency		Concept 3: Clinical setting		Concept 4: Surgical assistants
OR Conflict direction OR Conflict handling OR Conflict control OR Conflict Resolution	AND	OR Competence OR Ability OR Capacity OR Aptitude OR Skill OR Capableness	AND	OR Clinical context OR Clinical Environment OR Clinical location OR Operating Room Environment OR Healthcare Setting OR Clinical situation OR Clinical position OR Hospital Setting	AND	OR Surgical residents OR Surgical Trainee OR Surgical practitioners OR Junior surgeons

3. Study Selection and Screening

All retrieved articles were imported into EndNote (Version 18), and duplicates were removed. Study selection proceeded with title and abstract screening, followed by full-text review of potentially relevant studies. To ensure methodological rigor and maintain relevance, predefined inclusion and exclusion criteria—based on the research objectives—were applied during article selection (Table 2). The final selection of articles included in the review was independently assessed by two authors (Z.S. and S.N.). Any disagreements or discrepancies were resolved through discussion with a third author (Sh.B.) to reach a consensus, ensuring a rigorous and unbiased screening process.

Table 2. Eligibility Matrix: Inclusion and Exclusion Criteria

Study Characteristics	Inclusion Criteria	Exclusion Criteria
Population	Studies focusing explicitly on surgical residents or assessing their conflict management skills.	Studies not targeting surgical residents or lacking a clear population definition.
Concept	Studies that define, teach, or evaluate conflict management competencies.	Studies unrelated to conflict management or focused solely on technical/therapeutic issues.
Context	Studies conducted in or adaptable to real clinical settings.	Studies in non-clinical contexts or lacking applicable components.
Time Frame	Published between January 1, 2011, to March 20, 2024.	Published outside this range.
Language	English and Persian.	Any language other than English or Persian.
Study Design	Original research, reviews, and relevant letters to the editor.	Case reports, conference abstracts, editorials.

4. Data Extraction

To ensure transparent and comprehensive data reporting, this scoping review adhered to the PRISMA Extension for Scoping Reviews (PRISMA-ScR) checklist (12). This form was used to extract data from the included studies. A team meeting was held to ensure a shared understanding of terminology before distributing articles. The initial studies were assigned to two authors, and the data from the articles were then entered into the form. The data extraction table included items such as the year of study, article language, country, authors, conflict management competencies, and educational strategies for conflict management.

5. Collecting, Summarizing, and Reporting Results

After extracting data from the included studies, inductive content analysis was used to analyze the findings. The process began with coding, where key concepts were identified from the extracted data. Similar

or related codes were then grouped into broader categories. This step helped organize the data by identifying patterns and conceptual similarities among the codes.

Process for Data Synthesis:

Data were extracted from included studies using a structured PRISMA-ScR form covering Dimension, Main Components, Subcomponents, Key Findings, Objective, Study Type, Country, and Authors (Appendix 1).

Extracted data were summarized through tables and figures showing publication year, study type, and country distribution. An inductive content analysis was then conducted to identify key codes, subcategories, and categories related to conflict management competencies in surgical settings. Final results, limitations, and recommendations for future research were comprehensively reported.

Results

The number of retrieved articles from each database is shown in Table 3.

A total of 9,252 articles were retrieved in the database search. After duplicate article removal and screening, 35 articles were selected for final analysis. The characteristics of the final extracted articles are included in Appendix 1. The PRISMA flow diagram for the study is shown in Figure 2 below.

Among the included studies, the subspecialties represented were general surgery (30 studies), orthopedics (1 study), and mixed surgical cohorts (4 studies). This breakdown provides additional insight into the contexts in which conflict management competencies have been studied.

Table 3. Number of retrieved articles from each database

Database	Number of Articles Retrieved
SID	58
Magiran	32
Irandoc	29
Civilica	47
ERIC	345
Scopus	509
PubMed	2,902
ProQuest	621
PsychINFO	170
Web of Science	916
Emerald	230
EBSCO	223
Google Scholar	3,150
Total	9,232

Distribution of Studies by Publication Year

The 35 included studies were published between 2011 and 2024. The most studies were published in 2011 (13-16) and 2012 (17-20), with 4 studies each. The distribution of studies by year of publication is presented in Figure 3.

Type of Studies

The 35 included studies were classified into four main categories; the types of the final included studies are presented in Table 4.

Table 4. Types of the final included studies

Methodology	Method	Number of Studies
Quantitative Studies	Cross-sectional/Descriptive	8
	Retrospective	1
	Experimental (including RCT and intervention studies)	2
	Quasi-experimental	1
	Survey-based	3
Qualitative Studies	Content Analysis	3
	Phenomenological	2
	Grounded Theory	1
	Other (e.g., focus group or unspecified qualitative)	2
Mixed-Methods Studies	Mixed-methods (exploratory/explanatory not specified)	2
Review Studies	Systematic Review	5
	Scoping Review	3
	Analytical Review	2
Total		35

Distribution of Studies by Country

A total of 35 studies were included in the review, originating from various countries. The United States contributed the largest number of studies, with 15 (6, 13, 15, 18-29). The distribution of studies by continent is presented in Figure 4.

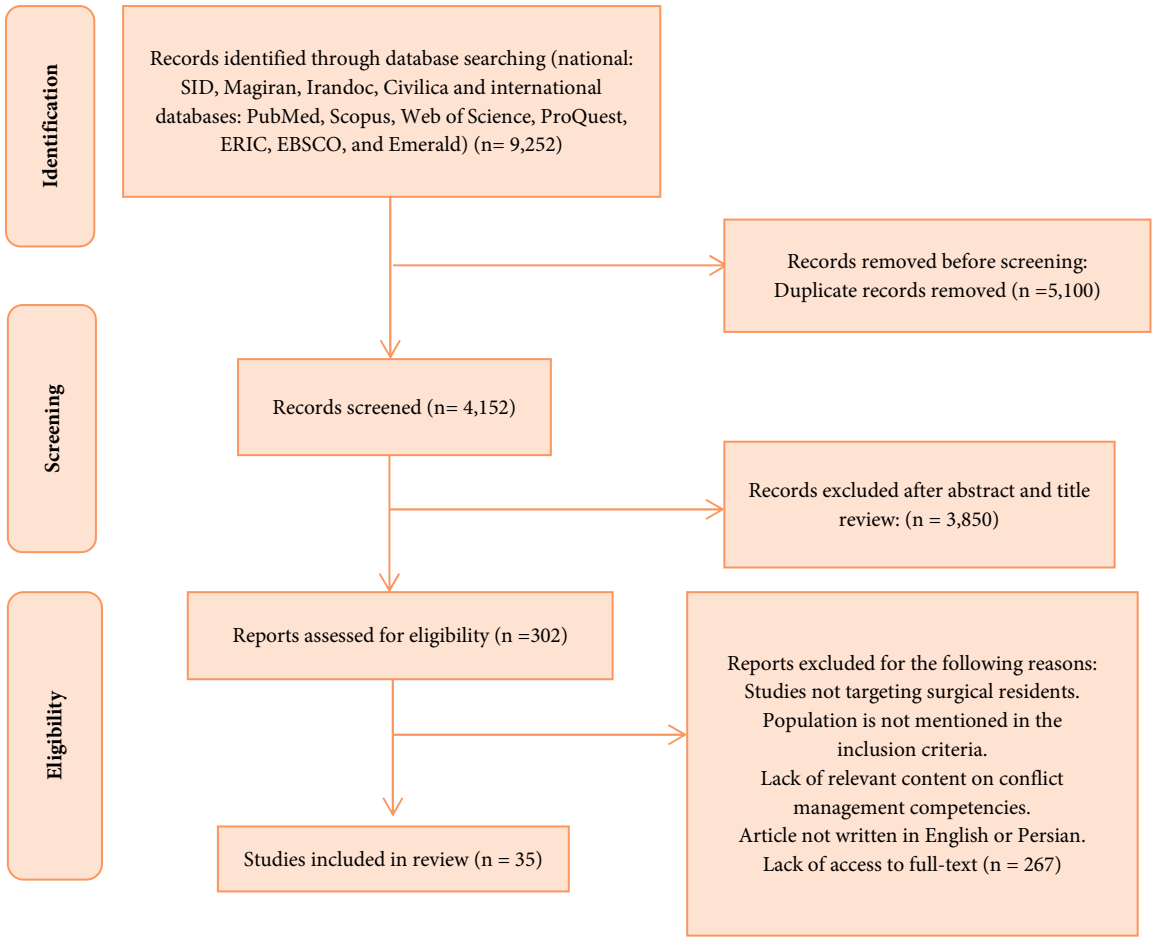

Figure 2. PRISMA flow diagram of the study selection process

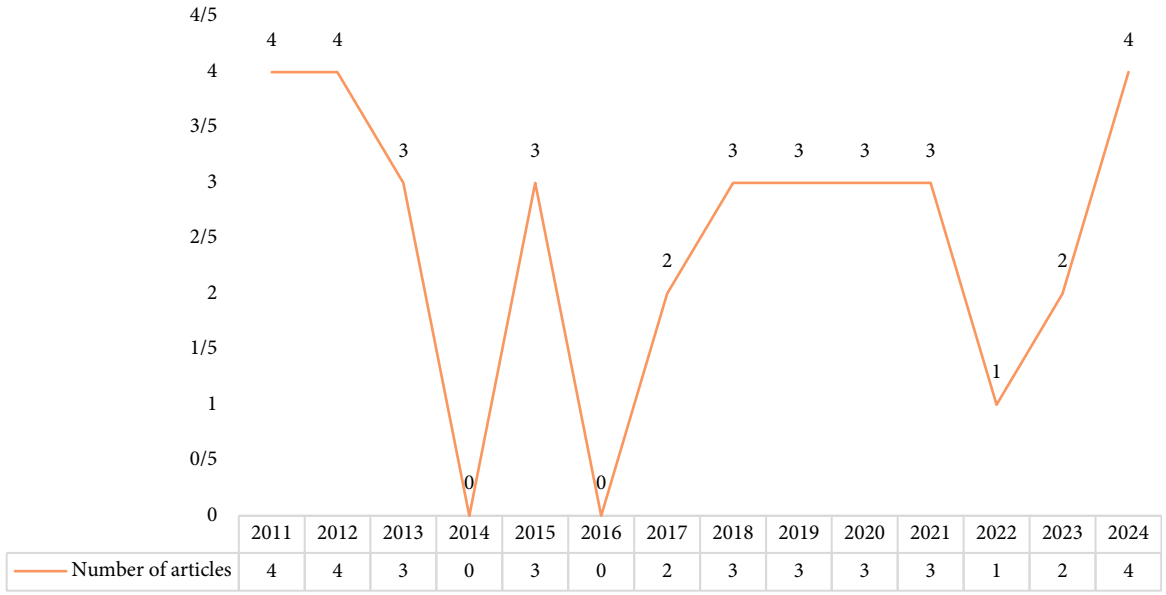

Figure 3. Publication Year of Studies



Figure 4. Distribution of Extracted Articles Based on Geographical Continents

Content Analysis of Extracted Data

An inductive content analysis approach was employed to analyze the extracted data.

The process began with identifying codes and their frequency. Similar codes were grouped into subcategories, which were further refined into broader categories. The codes and their corresponding categories are presented in Tables 5 and 6.

Table 5. Codes and their frequency

N.	Code (Frequency)	N.	Code (Frequency)	N.	Code (Frequency)
1	Brief didactics training (12)	18	Evidence-Based practice (11)	35	Stress (8)
2	Workshop-based training (9)	19	Professionalism (7)	36	Dynamic culture (6)
3	On-the-job and clinical environment training (7)	20	Emotional Intelligence (8)	37	Lack of proper planning (8)
4	Conflict simulation with feedback (6)	21	Managing hierarchy (7)	38	Organizational hierarchy (12)
5	Role-playing (5)	22	Self-improvement (7)	39	Political and social context (10)
6	Case study-based training (7)	23	Self-awareness (9)	40	Lack of medical personnel (5)
7	Experiential learning (7)	24	Active listening (6)	41	Diversity of roles and specialties (6)
8	Problem-Based Learning (6)	25	Clinical experience (7)	42	Clinical burnout and stress (6)
9	Team-based learning (9)	26	Uncertainty about treatment method (6)	43	Weak/incomplete communication (12)
10	Lecture (5)	27	The variety of moral, philosophical views (8)	44	Unclear responsibilities (4)
11	Reflective practice (6)	28	Insufficient patient information (7)	45	The educational nature of the clinical center (6)
12	Communication skills (8)	29	Variety of surgical procedures (6)	46	Delay reporting and managing conflicts (10)
13	Negotiation skills (14)	30	Unscientific decision making (6)	47	Autocratic leadership (3)
14	Empathy (8)	31	Role ambiguity (6)	48	Negative environments (6)
15	Flexibility (9)	32	Complexity of the clinical environment (9)	49	Judgment and decision-making skills (8)
16	Situations Analyzing skill (10)	33	Workload (11)	50	Check out other views (10)
17	Stress management (6)	34	Different scientific and experimental levels (5)		Total: 362

Table 6. Codes, sub-category, category, and themes obtained from articles

Category	Subcategory	Code (Frequency)
Educational Approaches to Conflict Competency Training	Formal and Structured Training	Brief didactics training (12)
		Workshop-based training (9)
		On-the-job and clinical environment training (7)
		Lecture (5)
	Interactive and Experiential Learning	Conflict simulation with feedback (6)
		Role-playing (5)
		Case study-based training (7)
		Experiential learning (7)
		Problem-Based Learning (6)
		Team-based learning (9)
		Reflective practice (6)
Conflict Management Competencies	Intrapersonal Skills	Empathy (8)
		Self-awareness (9)
		Self-improvement (7)
		Emotional Intelligence (8)
		Stress management (6)
		Flexibility (9)
		Clinical experience (7)
		Situations Analyzing skill (10)
		Evidence-Based practice (11)
		Judgment and decision-making skills (8)
	Interpersonal and Professional Skills	Communication skills (8)
		Professionalism (7)
		Managing hierarchy (7)
		Check out other views (10)
		Active listening (6)
Contextual Factors of Conflict Formation	Social Context and Organizational Factors	Role ambiguity (6)
		Complexity of the clinical environment (9)
		Workload (11)
		Dynamic culture (6)
		Insufficient patient information (7)
		Organizational hierarchy (12)
		Lack of medical personnel (5)
		The educational nature of the clinical setting (6)
		Delay reporting and managing conflicts (10)
		Unclear responsibilities (4)
		Autocratic leadership (3)
		Negative environments (6)
		Variety of surgical procedures (6)
		Diversity of roles and specialties (6)
		Lack of proper planning (8)
		Clinical burnout and stress (6)
		Political and social context (10)
	Personal and Role-related Factors	Uncertainty about treatment method (6)
		The variety of moral, philosophical views (8)
		Unscientific decision making (6)
		Different scientific and experimental levels (5)
		Weak/incomplete communication (12)
		Stress (8)

Discussion

This scoping review aimed to map the essential conflict management competencies for surgical residents in clinical settings. As a result of the content analysis process, three main categories were identified that reflect the multifaceted nature of conflict in clinical settings:

(1) Educational Approaches to Conflict Competency Training.

(2) Conflict Management Competencies.

(3) Contextual Factors of Conflict Formation.

1. Educational Methods: Bridging Theory and Practice

The first category includes formal and informal instructional strategies focused on experiential and reflective learning approaches—such as simulations, role-playing, case studies, and continuous feedback—to prepare learners for real-world conflict management effectively. The diverse teaching strategies—from formal courses and workshops to experiential learning through simulations and role-playing—highlight the complexity of preparing healthcare professionals for conflict resolution. These findings align with Kolb's experiential learning theory (30), emphasizing that active engagement with real-life-like scenarios enables learners to internalize and apply conflict management skills more effectively. Conflict simulation with feedback underscores Ericsson's concept of deliberate practice (31), reinforcing the importance of feedback and iterative learning in mastering conflict competencies. Such approaches not only develop cognitive understanding but also foster emotional readiness and behavioral adaptability, critical for navigating the unpredictable, high-stakes nature of clinical conflicts.

2. Conflict Management Competencies: Interpersonal and Emotional Foundations

The second category highlights the central competencies required for conflict resolution, including emotional regulation, communication, empathy, role clarity, and collaborative problem-solving as fundamental to resolving clinical conflicts. The competencies identified are consistent with established psychological and organizational theories. Empathy and perspective-taking facilitate mutual understanding and reduce miscommunication, resonating with Johnson and Johnson's Social interdependence theory (32). Emotional regulation's prominence reflects current evidence linking healthcare workers' stress management capacity with conflict outcomes (33).

3. Social Context and Organizational Factors: The Systemic Lens

The third category underscores the influence of systemic and contextual factors that shape conflict dynamics beyond individual interactions. Contextual factors such as hierarchical power imbalances, organizational culture, and political dynamics emerge as fundamental in shaping conflict patterns. These findings support Schein's model of organizational culture (34) and Coser's structural conflict theory (35), which articulate how embedded power relations and cultural norms create fertile ground for conflict. The identification of the political and social context extends the analysis to Jackson's social conflict resolution (36), emphasizing that conflict cannot be fully understood without considering the broader socio-cultural environment. Role ambiguity's influence on conflict supports role theory (37), highlighting how unclear expectations increase interpersonal tension.

Thus, conflict management requires not only skill acquisition but also clarity in professional roles. This systemic perspective underscores the need for organizational interventions alongside individual skill development. As Bronfenbrenner's (38) socio-ecological model suggests, effective conflict management must operate across multiple levels—individual, team, and organizational—to produce sustainable change.

Our integrative findings extend prior studies (39-41) by demonstrating the interconnectedness of educational, interpersonal, and organizational domains. While earlier research often examined these factors separately, our analysis shows their dynamic interplay and cumulative impact, underscoring that isolated interventions may fail to address the root causes of clinical conflict.

Strengths and Limitations of the Study

The key strengths and limitations of this scoping review are summarized in Table 7, providing an overview of its methodological rigor and contextual boundaries.

Practical Implications

The practical implications of this review for education, training, and organizational leadership are summarized in Table 8.

Table 7. Strengths and Limitations of the Review

Category	Description
Strengths	1. This scoping review systematically mapped a decade's worth of literature, providing a comprehensive overview of conflict management competencies relevant to surgical residents in clinical settings. 2. Inclusion of both national and international databases expanded the scope and relevance of findings across diverse healthcare systems. 3. Inductive content analysis allowed for the identification of key categories that offer practical insights for curriculum development and organizational policy.
Limitations	1. Potential publication bias: Relevant studies may have been missed due to limited indexing or non-publication in peer-reviewed sources. 2. Language bias: Restriction to English and Persian studies may have excluded evidence from other regions (e.g., South America). Future reviews, including additional languages, could provide a broader perspective. 3. Study heterogeneity: Variability in study design, settings, and populations limited comparability and synthesis. 4. Lack of quality assessment: As a scoping review, no formal appraisal of methodological quality was conducted. 5. Context specificity: Findings from culturally or institutionally specific studies may not be generalizable to all clinical environments.

Table 8. Recommendations for Education, Training, and Organizational Leadership

Domain	Recommendations
Education and Training	• Develop diverse learning programs combining formal instruction with experiential methods such as simulations, role-playing, case studies, and on-the-job training. • Embed continuous formative assessments to provide ongoing feedback and support deliberate skill refinement. • Integrate emotional intelligence and empathy training to improve interpersonal conflict resolution, focusing on emotional regulation and effective communication. • Design curricula that are sensitive to cultural, organizational, and socio-political contexts affecting conflict. • Clarify roles and responsibilities clearly within the curriculum to reduce ambiguity and role-based conflicts. • Encourage lifelong learning and reflective practice to support sustained development of conflict management competencies.
Organizational Leadership	• Cultivate transparent, democratic leadership and equitable power distribution. • Enhance communication infrastructure to facilitate information flow and early conflict detection. • Promote a positive organizational culture valuing open dialogue and shared goals. • Embed conflict management practices across individual, team, and organizational levels within healthcare institutions.

Conclusion

This scoping review synthesizes evidence that effective conflict management for surgical residents is a multifactorial competency requiring integrated development through tailored education and supportive organizational structures. Embedding these principles into CBME frameworks is essential for fostering resilient surgical teams and safeguarding patient safety. Future research should explore how these principles can be embedded into competency-based medical education to cultivate collaborative, resilient healthcare teams.

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Appendix 1. Characteristics of final extracted articles

Authors	Country	Study Type	Objective	Key Findings	Subcomponents	Main Components	Dimension
Surapaneni KM.(42)	India	Analytical review	ABC framework to enhance residents' conflict resolution skills	Expertise recognition, power balance, and transparent communication improve teamwork and patient-centered care	Recognizing expertise, Role and power balance, Transparent and empathetic communication	Respect for expertise, Balanced decision-making, Clear communication	Individual Interpersonal Organizational
Mohseni F, & et. al.(43)	Iran	Scoping review	Review of educational methods for teaching conflict management to medical students	Active and interactive methods were frequently used, but no single method proved superior.	Role-playing, Standardized patient, Case-based simulation	Learner-centered approaches for better conflict management	Active learning methods for conflict management in medical students
Mohseni F, & et. Al. (44)	Iran	Randomized controlled trial	Evaluating the impact of Fogg model-based training on medical students' attitudes toward conflict management	Training with the Fogg model significantly improved medical students' attitudes toward conflict management.	Increasing motivation, simplifying conflict management, Using supportive learning tools (e.g., reminder messages)	Enhancing communication, Impact of Fogg model on behavior change, Strengthening conflict resolution skills	Active learning methods for teaching conflict management
Okoli C, & et. al.(45)	India	Analytical Review	Improving residents' conflict resolution skills to enhance teamwork and patient-centered care	Fifty-two point two percent of residents lacked conflict management knowledge; 93% preferred avoidance; 83% interested in training	Decision-making, emotional regulation, effective communication	Cognitive, Emotional, Behavioral Skills	Conflict Competence
Gunasingha & et. al.(24)	USA	Quasi-experimental intervention study	Examining variations in conflict resolution styles among medical residents and their impact on conflict management skills	Integrating conflict management in curricula improved residents' skills. Simulation and virtual reality were effective.	Motivation enhancement, Simplified strategies, Supportive learning tools	Conflict resolution competency, Team communication improvement	Continuous training and assessment in conflict management
Konlan KD, & et. al. (46)	Ghana	Qualitative	Assessing the impact of conflicts among clinical professionals on patient care in Tamale Teaching Hospital	Conflicts affect professionals, hospitals, and policies. Poor conflict management leads to widespread negative consequences. Conflicts must be addressed immediately to avoid time and cost loss. High conflict experience exists within clinical teams.	Individual training, Organizational planning	Impact of conflicts on different hospital aspects	Strategic planning for clinical conflict management
Mohammed EN.(47)	Nigeria	Descriptive, cross-sectional	Examining knowledge, causes, and experiences of interprofessional conflict in a Nigerian university	Majority of clinical team members experienced interprofessional conflict, delaying career advancement. Poorly managed conflicts negatively impact patient care and accessibility to high-quality healthcare.	Addressing conflict sources, Ensuring a peaceful healthcare environment	Prevalence and impact of interprofessional conflict, Career progression delays	Fair compensation and conflict reduction in clinical teams

Andriopoulou M, & et. al.(48)	Greece	Descriptive, cross-sectional	Examining conflicts in the operating room, identifying causes, and proposing management strategies	Most participants experienced interprofessional conflicts, with workload and compensation disparities being key contributors. Lack of awareness about conflict management strategies was widespread. Organizational policies and democratic leadership improved resolution.	Early conflict identification, Democratic leadership, Equity in compensation, Empathy-driven teamwork	Role differentiation, Leadership structures, Fair resource distribution	Necessity of conflict management training for nurses and physicians in the operating room
Lyons O, & et. al. (49)	UK	Mixed-methods study	Implementation and evaluation of a conflict management framework in pediatric healthcare services	Training interventions reduced time spent on conflict resolution by 24%. Conflict resolution was more challenging for older patients and severe cases. Educational investments improved healthcare outcomes and efficiency.	Effective educational interventions, Patient-centered conflict management, Complexity of resolution in high-patient-load scenarios	Reducing clinical workload, Training healthcare teams, Minimizing patient hospitalization costs	Strategic planning and investment in conflict management competencies
Sivrikova N, & et. al.(50)	Russi	Survey	Assessing students' competencies in conflict management	Participants reported adequate conflict resolution skills. Self-reported competencies highlighted the importance of understanding communication context and predicting actions. Most students valued principles of tolerance but rated personal resilience lower. 80% agreed on non-violence as a core principle.	Multidimensional approach, Resilience training, Emotional regulation	Communication skills, Self-assessment of conflict resolution, Inclusion in educational programs	Long-term educational planning and integration of conflict management competencies in curricula
Dossett LA, & et. al.(23)	USA	Qualitative	Exploring interprofessional conflict scenarios among surgeons, its impact on personal, professional, and patient outcomes, and surgeons' decision-making in conflict situations	Conflict often stems from communication breakdowns and performance issues. Participants reported personal and professional consequences, including self-doubt, anxiety, and career delays. Reduced communication due to unresolved conflicts posed risks to patient safety. Identified strategies include relationship management, improved communication, and enhanced social capital.	Performance-related conflict sources, Organizational policy violations, Cultural tensions	Environmental resources and clinical team competencies, Gender-based disparities, Evidence-based guidelines	Strategic and structured planning for conflict management

Michael Shanahan E, & et. al. (51)	Netherlands	Qualitative, phenomenological	Exploring clinical educators' lived experiences of interprofessional conflict in medical settings	Physicians highlighted the psychological and behavioral issues of students as a major factor influencing conflict occurrence and intensity. Conflicts had a significant emotional impact on physicians, often leading to avoidance strategies. The study underscored how physician perspectives on challenging student interactions affected educational quality.	Challenges in evaluating attitudes, Role conflict due to workload, Professional behaviors and communication	Physicians' heightened responsibility, Psychological and attitudinal assessment	Addressing emotional and attitudinal factors in curriculum design
Barr KP, & et. al.(6)	USA	Descriptive	Evaluating the impact of workshop-based training on conflict resolution skills among physical medicine and rehabilitation residents in a group setting	Ninety-seven percent of participants felt prepared to manage conflicts after training. Simulation-based learning was highly effective and perceived as realistic. Skill application improved across all model stages.	Hot-seat simulation model, Standardized patient role-play, Acceptance of simulation training	Peer feedback and coaching, Simulation-based learning, Practical conflict resolution skills	Utilizing innovative and active methods for conflict management training
Broukhim M, Yuen F, & et. al.(21)	USA	Mixed-methods study	Exploring interprofessional conflicts in a hospital from the perspective of three healthcare student groups	Conflict is a significant part of clinical training, but education systems do little to prepare students for managing it. Students reported frequent conflicts with professionals in their own field. 44% were dissatisfied with conflict management approaches.	Interprofessional conflict themes: relationships, values, systems, role ambiguity, hierarchy, personality, communication	Conflict resolution styles, Prevalence in medical fields, Key sources	Organizational conflicts and their management in healthcare
Sinskey JL, & et. al. (28)	USA	Review	Developing a framework for improved conflict management among surgeons in operating environments	Effective communication improves conflict resolution. Cultural differences impact patient care. Structured training enhances teamwork in high-stakes environments.	Emotional regulation, Active listening, Formal conflict management training	Addressing vulnerable patient groups, Training for conflict resolution styles, Cultural competency	Enhancing communication skills and understanding patients' needs in conflict situations
Cullati S, & et. al. (52)	Switzerland	Qualitative, content analysis	Examining healthcare professionals' experiences and understanding of conflict impact on patient care	Forty-one percent of conflicts had potential patient care consequences, mostly delays and extended hospital stays. Intraprofessional conflicts reduced patient-centered care, while interprofessional conflicts affected timeliness.	Defining six key care dimensions: safety, effectiveness, patient-centeredness, timeliness, efficiency	Conflict effects on patient care quality, Delays in medical services, Direct health impact	Assessing the impact of conflict situations on patient health and their management
Pitsillidou M, & et. al. (53)	Cyprus	Survey	Identifying conflict management strategies among healthcare professionals in Cyprus hospitals	Workload and unclear directives cause conflicts. Most professionals report dissatisfaction with pay. Avoidance is the most used resolution strategy, followed by negotiation. More experienced staff prefer negotiation.	Communication and collaboration, Professional rights, Clear role allocation	Workload impact, Conflict resolution competencies, Organizational policies	Establishing a strategic vision for conflict reduction in healthcare organizations

Cochran N, & et. al. (22)	USA, Washington	Systematic review	Defining core competencies for effective conflict resolution among healthcare professionals	Essential competencies include emotional regulation, constructive communication, teamwork, and cultural awareness. Training enhances professional interactions and conflict resolution abilities.	Self-awareness, active listening, empathy, collaborative problem-solving	Individual, interpersonal, and group competencies	Integrating conflict management competencies into medical curricula
Wolfe AD, & et. al.(29)	USA	Intervention study	Enhancing conflict management skills through communication training	Training improved team dynamics and conflict resolution strategies. Emphasis on nonverbal communication, structured discussions, and team-based exercises was valuable. Motivation to engage in conflict resolution workshops declined over time.	Interactive workshops, Peer feedback, Communication skill enhancement	Conflict resolution training, Reflection in practice, Continuous evaluation	Evident effectiveness of educational interventions in clinical conflict management
Kim S, & et. al. (25)	USA, Washington	Scoping review	Reviewing studies on conflict management sources and outcomes in medical settings	Conflict sources include personal traits, poor communication, and organizational constraints. Leadership transparency and structured policies enhance conflict resolution.	Personal traits, leadership styles, systemic barriers	Individual, interpersonal, and organizational conflict factors	Strengthening communication and organizational management for conflict resolution
Jerng J-S, & et. al.(54)	Taipei, Taiwan	Quantitative, retrospective	Examining medical errors linked to interprofessional conflicts	Significant correlation between conflicts and medical errors. Surgical specialists experience conflicts more frequently. Most reported errors involve patient transfers, lab tests, surgeries, and imaging.	Job role distribution, Reporting mechanisms, Professional disagreements	High prevalence of clinical conflicts, Impact on patient safety, Institutional oversight	Establishing a reporting system for documenting and managing conflict situations
Leksell J& et. al. (55)	Sweden	Survey	Assessing physicians' conflict management competency levels	No significant difference in conflict management competencies among medical disciplines. Continuous education enhances conflict resolution skills. Physicians acknowledged workshops as effective for skill development.	University training impact, Experience-driven improvement, Consistency across specialties	Identifying essential competencies, Continuous assessment, Inclusion across medical fields	Training and integrating conflict management competencies into continuing medical education
Akel DT, & et. al.(56)	Egypt	Descriptive, cross-sectional	Analyzing factors and sources of conflict between physicians and trainees	Physicians and nurses share similar conflict causes and resolution approaches. Compromise is the preferred strategy among both groups, though physicians use it more frequently. Physician-student conflicts impact academic evaluations.	Workload issues, Personality differences, Educational disparities	Physician-nurse collaboration, Causes of conflict, Resolution strategies	Examining conflict management styles across clinical teams
Attri JP, & et. al. (8)	China	Systematic review	Investigating causes and factors contributing to conflicts in surgical environments	Effective communication prevents conflicts and improves teamwork. Operating rooms require strong collaboration due to shared responsibilities. Resolving conflicts enhances patient safety and professional relationships.	Impact of poor communication, Team-based conflict resolution, Multidisciplinary coordination	Positive conflict resolution, Professional collaboration, Respectful communication	Establishing reliable communication channels for conflict management in the operating room

Rogers DA, & et. al.(27)	USA	Qualitative, focus group	Exploring surgical team perspectives on conflict management training, its impact, and effective strategies	Surgeons primarily learn conflict management through trial and error, leading to stress and patient care disruptions. Continuous training enhances team cohesion and conflict resolution skills.	Problem-solving, Communication reinforcement, Emotional resilience	Training deficiencies, Impact on team performance, Stress reduction strategies	Importance of conflict management competency training for surgical teams
El-Masry R, & et. al.(57)	Egypt	Descriptive, cross-sectional	Investigating perceived sources of conflict between surgeons and anesthesiologists in a healthcare center	Conflict between anesthesiologists and surgeons stems from work pressures, unclear patient roles, and communication gaps. Staffing shortages and excessive workload are major contributors.	Anesthesia-surgery team dynamics, Workplace stressors, Decision-making challenges	Staff shortages, Conflict sources, Patient preferences	Importance of continuous patient communication for conflict management
Olson TJP, & et. al.(26)	USA	Descriptive, cross-sectional	Examining surgical team perspectives on conflict management and its consequences	Less experienced surgeons report higher conflict rates. Effective conflict management requires structured education, time, and experience. Surgeons with stronger patient communication skills manage conflicts more effectively.	Impact of surgeon experience, Postoperative psychological factors, Need for structured training	Academic vs. private practice conflicts, Experience-related conflict trends, Surgeon-patient communication	Managing high conflict rates between surgeons and the healthcare team in critical patient care
Opatt D, & et. al.(20)	USA	Qualitative, content analysis	Assessing conflict intensity and experiences among surgeons	Experienced surgeons report fewer conflicts. Disagreements over surgical choices, particularly in aesthetic procedures, are common. Surgeons in specialized cancer centers face higher conflict rates than those in general hospitals.	Variability in conflict across surgical fields, Experience-related trends, Aesthetic surgery disputes	Differences in perception, Conflict management strategies, Curriculum integration	Addressing surgeon-patient conflicts in selecting surgical interventions
Katz JD. (18)	USA	Systematic review	Reviewing common sources and solutions for conflict in healthcare settings	Poor communication contributes to medical errors and inefficiencies. Conflict resolution requires both institutional frameworks and personal strategies. Structured programs improve team cohesion and patient safety.	Miscommunication risks, Systematic barriers, Structured resolution approaches	Institutional and individual conflict resolution, Impact on patient safety, Strategic planning	Enhancing clinical team communication for effective conflict management
Lee L, & et. al.(19)	USA	Systematic review	Identifying conflict resolution methods and strategies in medical education	Formal conflict resolution training for surgeons is limited. Poor conflict management affects patient outcomes and career progression. AGME emphasizes communication skills in residency training.	Structured resolution models, Communication-based strategies, Leadership approaches	Accreditation standards, Conflict resolution techniques, Leadership styles	Importance of open and flexible communication for effective conflict management
Greer LL, & et. al. (17)	Netherlands	Systematic review	Examining intergroup conflicts in medical education	Task conflicts impact team performance but can be mitigated. Process and relationship conflicts hinder clinical efficiency. Structured resolution strategies improve conflict management.	Task, process, and relationship conflicts, Four resolution methods: coercion, submission, avoidance, problem-solving	Classification for better management, Conflict resolution strategies, Root cause analysis	In-depth analysis and categorization of conflict situations

Baldwin Jr DC, & et. al. (13)	USA, Chicago	Descriptive, cross-sectional	Examining conflict experiences, effects, and contributing factors among medical residents	Twenty percent of residents reported serious conflicts. 23.8% admitted to medical errors due to conflict. Neurology and obstetrics had the highest conflict rates, while pathology and radiology had the lowest.	High conflict prevalence, Link to medical errors, Specialty-based differences	Impact on patient care, Interprofessional collaboration, Conflict variation across specialties	Enhancing a positive team environment and reducing workplace stress
Saltman DC, & et. al.(16)	Australia, Sydney	Qualitative, content analysis	Developing a structured model for conflict resolution in medical education	Human interactions in medicine inherently lead to conflicts. Poor conflict management negatively affects patient satisfaction. A structured four-phase conflict resolution model enhances professional competency.	Conflict formation model, Impact on patient care, Intergroup communication	Structured training, Root cause analysis, Systematic resolution frameworks	Revising medical curricula based on conflict management models
Brown J, & et. al.(14)	UK, London	Qualitative, phenomenological	Investigating healthcare professionals' experiences with conflict and response strategies	Conflict stems from unclear roles, excessive workload, and avoidance behaviors. Leadership strategies include structured protocols, open communication, and proactive resolution approaches.	Role ambiguity, Time constraints, Leadership interventions	Workload reduction, Effective leadership, Continuous training	Examining barriers, sources, and strategies for conflict resolution by organizational leaders
Rogers D, & et. al.(15)	USA	Qualitative, grounded theory	Examining conflict formation in surgical teams to design educational management programs	Poor resource allocation and non-scientific language contribute to surgical conflicts. Emotional responses impact conflict resolution speed. Structured conflict management improves efficiency and team cohesion.	Resource allocation, Communication barriers, Positive and negative conflict outcomes	Team values, Leadership dynamics, Emotional awareness	Considering environmental and cultural factors for better conflict management

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Review Article

Explanation of the Optimal Structure for the University Education System in Realizing the Concept of Responsive Medical Education: A Narrative Review Study

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Abstract

Background: Medical universities are tasked with addressing societal needs and improving health outcomes effectively. They must provide education that trains skilled graduates capable of responding to public health challenges in alignment with contemporary requirements. The World Health Organization has underscored the importance of this approach. However, studies show that despite significant efforts, medical education in many universities has not sufficiently met societal demands. Addressing this issue requires fundamental changes to the educational system, effective collaboration with related sectors, such as hospitals and outpatient centers, and a comprehensive revision of curricula to achieve responsive medical education.

Objectives: This narrative review aimed to synthesize literature on the structural components, key challenges, and actionable strategies across leadership, faculty, and student domains required for fostering a responsive medical education system.

Methods: This study is a narrative review. Persian and English articles were retrieved using keywords such as "medical education," "responsive medical education," and "university educational system" from databases, including PubMed, Google Scholar, Scopus, and SID. Ultimately, 55 studies were selected for inclusion based on predefined inclusion and exclusion criteria.

Results: Based on the literature review, the necessity, benefits, challenges in implementation, and effective strategies for achieving responsive medical education were highlighted. These strategies were categorized into three groups according to the roles that universities and faculties play in advancing responsive medical education: The role of university leadership, the role of the faculty, and the role of students.

Conclusion: To implement responsive medical education, a group of individuals must first form with a deep belief in its necessity. Then, a team of experts should define a shared vision and communicate it within the organization to encourage participation in its realization. Empowerment courses and achieving small victories are highly beneficial in this process. This approach is expected to lead to an optimal state in medical education. However, the achievements must be institutionalized within the university's educational culture to ensure sustainability.

Keywords: Medical Education; Social Accountability; Community Health

Background

The university is a social institution that contributes to the comprehensive growth and development of society by training specialized human resources. In fact, the primary mission of a university is to respond to and help solve fundamental societal issues. The purpose of establishing medical universities is to train the necessary and efficient human resources in fields related to medicine, which contributes to improving public health (1). The history of responsive medical education dates

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back to the time of Hippocrates, and its importance has been emphasized ever since (2).

The World Health Organization defines social accountability as guiding educational, research, and service activities to address health concerns and needs in society (3). The health needs and priorities of a community vary over time, influenced by lifestyle, disease prevalence, perceptions of health, diagnostic and treatment costs, and more (1).

Responsive medical education should actively address the social and cultural needs of local communities. This approach can improve educational and health outcomes, enabling students to effectively confront real-world health challenges (4). Social accountability is measured by various criteria; the World Health Organization suggests four criteria: Justice, quality, effectiveness, and appropriateness (5). Additionally, Jalilian et al. proposed two more criteria: Professional ethics and community participation, making six criteria for social accountability (6).

Despite the emphasis on its necessity, studies show a significant gap between student education and meeting societal health needs, often accompanied by dissatisfaction in the educational process (7). A study examining the status of responsive education in clinical groups at Jahrom University of Medical Sciences in 2022 found that the scores for responsive education were not satisfactory (8). Another study in 2016 at Tabriz University of Medical Sciences revealed differences among educational groups, influenced by factors such as communication between educational group managers and the center for medical education development (9).

Akbari et al. categorized the challenges of responsive medical education into four classes: Flawed and non-community-oriented education, managerial issues, resource shortages, inadequate commitment from instructors, and student apathy (10). Henen noted that student education in society is insufficient for addressing community needs and problems; instead, it should focus on providing health services and research, requiring collaboration among policymakers, practitioners, health specialists, community members, educational institutions, and universities (11, 12).

Despite extensive research on social accountability, a unified framework delineating the implementation of social accountability programs and the categorization of stakeholder roles remains absent. This study seeks to address this gap by proposing structural requirements for university educational systems, aiming to operationalize the principles of responsive medical education. The framework offers clear, actionable strategies for educational managers and policymakers to enhance accountability and responsiveness in medical training.

Objectives

This narrative review aimed to synthesize literature on the structural components, key challenges, and actionable strategies across leadership, faculty, and student domains required for fostering a responsive medical education system.

Methods

The present study is a narrative review conducted with a systematic search approach to minimize selection bias. A comprehensive and in-depth search was performed in both English and Persian scientific databases, including PubMed, Scopus, Google Scholar, and SID, using the following Boolean search string: ("Medical education" OR "medical school") AND ("social accountability" OR "responsive education") AND ("structure" OR "model" OR "framework").

Inclusion criteria were:

1. Relevance to the research objective of defining structural requirements for responsive medical education.
2. Focus on medical sciences.
3. Availability of full-text articles.
4. Publication in English or Persian.

Exclusion criteria included studies unrelated to the research topic, conference abstracts without full text, and duplicates. The search covered studies published up to July 20, 2024.

A comprehensive search was conducted across PubMed, Scopus, Google Scholar, and SID databases up to July 20, 2024. The initial database search yielded a total of 142 records. After removing 24 duplicate records using reference management software and manual checks, 118 unique titles and abstracts were screened by two independent reviewers against the inclusion and exclusion criteria. Following this initial screening, 45 irrelevant records were excluded. Full texts of the remaining 73 articles were then retrieved and thoroughly evaluated for eligibility. Ultimately, 55 studies met all criteria and were included in this review for data extraction and qualitative synthesis.

Data extraction and synthesis involved systematically collecting relevant information from each study, including study type, key findings, and proposed strategies. A thematic analysis approach was applied to categorize the extracted data into three main groups of strategies for implementing responsive medical education at the university level.

Results

Necessity of Responsive Medical Education

The literature review revealed that social accountability is considered a primary mission of universities. This has been emphasized as one of the visions of the Islamic Republic of Iran for the horizon of 1404, highlighting the importance of addressing societal needs (13). Additionally, European countries have linked the future of their healthcare systems to societal needs (14).

Efforts to establish a socially responsive structure not only address community problems but also positively impact universities by fostering growth and development. This approach holds universities accountable for the care provided by graduates and the outcomes of research studies (15, 16).

Advancements in responsive education will significantly influence the development of third-generation universities. These universities succeed in identifying and addressing societal needs while integrating entrepreneurship into all activities (17, 18).

Benefits of Responsive Medical Education

The implementation of responsive medical education will ultimately lead to healthcare services provided by universities that meet four key indicators: Improvement and enhancement of quality, equity and fairness, relevance to community needs, and cost-effectiveness (19). Additionally, students will not only learn about various diseases and treatment methods but also gain awareness of the associated social issues (20). This approach also fosters critical thinking and reflection among students throughout their learning journey (21).

Challenges in the Way of Implementation

One of the main challenges in responsive medical education is the lack of coordination between educational content and societal needs. Many educational programs in various medical fields are traditionally designed based on scientific and theoretical requirements, which may not adequately address practical and social needs (22). Therefore, there is a need for an integrated and evidence-based approach to design and implement medical education programs. This approach should include continuous assessment of societal needs and alignment of educational content with these needs (23).

A study by Akbari et al., which aimed to explore faculty members' perceptions of challenges in responsive medical education, found that these challenges include managerial issues, resource shortages, flawed and non-community-oriented education, student apathy, and inadequate faculty commitment (10). Additionally, faculties often prioritize their own interests over societal priorities when defining their missions (10). Furthermore, the educational system interacts minimally with the healthcare system in addressing societal issues, resulting in reduced service delivery to the community (7).

Other operational challenges include managerial deficiencies, inadequate commitment among faculty members, lack of student motivation, and resource scarcity (24). Moreover, there are diverse interpretations of responsive medical education among administrators, faculty members, and program stakeholders (25).

Studies have shown that physicians often lack the necessary knowledge, attitudes, and skills for social responsiveness, which affects their confidence and anxiety, in addition to having negative social impacts (26). A study revealed that 54.3% of family physicians experienced a significant gap between theoretical education and practical expectations during their internship (27). Therefore, it is crucial that student education equips them with both professional skills and the ability to address challenges and problems (28). While educating students to solve community problems is vital and requires a supportive community environment, it should not compromise patient care and safety (29).

In summary, responsive medical education, as a novel approach, requires attention to existing challenges and opportunities in medical education. Given rapid technological and social changes, it is essential that medical education programs be updated and move towards innovative, evidence-based approaches (30).

Strategies for Achieving Responsive Medical Education

Various studies have shown that due to numerous advancements in medical sciences and changes in disease prevalence over time, the knowledge acquired by medical students is often sufficient only for a short period after graduation (16, 31). Therefore, comprehensive and practical planning is necessary, involving national policymakers, health experts, and stakeholder representatives to identify all educational, research, and service priorities in the health sector. In addition to setting national priorities, this planning can be tailored by individual faculties to address regional needs (1).

Several strategies for achieving responsive medical education have been identified in the literature review. These strategies range from curriculum changes to fostering student interaction with clinical environments.

For example, studies suggest that most curricula need revision due to a mismatch between theoretical education and clinical practice (32). A responsive educational program creates a bridge between scientific theories and their practical applications. It identifies the needs of learners and society, thereby aligning education with workforce demands. Such learning experiences enable students to apply their knowledge in real-world scenarios, transforming them into competent and creative professionals (33). Additionally, integrating community-based education into medical programs enhances students' practical and communication skills, preparing them for real-world challenges (34).

To advance social accountability in universities, alignment between defined goals and operational outcomes is crucial (35). Moreover, educational leaders play a pivotal role in achieving these goals. However, the current healthcare system faces a significant shortage of competent leaders in management roles, posing a serious obstacle to progress. Identifying and nurturing leaders capable of implementing responsive medical education and effectively engaging with society is essential (36).

In this research, based on the findings in the literature review, the strategies to achieve responsive medical education have been divided into three different categories based on the roles and duties of universities and colleges, professors, and students as the main stakeholders in advancing this important principle. These findings can be seen in Table 1.

Discussion

As mentioned, responsive medical education is an important approach that emphasizes responding to social needs and promoting health. This approach not only addresses social problems but also contributes to the growth and development of universities and the improvement of the quality of health services. However, the implementation of this approach faces challenges such as a lack of coordination between educational content and social needs, lack of resources, and other barriers. To succeed in implementing responsive medical education, an integrated and evidence-based approach is required, where societal needs are continuously assessed and educational content is aligned with these needs (22, 23).

In summary, implementing responsive medical education requires collaboration from all components of the educational system, including universities, professors, and students. By executing these strategies, it is possible to train physicians who can respond to societal needs and play an effective role in promoting public health. Our review proposes an innovative stakeholder-based framework that delineates distinct responsibilities for leaders, faculty members, and students, providing a clearer roadmap for implementation. This study has several limitations, including incomplete access to databases, potential selection bias in the narrative review, and focus on specific languages and sources (English and Persian). Future research could empirically evaluate the effectiveness of the proposed three-tiered framework for leaders, faculty members, and students, and develop validated tools to assess the impact of these strategies on health and educational outcomes.

As mentioned, the primary mission of universities is to respond to societal needs, although in some texts, it is considered one of the four main missions (49). Responsiveness should be evident not only in educational activities but also in research and the provision of health services (11). Despite recognizing the importance of this issue based on existing documents and evidence, and despite efforts in this direction, we have not yet reached the desired state in medical education, and many challenges remain in achieving responsive medical education.

Traditional medical education is often based on the transfer of knowledge from teacher to student and focuses on scientific content. This approach has often failed to meet the real needs of society and health systems. For example, a study found that many medical graduates lack the practical and communication skills necessary for interacting with patients and providing responsive health services (50). This highlights the need for a shift in educational approaches and a focus on evidence-based and community-driven education.

Among the activities undertaken to advance this issue is the establishment of responsive education committees or units in medical sciences universities, which are responsible for organizing responsive education programs within universities (51).

Although universities function differently in promoting responsive education, studies have shown that this difference is also pronounced within educational groups, occurring for various reasons, including evaluation methods, understanding and interest in responsive education, determining criteria for it, and the relationship between department heads and medical education development centers (9).

Table 1. Strategies for achieving Responsive Education

	Stakeholder Role
The roles and responsibilities of managers and officials of universities and colleges	Revision of goals, content, teaching method and planning in education in order to meet the needs of the society (10).
	Allocation of necessary research budgets in the field of statistics of the real needs of the society (1).
	Estimating the necessary infrastructure to access appropriate educational environments such as hospitals and clinic (37).
	Providing suitable conditions for the integration of different courses in appropriate educational environments such as classrooms, hospitals, etc (38, 39).
	Placement of social epidemiology course in the list of courses for medical students (10, 40).
	Providing suitable conditions for the development of the necessary abilities of volunteers to serve in rural and impoverished areas and their correct selection (1).
	Increasing motivation among faculty members to help improve responsive medical education (10).
	Cooperation of different units of the university, including health vice-chancellor, support, educational groups and university president's area (24).
	Considering students' needs for future careers (41).
	Estimating the necessary infrastructures for interdisciplinary education to promote collaborative learning (42, 43).
	Integration in the curriculum (38).
	Paying attention to social accountability criteria to determine the mission in the strategic plan of the university (9).
	Anticipating effective strategies to increase interaction between the healthcare system and educational groups (9).
	Encouraging educational experts and faculty members to conduct research (9).
	Efforts to effectively advance the continuous education program of graduates and faculty members based on the needs of the day (9).
	Using all facilities and human resources in educational groups to solve the challenges of the society (9).
	Holding social medical education courses in universities (44).
	Holding mentoring courses for faculty members to develop teaching and research skills (15).
	Early exposure and contact of the student with the work environment and the patient's bedside to understand the environment closely (10).
	Considering students' opinions and feedback (10).
The role and responsibilities of university faculty members	Using the methods of and rogogy (a theory based on adult characteristics) and hetagogy to create lifelong and comprehensive learning in the direction of social changes (13).
	Using new and student-oriented teaching methods (such as learning in small groups, problem-based learning, etc) (31).
	Using new evaluation methods such as logbook, portfolio, objective structured clinical evaluation (OSCE) (13).
	Creating diverse theoretical and practical experiences for students in order to develop their knowledge and skills (20).
	Using the integration approach and interdisciplinary courses in medical education (31).
	Increasing students' motivation to participate in group work (31).
	Teaching clinical reasoning to students (45).
	Empowering students to make decisions based on evidence (46).
	The attention of faculty members to the issue of research in education, innovative projects in education and educational research (13).
	Becoming aware of the needs and priorities in the society (47).
	Reducing the volume of course materials in order to increase students' motivation (10).
	Creating a sense of need for learning among faculty members (10).
The role of students	Establishing a close relationship between the student and the hospital environment and even the patients' families (20).
	Participation with motivation to identify and solve health problems (20).
	Maintaining your relationship with the university and educational environment (48).
	Conducting research in the field of health system (48).

There are various criteria for determining progress in responsive educational programs, including predicting societal needs, collaboration with the health system, training and providing human resources to play roles in society, outcome-based education, institutional governance, standards, quality improvement, mandatory mechanisms for accreditation, global principles, and local needs and community roles (6).

Resistance to change is always present in organizations, and these changes bring challenges. In a study by Taramsari et al., the Kotter model was proposed to address this issue (52). Based on this model, a responsive medical education model was suggested, which includes eight stages. Initially, in the preparation stage, a sense of need must be created among officials and stakeholders. Then, a team should be designated to execute the plan and take responsibility for it. These individuals must choose a clear vision and goal, which should be communicated effectively to officials and stakeholders. Responsive education courses should be held for these individuals to acquire the necessary capabilities and understand their roles in advancing this issue. There is a need to set smaller goals and achieve early successes to increase motivation. In the seventh stage, these achievements must be consolidated and, finally, institutionalized (53).

While this study provides a comprehensive structural framework synthesized from the international literature, determining the contextual optimality and operational feasibility of these components warrants empirical validation through Delphi consensus panels and longitudinal monitoring using social accountability key performance indicators (KPIs).

To bridge the gap between individual strategies and systemic implementation, the identified recommendations are integrated into a three-tier structural framework (Macro/Governance, Meso/Faculty, and Micro/Student). This operational structure demonstrates how top-down institutional support and bottom-up engagement interact to establish a socially responsive education system.

Conclusion

Effective implementation of responsive medical education requires a committed team that believes in its necessity, a shared vision communicated across the university, and targeted empowerment programs to achieve gradual successes. This study proposes an optimal three-tiered framework that defines the roles of the university and faculties, professors, and students in advancing responsive medical education. By consolidating these strategies into practice, universities can train physicians who effectively respond to societal needs and contribute to public health. While access to all databases was limited, this framework provides a foundation for policymakers, curriculum designers, and university leaders to guide future developments. Further studies are encouraged to test and expand this framework, ensuring its applicability across diverse educational contexts.

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Review Article

Large Language Model as an Emerging Technology in Medical Education: An Analysis of Scholarly Collaboration, Citation, and Vocabulary Co-occurrence

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Abstract

Background: The emergence of large language models has led to significant progress in various fields. In recent years, researchers have had a special focus on its applications in medical education.

Objectives: This study explores the social and intellectual framework of research on large language models as a growing technology in medical education across the Web of Science database.

Methods: The present study is a quantitative study performed using scientometric techniques. The statistical population consisted of texts containing 643 documents from the year of this study. Following the Prisma guidelines, studies were screened based on their titles, abstracts, and keywords, leading to the selection of 233 documents for the research population. No restrictions (such as year, time, country) were applied to the search. Data analysis was undertaken using VOSviewer software.

Results: The study found that the United States was the most active country, generating 90 papers and receiving 537 citations. Author Lee, Hyunsoo, received 163 citations, with JMIR Medical Education being among the most frequent authors and journals with 30 papers and 352 citations. The keywords “artificial intelligence” with 144 repetitions, “ChatGPT” with 131 repetitions, “medical education” with 97 repetitions, and “large language models” with 89 repetitions make them highly frequent words. Four clusters were formed from the keywords obtained in the study”.

Conclusion: The research in large language models and medical education is growing rapidly, with organizations revealing a strong interest in international cooperation. This field has great potential for development. Nevertheless, countries with more publications have not necessarily received more citations.

Keywords: Large Language Models; Artificial Intelligence; Medical Education; Scientometrics; Citation Analysis; Co-Occurrence

Background

Recent advances in artificial intelligence have enabled the development of more robust language models capable of generating fluent and coherent text. Among these models, " Large language models" stand out given their impressive size and ability to learn vast amounts of textual data (1). Large language models are semi-supervised and generative artificial language models trained on massive amounts of textual data. They can contextualize the ordinal nature of words effectively in a sentence to predict the most reasonable response (2). Essentially, large language models employ deep neural networks—complex structures with multiple layers of statistical correlation, or "hidden layers," that facilitate complex and fine-grained relationships as well as advanced information abstraction (3).

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The emergence of large language models can be traced back to n-grams models utilized in the 1980s (1, 4). Topic models such as hidden Dirichlet allocation came into existence during the 2000s (5). However, these language models were restricted by traditional statistical methods in natural language processing, which relied on word counts. As such, they suffered from limitations such as short-term memory, data fragmentation, difficulty in training, lack of semantic understanding, lack of generalizability, and low efficiency. In response to these challenges, OpenAI introduced the Transformer architecture in 2017. The core component of transformers is the attention mechanism. This mechanism enables the model to grasp the contextual connections between words (or other elements) in a sentence. Transformers apply multi-headed self-attention for analyzing the relationship between words in a sentence. Self-attention means that words pay attention to their relationship with other words, regardless of their relative or absolute position in a sequence (1, 6).

One of the AI tools developed based upon the transformers model was GPT, which was introduced in 2018. In the subsequent years, various versions of GPT were released. For instance, GPT-2, released in 2019, garnered attention for its remarkable capability to generate coherent and relevant text on a wide range of topics (7). The introduction of GPT-3 by OpenAI in 2020 marked a significant milestone in the field. The performance of the GPT-3 model, which employs 175 billion training data parameters, is noteworthy for its more accurate responses compared to its predecessors (8). Since its introduction in November 2022, Chat GPT 3.5 has been equipped with Transformer architecture capabilities (9). Continuing the development of generations of large language models, the emergence of GPT-4 in 2023 indicated significant progress (10). This version (GPT-4) has the ability to process inputs beyond text, including images and data (11).

Recent developments in large language models, such as ChatGPT and its newer model, ChatGPT-4, have transformed teaching methods within the field of medical education. In traditional medical education, the primary teaching method involves lectures delivered at specific times and locations (12). With the introduction of large language models, especially GPT chat and its subsequent versions, it is anticipated that the usage of this technology in medical education would revolutionize teaching methods in this field. GPT chat enhances students' understanding of medical knowledge by offering tailored and efficient learning experiences through simulated conversations, intelligent instruction, and automated question responses (13, 14). With the assistance of AI technologies, students are essentially placed in a simulated clinical situation. This simulation intends to mimic interactions between a student and a doctor, enabling the student to engage in critical thinking, make decisions, and engage in active learning (15, 16). For small group sessions, GPT-4 can facilitate discussions by creating thought-provoking questions, encouraging peer-to-peer interactions, and establishing an attractive and collaborative learning environment. To simulate a virtual patient, LLM can create realistic scenarios involving virtual patients, pose questions, interpret responses, and provide feedback (10, 17, 18).

Further, integrating GPT-4 large language and chat models into medical curriculum planning can assist the faculty in developing, updating, or revising medical curricula (16). Recent studies have indicated significant benefits of large language models in medical knowledge and reasoning; for example, in another study by Zei et al. (2023), they examined the potential of large language models such as ChatGPT, Bard, and Bing AI in medical education as well as clinical decision support for young physicians. Civaner et al. (2022) explored the use of large language models in medical school curricula from the perspectives of researchers and medical students (19). Another study found that ChatGPT achieved a score close to the passing level on the United States Medical Licensing Examination (USMLE) (20).

Scientometrics refers to the quantitative and qualitative study of scientific production, aimed at extracting patterns, trends, and knowledge networks. In other words, it is the science of measuring science, capturing all quantitative methods and patterns for measuring the production of science and technology (21). Although many studies have explored the usage of large language models in medicine and health from a scientometric perspective (including Mayta-Tovalino et al. (2024) (22) , Mousavi et al. (2024) (23), Liu et al. (2024) (11), and Wang et al. (24), there has been no comprehensive analysis of the trends, gaps, and key topics in global research on medical education. It is critical for educators, physicians, and students to have a thorough understanding of the research landscape and emerging opportunities in medical education. Thus, this study aims to conduct a Scientometric analysis of studies in this field, ascertaining the scientific standing of countries, influential researchers, collaborative

networks, popular topics, and overlooked areas of study. The goal is to provide insights into future research directions for researchers and policymakers in the field of medical education.

Objectives

Considering the issues raised in the previous section, the objectives of this research are as follows:

- Examine the scientific status of countries and identify leading countries.
- Analyze scientific collaboration networks between countries.
- Identify the scientific status of active and highly cited authors.
- Recognize hot topics and inspect the time trend of topics in the use of large language models in medical education.

Methods

The current research applied a quantitative-descriptive approach, employing scientometric techniques. The method used in this study was documentary, with data extracted from the Web of Science database on 06/28/2024. For data extraction from the database, two strategies were implemented. The study population consisted of 643 articles. Data were consolidated through removing overlapping and unrelated cases, leading to the selection of 233 documents for analysis and addressing the research questions. To eliminate overlap, the first step was to download and merge the two Excel outputs. Next, the duplicate items were removed and the necessary data were selected. Ultimately, the selected items were extracted from the database in Plain Text format.

In the first search strategy, the following were combined using Boolean operators, yielding 460 documents: ("Artificial Intelligence*" OR "Machine Learning" OR "Neural Networks*" OR "Natural Language Processing*" OR "Computer Vision*" OR "Generative Adversarial Networks" OR "AI Ethics" OR "AI Explainability" OR "Autonomous Agents" OR "Robotics" OR "Cognitive Computing" OR "AI Algorithms" OR "AI Applications" OR "speech processing*" OR "Audio processing*" OR "Image Processing*" OR "Smarting*" OR "Emotion processing*" OR "Environmental intelligence*" OR "expert systems*" OR "chat bots*" OR "Computer Reasoning" OR "Knowledge Acquisition") AND (“Large language models” OR “LLM architectures*” OR “Zero-Shot Learning” OR “Few-Shot Learning” OR “Transfer Learning” OR “Text Summarization*” OR “Machine Translation” OR “Question Answering” OR “Model Interpretability” OR "ChatGPT”) AND (“Clinical Training” OR ("Medical education*" OR “Evidence-Based Medicine” OR “Personalized Learning” OR “Resource Optimization” OR “Skill Development” OR “Virtual Patient Simulations” OR “Medical Chatbots” OR " Academic & Research Integrity").

For the second strategy, keywords ("Large Language Model*" OR “chatgpt*” OR “LLM”) and ("Medical Education*" OR "Medical Training*") were merged, resulting in 183 documents.

In this study, the results of two search strategies were analyzed, culminating in a total of 605 documents after merging and removing duplicates. Once the titles, abstracts, and keywords were reviewed, 372 documents were excluded, leaving a final selection of 233 documents (Figure 1).

In order to standardize keywords such as "medical education" and "medical training", "LLM" and "large language models", and "artificial intelligence" and "AI", a terminology was developed and applied in VOSViewer software.

Note that the first strategy aimed for comprehensive coverage, identifying studies that indirectly referenced large language models. The second strategy focused on directly retrieving studies associated with large language models and medical education. It should be noted that in our study, as in other scientometric studies, the threshold for creating scientific maps was determined based on the authors' opinions, which are presented below.

In this study, we utilized VOSviewer software to analyze scientific and citation networks of 54 countries, 101 authors (at least one article and 30 citations), 46 sources (at least one study and 10 citations), as well as word co-occurrence networks (with a frequency of at least 3). This analysis allowed us to identify 67 main keywords. Further, we examined the contribution of countries to the production and citation of documents using frequency and percentage frequency tests.

In this study, we ensured the quality of the selected studies through extracting data from the most prominent global database. Further, all selected articles had been published in reputable journals, with the researchers aiming to select only studies related to the application of large language models in medical education, rather than focusing on specific individuals or organizations. Thus, there has been no bias in the selection of data.

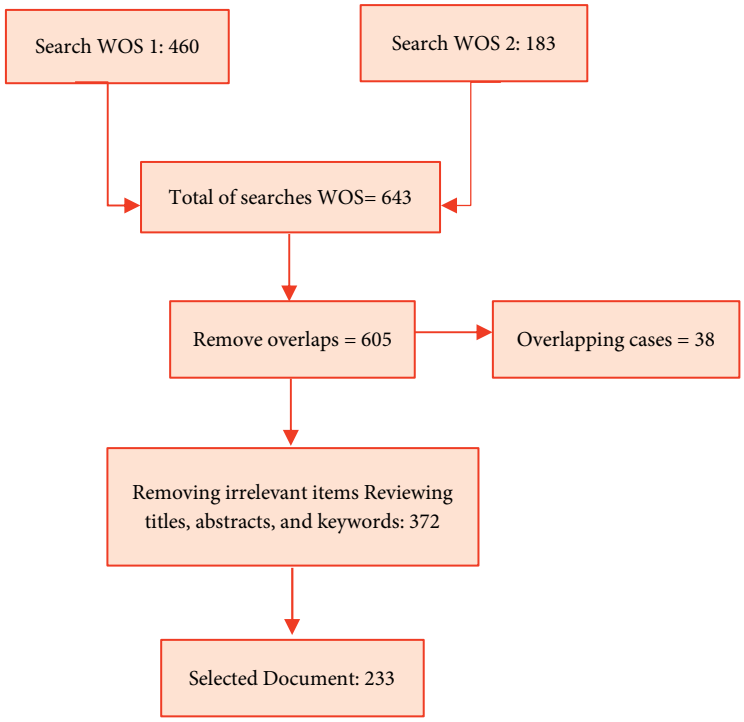

Figure 1. Study Selection Process

Results

1- Country Performance

In order to ascertain the performance of different countries, it was determined that 53 countries were actively involved in producing work in this field. As displayed in Figure 2, countries with larger nodes indicate higher levels of activity. The United States, with 90 documents, China with 26 documents, and England with 23 documents, are the top three countries in this field (Figure 2).

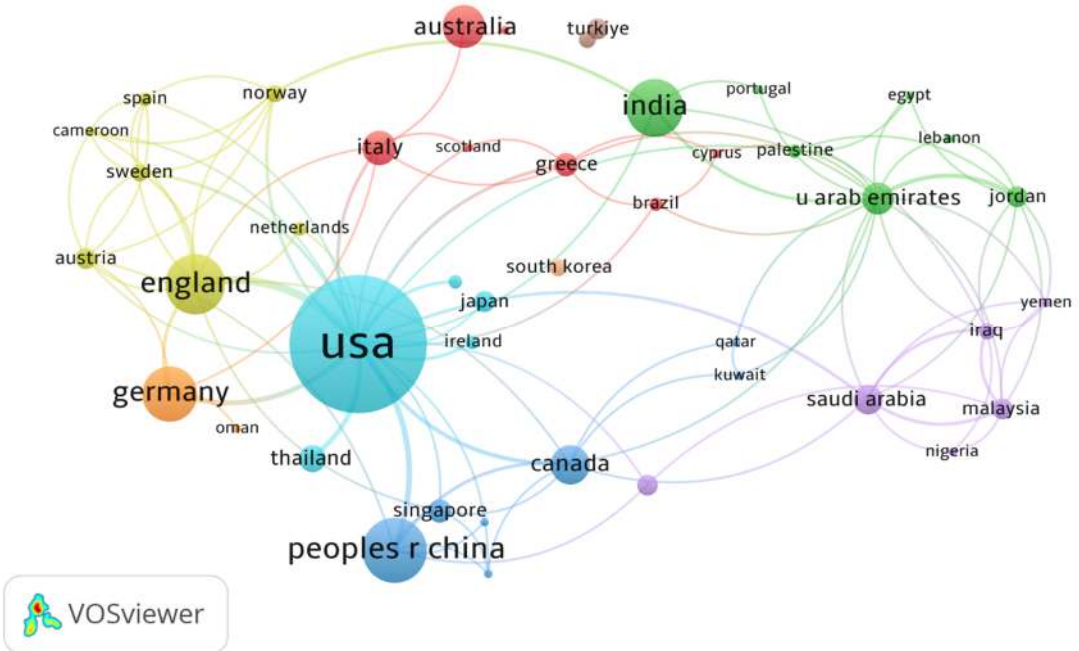

Figure 2. Scientific Map of the Activity of the Countries of the World in the Research of Language Models

According to the image above, India, Germany, Australia, Canada, Italy, the United Arab Emirates, and Saudi Arabia are the top countries in large language model research in the field of medicine.

The United States, with 90 documents producing 19.04% and receiving 537 citations, claims nearly 39% of the total citations in this field, making it a prominent country in the subject area. Nevertheless, the status of document production and receiving citations for some countries differs from their citation share, as outlined in Table 1. For example, Canada, with 11 documents, claims 11.16% of citations, while China, with 26 documents and a citation share of 8.58, and the United Kingdom, with 23 documents and a citation share of 4.72, do not have a favorable status.

Countries such as South Korea and India, though not among the top countries in document production, are in a good position in terms of receiving citations (9.01 and 3.86, respectively).

Table 1. Statistics of the Top Countries in Writing Research on Large Language Models

Rank	Country	Documents	Percentage Documents	Rank	Country	Citations	Percentage Citations
1	United States	90	19/04	1	United States	537	38/63
2	China	26	11/15	2	Canada	300	11/16
3	England	23	9/87	3	Germany	241	9/87
4	India	21	7/64	4	South Korea	230	9/01
5	Germany	20	5/15	5	China	155	8/58
6	Australia	13	4/72	6	Australia	142	5/58
7	Canada	11	4/42	7	England	133	4/72
8	Italy	9	4/39	8	India	132	3/86
9	United Arab Emirates	8	4/22	9	United Arab Emirates	127	3/43
10	Saudi Arabia	7	2/53	10	Kuwait	76	3/00

The trend of countries undertaking studies in the field of large language models in medical education was also analyzed based on the time period of the studies presented in Figure 3. The Overlay Visualization map applies colors to reflect the average year of publication of the articles in which a term appeared; yellow represents words mainly employed in recent articles, while blue indicates words primarily utilized in older articles (25). If items have a score value, their color is determined by the score value. By default, the map color ranges from blue (lowest value) to green and then yellow (highest value) (26).

According to the image, countries in the blue region have an average publication year between 2022.5 and 2023.00, revealing the lowest average level. Countries in the green range from 2023.2 to 2023.4 are considered medium-level. Dark green countries fall between 2023.5 and 2023.8, signifying high-level countries. Lastly, countries within the range of 2024.0 are emerging countries in this area.

2- Status of Cited Authors

In order to determine the citation status of authors, we found that 1,112 authors contributed to the studies. To identify highly cited authors, we selected authors whose works had at least 30 citations. As a result, we selected the names of 101 authors and generated maps of their citations. According to Figure 4, the authors with the highest number of citations are located in the center and the hot area.

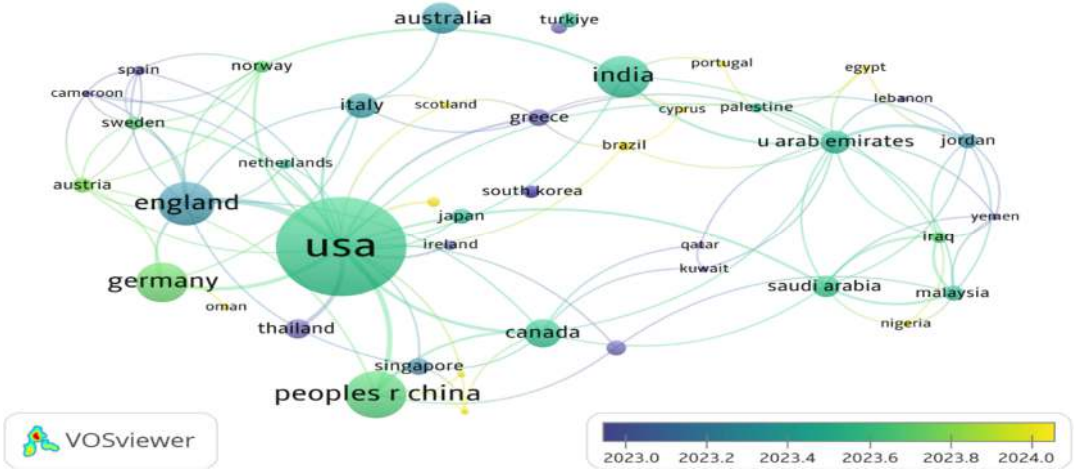

Figure 3. The Performance of Countries Based on Trends and Time Periods



Figure 4. Density Map of Highly Cited Authors in Studies

Author Density Map Figure 4 indicates that author Lee, Hyunsu is the most cited author with 163 citations. The citation status of the other top 5 authors, including Antaki, Fares, Duval, Renaud, El-Khoury, Jonathan, Milad, Daniel, Milad, Daniel, who are affiliated with the University of Montreal and Canada, is presented in Table 2. According to the citation density map, the most cited authors are located in the center of the map with the greatest heat.

Table 2. Most Cited Authors in Published Studies

Authors	Documents	Citations	Country	Organization
Lee, Hyunsu	1	163	South Korea	Keimyung Univ
Antaki, Fares	2	143	Canada	University of Montreal
Duval, Renaud	1	143	Canada	University of Montreal
El -Khoury, Jonathan	1	143	Canada	University of Montreal
Milad, Daniel	1	143	Canada	University of Montreal
Touma, Samir	1	143	Canada	University of Montreal

3- The status of citations to sources that publish scientific productions

It was found that out of 133 sources in this field, only three works were presented at conferences. For this review, sources that received at least 10 citations were chosen to create a citation map. The map, depicted in Figure 5, includes 46 sources.

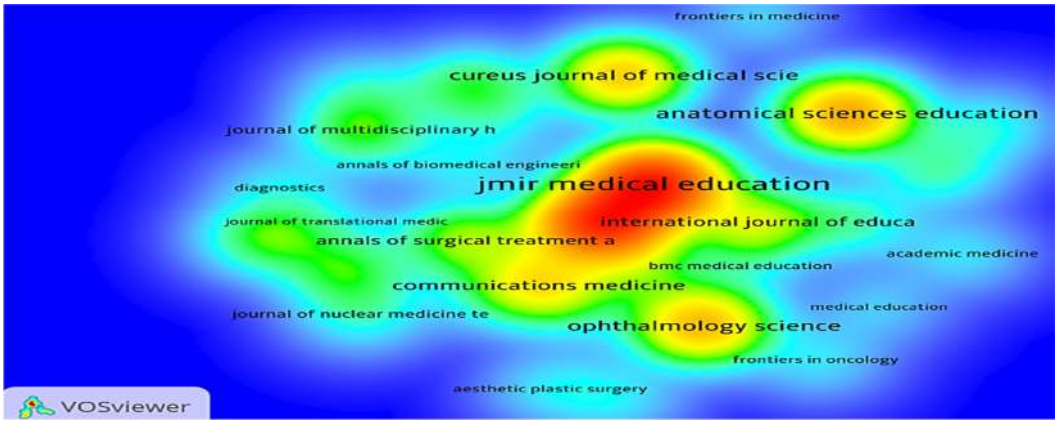

Figure 5. Density Map of Highly Cited Sources that Publish Studies

According to Table 3, JMIR Medical Education is the most produced and cited source. Anatomical Sciences Education Journal are 3 published documents in this field, while ranking second in terms of receiving citations, with 163 citations. Ophthalmology Science is the third publication with 143 citations.

Table 3. The most cited sources of publishing studies

Sources	Documents	Citations
JMIR medical education	30	352
Anatomical sciences education	3	163
Ophthalmology science	1	143
Cureus journal of medical science	26	127

4- Thematic Clusters

To investigate the main research topics in the field of large linguistic models and medical education, the frequency of vocabulary and hot topics in this area was examined. Words with a frequency of at least 3 were selected for this analysis. A total of 67 keywords were employed to form 4 subject clusters, which are illustrated in Figure 6. Word co-occurrence is a highly useful technique for identifying popular topics, trends, and the overall structure of scientific knowledge within a specific subject. Both word co-occurrence and scientific mapping serve as powerful tools for uncovering the conceptual framework of scientific fields (27, 28). These methods enable identifying thematic clusters, new concepts, and knowledge gaps by quantitatively examining scientific documents. The distance between specific keywords in co-occurrence maps reflects the degree of connection between them; the smaller the distance, the greater the connection between them. Further, more related keywords form a cluster that can be utilized to describe a core topic in research. These co-occurrence networks can be applied to analyze a complete set of topics (29). In this study, we applied content analysis to analyze clusters.

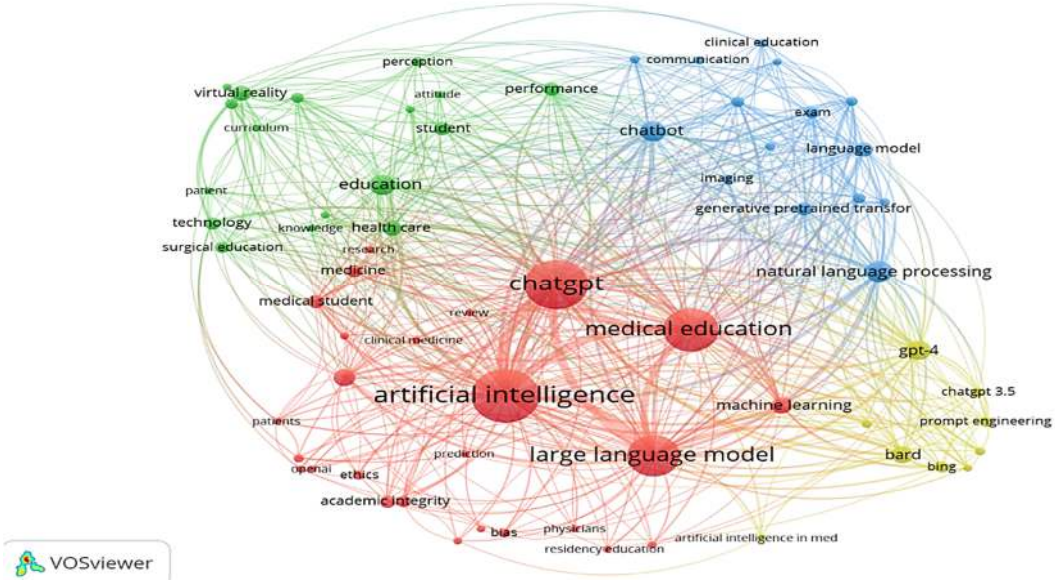

Figure 6. Thematic Clusters of Keywords of Studies in the Field of Large Language Models and Medical Education

In this map, the keyword "artificial intelligence" appeared 144 times, followed by "ChatGPT" with a frequency of 131, "medical education" 97, "large language models" 89, and "natural language processing" 24, representing the most frequent words. Content analysis was applied to examine thematic clusters, with the results of the analysis for each cluster listed in Table 4.

Trends and Average Year of Occurrence of Subjects

Figure 7 exhibits the Overlay visualization. This map indicates the overlap of keywords over time using a color spectrum, with colors closer to yellow representing more recent document dates. The denser a cluster appears in this map, the more significant it is relative to other clusters (30). In simpler terms, the more often a keyword appears, the more yellow its color will be (26, 31). Keywords found in studies within the 2022 timeframe in cluster "two" such as "virtual reality," "simulation," "clinical training," "student," "surgical training," "curriculum," and "health care" reflect the emergence of research on the application of interactive artificial intelligence technologies in the medical field, including surgery and clinical medicine. It presents the trend of studies in the area being studied in clusters "one and three" for the beginning of 2023. Keywords such as "artificial intelligence," "chatGPT," "medical education," "natural language processing," "chatbots," "bard," "bing," machine learning, and "scientific integrity" indicate the emergence of research on the application of large language models in the field of medical education.

Further, keywords in clusters "one and four" for 2023 and 2024 (nodes in yellow) including ChatGPT 3.5, ChatGPT 4, Ethics, Bias, Explainable AI, Decision Making, Answer, Question, and Patient Education are topics that have surfaced in the field of medical education in late 2023. These topics well indicate the advancement of large language models and their application in medical research, as well as the biases and ethical considerations surrounding the use of such technologies in medical education.

Table 4. Nouns are the Most Important Words in Thematic Cluster Analysis Studies of Large Language Models in the Field of Medical Education

Cluster	Important keyword	Analysis
Cluster 1: Application of artificial intelligence in clinical medical research	Artificial intelligence, large language model, machine learning, chatgpt, clinical medicine, Medical Education, Clinical Decision Making, Residency Education, Integrity, Bias, Ethics, Plagiarism	This cluster focuses on integrating artificial intelligence, large language models, and machine learning with educational and clinical applications in the field of medical education, while also considering ethical and scientific implications.
Cluster 2: Application of interactive technologies in surgical education	Augmented reality, simulation, surgical education, curriculum, student, performance, patient	This cluster focuses on educating medical students and surgeons using advanced technologies. It examines the role of the curriculum in integrating hands-on training with technology, emphasizing learning, surgical simulation, performance, and attitude.
Cluster 3: Application of chatbots in medical education evaluation and conversation	Chatbot, conversational agent, clinical education, generative pretrained transformer, multiple-choice question, exam, natural language processing, communication, reasoning,	This cluster explores the application of large language models and chatbots to enhance learning, clinical reasoning, and interactive teaching of medical students through natural language processing and exam simulation.
Cluster 4: Types of large language models and accuracy in medical research	Artificial intelligence in medicine, accuracy, Bing, Bard, ChatGPT 3.5, GPT-4, prompt engineering, Explainable AI	This cluster explores the role of advanced language models (such as ChatGPT 3.5, GPT-4, Bard, and Bing) and explainable AI in accuracy, prompt engineering, and medical education management to enhance the quality of medical student learning.

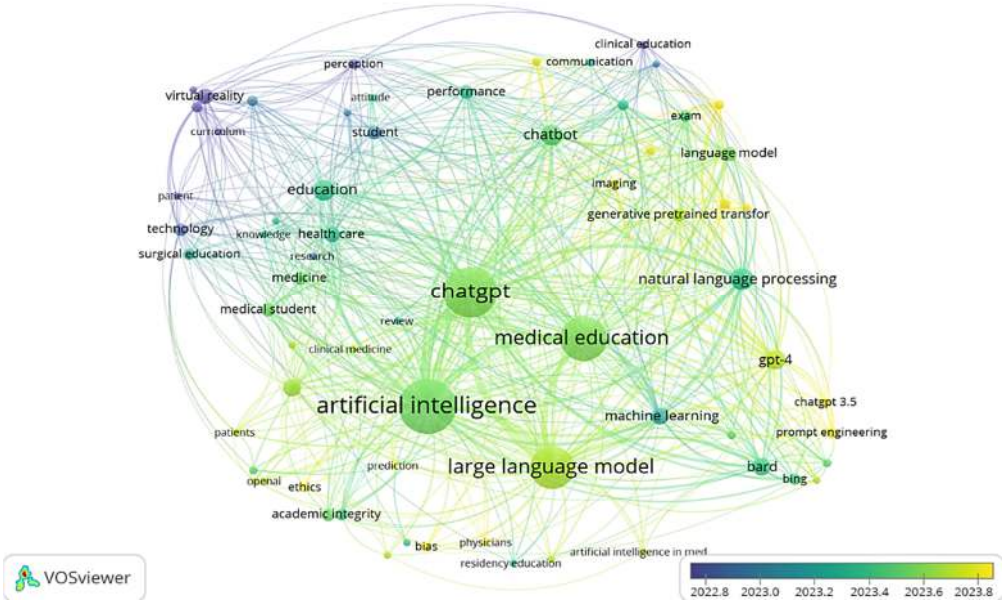

Figure 7. Vocabulary Overlay Map of Studies in the Field of Large Language Models and Medical Education Based on the Average of Normalized Citations

Discussion

The results demonstrate the growth and development of the field of large language models and the growing attention of the medical field to maximize the usage of this technology in education and the development of new methods in medical education.

The results indicate that the United States has had a significant impact on this field by generating 90

documents and receiving 537 citations, making it the leading country in the field of large language models and medical education. In addition to conducting extensive research in this field, the United States also claimed the largest share of citations and is ranked first. The research by Mousavi et al., (2024) (23), Liu et al. (2024)) (11), and Raman et al. (2023) (32), also confirms the leadership of the United States in producing documents and receiving citations. This indicates that adequate funding results in high-quality research, and the United States, as the richest country in the world, continuously invests in advanced scientific topics.

A time trend analysis of countries' activities based on the average year revealed that there has been little research generated in this field since the beginning. However, many countries began entering research in this field in 2023. The start of research in 2023 is visible on the map in purple, with a small volume. By the middle of the year, countries marked in green emerged with a significant extent of research in this field. Research in the United States also grew along this period. These findings align with the findings of Liu et al. (2024) (11), who examined global trends and hot spots in medical research, identifying countries such as the United States as leaders in this field.

The results regarding highly cited authors revealed that authors such as Lee, Hyunsu, despite having written only one document in this field, have received the most citations. Further, a review of journals publishing scientific resources indicated that the JMIR Medical Education journal is the most productive and cited journal in this field, with 30 articles and 352 citations. Our study's results show minor overlap with the research of Mayta-Tovalino et al. (2024) (22), and Raman et al. (2023) (32). However, our study, along with the two mentioned above, has focused on the scientists actively writing studies about large language models. This demonstrates that a scientific article will have a high impact if it contains suitable content and is written based upon the needs of the scientific community. A higher number of articles, while containing inappropriate content that does not fulfill the needs of the scientific community, may not necessarily have an impact on the research community.

From the cluster analysis, four clusters were created: "Application of artificial intelligence in clinical medical research", "Application of interactive technologies in surgical education", "Application of chatbots in medical education evaluation and conversations", and "Types of large language models and accuracy in medical research". Among these clusters, Cluster 1 is the central and strategic cluster that captures a combination of technological foundations, educational-clinical applications, and ethical concerns. These results indicate that these technologies have had a significant influence on optimizing medical decisions and ameliorating the quality of education. Nevertheless, challenges such as algorithmic bias, scientific integrity, and ethical issues of applying these technologies still persist as potential obstacles in this field.

For example, a study found that the use of large language models in the clinical field can result in accurate diagnosis when analyzing patient medical records (33). Further, Ravi et al. (2023) exhibited the impact of large language models on clinical decision-making in their research (2). Further, Liu et al. (2024) (11) conducted scientometrics research identifying clusters such as “Artificial Intelligence and Machine Learning”, “Education and Training”, “Healthcare Applications”, and “Data Analytics and Technology” as the main clusters. These clusters somewhat overlap with the findings of this study.

The results also reveal a rapid expansion in the use of these technologies since 2022, particularly in medical education and related research. This growth necessitates attention to ethical considerations and optimization of usage methods. Topics in 2022 focused on simulation in medical education based on AI technology in surgery. In 2023, the focus shifted towards language models, natural language processing, and text generation tools for creating exam questions, ensuring scientific integrity. By mid-2023 and into early 2024, attention turned to new GPT chat models such as GPT 3.5 and GPT 4. Discussions centered on the ethics and biases of using these technologies, explainable AI, and preventing scientific misconduct. These discussions aimed to enhance transparency and strengthen accountability in medical AI systems.

In medical education, explainable AI offers numerous capabilities. For instance, when AI provides an answer, it is critical for students, professors, or doctors to understand why the AI chose that answer. Explainable AI helps clarify the reasoning behind AI-generated answers, aiding in error identification and correction (34). In spite of the positive outcomes from research, the risks of using AI in medical education cannot be overlooked. A study by Ahn (2025) (35) reported that large language models sometimes provide misleading or incorrect information and have limitations. Another study by Weber et al. (2025) (36) indicated the shortcomings of large language models in

solving clinical problems, highlighting their inflexibility compared to human doctors.

The limitations of this study included relying solely on a single database and not evaluating the quality of the included studies.

Conclusion

In general, with the growth of research in the field of LLMs and medical education, as well as the high willingness of organizations to collaborate internationally, it is clear that this field has great potential for development. The overall results of this study indicate that the usage of artificial intelligence technologies in medical education currently focuses on large language models, chatbots, and explainable artificial intelligence. These technologies have the potential to enhance medical education and clinical decision-making. However, given that some previous studies have revealed practical weaknesses of LLMs, validation of AI tools is essential for the full and responsible use of these technologies in medical education. Thus, in order to develop and improve the use of large language model technology in medical education, it is suggested that national and international cooperation be developed, especially with identified active countries. Qualitative research and case studies should be undertaken to examine the application of LLMs in real-world and educational environments. It is important to examine the evolution of thematic clusters in this field based on 5-year time intervals to identify temporal changes and developments in the field under study. In order to develop and boost capacity for the use of LLMs in medical education, policymakers are advised to establish clear guidelines for data protection and prevention of misuse. The use of LLMs should be accompanied by explanations to earn the trust of faculty and students. Further, the integration of this technology into clinical skills training should be gradual, and empowerment courses should be conducted to acquaint faculty and students with its opportunities and constraints.

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Ethical approval: Not applicable.

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Review Article

Ethics on the Move: A Review of Medical Tourism and the Need for Robust Policy Responses

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Abstract

Background: Medical tourism is a growing global trend offering both benefits and challenges to healthcare systems. While it can boost service quality and economic outcomes, it raises important ethical concerns.

Objectives: This study aims to identify ethical considerations in medical tourism and provide actionable recommendations for policymakers to promote responsible and effective practices.

Methods: A systematized review was undertaken using PubMed, Scopus, Google Scholar, SID, and official reports, without restrictions on date or location. Thirty-six documents were selected, including 33 peer-reviewed articles, 2 reports, and 1 scholarly book. Selection followed clear inclusion and exclusion criteria focusing on ethical dimensions as well as methodologies. The ethical codes were extracted and grouped into five main themes and fifteen subthemes, providing a structured overview of cross-border healthcare ethics. The analysis included four key study terms to ensure comprehensive coverage of perspectives on medical tourism ethics.

Results: Ethical considerations fell into five main themes. Stakeholders' rights, particularly patient rights, were most prominent, encompassing 156 codes. Resource allocation captured financial and non-financial aspects, while financial considerations included patient costs, insurance, and government support. Cultural, political, and social factors influenced ethical practices, and policy-making covered legal frameworks, administrative efficiency, and ethical governance. Overall, 276 ethical codes were analyzed, highlighting the complexity of ethical issues in medical tourism.

Conclusion: Ethical challenges in medical tourism are context-dependent, with patient rights as the dominant concern. Policymakers should integrate ethics at all stages in order to ensure fair, safe, and culturally sensitive practices. Ongoing national and international guidelines are required, tailored to each country's context.

Keywords: Medical Tourism; Health Tourism; Ethics; Bioethics

Background

Historically, long-distance travel for medical purposes was limited to wealthy individuals or those desperate for recovery. In modern times, most physical, economic, and cultural barriers have been eliminated, resulting in increased international travel (1, 2). A 2015 study by Oxford Economics estimated that medical tourism involves approximately 16 million tourists annually and generates over 56 billion euros in revenue (3, 4). Between 2005 and 2007, the global medical tourism industry grew at an annual rate of about 20%, generating annual revenues around 60 billion US dollars. Nevertheless, more conservative estimates place the 2010 revenue closer to 40 billion dollars (1, 5).The Global Wellness Institute estimated wellness tourism alone generated $651 billion in 2022, projected to grow to nearly $1 trillion by 2030 (6). In some countries, medical tourism contributes 2–5% of GDP. For example, Thailand earns over $5 billion annually from this kind of tourism (7).

Thus, medical tourism has recently become a prominent topic in economic, cultural, social, and even

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political discussions across countries. As a multifaceted and rapidly growing global phenomenon, it plays a key role in national health policy-making and is considered as one of the most influential sectors for evaluation and sustainable development worldwide (8, 9).

In general, medical tourism is defined as travelling to another country to seek health services that are either prohibitively expensive or inaccessible in the home country (8, 10). More broadly, the term is often employed in the tourism industry to describe patients crossing international borders to receive non-emergency medical interventions (3).

Several terms are applied to express this concept; however, the preference for the term "Health Tourism" (1, 8) over "Medical Tourism" (11), "Curative Tourism," or even "Wellness Tourism" (12)—all having their conventional uses—likely originates from its comprehensiveness and impact (1). Some scholars argue that the term "Health Tourism" is more inclusive as it encompasses broader perspectives, including tourism tailored to disabilities, age groups, and specific traveller categories (8). Another related term found in the literature is "healthcare tourism," covering travel related to medical procedures, health, and wellness goals, including medical tourism, cosmetic surgery, spa visits, and alternative therapies (1). Some scholars even consider recreational and ancillary activities along a patient's travel from one country to another as part of medical tourism (13).

Thus, health tourism is understood as patients travelling abroad to access various health services (14). These services include a wide range of treatments, and the activity can be called medical tourism. In this study, we adopt an established definition of "medical tourism" as a sector of the tourism industry involving patients travelling from one country to another to receive better, higher quality, more affordable, or faster non-emergency medical services. Naturally, medical tourists consider all or some of these factors when selecting their destination and accomplish all or some of these objectives.

Some scholars question the ethical foundations of health tourism. For instance, Harvard Law Professor Glenn Cohen, author of *Patients with Passports: Medical Tourism, Law, and Ethics*, cited examples from Bangladesh and India, underscoring serious challenges associated with the sale of body parts of low-income citizens. Overall, Cohen adopts a skeptical stance toward medical tourism, contending that "medical tourists from the UK and Sweden have brought antibiotic-resistant bacterial infections found in India, Pakistan, and the Balkans," He further argues that this, among other reasons, causes undeniable harm to the healthcare system of host countries (15).

Some writers, recognizing the potential influence of economic on health tourism, describe health tourists as "forward-looking individuals" who seek services that are better, more affordable, and more sustainable irrespective of location (3).

Beyond the undeniable economic cycle, the extensive cultural exchanges, ancillary services such as the need to ameliorate quality and adherence to international standards, patient safety concerns, political conflicts and balances, language barriers, as well as other factors each require detailed and analytical consideration (1).

For instance, differing legal frameworks can be a driving factor for travel to obtain health services. In some countries, variations in laws, even among states, encourage travel for services that are not permitted at the place of origin (8). Undoubtedly, this issue requires multiple standards and regulations, including ethical ones (16).

Regarding the influence of legal, religious, and social factors, some studies claim that such differences can significantly affect destination choices (17). Obviously, in spite of the necessity to adhere to internationally accepted ethical principles, reviewing, analysing, and proposing measures for the ethical management of medical tourism—tailored to each country's laws, regulations, culture, and values could be helpful. Moreover, feasibility within existing conditions—is a pressing and essential need.

Accordingly, most scholars acknowledge that ethics constitutes a critical dimension of medical tourism (16).

While prior studies have addressed fragmented ethical aspects, this review integrates multidisciplinary perspectives into a unified framework.

Objectives

This study aims to identify ethical considerations in medical tourism and provide actionable recommendations for policymakers to promote responsible and effective practices.

Methods

This systemized review was performed to find answers to the question: "*What are the ethical considerations governing medical tourism worldwide?*" Our aim was to develop a comprehensive and acceptable

set of ethical considerations associated with medical tourism globally.

In May 2024, we conducted a comprehensive search for literature and related texts without applying any geographical or chronological restrictions. The search was carried out in scientific databases including PubMed, Scopus, Google Scholar, and SID, as well as in official reports and governmental documents. Keywords utilized in this process were "health tourism," "medical tourism," "ethical considerations," "ethical challenges," and "ethical guidelines," applied to both Persian and English literature. To illustrate our systematic search approach, an example of the strategy used in PubMed is presented: ("health tourism" OR "medical tourism") AND ("ethical considerations" OR "ethical challenges" OR "ethical guidelines"), with filters applied for English and Persian publications. The same strategy was consistently applied across all other databases. The detailed search algorithm is displayed in Figure 1.

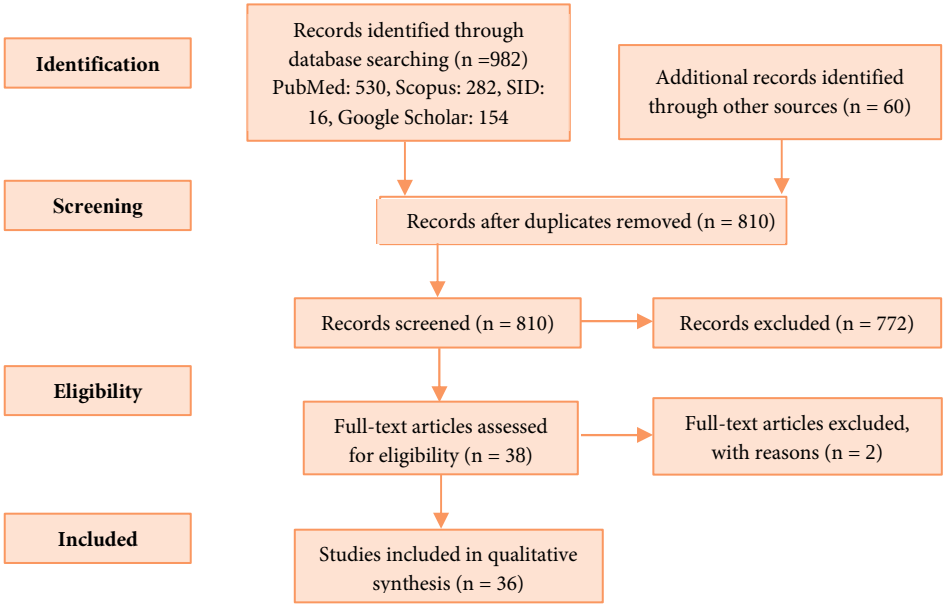

Figure 1. PRISMA flow diagram of the study selection process

We included studies, reports, books, and official documents addressing medical or health tourism and discussing ethical considerations, challenges, or guidelines, in either English or Persian, with no restrictions on geography or publication year. Studies with no focus on medical tourism, lacking discussion of ethical aspects, published in other languages, as well as conference abstracts, editorials, letters, and unpublished theses were excluded.

An initial search of article titles and abstracts using the specified keywords across reputable sources yielded 981 scholarly articles along with 60 other sources from other groups. After removing duplicates, 810 records remained. Screening of abstracts resulted in the exclusion of 772 articles unrelated to our research topic. Non-English studies were excluded in order to ensure the methodological rigor, replicability, and accessibility of the included sources. From the 38 remaining references, full-text review indicated that three, despite sharing similar keywords, were not relevant in content.

Ultimately, 36 references were included in this study, with their details presented in Appendix 1.

Subsequently, codes pointing to ethical considerations of medical tourism were extracted. Two researchers independently coded 20% of documents; discrepancies were resolved through consensus. Following in-depth group discussions among the research team, a framework was developed comprising 5 themes with 15 subthemes (Table 1).

Results

We identified meaning units pointing to ethical considerations of medical tourism and categorized them into 276 codes, 15 subthemes, and 5 themes.

The included literature was independently analyzed and coded by multiple researchers. Any discrepancies or disagreements in coding were resolved through group discussion and consensus, ensuring reliability and consistency in the thematic analysis. Table 1 shows the Classification of Extracted codes.

Table 1. Classification of Extracted codes

Theme	Subtheme	Code
Stakeholders' Rights	Rights of Service Recipients	Patient-provider communication
		Service quality and safety
		Quality of ancillary travel facilities
		Privacy and confidentiality
		Continuity of care and post-treatment follow-up
		Providing appropriate information
		Access to service and responsiveness
Rights of service providers		Financial resource allocation
		Allocation of other resources
Rights of other stakeholders		
Resource Allocation		
Financial Aspects		Medical tourist insurance
		Patient costs including treatment, accommodation, and ancillary expenses
		Government financial support
		Large-scale national costs
Cultural, Political, and Social Aspects		General culture, language, and religion
		Physician and medical culture
		Patient perspective
Policy Making		Administrative efficiency
		Legal issues
		General policy considerations

Theme 1: Stakeholders' Rights (156 codes, 56.5% of total)

This group classification includes the broadest and most frequent extracted codes. Since "stakeholders" in this study refers to all individuals involved in every stage of the medical tourism process, from implementation to outcome, and covers three subthemes, this indicates that much attention has been paid to the rights of stakeholders in the reviewed literature.

1-1) Rights of Service Recipients (141 codes, 91%): This group includes recipients of services at any part of the service delivery cycle, including medical tourists. Among various stakeholder groups, the majority of extracted ethical points addressed the rights of service recipients. Given the breadth and diversity of findings, frequent subcomponents were defined, including patient-provider communication, service quality and safety, quality of travel facilities, privacy and confidentiality, continuity of care and post-treatment follow-up, provision of appropriate information, access to service, as well as accountability. The research team delineated specific content examples for these subcomponents.

1-2) Rights of Service Providers (12 codes, 7.7%): This group includes all individuals involved in healthcare delivery and ancillary sectors serving the first stakeholder group, such as healthcare staff and travel facilitators. Ethical considerations considering these individuals' rights have remained far less unattended in existing studies compared to service recipients.

Rights of 3-1 Other Stakeholders (3 codes, 1.9%): Certain individuals, including organ donors (in living organ transplants) or surrogate mothers assisting in infertility treatments, though not being patient themselves, play significant roles in medical tourism programs. Their rights are recognized as part of the stakeholders in this healthcare industry.

Theme 2: Resource Allocation (16 codes, 5.8% of total)

The second theme, pertaining to the ethical considerations in resource allocation by policymakers, is split into two subthemes**.** (Due to its significance, this section has been separated from other policy actions and placed in the final theme).

2-1) Financial Resource Allocation (6 codes, 37.5%): This deals with issues such as distributive justice and prioritization of resources. This group is distinct from the theme of financial fields and contains a significant number of codes. However, owing to the emphasis of the texts on justice in allocation, this section has been considered separately.

2-2) Non-Financial Resource Allocation (10 codes, 62.5%): Although financial resources are prominent in principles of justice, ethical sensitivity in the allocation of other resources, including transplant organs or the capacities of the healthcare system in the host country, were more salient in the literature.

Theme 3: Financial Aspects (27 codes, 9.8% of total)

This theme captures patient costs, financial support, and impacts of expenditures on public health, categorized into four subthemes. This group comprises items that are generally associated with individual costs, support systems, or impacts on public expenditures. While it interacts reciprocally with the previous group and they influence each other, their definitions remain distinct.

3-1) Medical Tourist Insurance (7codes, 26%): The expectation of insurance coverage for medical services, including treatment and follow-up care, is addressed with associated ethical considerations.

3-2) Patient Costs Including Treatment, Accommodation, and Ancillary Expenses (17 codes, 63%): Financial concerns arise both in medical services and ancillary travel facilities while constituting the largest share of extracted codes in this part.

3-3) Government Financial Support (2 codes, 7.5%): Governmental responsibilities for supporting patients, including non-native medical tourists, extend to non-insurance supports such as loans and other facilities.

3-4) Large-scale national costs (1 code, 3.5%): This subtheme concerns justification and explanation for national budget allocation to medical tourism programs.

Theme 4: Cultural, Political, and Social Contexts (31 codes, 11.2% of total)

This theme includes ethical points associated with cultural, political, and social contexts influencing and influenced by medical tourism programs, with the following subthemes:

1-4) General Culture, Language, and Religion (24 codes, 77.5%): Effective communication between tourists and host country agents plays a substantial bilateral role in quality, continuity, and success of medical tourism.

2-4) Physicians and Medical Culture (2 codes, 6.5%): This subtheme refers both to individual traits of healthcare teams and the broader medical community perspective forming the ethical foundation of this industry.

3-4) Patient Perspective (5 codes, 16%): The health tourist's viewpoint, motivating their actions, plays a major role in effective communication.

Theme 5: Policy making (46 codes, 16.7% of total)

The breadth of this topic has placed it in the second place, indicating the attention of experts to examples such as legislation, supervision, and the establishment of guidelines, where a number of authoritative guidelines have also been included in our list of sources. It has three subthemes, with its details outlined in Table 2 according to their importance.

1-5) Administrative Efficiency (1code, 2%): Necessity of responsive and operational administrative structures for organizing medical tourism programs.

2-5) Legal Issues (15 codes, 33%): The undeniable overlap between legal and ethical issues, emphasizing that ethical analyses are incomplete while overlooking legal frameworks.

3-5) General Policy Considerations (30 codes, 65%): This section, capturing a significant portion of ethical issues related to policymaking, practically addresses the actions expected from planners and implementers of the health system's overarching programs in the field of medical tourism, at both national and international levels.

Table 2. Policymaking theme

Theme	Code
Administrative Efficiency	Inefficiency of administrative systems in handling medical tourism processes (e.g., bureaucracy)
Legal Issues	Legal restrictions on certain medical and diagnostic procedures in the country of origin
	Legal gap concerning stakeholders' rights in the host country
	Lack of international regulations in the field of medical tourism
	Differences in legal systems between the origin and destination countries
	Creation of distinct legal layers for medical tourists and local individuals
	Illegal medical tourism travel and its consequences
General Policy Issues	Lack of a documented ethical policy in response to medical tourism demands
	How governments inform about competing services
	Ignoring ethical considerations in planning for stakeholders
	Lack of sufficient supervision
	Need to ensure optimal choices for both tourist and host
	Absence of an international executive mechanism
	Neglect by policymakers of effectiveness

Discussion

A review of the literature suggests that ethical concerns in medical tourism have received notable scholarly attention. While some themes appeared more frequently, this does not necessarily reveal their superior ethical weight. Rather, such patterns often emanate from contextual factors and methodological choices influencing issue visibility and prioritization.

A. Rights of Stakeholders

The most prominent theme involves the rights of stakeholders—namely patients, providers, and other participants. Many studies reference bioethical principles in patient rights. For instance, Mogaka and colleagues, along with other researchers, highlight autonomy, informed consent, and accountability as essential ethical elements (11, 18). In the U.S., K. R. Matthews and A. S. Iltis stress autonomy in policy-making but caution that autonomy does not ensure delivery of promised treatments (19). In Iran, Mustafavi et al. highlight the ethical behavior and competence of hospital staff in attracting international patients (14).

Given the consensus—such as that by Qing Xu et al. in South Korea—that quality, affordability, and access are principal drivers of medical tourism (20), the ethical need for safe, high-quality care is clear. As tourism progressively blends leisure, prevention, and treatment (21), ethical infrastructure and planning become essential. Karimi Badrabadi et al.'s research in Iran reported that patients demand confidentiality (22). Also, Mogaka et al. emphasize that disclosure of risks and benefits is ethically vital (11). As such, timely and comprehensive patient information is not just ideal—it is an ethical right (23-25).

Beyond patients, institutions need to be accountable as well (26, 27). Iranian scholars such as Nikraftar et al. highlight that access to technology and cost-efficiency are crucial for both patient attraction and responsible policy-making (28). Likewise, providers require ethical protections. For example, South Korea's malpractice insurance for institutions treating foreign patients supports both ethics and competitiveness (20). Issues such as international insurance and accreditation, as discussed by Delgoshaei et al. (29), affect both parties.

A third group—"other stakeholders"—includes individuals such as surrogates. Del Rio and Zammi state that financial pressure can compromise their autonomy (30). Host communities have also rights, with guidelines stressing that visitors must respect local laws and norms (31).

Among all themes, stakeholder rights were the most widely recognized, consisting of autonomy, safety, quality, and ethical communication (32). Growing public awareness—amplified by digital media—has increased expectations (27). Patients now demand greater participation in decision-making, supported by accurate, transparent information. The decline of paternalistic models reinforces the need for ethical communication (33).

Ethical obligations also extend to intermediaries and facilitators. In complex treatments such as organ transplants or fertility services, donors and surrogates constitute another ethically significant group whose rights need to be protected.

B. Resource Allocation

Resource allocation is another major ethical issue. Medical tourism, as a continuous service model, consumes both financial and non-financial resources. While overlapping with financial concerns, this category merits distinct ethical attention under the principle of justice.

African scholars mention distributive justice, experimental treatments, and transplantation as major issues (11), warning that prioritizing foreign patients could neglect local needs. This concern is echoed globally, as unrestricted access for non-citizens may strain national systems (16). In Iran, Mustafavi et al. warn that tourism could compromise justice by compromising services for locals (14). Daniel and Elena Baldusco raise similar alarms (1).

Ethical frameworks underscore dignity and equal respect for all, regardless of nationality or background (34). A dilemma arises when systems have to balance taxpayer-funded care for citizens with revenue-driven services for foreigners. Both paths have ethical merit—beneficence and non-maleficence apply either way.

C. Financial Aspects

Financial concerns form the third core theme. Since affordability is a key motivation in medical tourism, financial ethics are of great importance.

Insurance is a recurring topic. In this respect, Matijesen et al. identify insurance as one of eight key drivers (35). Nevertheless, post-treatment costs can be staggering: P. B. McAuliffe et al. estimate U.S. follow-up expenses between $15,083 and $154,700 (36).

In Iran, Karimi Badrabadi et al. note that short wait times and specialization attract patients, but inadequate insurance and weak digital marketing are major gaps (22). Tourists also factor in travel, lodging, and support

costs—studies demonstrate that affordability of these services is critical (11, 37). Ambiguity in third-party insurance coverage is also an issue (19) .

National budgets may be strained by complications if care is subpar. Wessh J warns of costly outcomes burdening public systems (16). A utilitarian view supports efficient resource utilization for maximum benefit, while a principlist approach emphasizes financial ethics grounded in beneficence and minimal harm.

D. Cultural, Social, and Political Contexts

Cultural, religious, linguistic, and political factors heavily influence ethical interactions. Indonesian scholars (Abanit Asa et al.) found that religious and cultural factors have a great impact on patients' destination choices (38). Mathijsen also noted ethical strain from communication barriers and cultural mismatch (35, 39, 40).

For instance, shared values draw Bangladeshi patients to India. Physicians' ethics—shaped by local norms—can affect care quality. Patient expectations, dietary restrictions, and treatment attitudes are also significant matters (37, 41, 42).

International medical travel offers opportunities for ethical growth—if managed carefully. Legal and cultural differences need to be acknowledged, with dignity and preference of all parties respected. Upholding principles of beneficence, justice, non-maleficence, and autonomy is essential. Ethical tourism is contingent upon mutual respect embedded in communication and governance.

E. Policy-making

The final theme was policy-making. The wide scope of ethical concerns requires system-level attention (43). In Iran, inefficiencies such as delayed responses, lack of transparency, as well as poor coordination hinder development (44), undermining both service quality and speed.

Ethical and legal challenges often overlap. In this regard, Abolhasani highlights persistent legal uncertainties in areas such as malpractice, insurance, licensing, and medical technology access (45). Discrepancies between countries—on PGT, stem cells, or transplants—complicate regulation (46-48). Ignoring host laws can have serious consequences. Ethical standards can ban criminal acts by patients (31). Some travel abroad to bypass legal bans, creating dilemmas in areas such as DNR or futile care (11).

Policy-makers need to address these gaps. Feedback mechanisms—largely absent—could reduce unethical practices (36). Qing Xu warns that lack of oversight and market-driven approaches threaten ethics, urging international standards for legal, medical, and commercial integration (20).

Organizations such as WHO and PAHO can help create shared ethical guidelines, especially for sensitive services like surrogacy (49). Meanwhile, unlicensed providers and misleading digital platforms threaten public trust (19). Without oversight, unethical practices thrive—particularly under purely commercial models (1, 50).

In Iran, challenges include poor infrastructure, weak marketing, and no formal ethical codes (14, 28). Even though the 2020 Strategic Document mentions ethical values (32), no binding code governs the sector.

Policymaking and its associated ethical considerations in this domain appear to exert a significant influence on other stakeholders, especially in countries where healthcare services are predominantly state-managed, where such effects tend to be more pronounced. Resource allocation—whether financial or non-financial—maintains a bidirectional relationship with policymaking, and within the medical tourism service delivery cycle, each has the potential to either reinforce or undermine the other**.** This finding has been approved by the research team**.**

Evidence-based policymaking can prevent the waste of resources and minimize potential biases in resource allocation. This process should be reinforced through developing appropriate and enforceable regulations. Conversely, resource allocation grounded in sound principles establishes an environment that strengthens effective policymaking and fosters innovation, while appropriate feedback mechanisms help eliminate ineffective or impractical policies**.**

Likewise, in upholding ethical principles tailored to the cultural and social context and safeguarding the rights of all stakeholders, policymaking exerts both short-term and long-term effects.

Recommendations: The involvement of ethics experts through training and consultation at all stages of planning, implementation, and oversight can offer substantial benefits to medical tourism programs, including protecting stakeholders' rights, promoting positive cultural, political, and social outcomes, as well as supporting effective policy development alongside economic growth. Continuous updating of ethical guidelines provides a crucial first step. Addressing these considerations is necessary to prevent future challenges; as Qing Xu notes, inadequate regulations may deprive low-income populations of their rights and create

financial inconsistencies affecting society. With advances in novel treatments, such as transplantation and infertility therapies, ethically guided research and development is becoming increasingly important. Further, examining cultural interactions across diverse local contexts offers valuable opportunities for applied research.

Limitations: This study had several limitations. Inclusion of Persian-language sources (SID) may have introduced regional bias, and restricting the search to English and Persian publications could have excluded relevant literature in other languages. As noted in the Recommendations section, future studies could deal with these limitations by expanding the search to additional languages as well as databases.

Conclusion

In conclusion, medical tourism confronts significant ethical gaps due to limited regulation, oversight, and overly commercial approaches. As some scholars suggest, this stems from a lack of ethical orientation among policymakers (1, 11, 22, 50-52). Bridging this divergence requires a principled, collaborative approach—balancing commercial goals with core values of dignity, justice, and transparency.

Our study's five-theme structure offers policymakers a holistic tool for ethical gap analysis and can be employed to achieve their medical tourism developmental goals.

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Appendix 1. Article characteristics in the literature review

Article Title	First Author	Journal	Year	Country	Participant/Target Group	Study Type
Medical tourism among Indonesians: A scoping review	Gregorius Abanit Asa	BMC Health Services Research	2024	Indonesia	-	Review
Diasporic medical tourism: A scoping review of quantitative and evidence	Aneta Mathijsen	Globalization and Health	2020	Seven electronic databases across 4 continents: America, Europe, Asia, Africa	-	Review
Medical, Health and Wellness Tourism Research—A Review of the Literature (1970–2020) and Research Agenda	Lina Zhong	International journal of environmental research and public health	2021	China – UK	-	Review
Health Tourism—Subject of Scientific Research: A Literature Review and Cluster Analysis	Michał Roman	International journal of environmental research and public health	2023	Poland	-	Review
Determinants of Bangladeshi patients' decision-making process and satisfaction toward medical tourism in India	Muhammad Zakaria	Frontiers in public health	2023	Bangladesh	Bangladeshi health tourists with prior travel to India	Cross-sectional quantitative study
Medical tourism in Iran: Issues and challenges	Alireza Jabbari, Bahram Delgoshaei	Journal of Education and Health Promotion	2012	Iran	Health professionals and researchers	Descriptive, analytical, and qualitative
Ethical issues associated with medical tourism in Africa	John J. O. Mogaka	Journal Of Market Access & Health Policy	2017	South Africa	-	Review
Surrogacy and "Procreative Tourism". What Does the Future Hold from the Ethical and Legal Perspectives?	Valeria Piersanti	Medicine (MDPI)	2021	Italy	-	Review
Medical tourism in ophthalmology - review	Consuela-Mădălina Gheorghe	Romanian Journal of Ophthalmology	2022	Romania	-	Review
Eye disease and international travel: a critical literature review and practical recommendations	Jay Jun Lee	Journal of Travel Medicine	2023	Ireland	-	Review
Medical Tourism and Telemedicine: A New Frontier of an Old Business	Yan Alicia Hong	Journal Of Medical Internet Research	2016	China	-	Review

Complications of Aesthetic Surgical Tourism Treated in the USA: A Systematic Review	Phoebe B. McAuliffe	Aesth Plast Surgry (ISAPS)	2023	USA	-	Review
A bilingual systematic review of South Korean medical tourism: a need to rethink policy and priorities for public health?	Qing Xu	BMC Public Health	2021	South Korea	-	Review
A review of surrogate motherhood regulation in south American countries: Pointing to a need for an international legal framework	Gloria Torres	BMC Pregnancy and Childbirth	2019	Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay, Venezuela	-	Review
International stem cell tourism: a critical literature review and evidence-based recommendations	Samantha Lyons	International Health	2022	Malaysia		Review
Regulating Preimplantation Genetic Testing across the World: A Comparison of International Policy and Ethical Perspectives	Margaret E.C. Ginoza	Cold Spring Harborde Perspect ives in Medicine	2022	USA and 18 other countries	-	Review
The ethical experiences of trainees on short-term international trips: a systematic qualitative synthesis	James Aluri	BMC Medical Education	2018	USA	-	Review
Unproven stem cell–based interventions and achieving a compromise policy among the multiple stakeholders	Kirstin R. W. Matthews	BMC Medical Ethics	2015	USA	-	DEBABTE
Medical Tourism: Between Entrepreneurship Opportunities and Bioethics Boundaries: Narrative Review Article	Daniel Badulescu	Iranian J Publ Health	2014	Romania	-	Brief historical review
Developing an informational tool for ethical engagement in medical tourism	Philosophy, Ethics, and Humanities in Medicine	Krystyna Adams	2017	Canada	Phase 2: Medical tourism volunteers	Phase 1: Review Phase 2: Development of information tools
Identifying the themes of medical tourism business in Iran: A systematic review	Nafiseh Karimi Badrabadi	Journal of Education and Health Promotion	2022	Iran	-	Review
Ethics in Medical Tourism	Wessh J.	Green Verlag	2019	Germany	-	Academic article
The Dilemma and Reality of Transplant Tourism: An Ethical Perspective for Liver Transplant Programs	Thomas D. Schiano	Liver Transplantation	2010	USA	-	Case report

Australian news media framing of medical tourism in low- and middlein come countries	Imison M	BMC Public Health	2013	Australia	-	Review
Medical tourism in Iran:analysis of opportunities and challenges with MADM approch	Tourani S	Research Journal of Biomlogical sciences	2010	Iran	-	Review
Ethics in Health Tourism[In Persian]	Mostafav H	Quarterly Journal of Bioethics	2013	Iran	-	Review
Medical Tourism: Reasons for Choosing Iran[In Persian]	Mosadeghrad A	Payesh	2020	Iran	Health tourists to Iran	Qualitative – Interpretive Phenomenology
The Current Status of Medical Tourism: A Case Study of Iran[In Persian]	Delgoshaei B	Payesh	2013	Iran	In the qualitative phase: Stakeholder organizations and tourism experts with defined experience	Descriptive–Applied–Case Study
Identifying Factors Affecting the Attraction of Medical Tourists in Iran[In Persian]	Nikraftar T.	Journal of Health Management	2017	Iran	Surgery candidate tourists in Shiraz.	Descriptive–Correlational
Evaluating the Importance of Medical Tourism Performance in Tehran Province from the Perspective of Medical Tourists and Service Providers[In Persian]	Delgashaei B	Hospital Quarterly	2012	Iran	Health tourists and the heads and healthcare staff providing services in licensed hospitals in Tehran Province	Descriptive–Cross-sectional
A Study of the Effectiveness of Iran's Medical Tourism Websites[In Persian]	Tajzadeh Namin A.	Journal of Tourism Management Studies	2015	Iran	-	Review
Components and Content of Medical Tourism Facilitator Websites[In Persian]	Taghizadeh Yazdi M.	Journal of Tourism Management Studies	2016	Iran	Top websites facilitating medical tourism	Review AND Content Analysis
Legal and Juridical Aspects of Medical Tourism[In Persian]	Abolhasani N.	Quarterly Journal of Bioethics	2014	Iran	-	Review

Appendix 1- 2 Table of book characteristics in the literature review

Book	Author	Year	Country
Patients with passports. Medical tourism, law, and ethics	Glenn Cohen	2014	UK

Appendix 1-3. Table of document characteristics in the literature review

Document	Reference	Country
Global Code of Ethics for Tourism	-UNITED NATIONS -UNWTO*	-
Code of conduct for hospitals, clinlcs and medical travel companies	MTVQA**	-

Strides Dev Med Educ. 2026; 23(1):e1538. doi 10.22062/sdme.2025.200951.1538

Original Article

Students' Perspectives on Learning Basic Histology

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Abstract

Background: Histology plays a crucial role in shaping future physicians by providing a microscopic perspective on the human body. Despite its significance, both students and educators often perceive histology as a challenging and abstract subject. Limited research exists on students' perspectives regarding the difficulties encountered in this area of health science undergraduate programs.

Objectives: Characterize students' perspectives and experiences when learning basic histology as part of the medical program at the Universidad Tecnológica de Pereira, Colombia.

Methods: Ninety-five undergraduate medical students participated in a survey to gather their viewpoints on the basic histology curriculum. The responses address key issues from the student perspective, such as specific difficulties in their learning, identification of the most challenging theoretical and practical topics, struggles in image identification, and suggestions for course improvement.

Results: Hematopoiesis was identified as the most challenging topic in the curriculum (32.5%). Difficulties in image identification were expressed, citing similarities in histological tissues (25.6%), the aged and damaged condition of microscope slides (21.5%), and confusion in tissue orientation and sectioning (13.9%). Recommendations to improve the course included replacement of laboratory materials/instruments (14.9%), incorporation of prior anatomy knowledge (13.5%), increased hours with student monitors (13%), and integration of more dynamic activities (12.1%).

Conclusion: This study provides valuable insights into students' opinions and needs regarding basic histology, prompting a critical evaluation of the curriculum and teaching methodologies. Understanding these perspectives is essential for refining histology education, fostering a more effective, engaging learning environment for future healthcare professionals.

Keywords: Histology; Learning; Medical Education; Medical Student; Undergraduate Medical Education

Background

Histology, a fundamental branch of biology, involves the microscopic examination of the intricate structures comprising cells and tissues within the human body. Its significance extends to medical education, providing students with an in-depth understanding of diverse cell types, tissues, structures and organs. Traditional instructional approaches typically involve theoretical classes, elucidating the morphological and functional organization of cells. Complementary to this, educators utilize light microscopy photographs. Practical training further reinforces comprehension in laboratory settings where students employ optical microscopes to observe, identify, and interpret theoretical concepts (1).

Globally acknowledged as one of the most challenging courses in the health science curriculum (2), histology often becomes overlooked in the basic sciences as students' progress into clinical subjects (3). Insights from educational contexts in Turkey, Canada, Iran, and Saudi Arabia emphasize the significant impact of the learning environment on students' perceptions, influencing their training, attitudes toward the curriculum, and future professional practice (4-9). Notably, obstacles to learning have been recognized as

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factors that can negatively influence student motivation and academic achievements (10).

To enhance teaching quality and facilitate knowledge acquisition, it is imperative for educators to identify topics commonly found to be challenging within a subject. Understanding how students perceive the teaching methodologies can provide valuable insights into effective learning approaches (5, 6, 11). Students' perceptions influence both "hard" (academic achievement) and "soft" (satisfaction and development of key skills) learning outcomes, both directly and mediated through their approaches to study (9). As students' approaches to learning and the quality of their learning outcomes are strongly influenced by students' perceptions of the educational environment, it is vital and appropriate to study these perceptions (8). To achieve this goal, Learning Environments Research has established various instruments, such as questionnaires, for curriculum developers and educators to explore the psychosocial environment of the classroom from students' perspectives (6).

Despite over 4,000 medical schools around the world, there are few studies conducted in developing countries that focus on medical sciences pedagogy. To date, limited research has been conducted into students' perceptions of their difficulties in learning histology specifically and, to our knowledge, no such study has been conducted in Colombia, nor the American continent.

Objectives

This study aimed to characterize the students' perspectives and experiences of learning basic histology under the current curriculum taught in the medical program at the Universidad Tecnológica de Pereira, Colombia.

Methods

Design and Setting: The Histoembriology I course and its curriculum aimed to acquaint students with the fundamentals of medical histology, focusing on basic microscopy, cell, and tissue identification. A first semester course for medical students, the basic histology curriculum spanned a total of 108 hours, comprising 36 hours of theoretical lectures and 72 hours of practical exercises in the laboratory. The theoretical lectures underscored the structural and identification aspects of tissues at the cellular level, incorporating cellular and functional correlations. Each week, students had a total of six hours contact time comprising a two-hour theoretical lecture and a four-hour practical class in the laboratory, covering basic human histology. The course content covered surface epithelia, exocrine glands, connective tissue, adipose tissue, skin, blood tissue, cartilage tissue, bone tissue, muscular tissue, bone marrow, hematopoiesis, lymphoid tissue, and female and male genitalia.

The study design was a descriptive observational cross-sectional study adapted from a survey conducted by García et al. 2018 which investigated challenges faced by undergraduate biology students in learning basic histology at the University of Alicante, Spain (12). The survey was translated into Spanish, students' native language, and the multiple-choice answer options were adapted for the current basic human histology curriculum of the Universidad Tecnológica de Pereira. The content validity of the instrument was measured based on the feedback of three experts, all experienced histology tutors. The experts' recommendations were incorporated to ensure an accurate Spanish translation, and correct word order for items pertaining to the curriculum. The multiple-choice response options in the third part of the original questionnaire were removed based on their suggestions. Reliability coefficient, Cronbach's alpha, produced an acceptable reliability score for the questionnaire (α=0.90).

Ethical clearance for the study was obtained from the Investigation Ethics Committee at the same University, code 129-201123. The participants were fully informed of the study's objective. Participation in the study was entirely voluntary and anonymous. No personal data or data that could characterize the population were collected.

Participants and sampling: Participants consisted of undergraduate medical students at the Universidad Tecnológica de Pereira. The inclusion criteria were students who were in the first and second semester in the medicine program and who had completed the Histoembriology I course between June 2022 and November 2023. The exclusion criteria were students who dropped out of the course or those who did not sign an informed consent form to participate in the study.

The sample size was calculated using the formula $n = N/(1 + N * e^2)$ where: n = the sample size to be determined; N = the total population size, and e = the margin of error. Using the formula with a population of 125 students with a 95% confidence interval and a 5% margin of error, resulted in a sample size of 95 students.

Out of a total eligible population of 125 medical students across the three cohorts, 95 students completed the survey, yielding an effective response rate of 76%. All enrolled participants voluntarily completed the validated questionnaire.

Tools/Instruments

At the beginning of the survey, participants indicated which histology course cohort they were part of: June to October 2022, November 2022 to May 2023, or July to November 2023. The questionnaire comprised six questions. In the first question, students were asked to select the topics they found most difficult from a list of 15 predefined topics from the basic histology curriculum. Multiple choice question. Question 1: Which of the following curriculum topics did you find most difficult to learn? [Participants may select more than one answer] Answer options: Surface epithelia, exocrine glands, cytoskeleton and extracellular matrix, embryonic connective tissue, adult connective tissue, skin, blood tissue, cartilage tissue, bone tissue, muscular tissue, bone marrow, hematopoiesis, lymphoid tissue, female genitalia, and male genitalia.

The second question sought reasons for difficulties across 15 topics, presenting seven reasons or the option of indicating non-difficulty. Question 2: If you had difficulty learning the following topics, please select a reason by checking the box. If you didn't have any learning difficulties, select the "No difficulty" box. Topics: Surface epithelia, exocrine glands, cytoskeleton and extracellular matrix, embryonic connective tissue, adult connective tissue, skin, blood tissue, cartilage tissue, bone tissue, muscular tissue, bone marrow, hematopoiesis, lymphoid tissue, female genitalia, and male genitalia. Answer options: complex topic, many specific terms, requires a lot of memory, little time to learn, insufficient practice, abstract topic, I didn't go to class/I didn't pay attention, and no difficulty.

The third question involved selecting the five most challenging theoretical histological topics from a list of 24. Multiple choice question. Question 3: Select according to your criteria which were the 5 most difficult theoretical topics of the course. [Participants select five topics] Answer options: Epithelium and its morphological classification, apical specializations of the cell surface, cell junctions, cytoskeleton and extracellular matrix, basement membrane, exocrine glands and their classification, embryonic connective tissues, connective tissue cells, classification of connective tissue, epidermis, dermis, blood cells, cartilage tissue cells, isogenic group and cartilage matrix, chondrogenesis, bone tissue cells, osteogenesis, muscle tissue, erythropoiesis, granulopoiesis, lymphopoiesis, lymphoid organs, ovarian cycle/fallopian tube/uterus, and testicular cells/sperm ducts.

Question four explored reasons for challenges in image identification, offering eight predefined reasons and a blank space for additional responses. Multiple choice question. Question 4: Why is it difficult to identify an image under a microscope? Answer options: Lack of anatomical knowledge, difficulty defining cell boundary, tissue orientation or sectioning, histological staining (coloring), difficulty using the microscope, old/scratched/broken slides, microscope with poor light or low resolution, and similarity between tissues.

In the fifth question, students were required to identify the five most challenging practical histological topics from a list of 20. Multiple choice question. Question 5: Select according to your criteria which were the five most difficult practical topics of the course. [Participants select five topics] Answer options: Epithelium and its morphological classification, apical specializations of the cell surface, exocrine glands and their classification, embryonic connective tissues, connective tissue cells, classification of connective tissue, epidermis, dermis, blood cells, cartilage tissue cells, isogenic group and cartilage matrix, chondrogenesis, bone tissue cells, osteogenesis, muscle tissue, erythropoiesis, granulopoiesis, lymphoid organs, ovarian cycle/fallopian tube/uterus, and testicular cells/sperm ducts.

The final question invited students to suggest improvements to the histology course through a blank space or by choosing from 13 possible options. Multiple choice question. Question 6: Which of the following options would you consider could improve the learning of histology? Answer options: Carry out dynamic activities related to the topics, change the grading methodology, more student/teacher interaction, eliminate subject content, more time to study between exams, improve the teaching style of teachers, increase the course theoretical time, increase the course practical time, greater number of monitors with the monitor in charge, greater number of teachers consultations, replace the material and instruments that the laboratory has, improve the laboratory facilities, and have previous knowledge of anatomy.

Data collection methods: Employing a combination of quantitative and qualitative questions, the study

aimed to ascertain students' perspectives on the difficulties encountered when learning basic histology. Questionnaires were distributed via email during the final practical laboratory session and completed using Google Forms (Google, California, USA). All responses were anonymous, and informed consent was secured.

Data analysis: The data obtained were analyzed using descriptive statistics and analyzed using Microsoft Excel® (2025 edition). For questions one, three, five and six, percentages were obtained. For the second question the mode was acquired. Results were expressed in percentages. Open-ended questions one, four and six were categorized and analyzed thematically.

Descriptive statistics were calculated as absolute frequencies and relative percentages accompanied by 95% confidence intervals (95% CI) where applicable, to account for sampling variability from the target population of 125 students.

Results

Question one: Students' perspectives on the most difficult topics to learn on the basic histology curriculum.

Hematopoiesis emerged as the most challenging topic in the curriculum, selected by 80% of the students surveyed (76 out of 95 students). Exocrine glands followed with 34 answers, blood tissue and female genitalia were both selected by 20 students, and embryonic connective tissue with 19 responses (Figure 1 for full results). In response to this multiple-choice question, no student cited adult connective tissue and skin as difficult topics on the curriculum. Most students selected two or three topics for this question.

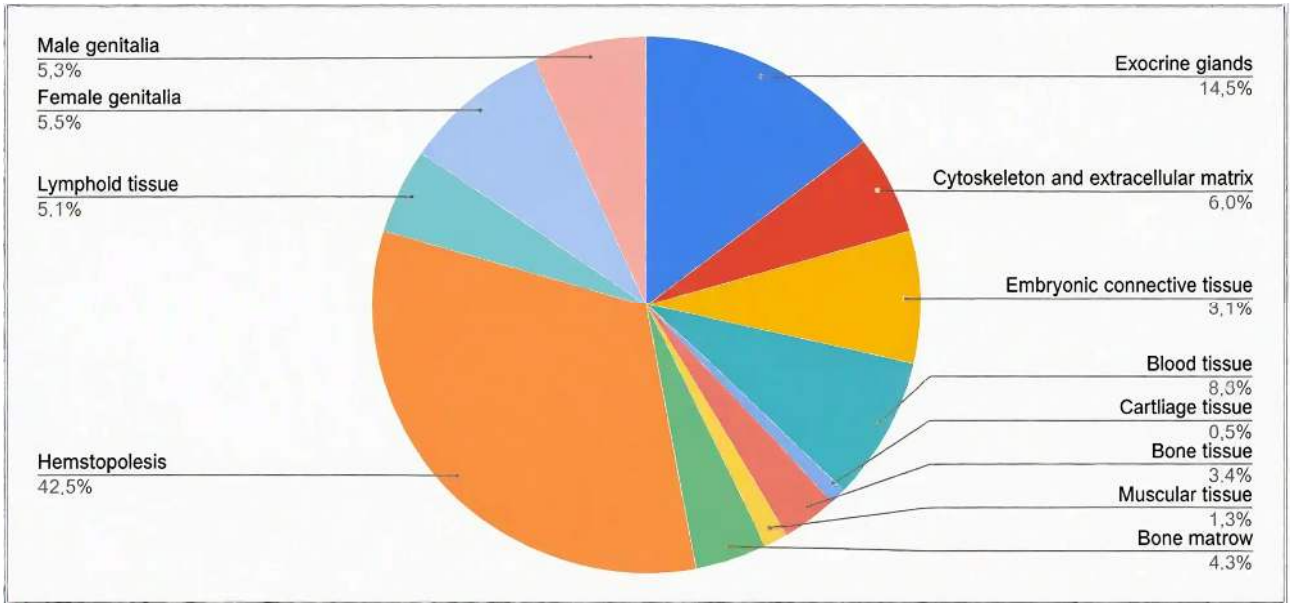

Figure 1. Students' perspective on the most difficult topics to learn on the basic histology curriculum

Note: Percentages for individual topics (e.g., hematopoiesis, 32.5%) represent the proportion of total responses recorded for this multiple-choice item, whereas 80% reflects the proportion of total participants (n=95) who selected this topic as challenging. Both metrics are presented for comprehensive descriptive clarity

Question two: Students' reasons for difficulties in learning the basic histology curriculum.

Of the students who responded that they had found one or more topics difficult, 40% cited hematopoiesis as the most complex subject. For other topics, the predominant response was that they weren't inherently difficult to understand. However, the breakdown of responses to the second question revealed that glandular epithelia was considered complex by 13.68%, blood tissue was seen as abstract by 12.63%, female genitalia was considered complex by 9.47%, and embryonic connective tissue was viewed as complex with lots of specific terms by 11.57% (Table 1 for full results).

Question three and five: Students' perspectives on the theoretical and practical topics they considered the most difficult to learn.

According to the students surveyed, the most challenging theoretical and practical topics in the basic histology curriculum were associated with

hematopoiesis, while the easiest were associated with skin, and cartilage cells (Table 2 for details).

Table 1. Students' reasons for difficulties in learning histology topics

Topics	Number of respondents (n=95)							
	Complex topic	Many specific terms	Requires a lot of memory	Little time to learn	Insufficient practice	Abstract topic	I didn't go to class/ I didn't pay attention	No difficulty
Surface epithelia	2	2	3	5	0	5	1	77
Exocrine glands	13	3	8	6	3	11	2	49
Embryonic connective tissues	11	11	10	4	1	5	2	51
Adult connective tissue	2	4	8	2	1	1	1	76
Cytoskeleton and extracellular matrix	4	11	6	3	1	4	2	64
Skin	1	3	5	1	0	3	2	80
Blood tissue	9	9	10	3	2	12	0	50
Cartilage tissue	1	3	6	3	0	3	1	78
Bone tissue	5	6	5	5	0	4	1	69
Muscle tissue	2	3	8	0	0	3	3	76
Bone marrow	14	5	5	4	1	7	1	58
Hematopoiesis	38	12	21	3	3	8	1	9
Lymphoid tissue	4	11	8	3	6	5	5	53
Female genitalia	9	8	8	4	0	2	2	62
Male genitalia	10	7	9	1	1	2	4	61

Table 2. Students' perspectives on the most difficult theoretical and practical histology topics

Topics	Theoretical topics		Practical topics	
	Percentage of respondents (%)	Number of respondents (n=95)	Percentage of respondents (%)	Number of respondents (n=95)
Epithelium and its morphological classification	7.4	7	9.5	9
Apical specializations of the cell surface	4.2	4	7.4	7
Cell junctions	18.9	18	-	-
Cytoskeleton and extracellular matrix	18.9	18	-	-
Basement membrane	1.1	1	-	-
Exocrine glands and their classification	24.2	23	38.9	37
Embryonic connective tissues	45.3	43	20	19
Connective tissue cells	0	0	7.4	7
Classification of adult connective tissue	3.2	3	11.4	11
Epidermis	0	0	3.2	3
Dermis	0	0	1.1	1
Blood cells	29.5	28	48.4	46
Cartilage tissue cells	0	0	2.1	2
Isogenic group and cartilage matrix	11.6	11	10.5	10
Chondrogenesis	6.3	6	6.3	6
Bone tissue cells	6.3	6	6.3	6
Osteogenesis	8.4	8	14.7	14
Muscle tissue	6.3	6	6.3	6
Erythropoiesis	62.1	59	85.3	81
Granulopoiesis	56.8	54	75.8	72
Lymphopoiesis	54.7	52	-	-
Lymphoid organs	14.7	14	24.2	23
Ovarian cycle/fallopian tube/uterus	46.3	44	29.5	28
Testicular cells/sperm ducts	24.2	23	17.9	17

Question four: Students' perspectives on the reasons why image identification was difficult

Concerning image identification using a microscope, 57 students cited difficulties due to histological tissues appearing very similar, 48 students cited microscope slides being old and damaged, and 31 students cited confusion arising from tissue orientation and section. In the open-ended response section, three students mentioned that structures, tissues, and cells were perceived as abstract, and one student stated the challenge of integrating all the topics by the end of the course (Figure 2 for details).

Question six: Students' suggestions for improving basic histology learning

Thirty-two students recommended replacing materials and/or instruments in the laboratory, while 29 proposed having prior knowledge of anatomy, 28 students desired more hours with student monitors, and 26 subjects advocated for more dynamic activities related to the topics. The sole suggestion given by one student in the blank space was for more autonomous time in the laboratory to study practical subjects (Figure 3 for details).

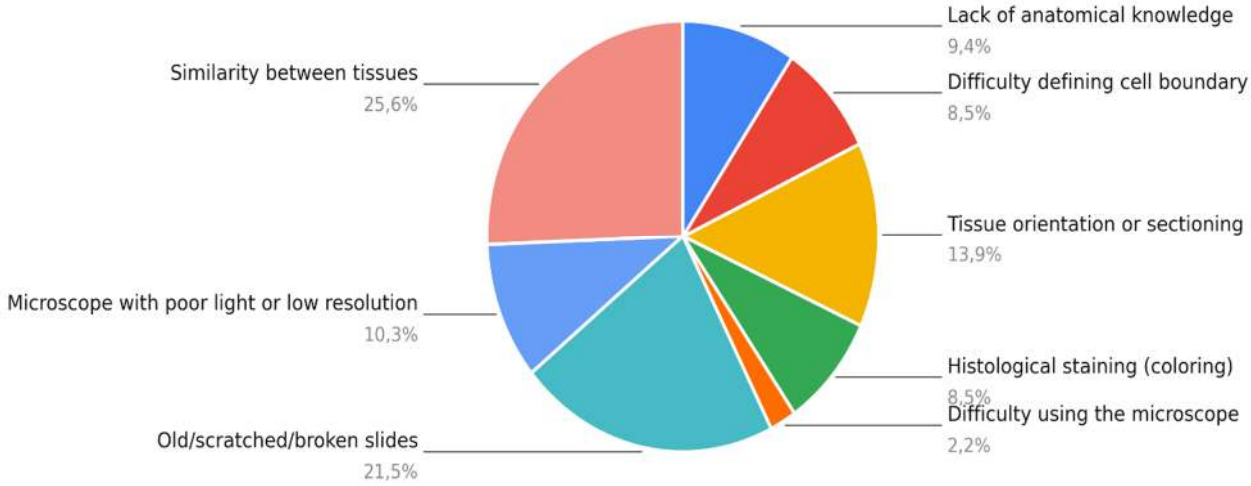

Figure 2. Students' perspectives on the reasons why image identification was difficult

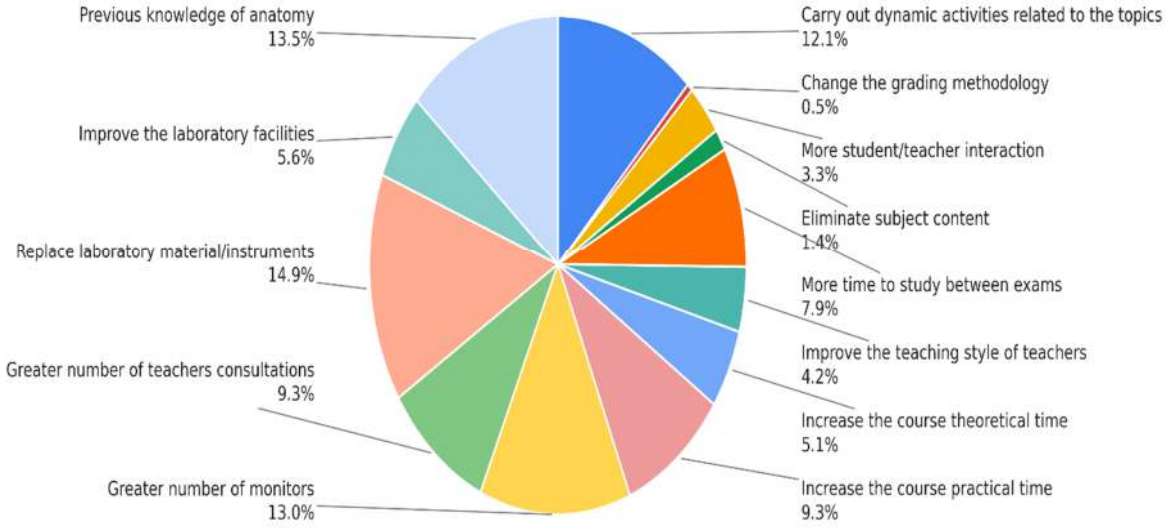

Figure 3. Students' suggestions for improving basic histology learning

Discussion

Globally shared challenges

Worldwide, histology experts have defined the essential topics necessary for a foundational understanding of this field of knowledge. In Cui & Moxham's study (2021) on the most difficult topics in a basic histology medical curriculum, they consulted an expert teaching panel to share their recommendations on which topics should comprise the core curriculum. The expert panel suggested the following core topics related to hematopoiesis: hematopoietic stem cells, bone marrow, megakaryocytes, progenitor cells and precursor cells such as proerythroblasts, reticulocytes, megakaryoblasts, myeloblasts, myelocytes (neutrophilic, eosinophilic and basophilic), stab (band) cells (neutrophilic, eosinophilic, & basophilic).

Core topics in reference to glands were: exocrine versus endocrine glands, unicellular and multicellular glands, cell types, intralobular ducts versus interlobular ducts, and exocrine glands classified by product, by mechanisms and by morphology. For blood tissue, the panel suggested that the core subjects were: blood composition, blood plasma, the percentage of each element on the tissue, complete blood count values and blood cell count, blood smear and stain, duration in circulation, life span of blood cells, and structure and function of blood cells such as erythrocytes, platelets/thrombocytes, lymphocytes, monocytes, neutrophils, eosinophils and basophils. Finally, concerning embryonic connective tissue (mesenchyme and mucous connective tissue) experts recommended that it be taught, but not as part of the core of the curriculum (13). These recommended core topics are all included in the Colombian medical students' basic histology curriculum at the Universidad Tecnológica de Pereira.

Similar results from our questionnaire can be observed in the 2019 study by García et al. in Spain. When students were asked about the most difficult subject on the histology curriculum, glands emerged as the hardest topic, named by 38.36% of respondents (12), a far higher number than in our results of 14.5%. The Spanish animal histology curriculum for biology students consisted of: surface epithelia, glandular epithelia, connective tissue, adipose tissue, bone tissue, muscular tissue, and nervous tissue (12). The Spanish curriculum inclusion of animal histology is very similar to the Colombian curriculum and may explain why results between the Colombian students and the Spanish students were similar regarding glands.

With regard to the reasons for difficulty in learning the basic histology curriculum, Eng-Tat et al. (2023) suggest that their Singaporean students face difficulties because of the nature and the nomenclatures of histology, and its main complaints were about insufficient learning time and the lack of clinical context (14). Tauber et al. in 2021, reported that the most common problems cited by their Czech students included limited study time for histology due to other time-demanding subjects such as anatomy, and problems with the correct recognition of structures (15). When García et al. in 2019 asked their Spanish students about the reasons why the topic identified – glands - was difficult, the most common responses were: I do not study the subject regularly (13.86%); It is very abstract (12.87%); and, there are not enough practical cases (11.88%) (12). Colombian students' perceptions on the reasons for difficulty were primarily that the topics were complex, required a lot of memory, and used many specific terms. These answers matched more closely those of Singaporean medical students which may be due to their curricular similarities.

The difficulties in image identification reported by our students are in line with global trends. Similar challenges, such as difficulty in focusing and identifying histological slides, were reported by medical students in India (16) and the Czech Republic (15). However, there are some notable differences between our results and those of García et al. (2019) in Spain. The difficulties with image identification reported by Spanish biology students were due to a lack of anatomical knowledge (77.23%) in contrast with our study of just 9.21%; difficulties in cell delimitation (72.28%) compared to our result of just 8.33%; a lack of histological section orientation (61.39%), again significantly higher than our results of 13.9%, challenges with staining techniques (30.69%) in contrast with our study's 8.33%, and difficulties in using a microscope at just 2.97% (12), a similar result to that of our study (2.19%). The significant contrasts above could suggest that the objectives of the Spanish and Colombian curricula are different while the basic histology curricula for medical students in India and Czech Republic are more similar to Colombia's, given the greater consistency in results between the studies.

With respect to the practical topics that students reported the greatest difficulty in learning, Teshome's survey of 184 medical students in Ethiopia in 2022 found that 65.76% reported finding practical histology more

difficult than theory. More than one-third of the Ethiopian medical students recommended that practical histology needed more lab sessions and these same students felt that they needed to put more effort into the subject (39.13%) (17). At the Universidad Tecnológica de Pereira, the recommendation is that the number of practical hours included in the basic histology curriculum be double that of theorical/lecture hours. Examining our results against those of García et al. (2019), we find that the hardest practical and specific topics were: isogenic groups at 27.72% for the Spanish students versus our study result of just 2.46%; direct and indirect bone formation for 24.75% of Spanish respondents against just 3.45% of respondents in our study, and chondrogenesis for 24.75% of Spanish students in contrast with our study results of just 1.48% (12). These significant differences may be due to the different objectives of the course compared to our academic program or a result of different teaching methods employed by Colombian teachers.

In studies where students were asked for suggestions to improve the teaching of basic histology, Basu & Roy in 2023 report that 16.5% of their Indian students suggested offering students doubt-clearing or Q&A sessions, and 2.35% suggested a greater emphasis on applied histology (16). Eng-Tat et al. in 2023 reported that 89% of their Singaporean student respondents strongly agreed that collaborative teaching with a pathologist was effective in their learning of histology (14). Taş in 2022 asked his Turkish students' opinions on using innovative approaches such as technology-adapted auxiliary course tools (education sets, mobile applications, and smart and digital devices) in histology education and 81% had positive opinions about such approaches, 7.5% were negative, and 11.5% reported that they were undecided. Curiously, these same students were asked about the necessity and utility of the histology course for clinical applications and, despite not yet having begun their clinical practice as first year students, 42% considered the course very necessary (18). In a survey of Chinese medical students by Ruan et al (2022), students suggested a prerequisite or foundational course in histology before taking the regular program would improve their learning and understanding of the basic histology course (19). Gribbin et al. in 2022 disclosed that their American students considered that staying up-to-date with histology lectures and laboratory work were both important for achieving a high level of competency in this discipline (20). In this same matter, Tauber et al. in 2021, in their survey of Czech medical students, found that students reported that using virtual microscopy alone or in combination with traditional glass slides was the most effective means of learning histology. When these students were asked what would help to facilitate the study of histology, the responses were: recommend just one main study source; introduce practical tests to self-evaluate their knowledge, and open the possibility of viewing more similar specimens from the same area (15). These student perceptions, and the similarities in the teaching methodologies they suggest, reinforce the importance of offering a histology course to undergraduate medical students.

Finally, Cui & Moxham in 2021 cited statistics from The International Federation of Associations of Anatomists showing that students on medical education programs in the United States received 22 hours ± 17SD hours devoted to laboratory practices in histology (13). Taş in 2022, within the scope of his study, asked Turkish medical students whether they considered the intensity of the theoretical histology course to be adequate at two hours per week. The length of the course – one semester - was found to be sufficient by 57.5% of students and insufficient by 24.1%. Additionally, the students were asked for their opinion on the necessity of practical histology courses. Practical histology education was considered necessary by almost three-quarters of respondents (73%), and unnecessary by almost a fifth (19.5%) (18). These students complete just half the number of practical hours that Colombian students receive.

Suggestions for pedagogical intervention: The limitations of the present study include the use of data from only one institution and a single undergraduate program. Another limitation is that it provides a one-sided perspective from students only, without any reflection or feedback from teachers. A further limitation is that the survey did not include data to characterize the surveyed population such as gender, academic term, or prior academic performance which reduces the analytical depth of the study. Recommendations for future research include incorporating teachers' opinions alongside those of students. Additionally, the absence of nervous tissue as a topic in our basic histology course, acknowledged as a curriculum limitation, prompts future investigations into its impact on students' comprehensive histological understanding. Finally, further research could explore

the consequences of such omissions on students' competence in an advanced histology course and their ability to integrate knowledge across disciplines.

Conclusion

The results of the present study characterize the perceptions of medical students regarding the curriculum of basic histology. This course is considered by undergraduate students to contain complex and abstract topics with a lot of specialist terms. Furthermore, students often have difficulty connecting the histology theoretical foundation with the laboratory practice, and they also acknowledge that similarities between different tissue types make some topics difficult to understand. Students made it clear that prior anatomical knowledge is important to deepen understanding on the course and that increasing the number of hours of practical sessions in the lab with better materials or instruments would significantly improve their learning.

Regarding the current basic histology curriculum, hematopoiesis and exocrine glands were highlighted as the topics students reported most difficulty in learning. This provides useful feedback and invites teachers to reconsider how these specific topics are taught within the course, the depth of their teaching, and the didactics of lectures and laboratory sessions. On the other hand, students perceived cartilage, muscle, and skin as easy to learn topics. These findings will be used to inform a targeted revision of the histology curriculum at our institution, focusing on the most challenging topics as identified by students so that more time can be allocated to those lectures during the course and more engaging teaching methods can be proposed.

Research in this field is lacking and students' opinions may be a useful point of departure to design more robust and detailed surveys that could lead to improved methods of evaluation for basic histology curricula. Surveying student perceptions enables teachers to evaluate the effectiveness of their teaching methods, as well as prompting students to reflect on their own learning process. To improve and facilitate student learning, more active learning strategies should be placed in the curriculum. Finally, as teachers, students should be motivated to consider the basic histology course and its curriculum as a science for the acquisition of skills for their future as physicians.

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Conflict of interests: There is no conflict of interest.

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Original Article

Effectiveness and Utility of Team-Based Learning in Teaching Integrated Competencies in Pharmacology: A Randomized Comparative Crossover Study

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Abstract

Background: The competency-based medical education (CBME) curriculum of India insists on a greater number of active learning sessions to teach integrated competencies. Self-directed learning (SDL) is a commonly used active learning session for a large number of students, whereas team-based learning (TBL) is a relatively untested approach in Indian medical schools.

Objectives: The aim of this study was to evaluate the effectiveness and utility of TBL sessions in teaching integrated pharmacology competencies within the CBME curriculum, and to assess student reactions and satisfaction with TBL.

Methods: We conducted a randomized crossover study among 87 second-year MBBS students at AIMSR, Chittoor, India, to assess the utility and effectiveness of TBL and SDL in teaching integrated pharmacology competencies. Pre- and post-test scores were compared using paired and unpaired t-tests, and student satisfaction with TBL was evaluated using a 5-point Likert scale via a digital questionnaire.

Results: The post-test performance of the TBL group was significantly higher than both its pre-test performance (P = 0.0001) and the post-test performance of the SDL group (P = 0.004). In contrast, there was no significant difference between pre- and post-test scores in the SDL group. Furthermore, student reactions and satisfaction with TBL were strongly positive.

Conclusion: Our findings indicate that TBL sessions are more effective than SDL sessions as active learning strategies, and that TBL can be successfully implemented in Indian medical colleges to teach integrated pharmacology topics within the CBME curriculum.

Keywords: Team-Based Learning (TBL); Self-Directed Learning (SDL); Integrated Curriculum; Pharmacology; Active Learning Sessions

Background

An active learning curriculum enhances both fellows' knowledge and faculty teaching skills (1). Medical educators have recognized the importance of active learning strategies such as small group teaching (SGT), problem-based learning (PBL), case-based learning (CBL), team-based learning (TBL), self-directed learning (SDL), small group discussions (SGD), student seminars, flipped classrooms (FC), and quizzes. Recently, the Indian medical education system has shifted from traditional teaching to competency-based medical education (CBME). The National Medical Commission (NMC) of India mandates a greater number of active learning sessions alongside didactic lectures in the CBME curriculum. Conventional pharmacology teaching methods are inadequate in developing students' reasoning skills. CBME emphasizes reducing rote memorization and adopting active learning strategies that foster critical thinking among students (2, 3).

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To facilitate active learning, SGT and PBL sessions are being adopted worldwide. In Indian medical schools, however, SGT and PBL are often not feasible due to an inadequate teacher–student ratio; therefore, SDL sessions are more commonly used. TBL may serve as a better tool to promote active learning in this context. The CBME curriculum consists of several integrated competencies, and TBL can be effectively combined with didactic lectures to teach these competencies. The key components of TBL include carefully formed and managed teams, pre-class preparation, individual readiness assurance tests (IRAT), group readiness assurance tests (GRAT) with scratch cards, problem-solving activities, peer evaluation, clinical problem-solving exercises, and timely feedback (4, 5). In TBL, student teams are actively engaged in brainstorming and applying concepts tested in the IRAT. Globally, a growing number of healthcare faculties have adopted TBL, and it has shown greater effectiveness in teaching complex subjects such as pharmacology, which requires integration with clinical therapeutics. Although SDL is mandated nationwide in the CBME curriculum, its effectiveness must be evaluated in comparison with other active learning strategies such as TBL.

I e typical class size in Indian medical schools is 150 students or more, making SGT and PBL sessions largely unfeasible. To facilitate active learning in large classes, TBL and SDL can be adopted, with TBL potentially offering greater benefits than SDL (6). In India, pre- and paraclinical subjects are usually taught away from the clinical setting, which prevents students from effectively connecting content delivered through didactic lectures with clinical applications (7). Within the CBME curriculum, many pharmacology competencies need to be integrated with other subjects, particularly general medicine. TBL and SDL sessions, when combined with lectures, may provide a more effective means of teaching such integrated competencies in medical schools with high student–teacher ratios. However, the effectiveness of TBL and SDL in teaching integrated competencies in Indian medical schools with large class sizes has not been adequately reported. Hence, this study was planned to evaluate the utility and effectiveness of TBL sessions in teaching integrated pharmacology competencies in comparison with SDL.

Objectives

To evaluate the effectiveness and utility of TBL and SDL sessions in teaching integrated pharmacology competencies within the CBME curriculum.

To assess student reactions and satisfaction with TBL

Methods

Design and setting: A randomized comparative crossover study was conducted among second-year MBBS students at the Apollo Institute of Medical Science and Research (AIMSR), affiliated with NTR Health Sciences University, Chittoor, India. Ethical approval was obtained from the AIMSR Research Ethics Committee (Ref: IEC17/AIMSR/05/2019). TBL sessions were conducted in a soundproof auditorium equipped with audiovisual aids and round tables, while SDL sessions were conducted in a lecture hall. Pretests (IRAT) and post-tests were conducted in the examination hall.

Components of TBL: Carefully formed teams (five students each) comprising a diverse mix of students were provided with study material and specific learning objectives (SLOs) on integrated topics one week prior to the session for preparation. An IRAT with well-structured five-option MCQs was conducted, followed by guided team-based problem-solving activities (brainstorming) and a GRAT using scratch cards. Frequent and timely feedback was provided on selected integrated concepts. Finally, each session concluded with a clinical problem-solving exercise based on a well-structured clinical case with structured questions (4, 5).

Participants: The sample size was calculated using the formula $N = (Z\alpha/2 + Z\beta)^2 \cdot \sigma^2 / d^2$, where N is the required number of participants, $Z\alpha/2$ is the Z-value for the desired significance level (1.96 for 5% significance, two-tailed), $Z\beta$ is the Z-value for the desired power (0.84 for 80% power), σ is the standard deviation of the within-subject difference (TBL – SDL) = 10, and d is the expected mean difference (effect size) between TBL and SDL = 5. By substituting these values, $N = 31.36$, which was rounded up to 32 per group (total sample size = 64). Each study group, however, consisted of more than 40 participants.

All participants were fully informed about the study objectives. Participation was voluntary, and there was no penalty for declining. The study was conducted among 2nd MBBS students. Of 150 eligible students, 87 provided consent and participated. Students were randomly assigned to TBL (n = 41) and SDL (n = 46) groups (Figure-1). Within the TBL group, students were further divided into 8–9 teams, ensuring diversity in academic performance (high, medium, and low performers) and gender distribution (5).

First stage of the study: Three faculty members from the Department of Pharmacology were involved in preparing the study material, specific learning objectives (SLOs), and MCQs, as well as implementing the TBL

and SDL sessions. Study material on recent trends in the management of diabetes mellitus, along with SLOs, was provided to students two weeks in advance for pre-class preparation.

Ten well-structured higher-order MCQs (designed to assess analysis, application, and evaluation skills), each with five options, were constructed and used to conduct a pre-test (IRAT) prior to the TBL/SDL sessions. In the TBL group, each team received one scratch card (Figure 2) along with the MCQs used in the IRAT. Teams were instructed to brainstorm the concepts tested in the IRAT for 40 minutes and then reattempt the same MCQs (GRAT) by scratching the correct option on the provided scratch cards. While designing the MCQs, correct options were aligned with the scratch card key. Scoring was based on the number of attempts: first scratch = 10 marks, second scratch = 7 marks, third scratch = 4 marks, fourth scratch = 1 mark, and fiNh scratch = 0 marks.

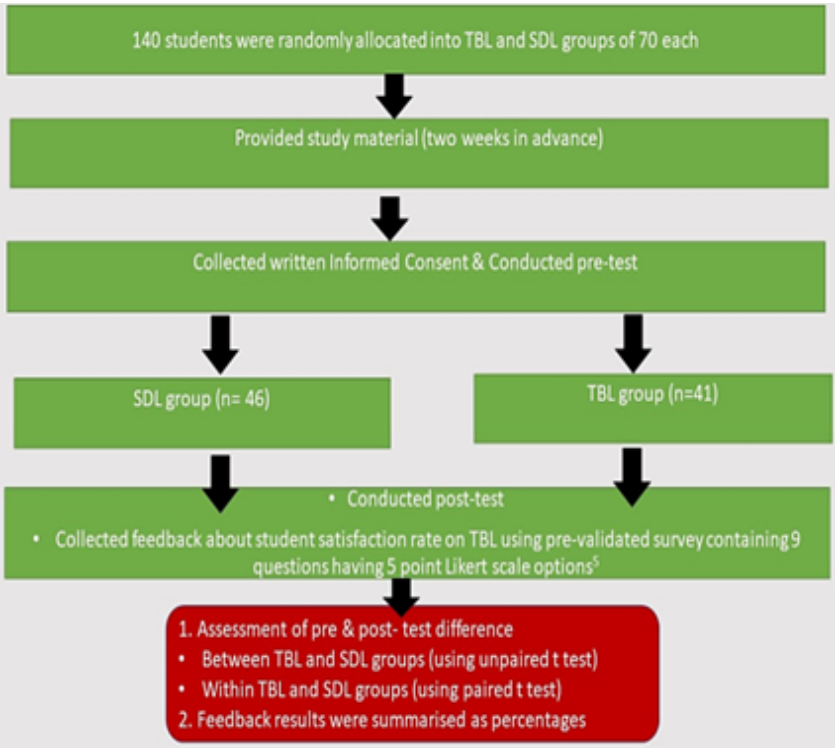

Figure 1. Flow chart of the study

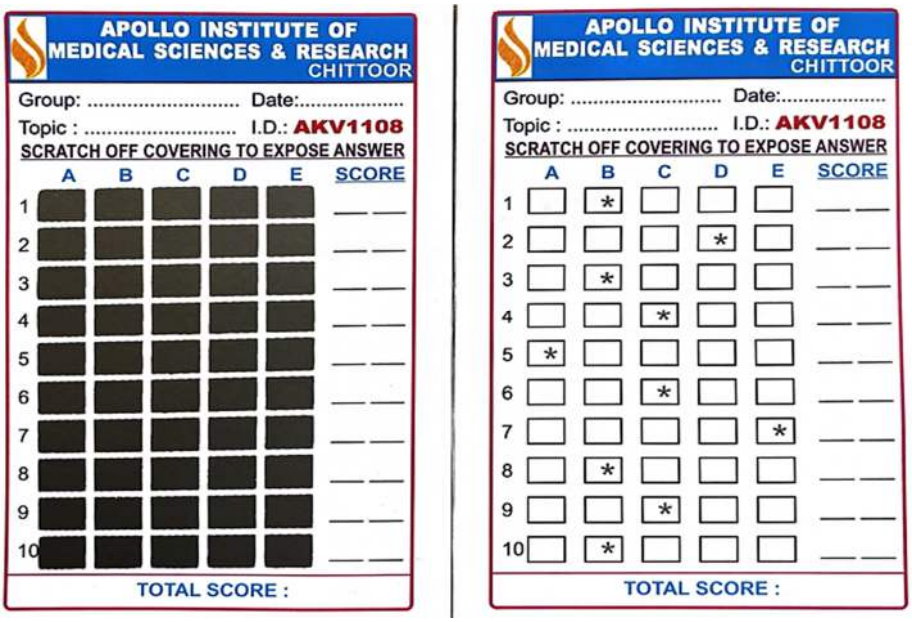

Figure 2. Scratch card: First scratch correct answer fetches more marks and subsequent scratches fetch less marks (1st scratch -10 marks, 2nd scratch-7 marks, 3rd scratch-4marks, 4th scratch -1 marks, 5th scratch -0 marks and total marks-100)

After collecting the scratch cards, the MCQs were projected on the screen, and students—especially from teams that did not perform well—were randomly selected to explain the rationale for correct and incorrect options. Simultaneously, frequent and timely feedback was provided on selected integrated concepts. Each session concluded with a clinical problem-solving activity based on a well-structured clinical case with structured questions.

Students in the SDL group were seated in a separate classroom, where they prepared the topic independently under the supervision of one faculty member. On the following day, a post-test was conducted for both TBL and SDL groups using slightly modified MCQs.

Second stage of the study: Students in the TBL group during the first stage were crossed over to the SDL group, and vice versa. Study material on recent trends in the management of chronic asthma, along with specific learning objectives (SLOs), was provided two weeks in advance for pre-class preparation. The rest of the procedures were similar to those followed in the first stage of the study.

Survey with a digital questionnaire: To assess student reactions and satisfaction with TBL, we used a modified, pre-validated survey consisting of nine questions on a 5-point Likert scale (8). Questionnaires employing Likert scales are useful for evaluating various aspects of a program, including overall satisfaction, specific course elements, and the learning environment.

This specially designed survey instrument assessed whether students would recommend TBL to their peers, whether the TBL module enhanced their understanding of the integrated topic, improved their self-directed learning skills, encouraged participation, or created barriers to learning. It also evaluated whether students were more satisfied with student-led TBL sessions, whether TBL should be incorporated into core curricular classes, whether they gained a better understanding of TBL pedagogy, and whether they felt they had successfully achieved the learning outcomes of the integrated topic. A total of 82 students participated in this survey using the 5-point Likert scale.

Data Analysis: Data were analysed using the Statistical Package for the Social Sciences (SPSS), version 26. Differences between pre- and post-test scores within each group, as well as between the TBL and SDL groups, were assessed using paired and unpaired *t*-tests. A *p*-value of <0.05 was considered statistically significant. Student satisfaction with TBL was analysed using descriptive statistics and expressed as percentage distributions, which were presented in pie charts.

Results

The pre-test difference between TBL and SDL was (–0.72), which was not significant (p = 0.55). However, the post-test difference between TBL and SDL was 1.02, which was highly significant (p = 0.004), indicating that TBL may be a more effective active learning strategy than SDL for teaching complex and integrated pharmacology competencies. The pre- to post-test difference in the TBL group was –1.95, which was highly significant (p = 0.0001), whereas in the SDL group the difference was –0.22, which was not significant (p = 0.53). I ese results suggest that SDL is less effective as an active learning strategy, while TBL is more effective and should be incorporated alongside SDL in Indian medical schools, where the CBME curriculum has been recently introduced (Table 1) (Figure 3 A-D).

Analysis of a digital questionnaire using a 5-point Likert scale demonstrated high student satisfaction with TBL as a teaching methodology. Student satisfaction rates exceeded 90% across all feedback questions (Figure 4 A-I).

Table 1. Pre-test and post-test score differences between and within TBL and SDL groups

Group	Mean	SD	Mean difference	P value
Pre-test difference between TBL and SDL (using unpaired t-test)				
TBL	3.20	1.54	-0.72	0.55
SDL	3.92	1.91		
Post-test difference between TBL and SDL (using unpaired t-test)				
TBL	5.15	2.03	1.02	0.004
SDL	4.13	1.94		
Pre-test and post-test difference in TBL group (using paired t test)				
Pre-test	3.20	1.54	-1.95	0.0001
Post-test	5.15	2.03		
Pre-test and post-test difference in SDL group (using paired t test)				
Pre-test	3.91	1.90	-0.22	0.53
Post-test	4.13	1.91		

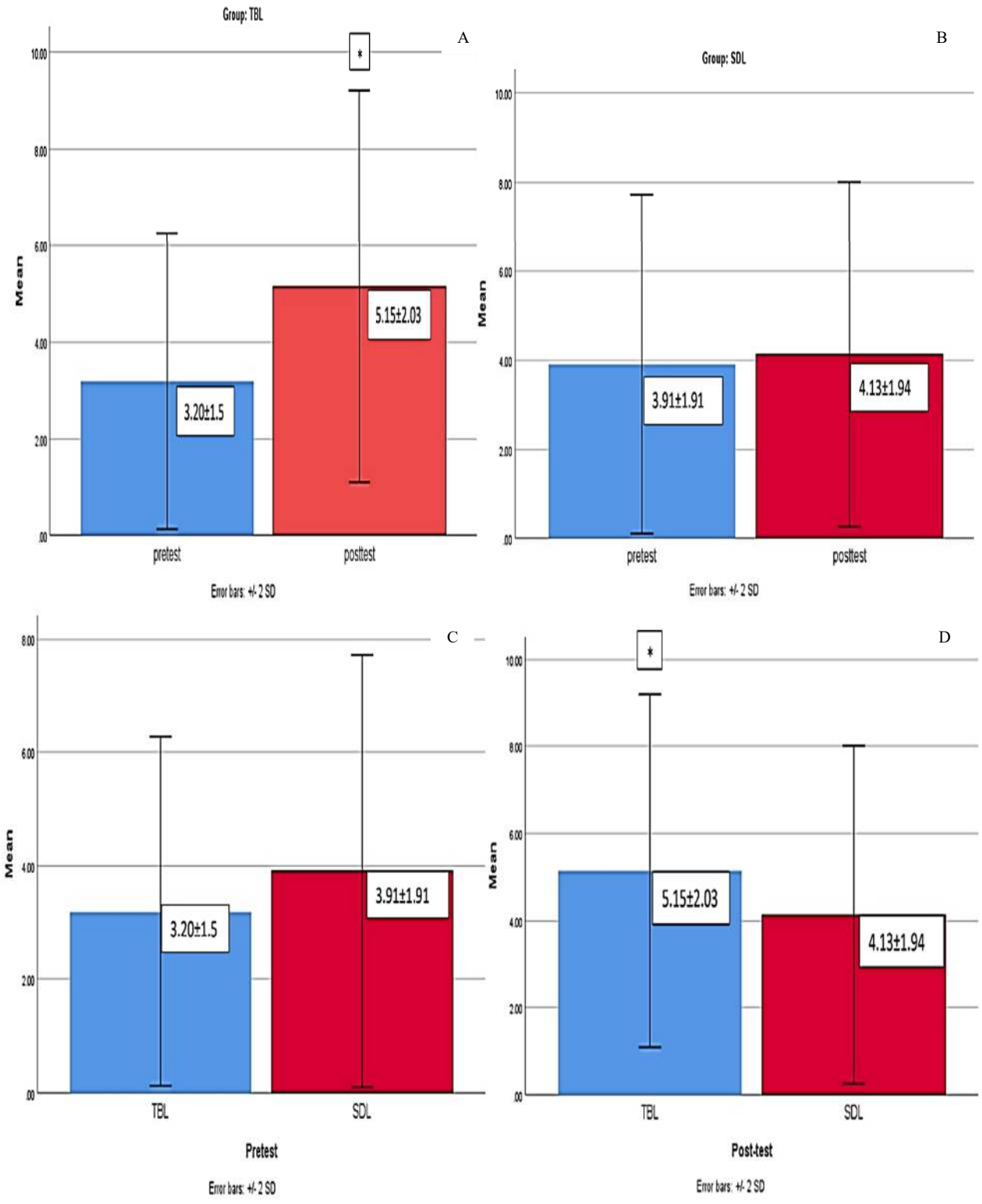

Figure 3. A: Pre-test and post-test score difference in TBL group (using paired t test) [*indicate p less than 0.05 (0.0001)]; B: Pre-test and post-test score difference in SDL group (using paired t test); C: Pre-test score difference between TBL and SDL groups (using unpaired t-test); D: Post-test score difference between TBL and SDL groups (using unpaired t-test) [*indicate p less than 0.05 (0.004)]

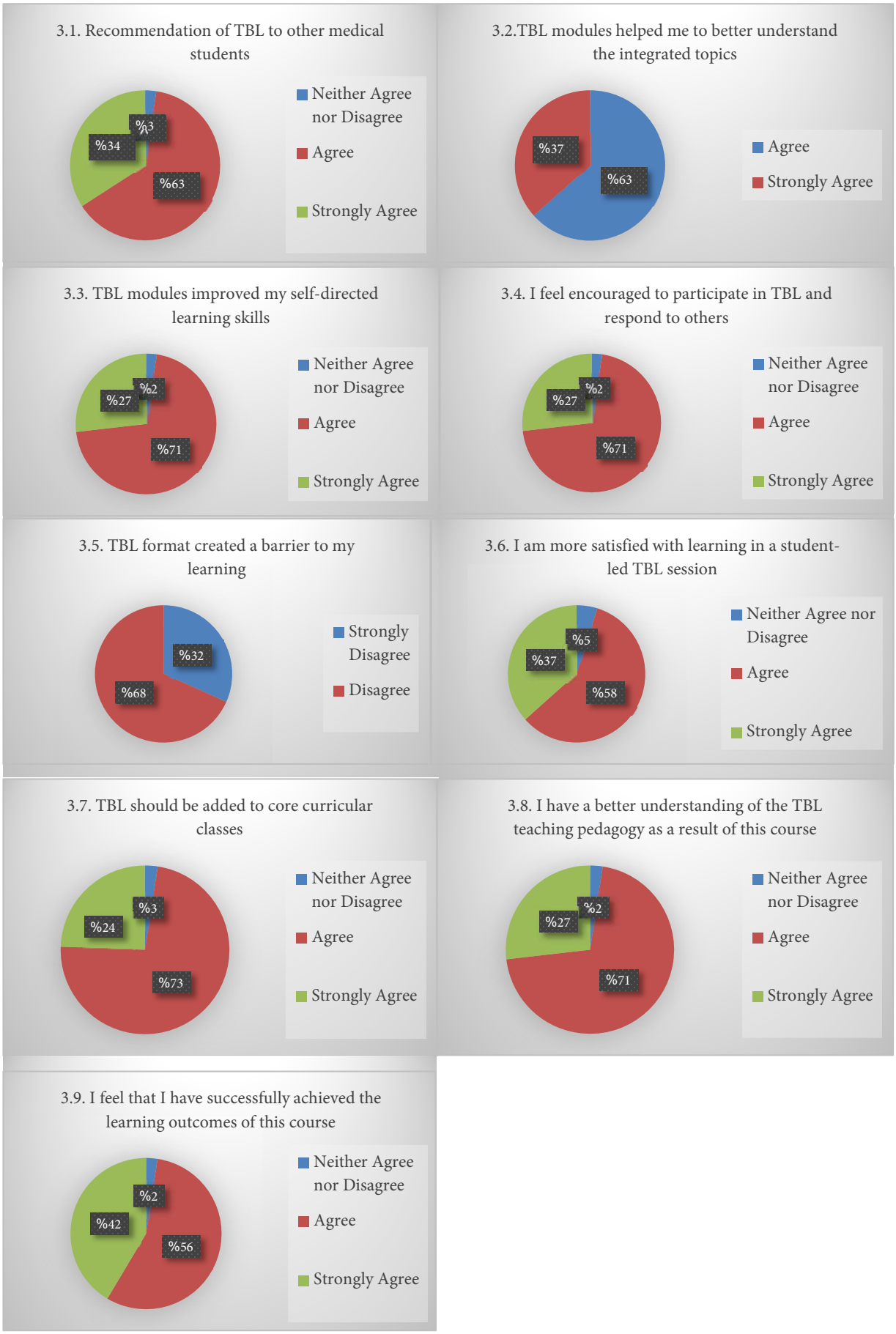

Figure 4. Student reaction and satisfaction rate on TBL- Modified pre-validated survey, containing nine 5 point-Likert scale questions

Most participating students indicated that they would recommend TBL to other medical students. They reported that the TBL module enhanced their understanding of the core concepts improved their self-directed learning skills, encouraged active participation, increased satisfaction with student-led learning, motivated them to include TBL in core curricular classes, deepened their understanding of the TBL pedagogy, and helped them successfully achieve the stated learning outcomes of the competency. Furthermore, students did not perceive the TBL format as a barrier to learning. These findings suggest that TBL may be the most appropriate active learning strategy and should be incorporated into all medical schools in India.

Discussion

The post-test performance of the TBL group was significantly higher than both its pre-test performance and the post-test performance of the SDL group, whereas there was no significant difference between pre- and post-test scores in the SDL group. In addition, student reactions and satisfaction with TBL were strongly positive. As our focus was on TBL, student reactions and satisfaction with SDL were not evaluated. Small groups of students working in teams are frequently used in medical education to enhance active learning and to develop communication skills (9). PBL, TBL, and SDL are prime examples of such strategies. Although there are logistical challenges in conducting PBL and SGD sessions in Indian medical schools, TBL and SDL can be adopted effectively and used in conjunction with lectures to teach integrated competencies. TBL is a student-centered yet instructor-led approach that enables one instructor to manage multiple small groups simultaneously, promoting interactive learning without requiring a large number of facilitators (10). In TBL, student teams are actively engaged in brainstorming and applying concepts tested in the IRAT. Our study demonstrates that TBL is an effective teaching strategy for integrated pharmacology topics and helps students improve performance, communication skills, and critical thinking.

SDL, on the other hand, is a process in which individuals take initiative—independently or with assistance—in diagnosing their learning needs, formulating goals, identifying resources, implementing strategies, and evaluating outcomes (11). With the introduction of CBME, SDL has gained increasing importance, as the curriculum mandates a certain number of SDL sessions in every subject and encourages students to view SDL as a lifelong learning strategy (12). However, our study suggests that TBL is more effective than SDL for teaching integrated pharmacology competencies. Despite this, the NMC does not mandate TBL sessions in the CBME curriculum. We strongly believe that the NMC should give greater attention to TBL and recommend implementing a certain number of TBL sessions in each subject to teach integrated competencies. TBL deserves more emphasis within the CBME curriculum (6). Regular TBL sessions may also foster SDL skills and lifelong learning strategies among students (13).

That said, TBL does involve logistical challenges, such as the need for a large, soundproof hall with audiovisual facilities, round tables and chairs for each team, scratch cards, and the additional workload for faculty (14). In contrast, SDL sessions are easier to conduct, requiring only a single faculty member in a lecture hall, and they may also promote lifelong learning attitudes (15).

Several studies comparing TBL with traditional teaching (16, 17) or with PBL (18) have reported higher ratings for TBL. Similarly, studies using TBL in pharmacology teaching observed that it enhanced understanding of complex concepts such as drug mechanisms of action, therapeutic uses, adverse effects, contraindications, and rational drug use (19, 20). Moreover, studies on clinical reasoning skills have shown that the addition of TBL sessions significantly improves clinical decision-making skills, indicating that TBL may be an appropriate method for teaching clinical decision-making. TBL groups scored higher and showed better retention of applied knowledge (21). A review article on systematic meta-analyses of TBL indicates that TBL pedagogy enhances the quality of medical education (22). To our knowledge, no previous comparative studies of TBL versus SDL in medical subjects, including pharmacology, have been reported. Based on our results, we recommend that all medical colleges in India adopt TBL as an active learning strategy, not only for integrated pharmacology competencies but also for competencies in other subjects.

The strength of the present study lies in its meticulously planned and executed comparison of TBL and SDL for teaching complex objectives in pharmacology, undertaken for the first time. Our results may encourage medical schools to incorporate TBL into the CBME curriculum, particularly for teaching complex and integrated pharmacology competencies

The limitations of the present study include the lack of prior awareness of the TBL methodology among both students and faculty, underscoring the need for proper

training of both groups to conduct such studies more effectively. Furthermore, as no comparative studies of TBL and SDL in pharmacology are available in the literature, additional research is required to substantiate our findings.

Conclusion

The post-test performance of the TBL group was significantly higher than both the pre-test performance of the TBL group and the post-test performance of the SDL group. Moreover, student reactions and satisfaction rates regarding TBL were strongly positive.

We conclude that TBL sessions are more effective active learning strategies than SDL sessions and can be successfully implemented in Indian medical colleges to teach integrated topics in pharmacology as well as other medical subjects. However, further research is needed to thoroughly evaluate the superiority of TBL over SDL in teaching complex and integrated competencies in pharmacology.

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Conflict of interests: There is no conflict of interest.

Ethical approval: Ethical approval was obtained from the AIMSR Research Ethics Committee (Ref: IEC17/AIMSR/05/2019).

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Original Article

Enhancing In-Class Independence: A Qualitative Exploration of Collaborative Constructivism among Medical English Students with a Flipped Classroom Approach

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Abstract

Background: The Flipped Classroom Approach (FCA) is rapidly being used in Medical English Education to encourage autonomy and active learning; although the qualitative data on in-class independence through collaborative constructivism, fostered by FCA and its underlying factors, remain underexplored.

Objectives: To explore how FCA facilitates in-class autonomy among medical English students through collaborative constructivist processes.

Methods: A total of 20 medical students enrolled in an FCA-based medical English course were purposively sampled to conduct a qualitative case study. The data was collected by forming three focus groups, semi-structured interviews, classroom observations, LMS logs, and reflective journals. The data collection spanned over 10 weeks, and the data were thematically analysed using Braun and Clarke's six-phase framework, followed by checks for intercoder reliability and triangulation to ensure trustworthiness.

Results: There was initial resistance to self-directed pre-class work among students, primarily because of cultural and technological barriers. However, students gradually turned confident, self-regulated, and developed ownership. Most students reported improved vocabulary retention and higher engagement. While structured pre-class materials, scaffolding, and role assignments mitigated imbalances in participation, peer discussions and instructor facilitation were pivotal in co-constructing knowledge, enhancing vocabulary retention, communicative skills, and engagement.

Conclusion: FCA enhances in-class independence and language competence among medical English learners when implemented with collaborative constructivist design and scaffolded supports. Institutions must invest in teacher training, digital literacy support, and structured pre-class scaffolds to maximize benefits.

Keywords: Collaborative Constructivism; Flipped Classroom; In-Class Independence; Medical English Education; Peer Learning;

Background

English efficiency is a necessary competence in medical education, enabling efficient interaction among healthcare specialists and enhancing patient well-being (1). As healthcare services have become globalized, proficiency in English is essential for medical and academic interactions. Nevertheless, the conventional lecture-based teaching in medical English courses is often criticized for its passive educational context, which restricts learner involvement and fails to nurture critical thinking. In contrast to the flipped classroom model, conventional lecture-base teaching leads to lower levels of student engagement, higher dissatisfaction, and restricted logical reasoning skills. This primarily owes to the absence of pre-recorded micro lectures, small group tasks, and the lack of structured pre-class quizzes which directly limit the critical thinking skills of students and their engagement with the course materials (2).

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Furthermore, the studies show that due to a greater focus on content delivery than learner participation, the didactic lectures often remain restricted to surface-level education in which pupils end up only memorizing theories instead of attempting deeper comprehension. (3). This is particularly challenging in English for Medical Purposes (EMP), where competencies such as cooperative problem-solving, communication abilities, and critical thinking are just as crucial as vocabulary.

The Need for Student-Centered Learning Approaches

To address these limitations, a paradigm shift has taken place towards learner-focused and constructivist pedagogies in medical learning, comprising the flipped classroom approach (FCA), dynamic education tactics, and problem-based education (4). The FCA converses conventional lecture-based mentoring by requiring pupils to study pedagogical ingredients before class, targeting concentrated in-class sessions focused on practical usages, peer cooperation, and interactive discussions (5).

Qualitative Research in Medical Education: The majority of research on FCA in clinical English education has traditionally focused on quantitative methodologies, highlighting exam performance and learner grades (6). Nonetheless, qualitative studies are crucial as they offer profound insights into the advancement of in-class independence, learner education know-how, and involvement patterns (7). Complementarily, qualitative research can capture the nuances of social and cognitive processes, making it an apt methodology for peer communication, reflections, and assisting educators in decoding learner insights in understanding the way FCA nurtures independent education and cooperative construction of knowledge. Existing research (8) provides strong support for the use of complementary qualitative methodologies to gain deep, nuanced insights into the FCA. Qualitative research and individualized interviews have been identified as key to capturing student feedback on emotional responses, the effect of social interactions on understanding, and cognitive sense-making during class and pre-class activities concerning nursing education.

Several authors have demonstrated how qualitative research methodology forms, specifically reflective interviews and observations, can capture the nuances of procedural change involved in socially situated learning and cognitive processing (9). Evidences emphasize the importance of observations in classrooms and semi-structured interviews in the interpretation of peer prompting and group roles (10). They also highlight the role of cognitive processes, such as monitoring and planning, in social contexts among Vietnamese students in EFL flipped classrooms. The demonstrated ability of qualitative research to interpret these complex, multifaceted learning variables aligns well with the analytical approach adopted in this study. Hence, this research adopts a qualitative approach to analyze how the FCA enhances in-class autonomy among medical English learners through cooperative constructivism. The research aims to bridge a knowledge gap in the existing literature by exploring the social and cognitive procedures that enable learners to become self-regulated students in a flipped classroom environment.

The Flipped Classroom Approach (FCA) in Medical English

In medical education, the flipped classroom approach (FCA) has taken over as a transformative instructional model, shifting the conventional lectured-centered paradigm toward one that cultivates dynamic learning and learner involvement. Within the context of clinical English, FCA rearranges pedagogical content delivery to pre-class activities, such as video lectures and readings, thereby preserving precious in-class time for application-centered, collaborative exercises. This methodology aligns with constructivist theories, which emphasize that students generate knowledge through active participation and cooperation (11).

Recent studies have reaffirmed the effectiveness of FCA in enhancing learner involvement in educational outcomes in clinical education. For example, a study implemented the FCA in a neuroscience module, providing learners with pre-class readings and video lectures, followed by in-class undertakings like quizzes and discussions. that the findings were overwhelmingly positive: 84% of pupils responded positively to the FCA, highlighting its stimulating and collaborative nature; 75% of learners completed their pre-season preparations, reporting that their misunderstandings and questions were better addressed during direct sessions in comparison to conventional environments (12). However, despite these benefits, there are still challenges associated with pre-class preparation and support. Relying on participant responses in the survey, which focused on attitudes rather than objective logs, leads to incomplete data on pre-class work completion (13). Furthermore, the "willingness to use" measure does not explicitly reveal how students interact with the content of pre-class sessions (13). The increased risk of unclear instructions and perceived cognitive overload

also exacerbates the challenges associated with pre-class engagement (14). However, some support mechanisms could be implemented to ensure effective student engagement with flipped classroom materials. Some authors state that guided worksheets, shorter segmented videos, and pre-class formative quizzes can be used to increase engagement and pre-class readiness (15). This type of scaffolding can mitigate the limitations of pre-work, especially for medical cohorts. Additionally, prompts for providing guidance could be directly embedded within the videos to make them more concise and explicit, thereby enhancing the accountability of the chosen media in the classroom (9). Therefore, pre-class preparation could be significantly improved by introducing practical design features that reduce cognitive overload.

In an adult health nursing course, quasi-experimental research analyzed the educational outcomes of a flipped classroom system. The study involved 485 nursing students, with the experimental category undergoing the FCA. The outcomes exhibited significant improvement in metacognitive abilities, self-assessed primary skills, and readiness for self-directed learning among students in the FCA category. Moreover, these students reported high levels of course satisfaction, suggesting that the FCA positively influenced educational inspiration and results (16).

Despite these effects, there is a lack of qualitative research scrutinizing how the FCA impacts self-directed learning and learner independence in medical English contexts. Understanding the student insights with the FCA can offer profound perceptions of its influence on their educational procedures and autonomy. Addressing this gap is critical for enhancing the execution of the FCA's implementation and improving learning strategies in medical English education.

Collaborative Constructivism and In-Class Independence

Vygotsky (17) and Piaget (18) are constructivist learning theorists who suggest that learning is a lively, cognitive, and social process in which students attain knowledge through collaboration with their peers. Collaborative constructivism builds on this by highlighting the role of societal cooperation, meaningful educational discourse, and scaffolding.

The Flipped Classroom Approach (FCA) promotes autonomy by allowing students to engage with lecture materials before a class, thus freeing up class time for peer cooperation, problem-solving, and active discussions (19). The FCA fosters a learner-centered educational environment, reducing reliance on teachers while improving independent learning. As (20) notes, the FCA enhances self-directed learning and motivation, as students own their studies through in-class discussions and pre-class preparations.

The Role of Peer Interaction in Constructing Knowledge

Peer collaboration is key to collaborative constructivism. Vygotsky's Zone of Proximal Development (ZPD) proposes that students learn best during their involvement with peers with higher skill levels, which enables scaffolded education (17). Studies suggest that FCA improves ZPD by allowing students pre -class exposure to content, permitting them to go into the classroom with foundational knowledge. This knowledge is then refined through collaborative educational deeds and social cooperation (21). Furthermore, the dialogic nature of classroom discourse in the FCA fosters profound learning. According to (22), knowledge is a co-constructed exploratory discussion where students justify, refine, and challenge their understanding. Recent research by (23) found that structured peer discussions in the FCA-centered courses significantly increased the conceptual understanding and critical thinking of the students in medical English contexts. These discussions also promoted Metacognitive consciousness, allowing students to manage their learning strategies and thought processes more efficiently (24).

Within this context, imbalances in peer participation and conflicts can be managed by increasing the scope for active learning embedded in flipped classrooms. To manage these imbalances, instructors must introduce explicit interaction protocols such as structured peer feedback, regular turn-taking, and role assignments enabling rotation of responsibilities (25). This can be combined with in-class scaffolding to redistribute participation and encourage quieter learners to contribute. Thus, a collaborative approach is fostered to resolve conflict and persistent imbalances to promote sustainable peer learning and problem-solving. Moreover, flipped classrooms promote peer modelling techniques, whereby quieter students seek the help of more extroverted classmates or peer groups to contribute to classroom assignments, by practicing before classes to familiarize themselves with vocabulary and grammar (25).

FCA as a Shift from Passive Reception to Active Engagement

Conventional, lecture-centered teaching often inspires passive learning where students obtain

information without engaging in higher-order cognitive procedures (11). The FCA reverses this dynamic, requiring students to communicate and process content before classes, thereby freeing up valuable classroom time for applied discussions, cooperation, and case studies (26).

Harden's research on flipped learning in medical education found that FCA significantly enhanced student autonomy. This occurred as students engaged in self-directed inquiry, formulated their own educational objectives, and cooperated with peers to solve medical case studies. This aligns with Paget's cognitive constructivism (1985), which theorizes that students actively construct meaning instead of passively absorbing information.

Emphasize that the FCA improves self-regulation abilities, encouraging students to handle their own learning schedules, clarify difficult concepts, and use theoretical knowledge during live classroom sessions (21). This enhances a sense of responsibility for education in students, strengthening their problem-solving ability and introducing greater independence.

Barriers and Challenges to Collaborative Constructivism in FCA

Collaborative constructivism presents several problems within FCA despite its benefits. Student resistance to active learning remains a significant factor, especially in cultures accustomed to teacher-centric education (26). Recent research by (24) found that while students initially struggled with the shift to FCA-centered education, the persistent students demonstrated better communication skills and academic self-confidence. Furthermore, instructor adaptability plays a critical role. Not every mentor is trained to enable learner-centered educational environments, and some may find it challenging to balance between student autonomy and guidance (19). Professional development programs for teachers should focus on collaborative classroom management, learning tactics, and assisted discussions to take full advantage of the FCA's effectiveness (27).

Digital literacy is another notable barrier. FCA depends hugely on digital resources, pre-class video lectures, and virtual discussion forums. A lack of technical skills among students can hamper engagement with pre-class resources, thus reducing the effectiveness of in-class discussions (28). Institutions should, therefore, integrate digital skills training to guarantee the smooth incorporation of FCA with interactive constructivist practices. However, evidence suggests variations in digital literacy. Suggest that digital literacy varies based on students' individual capabilities to innovate and depend on prior training and discipline (20). Furthermore, increased engagement with teachers regarding structured digital literacy might cause students to feel paralyzed to screen misinformation (29). Since students come from diverse backgrounds with varying levels of digital literacy, they might face difficulties in accessing clinical databases, learning management systems (LMS), and online medical journals. Nevertheless, this challenge can be addressed by designing specific mitigation strategies. According to (29), practical measures such as onboarding tutorials, baseline diagnostics, and utilization of multimodal resources could enhance self-efficacy when engaging with online platforms. This helps in the efficient usage of a medical dictionary application and major medical references that are published in English. Engaging with various media also helps in advanced perceptive capacity, which is in the comprehension and retention of clinical language. Additionally, guiding the onboarding in a stepwise manner and offering alternative formats may help bridge the gap in digital skills, particularly by providing a framework that links learning outcomes with digital literacy (29).

Research Question

How does the flipped classroom approach facilitate in-class independence among medical English students through collaborative constructivism?

Literature Review

Constructivist Theories in Language Education: Constructivist learning theories have long impacted pedagogical systems have been impacted by constructivist learning theories for a long time, particularly in language learning, by focusing on the social, dynamic, and cognitive processes involved in education. The contributions of Vygotsky (17), Piaget (18), and Bruner are central to this framework. Their theories focus on the significance of students constructing their own understanding of the world through collaboration with their environment and peers.

The Sociocultural Theory of Vygotsky underscores the social nature of learning by stating that collaborations inside an ethnic environment co-construct knowledge. Through supervision and interaction with other skilled teachers and peers (17), the Zone of Proximal Development (ZPD) of Vygotsky emphasizes that students can accomplish higher levels of understanding. In language education, this indicates

that learners can improve their linguistic skills through problem-solving activities and interactive conversations that occur within the ZPD. Contemporary studies in language learning highlight the applicability of Vygotsky's theory in recommending peer-mediated education, which allows students to strengthen their mutual understanding, focusing on clinical English settings and ESP or English for Specific Purposes (30).

Piaget's cognitive constructivism is highly significant to language learning because he emphasized the active creation of knowledge. He suggested that information is not passively received by the students. Instead, they dynamically shape their mental frameworks by interacting with the environment (18). In the context of clinical English, this theory proposes that students actively construct meaning as they engage more with the subject matter, including fresh awareness of prior know-how. This approach is central to the flipped classroom, where students are expected to be aware of the content before the particular class. It enables easier processing of materials and applies fresh information in a collaborative environment. Studies by (26) show that the flipped classroom improves learner involvement and mental advancement, encouraging them to be extremely individualized and dynamic. Besides, it also facilitates interactive learning experiences.

The Scaffolding Approach of Bruner matches the ideology of Vygotsky and Piaget, with the former highlighting the mentor's role in offering students. Indicates that scaffolding helps pupils to perform tasks that they cannot manage on their own (31). This support, in the shape of observation, outline, or prompts, gradually decreases since the skills required to perform independent tasks are slowly developed among the pupils. Scaffolding enables the continuous acquisition of complex concepts and skills in learning language, especially in clinical English. This system works best in a flipped classroom context, in which students frequently engage with interactive activities that encourage them to cooperate with peers and teachers so that their learning can be scaffolded. Incorporating this system into flipped classrooms will foster self-sufficiency and freedom in students. Eventually, they will be able to take ownership of their learning (22).

The importance of social cooperation, guided learning, and lively involvement in attaining linguistic skills is highlighted by these foundational constructivist concepts. From the standpoint of clinical English learning, they support the inclusion of flipped classroom practices, which promote student-centered learning and the interactive assimilation of knowledge. This theoretical framework is highly suitable for examining the way interactive constructivism, as facilitated by the flipped classroom system, can foster better in-class autonomy amongst clinical English learners.

Recent Contributions to Constructivism in Language Education

Contemporary research continues to support the importance of constructivist theories in language learning. Demonstrated that interactive education in a virtual setting facilitates the co-production of knowledge and simultaneously aids students' autonomy (23). Their research, focusing on virtual interactive language education, found that when students engaged in reflective practices and peer discussions, their linguistic ability and content appreciation significantly improved. Flipped classrooms promote dynamic education and better learner autonomy by shifting the mentor's role from a lecturer to a facilitator (28). This concept echoes Bruner's scaffolding idea. Furthermore, research by (21) indicated that the flipped classroom system is crucial in improving self-regulation in language students by actively encouraging them to take ownership of their learning. By engaging with content before a class, students are better prepared to participate in questions, discussions, and peer interactions during class. This autonomy is essential for fostering deeper educational understanding, as it allows students to be involved with higher-order thinking and problem-solving activities during class time; instead of just absorbing information passively.

Within this context, several examples illustrate how learner autonomy in the flipped classroom setting is manifested by scaffolding and peer communication. For example, students shift from passive reflexive note-taking to self-monitoring via guided worksheets and structured group roles (32). This delegates responsibility to the students, as they autonomously manage tasks and scaffold group roles before and after readiness checks. In another study, similar results were echoed, where scaffolded prompts and coded short vignettes were used for strategizing behaviour and influencing metacognitive dialogue (10). This demonstrates how autonomy is developed in students in a stepwise manner. Another exemplar study by (33) points out that structured peer feedback and peer-explained protocols foster self-assessment among students and enhance their self-assessment ability. These strategies serve as key indicators of student

autonomy, with communication among peer groups acting as a secondary resource for supported learning.

Flipped Classroom in Medical and Language Education: In the higher education sector, FCA, or the flipped classroom approach, has gained widespread recognition as it has the capacity to develop and retain dynamic education and long-standing learner association (13). The FCA reverses the conventional, lecture-centric structure by fostering an academic environment that encourages students to engage with academic resources before a class and spend classroom time on supportive, collaborative activities.

Effectiveness of FCA in Medical Education

The utility of the FCA in clinical education has been widely scrutinized, demonstrating its ability to boost clinical reasoning, problem-solving skills, and knowledge acquisition (34). Conventional didactic lectures often fail to engage students actively in learning complex clinical ideas, leading to the passive reception of knowledge (6). In contrast, the FCA offers a student-centered framework, facilitating students to learn at their own pace and become more independent (35). A meta-analysis of flipped classroom studies concerning medical learning found that students in FCA-centered courses demonstrated better knowledge retention and problem-solving skills compared to students based on lecture-centered traditional teaching (26).

Despite these advantages, qualitative research highlighting students lived experiences with the FCA in medical environments remains limited. The majority of current research relies on quantitative performance metrics rather than understanding the way FCA impacts student encouragement, interactive learning, and self-regulation (35-36). This gap underscores the necessity of meticulous qualitative studies that analyze involvement patterns, insights, and learner collaborations.

Flipped Classroom in Language Education: A Shift toward Active Learning

In language education, the FCA endorses cooperation, active communication, and group effort. Studies propose that students display better speaking efficiency, self-assurance, and self-directed learning behaviours in flipped language courses compared to those in conventional environments (3). The FCA shifts grammar and vocabulary instruction to pre-class activities and dedicates classroom time to highlight problem-solving exercises, peer discussions, and practical communicative tasks (37). Additionally, there is a growing body of evidence on how the flipped classroom approach fosters autonomous learning and metacognitive skills among medical English learners. A study correlated flipped classroom designs in nursing courses with enhanced scores for note-taking, self-testing, and pausing videos, all critical aspects of metacognition and self-regulated learning (38). This amounts to a significant increase in self-paced learning and improved student attention as they develop the right to manage their favoured tasks. Approximately 75% of medical students enrolled in flipped classrooms devote more time to self-study, which indicates a shift towards a student-centred approach and enhanced scope for cognitive engagement (39). Moreover, flipped classrooms help in the construction of answers to questions during the class and inspire discussions and recapitulation following the examinations, which supports active learning through better knowledge retention (40). Since vocabulary retention is crucial for remembering the patient safety terminology and effectively applying it in specific scenarios, such as documenting patient history, issuing patient discharge summaries, etc. Furthermore, research has shown that the FCA in English for Specific Purposes (ESP), including Medical English, can lead to significant improvements in students' abilities to use technical terms in professional environments (4). Medical pupils enrolled in an FCA-centered English course performed considerably better in medical communication tasks compared to traditional classes (41). The research highlighted the significance of interactive constructivism, where knowledge is dynamically co-constructed through case-centered education, role-playing, and peer discussion.

Challenges in Implementing FCA in Medical and Language Education

FCA offers several instructive benefits, but its execution is fraught with difficulties. Research indicates that learner resistance to mentor adaptiveness, self-directed education, and technological obstructions can influence the efficacy of FCA (21). With increased pre-class workload, several learners find it challenging to balance comprehension with in-class undertakings (35). Besides, teachers may need extensive training to transition from a lecture-centered role to that of a facilitator, which is critical for sustaining a supportive and collaborative environment (36).

Despite these difficulties, the FCA has been acknowledged as an efficient instructive gadget in medical and language learning, fostering interaction amongst students and enabling dynamic education.

Prospective studies should highlight qualitative scrutiny into student experiences, especially in ESP courses like medical English, to fully comprehend how the FCA adds to in-class autonomy, professional abilities, and linguistic advancement.

Collaborative Constructivism and Active Learning: In the context of language learning, collaborative constructivism is based on the notion that students co-construct knowledge through dynamic engagement with peers, negotiation of meaning, and social communication (27). This system aligns with the sociocultural theory of (17), which emphasizes the significance of societal communication in cognitive advancement. In the medical English classroom setting, collaborative education improves vocabulary acquisition and refines the communicative skills of students in professional medical environments (42).

The Role of Peer Interaction in Medical English Learning

Medical English courses, interactive activities, and peer discussions offer students the option to practice professional communications and medical terminology in realistic settings. Research proposes that dynamic involvement with peers assists students in processing and retaining domain-specific expressions more efficiently than conventional methods of rote memorization (23). Learners clarify ideas, strengthen their understanding of complicated medical terms, and foster collaborative education (22). Meanwhile, resistance to peer interaction among students can be addressed by maintaining clarity of roles, rotation of responsibilities, and identifying explicit rubrics, leading to early success, guided by confident peers (33). This considerably reduces anxiety and improves willingness to participate in peer interactions. Students involved in interactive education demonstrated better levels of language retention, inspiration, and involvement compared to those in teacher-centric contexts. In flipped classroom environments, with pupils reviewing course material before a class, interactive constructivism plays a crucial role in deepening in-class discussions and strengthening knowledge through peer scaffolding (28).

Cognitive and Social Benefits of Collaborative Learning

From a cognitive perspective, peer communication fosters the deep processing of information, as students actively reorganize their knowledge and incorporate fresh ideas into their existing psychological frameworks (31). Medical English students involved in group discussions often correct each other's misunderstandings, leading to more precise application of language and enhanced self-confidence in professional interactions (26).

Socially, cooperative constructivism improves problem-solving abilities, critical thinking, and enhances collaboration (43). Learners working in small clusters improve interactive communication skills essential for interdisciplinary cooperation and patient care (24).

Challenges in Implementing Collaborative Learning

Despite its advantages, implementing cooperative constructivism in medical English courses presents challenges. Some students may refuse peer communication due to the possibility of teacher-centered teaching or the fear of making errors (4). Furthermore, gaps in digital literacy can impede collaboration in technology-intensive learning environments in flipped classrooms (28). Tutors have huge responsibilities as supervisors, facilitators of discussions, and shapers of a cooperative classroom environments that encourage interactive and active engagement (30). Future studies should examine the long-term impacts of collaborative constructivism on clinical English aptitudes and explore methods to overcome obstacles that appear in peer instruction across different educational contexts.

Objectives

To explore how FCA facilitates in-class autonomy among medical English students through collaborative constructivist processes.

Methods

Research Design: To analyze student experiences in a flipped classroom approach (FCA)-focused clinical English course, a qualitative case study was designed. This choice was guided by the need for a detailed comprehension of collaborative communication, student engagement, and educational independence (21, 44). Qualitative case studies facilitate the meticulous exploration of pragmatic educational contexts, making them suitable for analyzing how students navigate an FCA context in clinical English learning (45). The credibility of the data was maintained not only through intercoder reliability but also by structured member checking, which involved validating participants by supplying them with brief analytic summaries (46). Furthermore, data sources, such as observation notes, were triangulated across different data sources, followed by audit trails on the raw data for theme development.

The transferability and peer communication were assessed by a concrete description, whereby all the data was confirmed beyond ray coder kappa scores (46).

Participant Selection: Purposive sampling was employed to select 20 medical pupils enrolled in an FCA-based medical English course. The choice ensured that respondents had diverse backgrounds with regard to prior exposure to FCA, language skills, and age (47). Inclusion criteria required students to have attended a minimum of 80% of classes and actively participated in classroom undertakings. Previous studies emphasize that purposive sampling is particularly effective in educational case studies where diverse viewpoints are critical for thematic exploration (48).

Data Collection Methods: To ensure methodological consistency and triangulation of data, a number of qualitative data assortment systems were applied (49).

- Classroom Observations: Structured and unstructured observations were conducted over 10 weeks, highlighting the communication of the students, their levels of involvement, and patterns undertaken (50). Because the server bias was minimized in the classroom by maintaining a standard protocol for coding behaviour to ensure consistency. Additionally, minimizing interaction and adopting a non-participant positioning helped facilitate the use of repeated coding and triangulation of observations with the LMS logs and student self-reports. Moreover, adherence to ethical guidelines, camera placements, and recording the number of visits served helps mitigate the Hawthorne effect. This ensured the credibility of the findings (51).
- Semi-Structured Interviews: With the help of semi-structured interviews, the diverse viewpoints of the students and teachers were assimilated, facilitating smooth feedback while keeping the focus on the main research questions (52).
- Focus Group Discussions (FGDs): To analyze cooperative educational knowledge, understanding of the FCA in clinical English learning, and peer dynamics, three focus groups were utilized (5-7 pupils each) (53).
- Student Reflections and Learning Journals: Students maintained reflective journals to document their difficulties, educational tactics, and self-perceived progress (54). These reflections offered rich insights into the advancement of the development of student autonomy.

Data Analysis Approach: Thematic exploration was used to identify patterns pointing to learning independence, cooperation, and in-class autonomy. Categorization and coding were conducted by the NVivo 12 software, confirming organized qualitative data modeling (55). Triangulation was applied to improve fidelity by cross-referencing learner reflections, observation notes, and interview transcripts (56). The six-phase framework of Braun (57) was applied for thematic adaptation:

1. Familiarization with data
2. Initial coding
3. Searching for themes
4. Reviewing themes
5. Defining and naming themes
6. Report writing

Intercoder dependability was ensured by cross-validating findings from two independent scholars (24). Reflexive thematic exploration confirmed a deep understanding of the student experiences, particularly in self-regulated education and collaborative studies (58). Ethical approval was obtained from UMREC (Research Ethics Committee), approval number UM.TNC(P&I)/UMREC/3/5670, ensuring informed consent, confidentiality, voluntary participation, and adherence to institutional ethical guidelines throughout the study and external oversight.

Results

Student Adaptation to the Flipped Classroom Approach

Initial Resistance and Challenges: The transition to the FCA posed initial challenges for medical English students. This sentiment aligns with findings, who noticed that learners often struggle to switch from passive to active educational modalities in flipped classrooms (12).

Technological barriers contributed to the initial resistance as well. Inadequate availability of digital materials and unfamiliarity with virtual education media slowed down the ability of some students to engage efficiently with pre-class resources. These barriers highlight the need for appropriate technological support when implementing the FCA in medical education.

Decreasing Resistance and Recognizing Benefits: Despite initial challenges, resistance to self-paced learning decreased as students started to recognize the advantages of the FCA. Engaging with pre-class resources enabled students to approach in-class activities with foundational comprehension, fostering a more communicative and stimulating educational

environment. They found that medical learners preparing before class achieved higher performance scores and needed fewer interventions during peer-supported educational sessions.

Role of Peer Discussions in Reinforcing Understanding: Peer discussions appeared as a crucial component in strengthening the understanding of medical English amongst students. Collaborative educational contexts allowed students to clarify concepts, share diverse viewpoints, and employ theoretical knowledge in practical situations. This cooperative system enhanced understanding and introduced self-confidence in applying medical terms correctly. Have documented the efficacy of peer-supported learning in medical competence acquisition, focusing on its role in enhancing the practical use and retention of knowledge (59).

In summary, the transition to the Flipped Classroom Approach initially presented opposition among medical English learners, but the continuous engagement with self-paced education and active participation in peer discussions facilitated adaptation. These findings demonstrate the value of providing educational support during the FCA transition and promoting collaborative learning outcomes to enhance student outcomes in clinical English learning.

Development of In-Class Independence: Learners illustrated growing self-regulation and self-assurance. Learner reflections on FCA adaptation are displayed in Table 1.

Table 1. Student perceptions of FCA (Thematic Summary)

Theme	Key Student Responses
Initial Resistance	"I was unsure about learning on my own at first."
Increased Autonomy	"Preparing before class helped me understand topics better."
Peer Learning	"Discussing with classmates made concepts clearer."

Table 1 presents a thematic summary of student perceptions of the adaptation of the Flipped Classroom Approach (FCA). Initially, students were reluctant to self-paced learning, as indicated by statements such as, "I was unsure about learning on my own at first." However, familiarity grew, and they reported increased autonomy, recognizing that pre-class preparation facilitated better appreciation of course materials. Additionally, peer discussions played a crucial role in reinforcing the understanding, with students highlighting the benefits of collaborative learning, stating, "Discussing with classmates made concepts clearer." These findings align with previous research indicating that FCA enhances student independence and engagement by fostering self-regulated learning and interactive discussions (60).

Instructor's Role and Classroom Dynamics: Teachers facilitated discussions instead of direct teaching. Observed teacher roles are summarized in Table 2.

Table 2 outlines the various roles instructors adopt in Flipped Classroom Approach (FCA) environments. Specifically, instructors serve as facilitators, leading discussions and encouraging critical thinking among students. They also act as moderators, fostering peer collaboration to enhance interactive learning experiences. Additionally, instructors assume the role of mentors, providing individualized feedback to support students' academic development and personalized learning goals.

Table 2. Instructor Roles in FCA Classrooms

Role	Description
Facilitator	Guides discussions, prompts critical thinking
Moderator	Encourages peer collaboration
Mentor	Provides individualized feedback

Discussion

Interpretation of Findings in Relation to Research Question: This study shows that the Flipped Classroom Approach (FCA) has a crucial, constructive influence on fostering in-class autonomy among medical English learners. Through organized pre-class activities, students get the option of self-directed involvement in content creation, facilitating deeper understanding and analytical comprehension before entering the classroom. Therefore, class time can be channeled to collaborative education, where students can co-construct knowledge through discussion and peer cooperation (11).

One of the major findings of this research was the growing level of self-regulation and student engagement. Students are more likely to come prepared by having access to resources before class, which enhances their ability to dynamically participate in discussions and cooperate efficiently with their peers (23). This autonomy is further supported by collaborative constructivism, which highlights the social nature of education and the significance of peer-to-peer communication (17). Students clarify uncertainties, build upon each other's knowledge, and discuss meaning, which adds to the co-construction of medical English efficiency (22).

This collaborative process, which was key to the FCA, also emphasized the significance of peer accountability. Rather than depending solely on the teacher, students became more accountable to their peers, recognizing that they would be required to group tasks and share insights from their pre-class work. This transition from a teacher-centered model to a student-centered one in the educational context supports growing autonomy, which is crucial for the advancement of medical communication competence (28). Besides, the results suggest that this transition made students more relaxed by allowing them to take ownership of their learning. In other words, the FCA increased the level of autonomy in students.

The research also found that mentor facilitation was extremely valuable in boosting the flipped classroom's efficacy. The classroom environment became more dynamic once the role of the mentor switched from a conventional lecturer to a facilitator. The learners got the opportunity to be actively involved in organizing activities (43). The instructor's capacity to scaffold learning knowledge base, encourage reflection, and lead peer discussions was required for collaborative constructivism to flourish (31).

Key Factors Contributing to Student Independence: Several factors were identified as contributing to the growing in-class autonomy of the learners within the flipped classroom model. The structured pre-class preparation, comprising communicative resources, readings, and videos, facilitated student involvement in the independent development of content. This independence in learning is necessary for students to feel valued and self-confident in the classroom (21). Also, the incorporation of active learning activities in class, for example, peer instruction and problem-solving tasks, enabled students to openly use their knowledge immediately, nurturing self-efficacy and autonomy in clinical English (28).

Additionally, the findings highlight the significance of social education in establishing autonomy. By engaging in discussions and peer communications, students could develop a sense of togetherness, where learning became a shared experience rather than a personal activity (27). Supported by the FCA model, this peer communication generated a sense of belonging, which subsequently inspired greater self-regulation and involvement (22).

Despite these successes, the execution of the flipped classroom was not free of challenges, though. Especially at the outset, some students expressed their reservation to the model, largely due to their lack of exposure to self-learning and dependence on teacher-led teaching (30). Demonstrated that the gaps in student digital literacy and a lack of acquaintance with the virtual learning environment can present crucial challenges to the success of the FCA (26). These challenges were particularly apparent among students who were ill at ease with technology or who did not see the instant worth of involving themselves with the pre-class content.

Challenges and Areas for Improvement: While the Flipped Classroom Approach (FCA) demonstrates strong potential for enhancing student autonomy, significant challenges remain with digital literacy and student opposition. Teachers must offer transparent guidance on how to approach pre-class resources and set expectation boundaries for active in-class engagement (11). Besides, providing training sessions on virtual platforms and digital gadgets before the course begins can be effective in lowering technological barriers and ensuring that all students are equipped for the FCA setting (30). To address initial student resistance to flipped classroom models and support digital literacy skill development, targeted tutorials can explain the scope for optional onboarding at the start of the course using digital submission tools and collaborative platforms, such as medical databases (61). Additionally, complex digital assignments could be simplified by providing stepwise guidance, subtitles for text readings, and instruction videos (61). Additionally, communicating the pedagogical rationale for students using handouts in actual languages to promote high-value activities helps bridge digital literacy. Furthermore, to foster collaborative approaches, pairing less tech-savvy students with technologically advanced peers can help with digital literacy in students. The success can be evaluated through repeated short trials, identifying students who improved more. Additionally, the existing technological knowledge of students can be evaluated at the start of the program. For students deemed less equipped with the necessary credentials, short lessons and videos on how to navigate through the interface can go a long way in instilling confidence among these students (61). Eventually, they could be brought up to the expected level, ensuring success in the FCA classrooms.

According to the research, peer cooperation was helpful, but there were occasional clashes among learners regarding different levels of preparation and involvement. Effective classroom management strategies that endorse

equitable participation and promptly resolve conflicts are crucial for the FCA's success in clinical English education (21). Teachers need to ensure that all learners are actively involved in discussions and that peer instruction roles are evenly shared among all participants.

Implications for Medical English Education: The research focuses on the prospect of the Flipped Classroom Approach (FCA) and collaborative constructivism in renovating medical English education. By incorporating dynamic educational tactics and shifting to a more student-centered teaching model, teachers can inspire growing autonomy among pupils while at the same time fostering collaborative education that improves medical interaction abilities (43). The findings suggest that the FCA provides students with the instruments essential to self-regulate and take ownership of their learning, which is a crucial component of success in the medical education sector.

Furthermore, this research adds to the broader literature on constructivist learning theories by demonstrating how collaborative education and peer communication can be applied to foster independent learning and efficiency in a specified zone, like medical English (17). If thoughtfully and adequately exercised, the findings also support the notion that incorporating technology into education has the ability to generate more engaging, meaningful learning experiences that equip students with practical, hands-on challenges.

Implications and Contributions

Theoretical Contributions: This research highlights the potential of the flipped classroom approach (FCA) in medical English education. By incorporating a qualitative structure, this study offers a pathway on how FCA can be employed to endorse in-class autonomy and collaborative constructivism. The findings suggest that collaborative learning and social adaptation supersede individual learning in the context of FCA, aligning this conclusion with the sociocultural theory of Vygotsky (17). This theory proposes that learning is intrinsically a social action, where learners can co-construct knowledge through collaboration, particularly in challenging sectors like medical English (22). Furthermore, the theory of cognitive constructivism by Piaget (1985) suggests that students are active and not passive learners, a conclusion that matches this research, where FCA ensures that students excel in their learning (18).

Furthermore, Bruner's scaffolding theory is reinforced by the findings, where students could slowly take on added learning responsibility through peer assistance and collaboration (31). This study enhances the qualitative literature on FCA by offering a strategic analysis of the way peer learning can foster self-regulation, independence, and a deep understanding of medical English.

This research, thus, offers a subtle qualitative perspective on FCA, filling a literature gap by illustrating the constructive role of social communication and collaborative constructivism in advancing in-class autonomy among medical English learners.

Pedagogical and Practical Implications: From the pedagogical perspective, this research suggests that FCA can reform clinical English education by advancing a dynamic, pupil-focused system of learning. The findings suggest that the combination of peer-to-peer tutoring, cooperative in- class activities, and pre-class preparation enhances student involvement and educational effects (28). Student-driven learning and peer communication are promoted by the FCA model, which generates a perfect milieu for clinical interaction as medical English pupils are required to process complex clinical expressions and interact in English within clinical set-ups (43).

In practical settings, teachers must assume the role of facilitators, not lecturers. The scaffolding inherent in the FCA allows tutors to plan communicative activities that encourage cooperative problem-solving, where pupils can participate in key interventions and develop their knowledge of clinical English with assistance from peer support (26). This can be achieved by role-playing, case-based discussions, and clinical simulations, which provide students with the environment to exercise real-life clinical interactions. Furthermore, mentors should be trained in the efficient use of technology to support pre- class engagement, for example, discussion boards, communicative video lectures, and quizzes, which are vital to the operational success of FCA (11). Furthermore, there should be clinical English books and curricula incorporating reflective practices and cooperative activities. Peer cooperation is crucial to enhancing autonomy. Hence, educators should include further cooperative ventures that will encourage students to practice and hone their competence with the support of feedback loops and group activities (23).

Policy and Institutional Considerations: From a policy and institutional perspective, this research supports the broader adoption of the flipped classroom approach in medical English programs. The FCA has the potential to align with global communication standards in clinical education, where the ability to interact efficiently in English is crucial. By emphasizing

autonomous education and peer cooperation, the FCA model echoes the growing demand for enduring learning and constant professional improvement in the clinical sector (43). However, this adoption cannot be facilitated without educational institutions investing in training programs for instructors, offering them the instruments and materials to efficiently accomplish the remits of the FCA. Infrastructural assistance is also necessary to ensure that students have access to essential technologies, such as communicative media, video recording gadgets, and learning management approaches (28). Besides, policymakers should inspire institutional flexibility to facilitate the redesign of traditional curricula to integrate more active learning tactics, comprising peer-led education and cooperative ventures (11). These policies must be implemented because they assist the constant professional development of mentors when they switch from lecture-oriented teaching to learner communication-focused pedagogical systems (26). This would ensure that the FCA is profitably implemented and maintained step by step.

However, some challenges are imposed by policies and institutional infrastructure. For instance: instructors require more time to design course materials and resources, possibly due to infrastructural issues, such as a lack of internet bandwidth (62). The administration could solve these problems by incentivizing faculty through practice assessment methods in flipped classrooms. Additionally, changes in incentivization policies could be adopted, along with conducting pilot evaluations with measurable indicators for performance and cost-benefit analysis across various phases (63). Therefore, policy levers could be developed to address faculty overload, and infrastructural changes should be set up in the form of centralized e-learning support.

Professional development in flipped classrooms is necessary to assign facilitators' roles to the instructors, as they take part in feedback cycles, role rehearsal, and co-planning (62). Consequently, the mode of action changes from the traditional lecturing model and transforms into a format for co-designing, microteaching, and reflexive practices. Hence, professional development (PD) acts as a way to enhance teacher adaptability to foster better outcomes for students. PDs also help in aligning assessments and emphasize the incentivization of redesigning, supported by dedicated institutional time (64). This enables teachers to adopt high-fidelity practices following teacher training. Overall, the focus of PD, clinical versus educational, directly supports teacher adaptability and delivers an approach to improve student outcomes.

Contextually, the following recommendations for training programs could be proposed to prepare instructors for the facilitative role required in effective FCA implementation. As evidenced by (65), instructors must be supported in designing multimedia and get training on successfully using online platforms so that they can prepare the students before the class. For this, technological adaptation, such as on-demand access, narratives for lectures, and creation of short videos are used in training programs to enable instructors to assume a facilitative role in flipped classrooms (66). Additionally, the instructors need to be trained in following collaborative guidelines and must learn to process formative assessment and active learning designs, which will enable them to adapt to the diverse backgrounds of the students. Instructors must also adhere to time management strategies, community building skills, and navigation skills for reflexive observations, guided by peer review (67). Implementating such iterative professional development approaches can refine the adoption of higher-order learning goals among instructors, allowing them to function as facilitators of student engagement.

Several limitations of this study should be acknowledged. First, the research employed a single-group qualitative design with a limited sample size of students from a single institution, which restricts the generalizability of the findings to broader educational settings. Second, due to the qualitative nature and absence of a concurrent control or randomized comparative group, the observed improvements in student engagement and active participation cannot be definitively attributed solely to the flipped classroom approach (FCA) without potential confounding factors. Finally, reliance on self-reported data and qualitative observations may introduce subjective bias; therefore, future studies employing multi-center, controlled quantitative, or mixed-methods designs are recommended to validate and expand upon these findings.

Conclusion

The Flipped Classroom Approach (FCA) efficiently fosters in-class autonomy among clinical medical English students, and this research emphasizes that. The FCA shifts the traditional teaching model, enabling students to assume greater responsibility for their learning. It also helps them to engage with content before the class and apply their knowledge

communicatively and cooperatively during the class. This transformation boosts students' autonomy and promotes deeper comprehension and retention of complicated clinical expressions and interactive skills. As suggested by findings, the FCA stimulates the immediate application of knowledge, active learning, and peer collaboration as crucial components for understanding clinical English in a medical milieu. Since students are involved with case-based actions, critical discussions, and role-playing, they enhance problem-solving and critical thinking skills that go beyond rote memorization, making the educational process more lively and professionally contextual. This research adds to the growing body of literature on the instructional benefits of the FCA, particularly in specific sectors such as clinical education, where interaction efficiency is vital.

Future studies should emphasize the longitudinal impact of FCA on clinical English efficiency, exploring whether the developments seen in the short term are sustained over time. Long-term research could offer valuable insight into the lasting advantages of FCA, advising how language abilities and the system impacts the professional interaction of students are maintained once they enter the clinical sector. Moreover, comparative research between the FCA and traditional pedagogical techniques would provide a clearer understanding of the benefits of the FCA in clinical language education. Such research could analyze the way FCA revolutionizes traditional systems in fostering linguistic skills, self-assurance, and medical decision-making abilities, all through cooperative effort. Additionally, studies should explore the difficulties and challenges to the extensive adoption of the FCA, involving learner approaches, teacher readiness, and limitations in the adoption of technology. Future research can address these issues and help educational institutions in shaping more efficient, wide-ranging, and sustainable medical English curricula that better equip students for the requirements of contemporary healthcare.

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Original Article

Teacher- and Student-Centered Learning in a Hierarchical, Collectivist Context

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Abstract

Background: The worldwide implementation of student-centered learning (SCL) often assumes cultural universality, overlooking instructional friction in hierarchical, collectivist societies characterized by high power distance.

Objectives: To assess and compare the impact of teacher-centered learning (TCL) and three active SCL modalities (flipped classroom [FC], question-based discussion [QBD], and peer-assisted learning [PAL]) on cognitive knowledge and satisfaction among Indonesian undergraduate medical students, while exploring underlying student experiences.

Methods: A concurrent triangulation mixed-methods trial was conducted among 164 second-year medical students randomly allocated to four parallel arms during a medical mycology module: TCL (n=40), FC (n=42), QBD (n=38), and PAL (n=44). Knowledge acquisition was evaluated using a 10-item post-test, while satisfaction was assessed via a validated 5-point scale and three open-ended qualitative prompts. Quantitative data were analyzed using Kruskal–Wallis and Bonferroni-adjusted post-hoc tests (α=0.05). Qualitative responses were analyzed via inductive thematic analysis.

Results: Knowledge post-test scores showed no statistically significant differences across the four instructional modalities (TCL median=80 [IQR=20]; FC median=80 [IQR=20]; QBD median=80 [IQR=10]; PAL median=80 [IQR=18]; H=3.401, p=0.344, $\eta 2$ =0.0025). In contrast, student satisfaction differed significantly (H=31.74, p<0.001, $\eta 2$=0.179), with TCL yielding significantly higher satisfaction than FC (p=0.003), QBD (p<0.001), and PAL (p=0.019). Qualitative synthesis identified two overarching themes: positive learning experiences and contextual challenges. SCL provoked student anxiety regarding public performance and peer competence, whereas PAL mitigated face-threat concerns by fostering psychological safety.

Conclusion: While immediate cognitive recall did not differ statistically among instructional methods, students exhibited a pronounced cultural preference for authoritative teacher-centered instruction. Active learning in hierarchical, collectivist settings require structured scaffolding—such as small-group peer facilitation—to mitigate cultural anxiety and optimize learner engagement.

Keywords: Medical Education; Undergraduate; Student-Centered Learning; Problem-Based Learning; Peer-Assisted Learning; Cultural Diversity; Collectivism; Power Distance; Educational Measurement; Mixed-Methods Research; Indonesia

Background

Traditionally, the didactic lecture was one of the staple methods of teaching in higher education, as it enables the delivery of learning materials to a large group of students at once. However, this teacher-centered learning (TCL) approach limits students' active

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participation, and its benefits are increasingly questionable (1, 2). Nowadays, student-centered learning (SCL) is attracting attention for its promising potential (3, 4) and alignment with the principles of adult learning (5-7).

Historically, initial research on SCL was conducted in Western countries, with problem-based learning (PBL) among the most studied in medical education (8-11). In the past few decades, learning reforms in higher education have been attempted across many Asian countries, shifting traditional TCL approaches towards SCL pedagogies. Although the implementation of SCL, such as PBL, rapidly grew across medical schools in Asia, these learning reforms were not without issues (12, 13). In teaching and learning, culture holds a significant influence (14), thus "learning will not necessarily have the same outcomes in a place where institutional conditions and cultural values are different" (13).

Indonesia was one of the Asian countries participating in said learning reform. In terms of learning environment, Hofstede et al.'s theory of cultural dimensions described Indonesia as having two main characteristics: hierarchical and collectivist. Teaching and learning in a hierarchical setting are characterized by the presence of 'power distance' between the teacher and the learner. In contrast, a collectivist setting is characterized by the tendency to achieve and maintain the best interest of the group (14). The effect of these cultural aspects has been reported in a few studies involving clinical clerkship students (15, 16). At the undergraduate medical education level, studies describing students' experiences with SCL mostly used PBL or case-based methods (17-20). This study was primarily intended to add another perspective to the existing body of knowledge on the implementation of SCL methods beyond PBL and case-based methods among undergraduate medical students in Indonesia.

Objectives

This study aimed to measure knowledge and satisfaction, as well as to explore the learning experiences related to the satisfaction of students who underwent different teaching methods, namely TCL and several SCL methods, flipped classroom (FC), question-based discussion (QBD), and peer-assisted learning (PAL), in the topic of medical mycology.

Methods

This is an experimental, mixed-methods study using a concurrent triangulation design, in which quantitative and qualitative data were collected in a single phase. This design allows for a more complete understanding of the experimental study by merging two data sets during interpretation after the respective analyses. The interpretation process is iterative, allowing continuous, complementary corroboration of the study objectives (21). Quantitative data provided an overview of the first study objective, which was to measure and compare the effectiveness of TCL and several SCL methods in increasing undergraduate medical students' knowledge about medical mycology. Qualitative data provided participants' perspectives on their learning experience with these learning methods, allowing further elaboration on what may have affected the quantitative data.

This study was conducted at a private medical school in Indonesia, and the sample size was determined using a total sampling approach. All eligible second-year medical students in the medical mycology module were included in the study. In total, 164 students were recruited and categorized into four groups, allowing the analysis to represent the entire accessible population for the academic year. The topic of medical mycology was selected because the application of various SCL approaches in this topic remains limited. In many institutions, teaching in this area still relies primarily on TCL, with laboratory sessions and case-based learning occasionally incorporated (22). All students provided written consent, and those who did not attend the lecture or did not consent to participate were excluded. The medical school ethical committee approved this study.

Students were first ordered by ascending student identification numbers. Simple randomization was then performed by the faculty administration team using an internet-based random number generator (Calculator.net), producing a randomized sequence used to allocate students into four groups based on the assigned learning method. Group 1 was assigned the TCL method, while groups 2-4 were assigned sequentially to the flipped classroom, QBD, and PAL. Subsequently, PAL participants were further divided into 4 groups consisting of 11 individuals using the same randomization method. In TCL, a lecturer taught the material using a PowerPoint slide in one 100-minute offline session, occasionally incorporating two-way interaction through questions and answers. In the FC method, the lecturer provided learning materials in the form of PowerPoint slides three days before the offline synchronous learning, during which the facilitator held a question-and-answer session. In the QBD method, students were required to answer several case study

questions in medical mycology and present their work via a PowerPoint presentation. The PAL method was similar to QBD, except it was conducted in smaller groups and facilitated by peer tutors from a higher academic year (cross-age peer tutoring). A training-of-tutor session was conducted to ensure standard and consistency.

Data, including post-test scores and students' satisfaction, were collected via an online questionnaire comprising 10 short-answer questions. A correct answer scores 10 points, and an incorrect answer scores 0 points. Students' satisfaction was measured using a 5-point Likert scale. The questionnaire was modified from those of Haviz (23) and Keengwe (24), translated into Indonesian, and validated (Appendix 1). Item validity was assessed using corrected item-total correlations, with coefficients greater than 0.30 considered acceptable. The questionnaire's reliability was evaluated using Cronbach's alpha. The data were analyzed using SPSS for Windows version 26. Normality was assessed using the Kolmogorov-Smirnov test. Differences between groups were tested using the Kruskal-Wallis test, followed by a Bonferroni post-hoc test when significant differences were found. A p-value of ≤ 0.05 was considered statistically significant. The effect size was calculated as follows: $\eta^2 = (H - k + 1) / (N - k)$ where H is the Kruskal-Wallis statistic, k is the number of groups, and N is the total sample size. The interpretation thresholds were as follows: small effect (0.01-0.06), medium effect (0.06-0.14), and large effect ($\eta^2 > 0.14$).

Students' satisfaction was assessed through their responses to 3 open-ended questions: whether the learning method met their expectations, the challenges encountered during learning, and the positive aspects of the learning method. The qualitative data were analyzed using a data-driven inductive approach to thematic analysis (25). Raters initially excluded brief responses that offered no additional elaboration, such as "-", "none", "yes", "no", or similar remarks. An initial codebook, including codes, definitions, and categories, was developed by one of the authors. To ensure the rigor of the analysis process, interrater meetings were held occasionally with all authors to discuss the codes, categories, and themes developed. Member checking with several participants was conducted to clarify unclear data, ensuring raters did not make interpretations based on their own assumptions when in doubt. The final codebook, finalized after agreement among all raters, was presented in a matrix table to facilitate comparing groups (26).

In qualitative research, the researchers' positionality is an important factor in increasing accountability within a given study (25). SSS, BPR, and VDJJ were assistant professors, CDK was a teaching assistant, and AIG was a fourth-year undergraduate medical student at the medical school at which this study was conducted. DD was an assistant professor at another medical school in Indonesia. Study. SSS was involved in teaching the participants in the TCL intervention group. Several steps throughout this study were designed to mitigate the effects our positionalities might have on this research. Occasional meetings were held with all authors, during which we actively encouraged one another to share our opinions on various aspects of the study and its progress. Member checking with participants also helped prevent the author's interpretation of what might not accurately represent the participant's voice.

Results

Participants, post-test scores, and students' satisfaction: A total of 164 second-year medical students were assessed for eligibility and agreed to participate in the medical mycology instructional module. Participants were randomly allocated to one of four parallel instructional groups: TCL (n=40), FC (n=42), QBD (n=38), and PAL (n=44). All 164 participants completed the allocated instructional intervention as well as the post-intervention knowledge and satisfaction questionnaires, yielding a 100% completion rate for the quantitative phase. For the qualitative component, 164 students submitted written responses to the open-ended satisfaction prompts; after excluding 74 responses that lacked substantive elaboration (e.g., single-word answers or dashes), 90 informative qualitative responses were included in the thematic analysis (Figure 1).

The post-test scores did not follow a normal distribution ($p<0.001$). All groups shared the same median value of 80. Although the TCL group had the highest score, the differences between groups were not significant ($H=3.401$, $p=0.344$, Table 1). The effect size was very small and negligible ($\eta^2 = 0.0025$).

Corrected item-total correlation analysis showed that all questionnaire items exceeded the validity criterion ($r > 0.30$), except for concern about unclear learning material (question 4, $r = 0.174$), the need for more time to learn (question 6, $r = 0.255$), and perceived independence in learning (question 7, $r = 0.19$). Although their limited variability may have contributed to the lower correlation values, these items were retained since they captured relevant aspects of students' experiences. The questionnaire's internal consistency was good, with a Cronbach's alpha of 0.806.

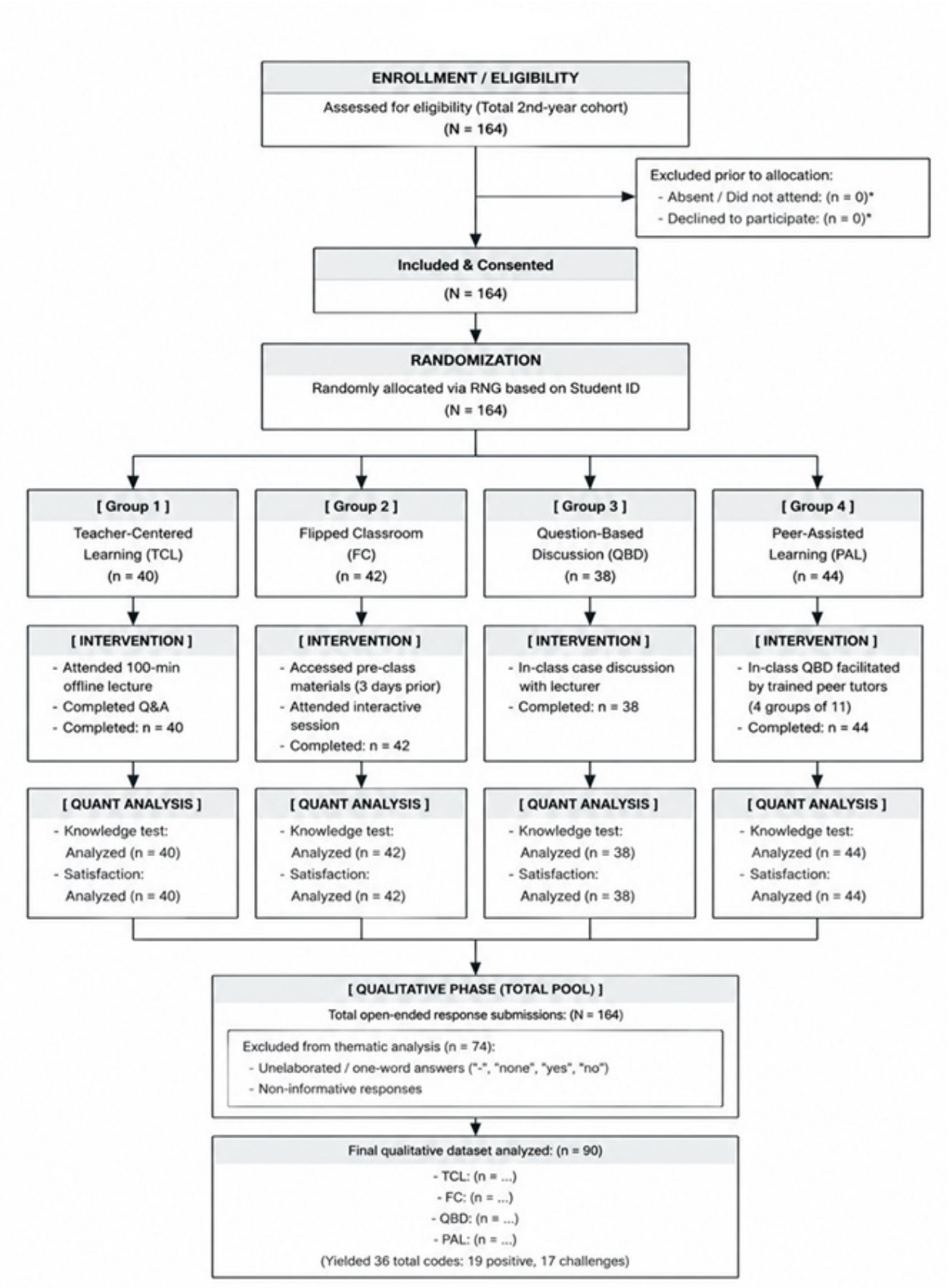

Figure 1. Modified CONSORT flow diagram of participant progression through the study.
The diagram outlines student enrollment, random allocation into the four instructional modalities (TCL, FC, QBD, and PAL), intervention completion, quantitative assessment, and subsequent inclusion/exclusion of open-ended qualitative responses for thematic analysis.

Table 1. Post-test scores and quantitative data on students' satisfaction

Group	N	Median (min-max)	IQR	Mean (standard deviation)	p-value*
Post-test score					
TCL	40	80 (50-100)	20	80.50 (11.536)	0.344
FC	42	80 (50-100)	20	80.00 (13.793)	
QBD	38	80 (60-90)	10	77.63 (8.833)	
PAL	44	80 (50-100)	18	80.23 (13.552)	
Quantitative data on students' satisfaction					
TCL	40	40.00 (34-50)	6	40.77 (4.486)	<0.001
FC	42	37.00 (24-49)	4	37.02 (4.420)	
QBD	38	34.00 (25-43)	7	34.58 (4.512)	
PAL	44	37.50 (30-48)	5	37.82 (3.919)	

*Kruskal-Wallis test. N: Number of students. IQR: Interquartile range. TCL: Teacher-centered learning. FC: Flipped classroom. QBD: Question-based discussion. PAL: Peer-assisted learning.

Student satisfaction scores were not normally distributed ($p<0.001$). The TCL group had the highest median score, while the QBD group had the lowest ($H=31.74$, $p\leq0.05$; Table 1). The effect size indicated a large effect ($\eta^2 = 0.179$). Post-hoc analysis showed that the TCL group's median score was significantly higher than those of the other groups ($p\leq0.05$, Table 2). Among the three SCL groups, the PAL and FC groups had higher median scores than the QBD group. Although the PAL group had a slightly higher median score than the FC group (37.50 and 37.00), the difference was not statistically significant.

Table 2. Post-hoc analysis on quantitative students' satisfaction data (Bonferroni test)

Comparison between groups		p-value
A	B	
TCL	FC	0.003*
TCL	QBD	0.000*
TCL	PAL	0.019*
FC	QBD	0.189
FC	PAL	1.000
QBD	PAL	0.032*

*TCL: teacher-centered learning. FC: flipped classroom. QBD: question-based discussion. PAL: peer-assisted learning.

Initially, 74 responses that lacked additional elaboration were excluded. The remaining responses were categorized into two main themes: positive learning experiences and challenges. Raters developed a codebook consisting of 36 codes: 19 reflecting positive experiences and 17 representing challenges encountered during learning. The codes were grouped into several categories. Four categories were identified for positive learning experiences: delivery of learning method, facilitator's role, perceived outcome or benefit, and other. Challenges were categorized into those encountered in class and those encountered outside of class (before or after class). All raters agreed on the codebook, which was presented as a matrix showing in which group(s) each code was found, facilitating a practical comparison of results across groups. Relevant quotes corresponding to the themes are presented in Appendix 1-3.

Each group has its own positive learning experiences and challenges. Regarding positive experiences, most methods showed fairly similar results. However, based on the matrix, the FC group had the highest number of positive learning experiences (18 codes), followed by the TCL group (17 codes). Among the four groups, the QBD group encountered the most challenges.

Small Class Size and Interactivity: Students in both TCL and SCL groups reported that interactivity was a positive learning experience. Although some students found it challenging to recall prior knowledge and felt pressure to think critically during these sessions, they believed these interactions helped them better memorize and recall learned material and develop critical thinking skills. Students also highlighted a strong preference for smaller class sizes. They felt that smaller classes promoted more effective interaction, enabling greater participation and personalized engagement. "Indy" (pseudonym, FC group) described how *"this class would be most effective if done in small groups."* Similarly, "Sharon" (pseudonym, TCL group) believed that "Question-and-answer (interaction) encouraged students to pay attention and think."

Students' Learning Experiences with SCL Methods: Students from all SCL groups reported that these learning methods stimulated their motivation to learn. However, they also emphasized that adequate preparation beforehand was a significant challenge.

The challenge was if before class (we) really did not study and find the material, (we) would feel slightly confused in class because further explanations were only given for things that were not adequately covered during (peer's presentation, so before class (we) really need to read the material on our own. (Anne, pseudonym, QBD group on the challenges encountered during the learning process).

During the preparation phase, students faced several difficulties, including selecting appropriate references ("finding suitable learning source"), independently comprehending pre-class materials ("understanding pre-class material"), and misjudging the depth of study required ("misperception"). These challenges were further compounded by a sense of doubt over their capability to learn independently ("lack of confidence"). Supporting quotes are provided in Appendix 1-3. Regardless, students across all SCL groups reported that preparing beforehand gave them prior knowledge that enhanced their in-class learning. For example, "Astrid" (pseudonym, QBD group) stated that *"(she) understood better because (she) had read for the presentation and became more prepared in answering questions"*.

Interestingly, students in the PAL group reported several positive experiences not observed in the QBD group, despite similar content delivery by a different facilitator. These positive experiences included ample opportunities to ask questions ("chance to ask"), more personal student-teacher interactions ("more personal"), and less pressure ("creates a safe environment"). In addition, several challenges commonly found in the QBD group, including pressure to be more active ("the demand to be more active"), misperception, difficulties in "understanding certain concepts", and feeling pressured by the "time constraint", were not observed in the PAL group.

Facilitator's Role: Facilitators in both TCL and SCL groups were portrayed as professionals competent in their subjects, serving as reliable learning sources. Students appreciated how facilitators, whether teachers or peer tutors, created optimal learning environments through positive attitudes and personality traits such as kindness, fun, encouragement, patience, and understanding. Both TCL and SCL students valued the chance to ask questions and receive appropriate feedback, including clarifications on confusing concepts.

The source of material became clearer, the doctor (i.e. facilitator) was also very helpful in correcting, supplementing, and explaining important points of this topic, so we did not lack any information or explore this topic too far and out of topic, very helpful. Abby, pseudonym, QBD group, on the positive aspects of the learning method.

Discussion

Both TCL and SCL methods were comparable in improving students' comprehension in medical mycology, as reflected in their post-test scores. This indicates that all methods had a similar impact on students' achievement of the expected learning outcomes. In terms of preference, students in the TCL group reported higher satisfaction than those in the SCL groups. Among the SCL methods, PAL had the highest median satisfaction score, significantly higher than QBD, though not significantly different from FC, suggesting that students tended to gravitate towards more teacher-oriented approaches. They also indicate that, among the SCL approaches examined, PAL and FC were more favorably received compared to QBD. Qualitative analysis of students' satisfaction data allowed further exploration of their learning experiences underlying their satisfaction or dissatisfaction with the learning methods. Although 74 qualitative responses were excluded for lacking analyzable content, this exclusion did not affect the quantitative satisfaction results and is expected to have only a minimal impact on the qualitative interpretation.

First, across all groups, students appreciated interactivity and the opportunity to learn in smaller classes. As context, regular classes at this university typically include around 200 students, whereas this study involved a maximum of 44 students per group. Syah et al. noted that students in a collectivist setting prefer smaller groups to maintain collective harmony (27). In our study, students expressed a similar preference, noting that a smaller class size helped them engage in more personal interactions, maintain better focus, feel more confident speaking up during discussions, and experience a more conducive learning environment.

Students in both TCL and SCL groups described interaction as "challengingly beneficial". During question-and-answer and discussion sessions, some students lacked confidence, struggled to recall prior knowledge, and felt pressured to think more critically. Such pressure may be related to the characteristic of a collectivist setting, where losing face is avoided (27). Despite these challenges, students remarked that such interactions helped them memorize and recall material and enhanced their critical thinking. Aside from active participation, effective learning requires engaging students with the appropriate level of difficulty, known as desirable difficulty, which promotes long-term

retention and retrieval (5). Question-and-answer strategies are one approach to introducing desirable difficulty (28).

One of the most prominent challenges for SCL groups was preparing independently before synchronous sessions, a finding consistent with previous studies (29-31). This challenge may be more pronounced in hierarchical and collectivist contexts, where students are strongly accustomed to TCL. Studies have reported that students often feel confused or uncertain about directing their own learning (32, 33). Our findings suggest that to improve the learning experience in SCL, teachers should provide clear, specific instructions, references, and learning objectives. During synchronous sessions, the role of the teacher or peer tutor remains important for equalizing understanding and correcting misconceptions that may arise during self-directed learning.

Another interesting finding is that students in both TCL and SCL groups highlighted the facilitator's attitude as a positive aspect of their learning experience. In a hierarchical setting, teachers often play a dominant role (27), which may inhibit active participation. Based on the student reflections in this study, we propose that teachers or facilitators create a 'safe learning environment' to reduce power distance and encourage more active student participation.

Interestingly, students responded more positively to PAL compared to QBD, despite both using the same question set. As previously discussed, the smaller class size created a more personal and safe learning environment, which, along with the presence of peer tutors, allowed students to ask questions and engage in discussion. This SCL approach produced a learning experience comparable to TCL while maintaining SCL's benefits. Keerthirathne noted that having a peer as a facilitator can help reduce the hierarchical gap (34), an observation also made in this study. However, this advantage should not be taken at face value. Learning from peers might pose certain difficulties, such as doubt about a peer's explanation or partial comprehension of the topic. This is understandable within a hierarchical learning culture, where teachers are perceived as reliable and competent figures expected to guide students (27).

Overall, each method exhibits its own strengths and weaknesses. Nevertheless, within a hierarchical, collectivist culture, our findings still suggest that TCL remains the preferred approach. Given the positive experiences and challenges of each method, a combination of them may be beneficial. Among all methods examined, QBD posed the greatest challenges, generated the lowest positive experiences and satisfaction scores, and yielded the lowest post-test score. However, this was not statistically significant.

Several aspects could be improved in future research. Learning and culture are both very complex matters. Incorporating questions specifically targeted at cultural dimensions may yield deeper insights. Alternative approaches, such as focus group discussions or ethnographic studies, may yield novel insights. Further studies are also needed to explore the potential applications of SCL methods in hierarchical and collectivist settings across different medical topics, levels of education (clinical rotations or residency), and SCL methods. Finally, future studies should consider the potential instructor-related response bias arising from participants' interactions with a familiar instructor and adopt an appropriate approach to mitigate its effects.

Conclusion

In the context of a collectivist, hierarchical culture in this study, both TCL and SCL are comparably effective in increasing undergraduate medical students' knowledge of medical mycology. Although TCL demonstrated an advantage in student satisfaction, a combination of TCL with SCL methods, such as PAL and FC, may be worth considering, as they offer complementary strengths and benefits not found in the TCL approach. The use of QBD is not recommended unless accompanied by certain modifications. Whether these findings apply to broader Asian countries or different medical topics remains to be explored in future research.

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Appendix 1. Students' Non-formative Evaluation Questionnaire

After experiencing particular learning method, students have to fill this non-formative evaluation questionnaire based on what they got and experienced from that learning method. Please answer these questions honestly based on your experience.

The learning method being used in my group improved my study skills.
- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

The learning method being used in my group motivated me to study harder.
- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

I prefer the learning method being used in my group than the other groups' learning method.
- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

I am concerned and worried of not getting sufficient knowledge, with the learning method being used in my group.
- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

I feel that my group's learning method was more enjoyable than the other groups' learning method.
- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

I feel that I needed more time to learn if I am using my group's learning method.
- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

The learning method being used in my group facilitated me to be more independent in finding and searching information needed in the subject.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

The provided study references/literatures were sufficient and helpful in facilitating me to find the study materials.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

The learning method being used in my group improved my critical-thinking and problem-solving abilities.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

In general, I was satisfied with my group's learning method.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

Did your group's learning method fulfill your expectation?

Please include/elaborate your reason(s)

What challenges did you encounter and feel during your learning process?

What were the pros/advantages of your group's learning method? Please specify (examples: clear learning references, the lecturers were able to teach well, etc.)

Appendix 2. Codes, definitions, and categories reflecting positive learning experience, and the learning methods in which they were observed

Category	Coding	Definition	TCL	FC	QBD	PAL
Delivery of learning method	Concise	Student's perception on the brief, yet comprehensive and clear explanation regarding the taught material.	O	O	O	O
	Perceived benefit of prior knowledge	Student's perception on how learning before class provides advantages.		O	O	O
	Interesting	Sstudent's perception on how the learning method sparks curiosity and/or attracts attention.	O	O	O	O
	Interactive	Student's perception on how there was sufficient engagement between students and facilitator or among students during learning.	O	O	O	O
	Chance to ask	Student's perception on how there was sufficient opportunities for students to discuss any inquiries relating to the topics in review with facilitator or peers.	O	O		O
	Conducive environment	Student's perception on how there was a setting in which they feel less distraction and/or pressure while learning.	O	O	O	O
	More personal	Student's perception on how student-teacher interactions felt less distant.	O	O		O
Facilitator's role	Creates safe-learning environment	Student's perception on any facilitator's characteristics that enable a conducive setting in which students feel secure and comfortable to learn without unecessary pressure.	O	O		O
	Valid source of information	Student's perception on how facilitator is sufficiently competent to provide credible knowledge regarding the learning material.	O	O	O	O
	Highlights key points	Student's perception on how facilitator aids their learning process by emphasizing essential information regarding the learning material.	O	O	O	O
	Source of feedback	Student's perception on how facilitator provided useful evaluation, response, and/or criticism for the students relating to their learning process.	O	O	O	O
Perceived outcome or benefit	Motivation to learn	Student's perceived benefit on how the applied learning method stimulates and encourages them to study.	O	O	O	O
	Comprehension	Student's perceived benefit on how the applied learning method aids them in understanding the taught learning material.	O	O	O	O
	Facilitates memorization	Student's perceived benefit on how the applied learning method aids them in remembering learnt material.	O	O	O	
	Facilitates recall	Student's perceived benefit on how the applied learning method aids them in the recollection of learnt material.	O	O		
	Critical thinking	Student's perceived benefit on how the applied learning method aids them in developing an in-depth and meticulous approach to a topic or an issue.	O	O	O	O
	Confidence	Student's perceived benefit on how the applied learning method helps build self-assurance and conviction in one's own capability.			O	O
	More focused	Student's perception on how they experience better concentration while learning with the learning method applied.	O	O	O	O
Other	Personal preference	Student's personal inclination towards one learning method over the other.	O	O	O	

TCL: teacher-centered learning. FC: flipped classroom. QBD: question-based discussion. PAL: peer-assisted learning

Appendix 3. Codes, definitions, and categories reflecting challenges, and the learning methods in which they were observed

Category	Coding	Definition	TCL	FC	QBD	PAL
In-class	The demand to be more active	Student's perceived pressure to be more involved during the learning process.	O		O	
	Lack of confidence	Student's sense of insecurity or doubt about their own knowledge and capability over certain topics that affect their participation in learning activities.	O	O	O	O
	Recalling prior knowledge	Student's perceived difficulty in recollecting and utilizing learnt material.	O	O		
	Maintaining focus	Student's perceived difficulty in paying attention and processing taught information consistently throughout class.	O		O	O
	Following facilitator's pace	Student's perception on how the explanation given in class is too fast to process optimally.	O			
	The demand to think critically	Student's perceived pressure to apply an in-depth and meticulous approach to a topic or an issue regarding the materials being taught.	O	O	O	O
	Misperception	Perceived gap and/or difference in comprehending the topics being taught between students and facilitator.		O	O	
	Awkwardness	Student's perception of an uncomfortable or inconvenient setting in the learning environment.				O
	Class schedule	Student's perception on how the timing of learning method affected their learning process.			O	O
	Unfamiliarity with learning method	Student's perceived difficulty in learning due to newly introduced study approach.			O	O
	Incomplete understanding of topic	Student's perceived difficulty in comprehending the taught material wholly.	O	O	O	O
	Learning from peer's explanation	Student's perceived difficulty in learning from fellow students.			O	O
Outside of class	Understanding certain concept	Student's perceived difficulty in following through a material that is above their own capability to comprehend.	O	O	O	
	Time constraint	Student's perceived pressure coming from the limited duration to prepare and/or comprehend the topic being taught.	O	O	O	
	The need to prepare	Student's perceived demand and/or pressure to learn before class in order to optimize learning.		O	O	O
	Understanding pre-class material	Student's perceived difficulty to independently comprehend the provided learning material before class.		O	O	O
	Finding suitable learning source	Student's perceived difficulty to discover and curate appropriate and valid references for the topic in review.		O	O	O

TCL: teacher-centered learning. FC: flipped classroom. QBD: question-based discussion. PAL: peer-assisted learning

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Original Article

Comparing Lecture, Reflection, and Active Learning Approaches for Enhancing Medical Professionalism Among Undergraduate Medical Students in Thailand

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Abstract

Background: Medical professionalism is crucial in the practice of medicine. Managing medical professionalism presents challenges to ensure that medical students develop a comprehensive sense of professionalism.

Objectives: This research aimed to compare pretest and posttest scores of medical professionalism among students who were randomly assigned to one of three instructional approaches—lecture-based learning, reflection-based learning, and active learning—and to evaluate the relative effectiveness of these methods in promoting professionalism.

Methods: The study was conducted among 36 fourth-year medical students enrolled in a psychiatry course during the 2023 academic year. Three teaching modalities were implemented: (1) lecture-based learning, (2) reflection-based learning using the film Patch Adams, and (3) active learning integrating reflection, role modeling, and case-based scenarios. Medical professionalism was assessed using the Medical Professionalism Scale (MPS), which evaluates six dimensions: altruism, accountability, excellence, duty, honor and integrity, and respect for others.

Results: No statistically significant pretest–posttest differences were found in the Lecture-based and Reflection-based learning groups. In contrast, the active learning approach produced significant posttest improvements in four key dimensions—Altruism, Accountability, Duty, and Respect for Others ($p < 0.05$)—with medium-to-large effect sizes. These gains were independent of students' baseline professionalism, indicating that active learning facilitated professional development regardless of initial competency levels.

Conclusion: An integrated active learning model combining reflection, role modeling, and scenario-based discussion effectively enhances professionalism in psychiatry education. It should be selectively applied to courses emphasizing ethics, empathy, and patient-centered care, with continuous evaluation to sustain professional identity.

Keywords: Medical Professionalism; Active Learning; Medical Education

Background

Medical professionalism represents values and behaviors that foster public trust in physicians (1, 2). It has been recognized as one of the essential core competencies in medical education worldwide, influencing patient outcomes, healthcare quality, and physician well-being (3, 4). In recent times, this issue has garnered significant attention as reports from the United States, Europe, and Asia have documented medical errors and patient safety concerns linked to lapses in professionalism (5, 6). For example, a global survey indicated that unprofessional behavior is a contributing factor in nearly 10–15% of serious medical errors (7). Furthermore, Thailand has faced a physician migration crisis, in which a substantial proportion of doctors have resigned from the civil service system to work in private hospitals or abroad. This trend has been linked not only to workload and compensation issues but also to dissatisfaction with professional values and work environments (1). Therefore, the development of medical professionalism among physicians is of utmost importance, which should begin with educational

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management and teaching processes designed to promote comprehensive professional identity formation. In the context of Thailand, the teaching and educational management for producing physicians has been highly successful in preparing graduates capable of diagnosing and rehabilitating patients who access health services. However, the physician density in Thailand remains below the OECD average (0.8 vs. 3.6 per 1,000 population), and there continue to be challenges in providing holistic health services, including preventive and health promotion services (8, 9). Importantly, physician shortages and migration highlight not only workforce quantity issues but also the need to strengthen the quality of medical training. Ensuring that physicians embody professionalism can help improve retention, patient trust, and the delivery of holistic health services. This connection underscores why medical professionalism must be embedded and reinforced within medical teaching and training, alongside clinical practice. Teaching medical professionalism presents challenges for educators due to the unique characteristics of professionalism, which differ from other professions and are closely related to compensation and societal expectations. Consequently, medical professionalism is highly specific, resulting in a non-static educational management model that must be continuously developed to align with the circumstances and context of each educational institution (10, 11). Previous studies have shown that most medical students tend to learn about professionalism through direct experiences with role models, which has proven to be an effective teaching method (7). Reflection has been incorporated into the teaching and learning process to enable medical students to contemplate their experiences and foster internal growth. Additionally, instruction is supplemented with case scenarios and team-based approaches to enhance students' understanding of context and teamwork skills (12-14).

The teaching and educational management of professionalism should define cultural contexts and create an environment that supports professional behavior. Instructors should be trained to effectively teach and assess observable behaviors of students during the learning process. Moreover, this teaching process should involve the continuous development of assessment tools for professionalism, which remains a challenging issue, as there is currently no clear or widely accepted method of evaluation (5, 10, 15). Currently, teaching approaches for medical students are continuously being developed to align with changing contexts and circumstances (11, 14, 16). The focus is on equipping medical students with knowledge and skills through novel instructional methodologies, such as Active Learning, which emphasizes hands-on practice using a variety of teaching techniques. Previous studies have shown that students who engage in active learning have higher examination scores compared to those who learn through traditional lectures. However, when given a choice, students still prefer traditional lecture models, as they feel it enhances their understanding after the class (17, 18). Despite these advances, there remains a clear gap in the literature regarding the direct comparison of teaching models—specifically lecture-based, reflection-based, and active-learning approaches—for fostering professionalism in undergraduate medical education. For instance, studies by Guraya et al. (13) and Buhumaid et al. (16) have examined reflective or active-learning methods independently, yet a direct, head-to-head comparison among these approaches remains limited. Most existing studies have examined these approaches in isolation or focused primarily on knowledge acquisition and academic performance rather than on professionalism outcomes (11, 13, 16). Very few studies have investigated whether active learning can enhance the broader dimensions of professionalism, such as professional attitudes, values, behaviors, and teamwork, beyond its well-documented effects on examination scores. Furthermore, little evidence exists from diverse cultural contexts, including Southeast Asian countries like Thailand, where sociocultural factors may significantly influence professional identity formation and the effectiveness of professionalism training approaches (19, 20, 21). What makes the present study innovative is its direct, head-to-head comparison of teaching approaches—lecture, reflection, and active learning—within the same cohort of Thai medical students, its emphasis on professionalism dimensions (values, attitudes, and behaviors, not just knowledge), and its incorporation of reflection combined with contextualized, case-based teaching strategies tailored to Thai cultural and educational contexts (16, 20, 21). Addressing this gap is crucial to guide educators in selecting teaching methods that not only enhance knowledge but also foster the values, attitudes, and behaviors that define medical professionalism.

As an educator in psychiatry for medical students, the researcher recognizes that traditional lecture formats alone are insufficient to promote the level of professionalism expected of future physicians. This personal observation aligns with the study's objective—to identify and compare instructional

models that best enhance medical professionalism among students. Accordingly, the researcher aims to examine changes in students' professionalism scores between pre-test and post-test through lecture-based, reflection-based, and active learning methodologies, and to compare the overall levels of professionalism across these instructional models.

Objectives

This research aimed to compare pretest and posttest scores of medical professionalism among students exposed to different instructional approaches—lecture-based learning, reflection-based learning, and active learning—and to evaluate the relative effectiveness of these methods in promoting professionalism.

Methods

Study design: A quasi-experimental pre-test/post-test comparative educational intervention study was conducted using different instructional models within the psychiatry course, including: 1) Lecture-based learning, 2) Reflection-based learning on the film "Patch Adams," and 3) Active learning that emphasized integrating reflection, role models, and case scenarios. All 36 students were randomly assigned to one of the three instructional methods using a simple randomization procedure to ensure balanced group sizes (approximately 12 students per group). This random allocation minimized selection bias and maintained comparability among instructional conditions. To maintain consistency across groups, all instructional sessions were conducted within the same course schedule, by the same instructor, and using equivalent assessment procedures. Additionally, the researcher provided students with opportunities for feedback regarding the educational management to ensure transparency and fairness throughout the process.

Participants: This research examined teaching models that promote medical professionalism among 36 fourth-year medical students enrolled in the psychiatry course during the academic year 2023. The total population consisted of 36 students, and thus the entire cohort was included as the study sample. The researcher obtained informed consent from all participants for data collection, and participation in the study was voluntary; students could withdraw from the study or drop the course without any impact on their academic performance. The sample size was determined by the total number of students enrolled in the psychiatry course during the study period. As this was a full-cohort study of all eligible students, no additional recruitment was conducted. A post-hoc sensitivity analysis indicated that with N = 36 (12 per group), $\alpha = 0.05$, and power = 0.80, the study was sufficiently powered to detect medium-to-large effect sizes ($f = 0.35$). This suggests that the sample size was adequate for detecting meaningful effects while acknowledging reduced sensitivity for smaller effects. This study was conducted within a single psychiatry course because professionalism training is formally integrated into this module at the institution, providing a consistent context for intervention and assessment. While this limits generalizability across all medical courses, it allowed for controlled delivery of the three instructional methods within a uniform curriculum structure. Data analysis was performed by a statistician blinded to the group assignments to minimize potential bias during data processing. However, full blinding of the course instructor was not feasible due to the educational context, and this was noted as a study limitation.

Setting

The teaching of professionalism: In teaching medical professionalism, the researcher prepared the necessary components of the course, including a structured lesson plan for each instructional method, course content, films, the Medical Professionalism Scale (MPS), and an online assessment. During the initial teaching session, the researcher explained the instructional process and sought consent for data collection. Subsequently, medical students completed the Medical Professionalism Scale (MPS) before the class. Each instructional method was conducted in a 3-hour session, with identical learning objectives focused on understanding and applying the six dimensions of professionalism: Altruism, Accountability, Excellence, Duty, Honor and Integrity, and Respect for Others. The sessions were spaced one week apart to minimize carryover effects and allow for reflective consolidation between formats. The teaching methods were divided into three formats as follows:

1) Lecture-based learning: The researcher delivered a structured 90-minute lecture covering the definitions, principles, and dimensions of medical professionalism, supported by PowerPoint slides and clinical examples. The remaining time was used for Q&A and guided discussion, where students analyzed short case vignettes related to ethical decision-making and professionalism lapses observed in clinical practice.

2) Reflection-based learning: The researcher initiated the session by having students watch selected scenes from the film "Patch Adams" (approximately 45 minutes), focusing on doctor–patient empathy,

ethical conflict, and teamwork. Students then engaged in guided reflection for 60 minutes, writing short reflective notes on their learning experiences. In the final segment, the researcher facilitated a discussion linking these reflections to the six dimensions of professionalism, emphasizing how compassion, respect, and accountability manifest in clinical behavior.

3) Active learning: Students were asked to watch "Patch Adams" at home prior to the session. The class began with a 45-minute small-group reflection on learned experiences, followed by a "Role Model" activity, where students shared personal examples of professional role models and analyzed their behaviors using the MPS framework. The researcher then conducted a case-based scenario discussion (60 minutes) using three real-life cases drawn from psychiatry and general medical settings, including:

A physician facing ethical conflict between patient confidentiality and family pressure.

A team-based scenario illustrating accountability and interprofessional communication.

A case highlighting altruism and emotional resilience in managing difficult patients.

Students worked collaboratively to identify professionalism issues, propose solutions, and reflect on behavioral implications. The final 30 minutes were dedicated to group synthesis and reflective journaling on key takeaways.

Upon completion of the teaching session, students reflected on their thoughts following the activities and completed the Medical Professionalism Scale (MPS) after the class.

Questionnaire: A 31-item Medical Professionalism Scale (MPS) was utilized in this study (9). The MPS, a 6-point Likert-type scale, assessed six dimensions of medical professionalism as follows:

1) Altruism (6 items)
2) Accountability (5 items)
3) Excellence (5 items)
4) Duty (5 items)
5) Honor and Integrity (5 items)
6) Respect for Others (5 items)

The MPS was originally developed and validated for use in Thai medical students by Sumalrot et al. (2018) demonstrating strong construct validity and reliability (Cronbach's alpha = 0.92). This instrument has since been applied in multiple Thai studies on professionalism and is considered an appropriate and culturally relevant tool for assessing professionalism in medical education in Thailand (9).

Statistical analysis: All analyses were performed using the Statistical Package for the Social Sciences (SPSS, Version 26). Prior to inferential testing, the normality of change scores (Δ = Post-Pre) was examined using the Shapiro–Wilk test, along with an inspection of skewness and kurtosis values to verify the suitability of parametric analyses for a small sample size. Levene's test was used to assess the homogeneity of variances. The primary outcome was the overall Mean Professionalism Scale (MPS) score. A one-way ANCOVA was conducted with post-test MPS scores as the dependent variable, teaching approach (lecture, reflection, active learning) as the fixed factor, and pre-test scores as a covariate (model: Post ~ Group + Pre). Results were reported as $F(df_1, df_2)$, p-values, partial eta squared (ηp^2), 95% confidence intervals, and estimated marginal means (EMMeans) adjusted using the Bonferroni–Holm correction. For the six subdimensions of professionalism (altruism, accountability, excellence, duty, honor/integrity, and respect for others), a MANOVA was first conducted to examine overall differences among instructional methods. When a significant multivariate effect was found, follow-up repeated-measures ANOVAs were performed for each dimension, applying Holm or Benjamini–Hochberg corrections to control for multiple comparisons. Effect sizes were expressed as ηp^2, and pairwise contrasts were reported using Hedges' g (or Cohen's d_n) with 95% confidence intervals. Paired-sample t-tests were employed for within-method pre–post comparisons, with corresponding Cohen's d_n (dz) values and 95% CIs computed to interpret the magnitude of pre–post changes. There were no missing data; all 36 participants completed both pre- and post-assessments under each instructional condition. Each instructional method involved approximately 12 students per rotation, which may have limited statistical power and increased the risk of Type II error. However, the post-hoc sensitivity analysis confirmed that the achieved power (0.80) was adequate for detecting medium-to-large effects, and all key outcomes were accompanied by effect sizes and confidence intervals to ensure interpretability and transparency.

Results

The effects of three teaching approaches—lecture, reflection, and active learning—on students' posttest Mean Professionalism Scale (MPS) scores (while controlling for pretest scores) were examined using a one-way ANCOVA. The analysis revealed a statistically

significant overall model, $F(5, 29) = 24.12$, $p < 0.001$, with an adjusted R^2 of 0.773, indicating that approximately 77.3% of the variance in posttest scores was explained by the model. The pretest MPS score was a significant covariate, $F(1, 29) = 49.65$, $p < 0.001$, $\eta p^2 = 0.631$ suggesting that students' initial professionalism levels were strongly associated with their posttest outcomes. Importantly, there was a significant main effect of teaching approach, $F(2, 29) = 5.41$, $p = 0.010$, $\eta p^2 = 0.272$, indicating that the type of instructional method had a meaningful influence on students' professionalism development after controlling for baseline differences. A preliminary one-way ANOVA was first conducted to verify group equivalence at baseline. The results indicated no significant differences in pretest MPS scores across the three instructional groups, $F(2, 32) = 3.307$, $p = 0.059$ (Table 1), thereby satisfying the assumption required for ANCOVA that groups did not differ significantly on the covariate. These results, presented in Table 2. Table 3 presents the estimated marginal means and 95% confidence intervals for posttest MPS scores adjusted for pretest performance. The Active Learning group achieved the highest adjusted mean posttest score (M = 185.03, SE = 1.63, 95% CI [182.24, 187.82]), followed by the Reflection group (M = 175.44, SE = 1.46, 95% CI [172.44, 178.43]) and the Lecture group (M = 174.84, SE = 1.55, 95% CI [171.65, 178.02]). Post hoc pairwise comparisons using the Bonferroni–Holm adjustment indicated that the Active Learning condition produced significantly higher posttest scores than both the Lecture and Reflection conditions, whereas no statistically significant difference was found between the Lecture and Reflection groups.

Table 1. One-way ANOVA comparing pretest MPS scores across teaching approaches

Source	Sum of Squares	df	Mean Square	F	p-value
Between Groups	1,374.45	2	687.22	3.307	0.059
Within Groups	6,650.51	32	207.82		
Total	8,024.97	34			
a. Means ± SD: Lecture = 164.33 ± 22.32 Reflection = 178.17 ± 7.34 Active Learning = 176.73 ± 7.56 b. Computed using alpha = .05					

**statistical significance at the level 0.01, *statistical significance at the level 0.05

Table 2. One-way ANCOVA for MPS posttest mean scores across different teaching approaches (lecture, reflection, and active learning), controlling for MPS pretest mean scores as covariates

Dependent Variable: MPS Posttest Mean Score					
Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**p-value**
Corrected Model	2,589.17	5	517.83	24.12	0.000**
Intercept	194.44	1	194.44	9.06	0.005**
Pretest Mean Score	1,065.63	1	1,065.63	49.65	0.000**
Teaching Approach	232.19	2	116.09	5.41	0.010*
Error	622.36	29	21.46		
Total	1,120,712	36			
Corrected Total	3,211.54	35			
a. R Squared = 0.806 (Adjusted R Squared = 0.773) b. Computed using alpha = .05					

**statistical significance at the level 0.01, *statistical significance at the level 0.05

Table 3. Comparison of MPS posttest mean scores across different teaching approaches

Dependent Variable: MPS Posttest Mean Score				
Teaching Approach	**Mean**	**SE**	**95%**	
			Lower	**Upper**
Lecture	174.84	1.55	171.65	178.02
Reflection	175.44	1.46	172.44	178.43
Active Learning	185.03	1.63	182.24	187.82
a. Covariates appearing in the model are evaluated at the following values: MPS Pretest Mean Score = 175.03.				

SE: Standard error; CI: Confidence Interval

The effects of the three teaching approaches on six dimensions of professionalism (altruism, accountability, excellence, duty, honor and integrity, and respect for others) were examined using a multivariate analysis of covariance (MANCOVA) with pretest subdimension scores entered as covariates to control for baseline differences. This analysis was conducted on posttest scores rather than change scores, ensuring comparability across groups after accounting for pretest performance. The overall multivariate test revealed a statistically significant effect of teaching approach on the combined dependent variables, Wilks' $\Lambda = 0.682$, $F(12, 56) = 1.87$, $p < 0.05$, $\eta p^2 = 0.29$, indicating that the instructional methods collectively influenced students' professionalism development. Follow-up univariate analyses showed that significant differences emerged in three dimensions: altruism ($F(2, 33) = 4.29$, $p = 0.022$), duty ($F(2, 33) = 3.30$, $p = 0.040$), and respect for others ($F(2, 33) = 3.39$, $p = 0.046$). In all three cases, students taught through the active learning approach demonstrated the greatest mean improvements (altruism: $M = 0.50$, $SD = 0.43$, 95% CI [0.24, 0.77]; duty: $M = 0.38$, $SD = 0.54$, 95% CI [0.18, 0.58]; respect for others: $M = 0.19$, $SD = 0.26$, 95% CI [0.02, 0.37]) compared with those in the lecture and reflection groups. No significant differences were found for accountability ($p = 0.523$), excellence ($p = 0.378$), or honor and integrity ($p = 546$). These results are presented in Table 4.

Table 4. Comparison of mean differences in pretest and posttest MPS scores between types of teaching approaches using a MANOVA test

Dimension	Teaching Approach	Mean	SD	F	p-value	95% CI	
						Lower	Upper
Altruism	Lecture	0.075	0.559	4.289	0.022*	-0.195	0.346
	Reflection	0.013	0.305			-0.245	0.273
	Active Learning	0.500	0.432			0.241	0.759
Accountability	Lecture	0.127	0.553	0.661	0.523	-0.137	0.392
	Reflection	0.000	0.443			-0.253	0.253
	Active Learning	0.200	0.255			-0.053	0.453
Excellence	Lecture	0.000	0.663	1.003	0.378	-0.291	0.291
	Reflection	0.066	0.274			-0.212	0.345
	Active Learning	0.266	0.420			-0.012	0.545
Duty	Lecture	0.145	0.410	3.298	0.040*	-0.064	0.355
	Reflection	0.033	0.238			-0.167	0.234
	Active Learning	0.383	0.536			0.183	0.584
Honor and Integrity	Lecture	0.018	0.328	0.617	0.546	-0.199	0.163
	Reflection	0.033	0.280			-0.140	0.207
	Active Learning	0.116	0.275			-0.057	0.290
Respect for others	Lecture	0.121	0.334	3.385	0.046*	-0.302	0.060
	Reflection	0.000	0.284			-0.173	0.173
	Active Learning	0.194	0.264			0.021	0.368

SD: Standard deviation; CI: Confidence Interval
**statistical significance at the level 0.01, *statistical significance at the level 0.05

The within-group changes in Mean Professionalism Scale (MPS) subdimension scores before and after instruction under each teaching approach (lecture, reflection, and active learning) were examined, and the results are summarized in Table 5. To further explore whether posttest performance was dependent on baseline professionalism levels, pre–post Pearson correlation coefficients were also calculated for each group and dimension.

Across all six dimensions, significant pre- to posttest improvements were observed primarily in the active learning condition. Specifically, substantial gains were found in altruism ($p = 0.005$, Cohen's $d = 1.57$, 95% CI [0.96, 2.18]), accountability ($p = 0.033$, $d = 0.73$, 95% CI [0.28, 1.18]), duty ($p = 0.008$, $d = 1.08$, 95% CI [0.59, 1.57]), and respect for others ($p = 0.026$, $d = 0.75$, 95% CI [0.30, 1.20]). These represent medium-to-large effect sizes, indicating meaningful improvements in professionalism following the active learning intervention. Importantly, the correlation analysis revealed strong and significant pre–post relationships in the lecture ($r = 0.75–0.92$, $p < 0.01$) and reflection ($r = 0.62–.89$, $p < 0.05$) groups, suggesting that students' posttest scores largely reflected their initial levels. In contrast, correlations within the active learning group were weak and nonsignificant across all

dimensions (r = 0.14–0.54, p > 0.05), indicating that the benefits of active learning were largely independent of baseline professionalism scores.

In contrast, neither the lecture nor reflection approaches produced statistically significant pre- to posttest changes across any dimension (p > 0.05), and no significant differences were observed for excellence (p > 0.05) or honor and integrity (p > 0.05) under any teaching approach.

Table 5. Comparison of Mean pretest and posttest MPS scores within each teaching approach

Dimension	Teaching Approach	Pre-test	Post-test	p-value	Cohen's d	95% CI		r	p-value
						Lower	Upper		
Altruism	Lecture	5.18±0.78	5.27±0.71	0.545	0.12	-0.19	0.43	0.747	0.005**
	Reflection	5.45±0.39	5.47±0.30	0.878	0.06	-0.25	0.37	0.651	0.022*
	Active Learning	5.28±0.46	5.75±0.17	0.005**	1.57	0.96	2.18	0.302	0.367
Accountability	Lecture	5.15±0.77	5.28±0.71	0.400	0.17	-0.14	0.48	0.750	0.005**
	Reflection	5.61±0.26	5.61±0.41	1.000	0.00	-0.31	0.31	0.199	0.536
	Active Learning	5.54±0.29	5.74±0.25	0.033*	0.73	0.28	1.18	0.537	0.088
Excellence	Lecture	4.98±0.81	4.98±0.73	1.000	0.00	-0.31	0.31	0.670	0.017*
	Reflection	5.48±0.38	5.55±0.42	0.417	0.17	-0.14	0.48	0.777	0.003**
	Active Learning	5.45±0.32	5.69±0.33	0.096	0.73	0.28	1.18	0.169	0.619
Duty	Lecture	4.93±0.77	5.06±0.72	0.266	0.18	-0.13	0.49	0.865	0.000**
	Reflection	5.45±0.47	5.48±0.52	0.638	0.06	-0.25	0.37	0.890	0.000**
	Active Learning	5.43±0.36	5.80±0.28	0.008**	1.08	0.59	1.57	0.386	0.242
Honor and Integrity	Lecture	5.20±0.78	5.16±0.79	0.723	-0.05	-0.36	0.26	0.920	0.000**
	Reflection	5.71±0.32	5.75±0.32	0.689	0.13	-0.18	0.44	0.621	0.031*
	Active Learning	5.70±0.32	5.81±0.30	0.237	0.35	0.02	0.68	0.584	0.059
Respect for others	Lecture	5.31±0.63	5.18±0.74	0.166	-0.19	-0.50	0.12	0.900	0.000**
	Reflection	5.68±0.27	5.68±0.26	1.000	0.00	-0.31	0.31	0.448	0.144
	Active Learning	5.71±0.34	5.92±0.15	0.026*	0.75	0.30	1.20	0.144	0.352

CI: Confidence Interval

**statistical significance at the level 0.01, *statistical significance at the level 0.05

Discussion

This research conducted teaching regarding medical professionalism in a psychiatry course using different instructional methods, including 1) Lecture-based learning, 2) Reflection-based learning on the film Patch Adams, and 3) Active Learning that integrated Reflection, Role Model, and Case Scenario. Data was collected from fourth-year medical students during the academic years 2023, assessing medical professionalism using the Medical Professionalism Scale, which consists of six dimensions: Altruism, Accountability, Excellence, Duty, Honor and Integrity, and Respect for others. All 36 students were randomly assigned to one of the three instructional methods using a simple randomization procedure to ensure balanced group sizes (approximately 12 students per group). This random allocation minimized selection bias and maintained comparability among instructional conditions. The findings revealed that both lecture-based and reflection-based learning methods produced no significant differences in MPS scores between the pretest and posttest across all dimensions. However, these results should be interpreted within the context of this short-term intervention. The lack of measurable improvement does not imply that lecture- or reflection-based methods are inherently ineffective, but rather that they were less effective under the limited time frame and design of this study. Professionalism requires not only cognitive understanding but also affective engagement and behavioral modeling—elements that may be less emphasized in purely didactic or film-based reflection formats. One explanation is that lectures are primarily teacher-centered and emphasize knowledge transmission rather than value internalization or behavioral practice. As a result, students may memorize principles of professionalism without experiencing the emotional or ethical dimensions that drive genuine professional growth. Similarly, while reflection through film may be thought-provoking, it often lacks opportunities for dialogue, feedback, or real-life application. Consequently, these approaches may raise awareness but provide limited opportunities for students to translate abstract values into enduring professional behaviors. This finding is consistent with prior studies showing that didactic or observational

teaching alone seldom produces behavioral change (2, 3, 12). To reduce redundancy, the discussion of short duration and limited experiential exposure has been streamlined here: professionalism develops gradually through sustained reinforcement and interactive learning experiences (5). In contrast, the active learning approach significantly improved students' MPS scores in the dimensions of altruism, accountability, duty, and respect for others, demonstrating medium-to-large effect sizes. Active learning fosters self-directed preparation before class and promotes interactive, student-centered engagement during instruction. Instructors stimulate critical thinking and self-reflection by posing thought-provoking questions that encourage deeper exploration of professional values. These findings are consistent with previous studies that highlight the integration of knowledge, attitude, skills, and identity through participatory learning, as well as the positive impact of team-based and case-driven instruction on students' professional awareness. Exposure to exemplary role models and authentic case scenarios further supports the internalization of professional values, helping students translate theoretical understanding into practical behavior (10, 13). This approach also corresponds with evidence from meta-analyses in Medical Teacher and Academic Medicine, which demonstrate that active and case-based learning outperform traditional methods in improving empathy, accountability, and ethical reasoning (10, 12). Similarly, previous studies have demonstrated that reflective and case-based learning approaches effectively enhance professional competencies, including interpersonal skills and ethical reasoning, across diverse educational contexts (16, 19, 21), consistent with the present study's finding that active learning yielded the highest posttest MPS scores compared with lecture-based instruction. However, the results from this study should be interpreted cautiously within its specific educational setting. In longer or more immersive programs, reflection-based strategies have also been shown to yield positive outcomes, suggesting that the effectiveness of any method may depend on implementation depth and institutional support. Overall, the active learning approach produced the greatest gains in professionalism outcomes. By emphasizing engagement, self-directed preparation, critical reflection, and role modeling, it facilitates both cognitive and affective learning. Through discussions, case analyses, and exposure to authentic clinical scenarios, students connect professional values to real-world practice—transforming abstract principles into professional identity formation. This pattern reflects the concept of transformative learning, in which reflection and experience interact to produce lasting behavioral change (11, 12, 15). Importantly, in the Thai context, these findings hold particular relevance. The active learning model—through its emphasis on empathy, collaboration, and moral reflection—can contribute to addressing broader national concerns such as physician migration and professional dissatisfaction. By fostering stronger professional identity and intrinsic motivation among medical trainees, active learning may enhance career satisfaction and commitment to patient-centered care, helping to retain compassionate physicians within the Thai healthcare system.

The correlational analyses further clarified these learning dynamics. In the lecture- and reflection-based groups, posttest professionalism scores were largely predicted by pretest levels, indicating that students with higher baseline professionalism tended to maintain stronger outcomes. In contrast, in the active learning group, posttest outcomes were independent of baseline scores, suggesting that this approach enables all learners—regardless of starting point—to achieve meaningful development. This result supports Dornan's experiential learning model, which posits that learning is socially situated and transformative rather than dependent on pre-existing attitudes (22). Such adaptability underscores the inclusive and equitable nature of active learning in fostering professionalism (14). Despite these promising results, several limitations must be acknowledged. First, the study employed a randomized quasi-experimental design, which minimized selection bias but was constrained by the small sample size (n = 36; ~12 students per group), limiting generalizability. Second, potential confounders such as gender and prior experience were not controlled, though random assignment likely reduced systematic bias. Third, professionalism was assessed using a self-report scale (MPS) without complementary objective measures, such as faculty ratings or observed behavior. Fourth, the study focused on a single institution and short-term course, which limits external validity. Nonetheless, the use of random assignment, identical learning objectives, and consistent instruction supported internal validity and reliable group comparisons. Future research should involve larger, multi-institutional samples and mixed methods (e.g., longitudinal follow-up and qualitative inquiry) to capture professionalism's gradual, multidimensional development.

Overall, the results suggest that active learning should not be applied uniformly across all areas of

medical education but rather be strategically targeted to disciplines that emphasize ethical decision-making, empathy, and clinical judgment—such as psychiatry, internal medicine, and community health. In these contexts, professionalism training benefits most from structured role modeling, case-based reflection, and scenario-driven learning activities that simulate authentic patient interactions. Within Thailand's evolving medical education landscape, integrating active learning modules could strengthen professionalism, reinforce ethical standards, and support the national goal of cultivating resilient, service-oriented physicians. Faculty development programs should therefore prepare instructors to facilitate reflective dialogue, model professional behavior, and provide formative feedback (5, 6). Furthermore, institutional policies should create supportive learning environments that visibly model professionalism and embed active learning strategies into clerkships and communication skills curricula. These measures will help ensure that Thai medical students develop not only professional knowledge but also enduring ethical commitment and compassion in clinical practice (10-12).

Conclusion

In conclusion, this study demonstrates that the integrated active learning approach—combining reflection, role modeling, and case-based scenarios—was the only instructional method to produce statistically significant and meaningful improvements in key professional competencies, specifically altruism, accountability, duty, and respect for others. These findings underscore that professionalism development is most effectively achieved through structured experiential and participatory learning rather than through passive, lecture-based or observational approaches. This core outcome provides strong preliminary evidence that active learning fosters measurable growth in professionalism by engaging both cognitive and affective domains. Importantly, its success in the present study appears closely tied to the psychiatry course context, which emphasizes empathy, ethical reasoning, and patient-centered communication. Such context-specific integration highlights the value of aligning active learning with disciplines that naturally promote interpersonal and ethical dimensions of medical practice. Ongoing evaluation of such interventions is recommended to further validate their impact, refine teaching strategies, and ensure long-term sustainability. Future research should extend this model across diverse medical disciplines and institutions to examine scalability, faculty readiness, and curriculum alignment that support reflective dialogue, role modeling, and authentic clinical learning. Taken together, these findings offer compelling evidence for strategically embedding active learning in professionalism education, providing a promising pathway for cultivating the cognitive, affective, and behavioral foundations of professional identity formation among future physicians.

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Original Article

Delivering Effective Presentations at Scientific Conferences: A Quasi-Experimental Study among Health Science Faculty

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Abstract

Background: Essential conference practices may not be known to faculty members.

Objectives: This study aimed to assess the knowledge of pre-, during-, and post-conference best practices, as well as the perceptions of faculty members before and after attending a workshop on delivering effective presentations at scientific conferences.

Methods: This quasi-experimental study included 31 faculty members from the health sciences who attended a workshop in April 2023. The data were collected in Microsoft Forms. Nonparametric tests were applied as appropriate for the data distribution. A p value < 0.05 was considered statistically significant.

Results: The mean age of the participants was 39.7±8.2 years. The majority were female [17 (54.8%)]. Most participants felt that attending a conference onsite was better than attending online because interaction with the audience was better. The majority of participants preferred oral presentations over poster presentations to reach a wider audience. Hardly 10% of the participants engaged in post-conference activities. Self-perceived knowledge regarding preparations to be made before attending conferences, recommendations to be practiced during conference presentations, activities to be accomplished after attending conferences, and self-perceived confidence levels in attending conferences were reported to have improved significantly ($p<0.001$) among the participants after attending the workshop. The median knowledge score on the pre-test was 12 (Q1 = 11, Q3 = 16), and that on the post-test was 15 (Q1 = 14, Q3 = 18) ($Z = 3.422$, $p = 0.001$).

Conclusion: The workshop increased the participants' knowledge and confidence levels in essential aspects of the conference presentations. Hence, more such training programs are needed for health science faculty members.

Keywords: Effective Conference Presentations; Health Science Faculty Members; Knowledge; Perception; Workshop

Background

Scientific conferences are popular platforms for presenting research work to large audiences. They are often the first opportunity to disclose potential and novel findings of their research work to relevant delegates (1). It facilitates earlier communication of information long before it is published as a full manuscript in any reputed journal (1). In addition, it allows rapid feedback from experts in the same field, thereby opening the door for further collaborative work (2).

To achieve a successful conference presentation experience, certain key strategies need to be accomplished by presenters. These include planning preparatory activities prior to attending a conference, meticulously designing the presentation material and sharing information and finally providing takeaways to the audience to create an opportunity for further networking with them in the future (3). However, many scientific presentations fail to provide productive experiences for presenters because of failure to accomplish any of these steps effectively (4, 5). Networking at conferences is also not as easy as it is in other settings. This is because social interactions at conferences often take place outside known social

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structures, and the ties between attendees are often weak; therefore, most interaction processes at conferences are uncertain with respect to their outcomes (6). The experiences of early career researchers in conference presentations have been reported not to improve appreciably (7). In a study conducted in Germany, only 18.4% and 31.3% of the conference attendees of a previously held international conference were found to establish a research collaboration and exchange study materials or devices with other persons or institutions, respectively. Information on tips on funding opportunities and funding organizations was received from others by only 15.9% and 12.4% of delegates, respectively (6).

Presenting scientific work flawlessly is one of the most fundamental skills for a researcher (8). Unfortunately, this skill has not been effectively taught in medical education (9).

In addition, several ethical aspects related to scientific presentations at conferences are unknown to presenters. For example, teaching faculty have been observed to refrain from acknowledging the sources of the scientific matter presented at conferences, as they are ignorant of its importance and necessity (10). Therefore, there is a need to train faculty members in identifying suitable conferences, improving their presentation skills, providing information on funding agencies that support conference registration fees and travel, addressing various ethical issues related to conference presentations and providing tips to improve networking with other delegates.

Objectives

This study was therefore performed to assess the knowledge of pre-, during-, and post-conference best practices and perceptions of faculty members before and after attending a workshop on delivering an effective presentation at scientific conferences.

Methods

Study design: This was a quasi-experimental study with an intervention in the form of a three-hour onsite workshop on "Making effective presentations at scientific conferences" held on 24th April 2023.

Participants: A total of 32 participants had registered for this workshop. However, one person could not attend this workshop. All the 31 participants who had attended this workshop also provided consent to participate in this research study. Hence these 31 participants constituted the sample size. The sampling method used was therefore universal sampling involving the inclusion of all participants enrolled in the workshop provided they gave consent to participate. The use of universal sampling from a single workshop cohort is a significant limitation of this study. Additionally, as a non-random sampling method was used, the generalizability of the findings is limited.

Both the facilitators of the workshop were members of the Department of Medical Education at this institution. They also monitored and mentored the participants during the hands-on activities during the workshop. Approval to conduct this research study as a part of the workshop was obtained from the Institutional Ethics Committee. The approval number was IECKMCMLR-03/2023/74 dated 15th March 2023.

Data collection tools: The pre- and post-test questionnaires used in this study were designed as Microsoft forms. Content validation of these tools was performed by two faculty members from the Department of Medical Education of this institution. One was a Professor in Forensic Medicine, and the other was an Associate Professor in Internal Medicine. Both had presented research papers at several national and international conferences in the past. They were asked to rate each item in the questionnaire on a four-point Likert scale, with the options "not relevant," "somewhat relevant," "quite relevant," and "highly relevant." The items selected as "quite relevant" and "highly relevant" by both these experts during the content validation process were retained in the questionnaire by the investigators. The content validity index and content validity ratio for the items in the pre-test questionnaire were calculated as 0.93 and 0.89, respectively, via the Lawshe's method.

Pilot testing was performed among three faculty members who were not participants in the workshop. The pre-test questionnaire took approximately 15 minutes to complete. The Cronbach's alpha value of reliability of the pre-test questionnaire based on the responses of the 31 participants was 0.727. Criterion validity of the questionnaire could not be assessed, as there was no gold standard instrument for comparison. Both the pre- and post-test questionnaires were anonymous, and the links were shared through email to the participants before and after the workshop, respectively.

The information sheet and the consent form were included in the initial part of the pre-test questionnaire.

Details of the pre-test questionnaire, the post-test questionnaire, and the feedback form and the scoring system used are available in the figshare data repository: https://doi.org/10.6084/m9.figshare.30444488

To link the pre- and post-test questionnaires, each participant was instructed to fill in a five-digit Arabic numeral of their choice, using the same number in both forms. To minimize the chances of repetition of the numbers chosen by the participants, they were instructed to use a numeric sequence without repetition of the same digit throughout or to avoid sequential numbers.

Procedure: The details of the conduct of this workshop and the preworkshop is available in the figshare data repository: https://doi.org/10.6084/m9.figshare.30444464

Data analysis: Data entry and analysis were performed via IBM SPSS for Windows version 25.0 (Armonk, New York). The normality of the participants' scores was assessed using the Shapiro-Wilk test. All the continuous variables, except for the age of the participants, did not follow the normal probability distribution. The descriptive statistics were expressed as mean, proportions, medians, standard deviation, and interquartile ranges. The Kruskal-Wallis test, Wilcoxon signed-rank test, and Mann-Whitney U test was used to test associations. A p value less than 0.05 indicated a statistically significant association.

Results

The mean age of the 31 participants was 39.7 ± 8.2 years. Their age ranged from 28 to 57 years. The median teaching experience was 11 years (IQR: 4–15 years). The duration ranged from six months to 30 years (Table 1).

A total of 26(83.9%) participants had presented research papers at various scientific conferences (Table 2).

The majority of participants [21(67.7%)] felt that attending a conference onsite was more beneficial than attending it online. The majority [21 (67.7%)] of them preferred oral mode of presentation over posters (Table 3).

The majority of the participants [21(67.7%)] felt that the presentation skills of presenters generally improved during virtual conference presentations using online platforms. (Table 4) Prior to the start of the workshop, only 11 participants (35.5%) knew what a predatory conference was and how to identify the same. Only 7 participants (22.6%) knew that the validity of yellow fever vaccination starts 10 days after vaccination and lasts for a lifetime. Only 7 participants (22.6%) knew that ePosters can also be displayed in asynchronous mode.

Table 1. Sociodemographic distribution of the participants (n=31)

Characteristics	Category	n (%)
Age group (years)	26-35	10 (32.2)
	36-45	14 (45.2)
	46-55	5 (16.1)
	>55	2 (6.5)
Gender	Males	14 (45.2)
	Females	17 (54.8)
Specialty	Preclinical subjects*	11 (35.4)
	Para clinical subjects**	2 (6.5)
	Clinical subjects***	16 (51.6)
	Allied health sciences****	2 (6.5)
Designation	Professor	4 (12.9)
	Additional Professor	1 (3.2)
	Associate Professor	13 (41.9)
	Assistant Professor	5 (16.1)
	Senior Resident	6 (19.4)
	Tutor	2 (6.5)
Teaching experience as a faculty member (years)	≤5	9 (29.0)
	6-10	6 (19.4)
	11-15	10 (32.2)
	>15	6 (19.4)

*Departments of Physiology (7), Anatomy (3), Biochemistry (1)

**Departments of Pharmacology (1), Forensic Medicine (1)

***Departments of Surgery (6), Anaesthesiology (3), Orthopaedics (2), Internal Medicine (1), Dermatology (1), Emergency Medicine (1), Psychiatry (1), Radio Diagnosis (1)

****Department of Audiology and Speech Language Pathology (2)

Table 2. Prior experiences of the participants in relation to scientific conferences (n=31)

Characteristics	Category	n (%)
Attended scientific conferences (n=31)		31 (100.0)
Presented research papers at conferences (n=31)		26 (83.9)
Type of the conferences where the papers were presented (n=26)*	International	15 (57.7)
	National	22 (84.6)
	State	13 (50.0)
	Regional	5 (19.2)
	Virtual	6 (23.1)
Number of papers presented (n=26)	1-5	15 (57.7)
	6-10	5 (19.2)
	>10	6 (23.1)
Delivered online presentation in virtual conferences after the onset of COVID-19 (n=26)		6 (23.1)
Skills acquired while presenting papers in virtual conferences (n=6)*	Learnt usage of online presentation platforms	6 (100.0)
	Learnt about techniques to design an e-poster	3 (50.0)
	Bettered online presentation skills	1 (16.7)
Availed financial support for meeting conference registration fees (n=31)#		12 (38.7)
Availed travel grants for attending conferences (n=31)@		6 (19.3)
Practice of carrying first aid kits while attending conferences (n=31)‡		18 (58.1)
Practice of carrying electronic devices while attending conferences (n=31)†		31 (100)

*Multiple responses

*#Source of fund: University fund (12), The Centre for International Cooperation in Science, Government of India (1), International Association of Forensic Sciences (1).

*@Source of travel grant: University fund (2), Association of Clinical Biochemists of India (1), World Congress of Dermatology (1), Indian Association of Dermatologists, Venereologists and Leprologists (1), Center for International Co-operation in Science, Government of India (1), International Association of Forensic Sciences (1)

*‡Contents of first aid kit: Paracetamol (18), Hand sanitizer (18), Medications for pain relief (16), Antihistamines (13), Antibiotics (12), Dressing bandages (9), Antiseptic cream 8, Paper soap (7), Analgesic ointment (6)

*†Types of electronic devices: Pen drives (23), Laptops (19), Power banks (8), Tablets (6)

Table 3. Perception of the participants regarding the preferred type of conference and mode of scientific paper presentation (n=31)

Perception	Category	n (%)
Participating in a conference onsite is more beneficial than attending it online (n=31)	Yes	21 (67.7)
Reasons stated (n=21)	Interaction is better	13 (61.9)
	Better participation of the audience in discussions	5 (23.8)
	Attention span of the audience will be better	2 (9.5)
	Presentation skills can be better showcased by the presenter	1 (4.8)
Participating in a conference online is more beneficial than attending it onsite (n=31)	Yes	10 (32.3)
Reason stated (n=10)	Easier to ask questions to the presenter through online platforms	3 (30.0)
Preferred mode of presentation in conferences (n=31)	Oral presentation	21 (67.7)
	Poster presentation	10 (32.3)
Reasons stated for preference of oral presentation (n=21)**	Better scope for reaching a wider audience	17 (80.9)
	Adds more weightage to Curriculum Vitae	9 (42.9)
	Requires less preparation to arrange presentation materials	5 (23.8)
Reasons stated for preference of poster presentation (n=10)*	Less stressful way of presenting	7 (70.0)
	Better platform for discussion with the audience	4 (40.0)

*Multiple responses

Table 4. Perceptions of the participants regarding virtual conferences, international conferences and credit hours (n=31)

Perception	Category	n (%)
Perceptions regarding virtual conferences (n=31)*	The presentation skills of presenters have improved during presentations in virtual conferences using online platforms	21 (67.7)
	It has reduced information exchange between delegates	18 (58.1)
	Delegates have become more familiar with the usage of online platforms	7 (22.6)
	Presenters learnt ways of preparing e-presentation materials	2 (6.4)
Physically attending conferences overseas has more academic benefits than the ones conducted within the country (n=31)	Yes	5 (16.1)
	No	12 (38.7)
	Not sure	14 (45.2)
Reasons stated in favour (n=5)	Opportunity to interact and share information with multinational delegates	5 (100.0)
Reasons stated for not in favour (n=12)*	The amount of information acquired depends on the attitude of the attendee and not on the level of the conference	7 (58.3)
	Academic benefits can be obtained by participating in a well-conducted regional conference too	6 (50.0)
Regarding usefulness of credit hours awarded for attending conferences	Useful	6 (19.4)
	Neutral	20 (64.5)
	Not useful	5 (16.1)
Reasons stated for the usefulness of credit hours (n=6)	Encourages delegates to attend conferences	3 (50.0)
	Adds more weightage to Curriculum Vitae	3 (50.0)
Reasons stated for non-usefulness of credit hours (n=5)	Not mandated by regulatory bodies/Not relevant	5 (100.0)
The reason stated for neutrality regarding credit hours (n=20)	Not aware of its benefits	9 (45.0)

*Multiple responses

Only 4 participants (12.9%) knew at least one software to design an ePoster. Seven participants (22.6%) had the misconception that the presenters should be fully dependent on PowerPoint slides to deliver their oral presentations at the conferences. Only 2 participants (6.4%) knew all ten recommendations of making a PowerPoint slide for an oral presentation that was enquired from them. None of the participants knew all ten ethical issues concerning presentations at scientific conferences enquired from them. Only 1 participant (3.2%) answered five out of these ten questions correctly.

After presenting their research papers, conference presentation experiences were shared on Facebook, Zoom, and Google Slides by 2, 1, and 1 participant, respectively. Changes in departmental activities, such as introducing newer teaching-learning methods and conducting research in previously unexplored areas, after attending conferences were accomplished by only 3 and 1 participant, respectively.

Self-perceived knowledge and self-perceived confidence levels in attending conferences were reported by participants to have improved significantly after attending this workshop (Table 5).

Table 5. Self-perceived knowledge of pre-, during-, and post-conference best practices and self-perceived confidence level in attending conferences among the participants before and after the workshop (n=31)

Characteristics	Before the workshop Median score IQR (Q1,Q3)	Minimum score, Maximum score	After the workshop Median score IQR (Q1,Q3)	Minimum score, Maximum score	Z value	p value
Self-perceived knowledge regarding preparations to be made before attending conferences	7(5,8)	3,10	9(8,9)	5,10	3.768	<0.001
Self-perceived knowledge regarding recommendations to be practiced during the conference presentations	7(6,8)	4,10	9(8,9)	6,10	3.799	<0.001
Self-perceived knowledge regarding activities to be accomplished after attending conferences	7(5,8)	4,10	9(8,9)	7,10	3.635	<0.001
Self-perceived confidence level in attending conferences	7(6,8)	3,9	9(8,9)	7,10	4.023	<0.001

IQR: Interquartile range

The median knowledge score on the pre-test was 12 (Q1 = 11, Q3 = 16; range: 0–18). The median knowledge score on the post-test was 15 (Q1 = 14, Q3 = 18; range: 3–21).

These differences in scores among the 31 participants were significant according to the Wilcoxon signed-rank test (Z=3.422, p=0.001). The Cohen's d effect size was 1.18 (95% CI 0.71-1.63). The Rank biserial correlation was 0.883, indicating a good magnitude of the intervention effect.

The feedback given by all the participants was rated as good or above for parameters such as content and delivery of the talk, explanations provided, and the use of audiovisual aids (Table 6).

Table 6. Feedback regarding the workshop among the participants (n=31)

Characteristics	**Minimum score, Maximum score**	**Average feedback score ± SD**
Content of the talk	3,5	3.7±0.9
Delivery of the talk	3,5	3.6±0.8
Explanations provided	3,5	3.8±0.9
Use of audio-visual aids	3,5	3.8±0.8
Interactivity with the audience	2,5	3.6±1.0
The usefulness of resource materials shared before the start of the workshop	2,5	4.3±0.7
The usefulness of hands-on exercises during the workshop	4,5	4.4±0.5
Characteristics	**Category**	**Number (%)**
Interactivity with the audience	Excellent/Very good/Good	29 (93.5)
	Average	2 (6.5)
Usefulness of the resource materials shared before the start of the workshop	Very useful/useful	28 (90.3)
	Somewhat useful	2 (6.5)
	Less useful	1 (3.2)
Usefulness of the hands-on exercises during the workshop	Very useful/useful	31 (100.0)
Time allotted for the hands-on exercises during the workshop	Adequate	29 (93.5)
	Less adequate	2 (6.5)
Time allotted for discussion at the end of each session	Adequate	29 (93.5)
	Less adequate	2 (6.5)
The overall pacing of the workshop	Just right	30 (96.8)
	Too fast	1 (3.2)
Total		31 (100.0)

There was no association between the participants (n=26) of their prior experience in presenting research papers at conferences and their knowledge scores obtained in the pre-test (p=0.341) or their perceived confidence level in attending conferences prior to attending this workshop (p=0.237) according to the Mann-Whitney U test.

There was no association between the number of research papers presented at conferences (categorized as 1-5, 6-10, >10 papers) and the participants' (n=26) knowledge scores obtained in the pre-test (p=0.64) or their perceived confidence level in attending conferences prior to attending this workshop (p=0.6) according to the Kruskal-Wallis test.

Discussion

Addressing the knowledge gaps among the participants

The baseline knowledge deficit was widespread among the participants of this study, regardless of their prior experience in presenting research papers at various conferences.

About one-third of the participants were aware of predatory conferences and their identification. Only two participants knew all ten recommendations correctly for making a good PowerPoint slide for an oral presentation. None of the participants were aware of all ten ethical issues concerning presentations at scientific conferences. These findings support the need for this workshop to enhance health science faculty members knowledge of best practices related to scientific conferences.

Discussion of the preferences for conference types and modes of scientific paper presentation among participants

More than two-thirds of the participants felt that attending conferences onsite was more beneficial than attending them online, mainly because of better interaction with other delegates. In another study performed in France, better concentration and time

dedication for conference meetings were reported more frequently among onsite attendees than among online attendees (11).

Despite several limitations, virtual conferences gained popularity during the COVID-19 pandemic. This platform was used extensively to sustain conference presentations during these unprecedented times. Some virtual conferences offer more focused research areas, as they are easier to organize and manage than larger meetings (12). Presentation in the cozy home or a familiar workplace environment makes the presenters feel more comfortable during virtual conferences (13). All six presenters in the present study who had presented at virtual conferences reported that they learned to use online presentation platforms through this experience. In a study performed in South Korea, delegates attending a virtual conference were surveyed regarding their perceptions of their presentation experiences. Over the three days of this conference, 31.9% attended more than 80% of the sessions. Positive perceptions were expressed by the delegates regarding convenience and accessibility, the quality of planning and organization of the virtual conference, social exchanges and the use of information technology. As a result, 49.8% preferred virtual conferences over conventional conferences, and 59.2% felt that the popularity of virtual conferences would continue even after the COVID-19 pandemic was brought under control. Additionally, 53% of the respondents agreed that technical barriers need to be addressed for the successful delivery of virtual conferences (14). To overcome internet related barriers encountered during virtual conference presentations, the organizers often advise presenters to share a prerecorded video of their presentation with subtitles of the talk to make it easier for international audiences to comprehend the presentation. These aspects were covered in this workshop through hands-on exercises. One drawback of presenting at virtual conferences is the inability to see the audience during the presentation (13).

Presentations at any conferences are given either in an oral or poster format. Owing to the limited number of slots, oral presentations are usually reserved for robust research studies. In the short period of time allotted for the paper presentation, this mode of presentation ensures that the study findings reach a larger number of delegates. The effectiveness of an oral presentation largely depends on the quality of the slides prepared by the presenter. In the present study, nearly one-fourth of the participants had the misconception that the presenters should be fully dependent on PowerPoint slides to complete their oral presentations at conferences. Over dependence on the slides often occurs due to inadequate preparation by the presenter and may lead to prolonged presentation time. It is recommended to spend no more than 1 minute per slide so that the entire presentation does not exceed 10 minutes (2). Appropriate timing for presentation can be achieved by performing mock presentations in front of guides, mentors, and peer groups (2). The use of a PowerPoint timer or other timing tools can help presenters keep track of the duration of the presentation (15). Mentors may be encouraged to ask some questions toward the end of the presentation to obtain constructive feedback and build confidence in their answers (2, 16). Rehearsal is a key strategy to deliver a clear presentation (17). Organizing thought tools such as mind mapping help provide a clear structure for the flow of a presentation (17). Becoming familiar with the audience by interacting with them prior to the presentation helps one feel more comfortable during the presentation (18).

The use of multiple methods, such as embedding relevant audio and video clips in the PowerPoint presentation, helps prolong attention span which will keep the audience engaged throughout the presentation (3).

Presenters are advised to avoid becoming a “paper reader”, “PowerPoint abuser”, “unprepared

(non-practicer and repeater)”, “numbers freak”, “feedback artist”, “technophobic resistor”, or “pointless blatherer” during the oral presentations (13). These aspects were emphasized, and hands-on training on adding timers, videos, and audio clips to PowerPoint slides was provided to the participants as a part of this workshop.

In this study, more than two-thirds of the participants preferred oral presentation over poster presentation mainly to reach a wider audience. The disadvantages of poster presentations were highlighted in a study performed in the United Kingdom (UK), where just 5% of delegates were reported to have read any of the posters (19). Very few questions were asked of ePoster presenters, and among them, only 7% of the questions were relevant and useful to the presenters. The factors that increased posters’ visual appeal, as stated by the delegates in the UK based study, were the pictures/graphs, the scientific content, and the limited use of words in the poster (19). Fonts in the poster should be of a size that can be read from a distance of 1 meter (2). To provide additional details not included on the poster, a handout or a citation to the pertinent research can be given to the delegates (20). Several software tools are currently available to make attractive

ePosters appealing to delegates. However, more than 80% of the participants in this study were unaware of the names of any software used to design an ePoster. The use of different software to design one was covered in this workshop through hands-on exercises.

Hardly one-third of the participants in this study preferred poster presentations over oral presentations. Poster presentations have certain advantages, such as delegates can read through the posters at their own pace and they have the opportunity for interpersonal communication with presenters to clarify doubts (20).

Discussion on pre- and post-conference activities among the participants

Preparedness on the essential pre-conference practices was inadequate among the participants in this study. Not all the participants in this study carried all the essential electronic devices required for the conference presentation. For conference participants who are presenting a paper, the presentation materials should be safe. The presentation slides to be used for the oral presentation can be saved on a thumb drive or in cloud as a backup in case of computer malfunction (12).

Only about 60% of the participants in the present study had carried first-aid kits while attending conferences in the past. These are essential items during travel. The contents of the kit vary based on the conference location. For example, in a sunny place, sunscreen is beneficial. Medications, both prescription and over-the-counter medications, should be taken according to individual requirements (21). Hence, it is important for conference participants to be aware of the various logistics required while attending conferences (12). This finding highlights the need for logistical preparedness training as a part of such workshops.

It is advisable to check out the presentation room and the facilities to be used well before the presentation to become familiar with the setting (18). These include standing at the podium, examining the slide advance and laser pointer devices, setting up the microphone, becoming familiar with the electronic timer or time-warning lights, and any other controls (22). Personal laptop should be connected into the system, and any audio or video files intended to be played during the presentation needs to be checked for volume and clarity well before the session begins (23). It may also be beneficial to carry a multiprong adapter compatible with any socket particularly during international travel (21). Additionally, carrying business cards can facilitate the networking process (21).

Less than 40% and less than 20% of the participants in this study, had received financial support from various funding agencies to meet the conference registration fees and had utilized travel grants, respectively. Undeniably, attending reputed conferences, particularly international ones, can be financially burdensome. Therefore, it is essential to explore funding opportunities such as scholarships or travel grants. Funding sources are often available, and researchers need to be familiar with the appropriate sources that are compatible with their area of research and apply early to take advantages of these funding opportunities (12). Therefore, information on various funding agencies was shared with the participants of this workshop.

Similar to pre-conference practices, post-conference essential practices were very minimal among the participants in this study. Although the conference has concluded, the post-conference phase is as important as the previous phases of the conference. This is when efforts for networking for the expansion of professional communities for fostering idea exchange and exploring further avenues of research should be actively pursued (24). To begin with, presentation assessment soon after the conference is to be done as "feed-up" which evaluates whether the presentation goal was achieved from a presenter's perspective, then "feed-back" is to be obtained from the audience who attended the presentation; and "feed-forward" on the activities to be undertaken soon after the presentation (24, 25).

Merely presenting research work at a reputed conference does not ensure recognition among the wider scholarly community, as many researchers may not have attended the presentation. Hence, publishing research in academic journals has become imperative after a conference presentation as a "feed-forward" measure to reach a global audience (26). However, a systematic review and meta-analysis reported that only 41.8% of papers presented at conferences reached full publication in journals (27). Therefore, it is essential to encourage researchers to publish their work soon after the conference presentations. As another "feedforward" measure, contacting conference acquaintances through email or social media platforms within 3 days after the conference is advisable (12, 26). In this regard, including one's email address or social media addresses on the poster or PowerPoint slide and sharing business cards with delegates will make it easy for the people to contact the presenter (17). Business cards with photographs of the presenter help in remembering the person and the interaction, thereby increasing the likelihood of establishing successful networks (26). Communication during this phase also need to be personalized and

impactful, highlighting specific aspects of their research that align with the interests of the recipient. This approach shows the seriousness of the communication by the presenter and ensures that it is not perceived as a mere formality (26).

In the present study, post-conference activities such as sharing presentation materials on social media platforms, initiating changes in departmental activities and pursuing new avenues of research related to the conference topic were very minimal among the participants. Posting the summaries of the presentations on online platforms and writing blogs to share the experiences at the conference will help establish more contact and foster collaboration with like-minded researchers (8). However, one needs to be very careful regarding ethical aspects while sharing research content on social media platforms. In an online survey conducted in the UK, 22.3% of the delegates at a conference posted other presenters' slides on various social media platforms (28). The most common reason for posting slides as stated by more than one-third of them was the dissemination of information (28). The drawbacks of posting speakers' slides on social media, as stated by these participants, included violations of intellectual property rights (52.4%), unauthorized distribution of content (48.6%), political sensitivity (24.9%), legal concerns (13%), and malicious use or criticism (11.3%) (28). Although it is a good practice to share conference slides for the benefit of all delegates, it is essential to obtain appropriate licences and consent from presenters before conference organizers share their slides on open domain platforms such as social media (28). Similarly, soon after the Computer-Based Presentations, slides should not be accessed without the consent of the presenter (29). If conference organizers wish to host presentation files of all speakers on the conference website, then they must seek their prior consent (29). Other ethical aspects, such as funding sources of the research study and any assistance utilized for manuscript writing, should be acknowledged in the presentation, and conflicts of interest, if any, should be disclosed (1). Similarly, the presentation of photographs of patients at conferences requires their consent, and the patient's identity should be concealed as much as possible (30). Several of these ethical aspects, along with others were unknown to the participants of this study and hence were covered extensively in this workshop.

Tips for writing effective conference reports, suggestions for expanding professional networking, strategies to bring about changes in departmental activities, and encouragement for the publication of the research paper after its successful conference presentation were provided to the participants during this workshop.

Discussion on the effectiveness of this workshop in improving knowledge and perceptions of best practices in conference presentations among the participants

The knowledge of the participants in this study regarding conferences significantly improved after attending this workshop, as evidenced by higher post-test scores over pre-test scores. The effect size was high indicating a good magnitude of the intervention. The self-perceived knowledge regarding pre-, during-, and post-conference best practices as well as self-perceived confidence levels in attending conferences, improved significantly among the participants after attending this workshop. This was possibly due to the comprehensive nature of this workshop, which covered best practices to be followed during the pre-, during-, and post-conference phases. However, the small sample size of the participants recruited via the non-random sampling method limits the generalizability of the findings. Additionally, as this study was conducted without a separate control group, it has limitations in establishing a causal inference. (8) where the intervention arm delegates received presentation advice and virtual presentation tips from experts along with information packages about conferences, whereas the control arm received only information packages. The treated presenters were found to perform significantly better by a standard deviation of 0.22 of the win rate, and they gave more effective presentations (d=0.21) and used more effective slides (d=0.19) than their nontreated peers (8). These observations underscore the importance of providing periodic training to conference presenters to enhance their presentation skills.

In a study performed in the USA, the self-perceived effectiveness of conference presentations was significantly influenced by a greater number of conference presentations of the participants. In the same study, participants reported that a lack of confidence was associated with a higher risk of process anxiety during the preparation of the talk. This, in turn, was associated with a greater risk of performance anxiety related to the delivery of the talk (31). In the present study, the number of conference presentations was not associated with the participants' knowledge regarding recommendations for conference presentations or their self-perceived confidence levels in attending conferences prior to attending this workshop. However, after attending this workshop, these parameters improved

significantly. Hence, recommended best practices related to conferences should be periodically reinforced among faculty members with the help of training programs such as workshops.

Limitations: The sample size was not based on statistical power calculations and was insufficient for robust statistical analysis. The study was conducted without a separate control group, which limits causal inference. This was a single-center study involving a small group of participants attending a workshop. Therefore, a non-random sampling method was used for participant recruitment.

Consequently, the findings of this study may not be generalizable to other settings. Certain outcome variables were self-reported by the participants based on their perceptions and hence may not be accurate reflections of actual scores. There was no follow-up among the participants to check whether the knowledge and skills acquired by the participants after participation in this workshop had benefited participants during subsequent research paper presentations at any conferences attended thereafter.

Conclusion

This workshop successfully improved knowledge among the participants in critical areas, such as identifying predatory conferences, ethical presentation practices, and preparing a good PowerPoint presentation slide.

Pre-conference activities were found to be inadequate, and post-conference activities were found to be very minimal among the participants. Information on these aspects was provided comprehensively to the participants as a part of this workshop. Most participants preferred onsite conferences and oral presentation modes for better interaction with a larger audience. The self-perceived confidence levels and knowledge of the participants regarding pre-, during, and post-conference best practices improved significantly after the workshop. Future workshops should emphasize hands-on exercises and include longitudinal follow-up to assess the long-term retention of skills and their application by the participants in actual conference settings.

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Conflict of interests: There is no conflict of interest.

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Original Article

Linking Special Care Dentistry Curriculum to Seemingly Irrelevant Comedy Multimedia

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Abstract

Background: Special care dentistry constitutes a vital subject of undergraduate dental education. Providing proper dental care for vulnerable patient groups requires graduates who possess a firm grasp of and training in this discipline. However, the perceived dullness of the subject poses a significant barrier to effective student engagement and learning.

Objectives: This study aimed to explore the effect of incorporating comedy movie clips and memes into the lectures on students' learning experience and their long-term retention of the subject.

Methods: As an exploratory study, over three years, selected multimedia elements were integrated into Special Care Dentistry lectures at Ahram Canadian University in Egypt. A total of 700 students were invited to participate, and 108 completed the survey (response rate: 15.4%). Responses were collected electronically and analyzed statistically.

Results: The vast majority of participants (over 97%) found the teaching method appropriate, and none rated it as not valuable at all. More than 99% of participants reported that the videos enhanced their understanding, and nearly all participants, except one, indicated that the multimedia made the lectures more enjoyable. Moreover, 66.7% reported recalling the multimedia and its linked scientific content years after passing the course.

Conclusion: Respondents reported favorable perceptions of comedy-based multimedia. However, the single-group design, low response rate, and reliance on self-reported outcomes do not establish an effect on objective learning or long-term retention.

Keywords: Audiovisual Aids; Education; Multimedia; Teaching Materials

Background

Special care dentistry (SCD) represents the branch of dentistry concerned with providing oral healthcare to patients with physical, medical, developmental, or cognitive conditions that limit their ability to receive routine dental care. Effective management of such patients requires an understanding of the underlying pathophysiology, clinical picture, pharmacological concerns, and the dos and don'ts in the dental treatment of patients with these particular conditions. Consequently, the discipline integrates general physiology, general pathology, pharmacology, and all the dental sciences, making the subject one of the most challenging in undergraduate studies for dentistry students (1, 2).

Adequate education and training of students about SCD play a crucial role in ensuring the delivery of appropriate, efficient, and safe oral healthcare services to patients with disabilities. Otherwise, massive significant inequalities in oral healthcare delivery emerge for these vulnerable patient groups (3).

Despite its importance, SCD is often perceived as a dull subject with many details. Traditional lectures and textbooks may fail to convey their clinical relevance, particularly when students find the material abstract or difficult to relate to practice (4). This challenge is compounded by the learning preferences of modern students -commonly referred to as "digital natives"- who were born in the era of digital innovations and are daily engaged in using media and social media (5).

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Therefore, innovative teaching strategies are necessary to maintain students' attention, enhance their engagement, and improve the long-term retention of content. The use of humor and entertainment has been shown to support these goals by reducing anxiety, stimulating interest, and fostering a positive learning atmosphere (6). Previous studies explored the impact of various multimedia tools -including scientific educational & procedural videos (7-10), videos of cases (11), games (12, 13), comics (4), and animations (14, 15) on the effectiveness of the education process of different subjects.

In these studies, various methods were tested, including: videos illustrating the content for research methods courses (7), animated videos for basic medical sciences (8), videos of clinical scenarios (9), and generating medical-based games for students to play (10, 11). Other studies have assessed the use of memes in forensics courses (12), comics (4), and simple animations (13) for biology courses. Despite the methodological variety, all the aforementioned studies yielded promising results on the use of multimedia in enhancing the quality of the educational experience.

To date, however, the integration of non-traditional teaching methods in SCD has not been systematically investigated. The current study aims to evaluate the impact of incorporating seemingly unrelated video clips from well-known movies, cartoons, and internet memes into SCD lectures on students' enjoyment, perceived learning experience, and long-term retention of course content.

Objectives

This study aimed to explore the effect of incorporating comedy movie clips and memes into the lectures on students' learning experience and their long-term retention of the subject.

Methods

Study design and settings: The study protocol was registered on *ClinicalTrials.gov* (ID: NCT06366165) on April 15, 2024. This exploratory study was conducted over a period of three years, starting in the fall of 2021, at Ahram Canadian University in Egypt. It focused on evaluating a teaching method implemented in the Special Care Dentistry (SCD) curriculum for undergraduate dental students.

The curriculum covers a range of systemic disorders, including hematological, immunological, endocrine, cardiovascular, neuromuscular, hepatic, and renal conditions. For each topic, lectures included a brief note about the relevant physiology, followed by a summary of the potential pathologies. Then, the general and oral manifestations of the disease are presented, and lastly, the modifications to routine dental management for the affected patient are discussed.

Intervention: SCD lectures were redesigned to intersperse scientific content with comedy movie clips and internet memes. These clips, sourced from well-known movies or cartoons available on YouTube™, were not scientifically focused but were selected for their humorous content and ability to illustrate features related to the lecture material, such as organ behavior or disease manifestations.

Examples include a clip from the movie "Harry Potter and the Prisoner of Azkaban."; where a female visitor got inflated starting from the fingers to legs. The clip was used as simulation of finger clubbing and peripheral edema caused by heart failure. Each clip, lasting no more than two minutes, was embedded at 10–15-minute intervals to maintain engagement during the discussion of scientific content.

After 2.5 years of implementing this intervention, all former students (n = 700) were invited to participate in an online survey to share their perceptions of the teaching method's appropriateness, value, and enjoyment, and to assess whether they recalled the multimedia-linked content.

Outcomes and participants: The survey was designed using Google Forms, and invitations were sent online to all former students via the university's official communication and learning platform, Microsoft Teams. The first invitation was sent in early March 2024, followed by a reminder one month later. Responses were received over a period of two months; after which, the data were statistically analyzed.

Of the 700 students invited, 108 responded (15.4%). Because participation was voluntary, nonresponse bias cannot be excluded. We were unable to compare respondents with nonrespondents because individual-level data on nonrespondents were unavailable. The time elapsed since course completion ranged from 9 months to 2.5 years. Given the modest response rate, potential non-response bias should be considered when generalizing these findings.

All students who had enrolled in the SCD course between fall 2021 and summer 2023 were eligible, representing the entire study population (n = 700). As all eligible students were invited, no sampling procedure was required.

The inclusion criteria for the study were enrollment in the SCD course during the specified period. The only exclusion criterion was unwillingness to participate.

Participation was entirely voluntary and anonymous; even the email addresses of the participants were not gathered.

The study addressed a group of outcomes: the appropriateness of the multimedia used in teaching the course content, its effect on the students' learning experience (Yes/No and how valuable), perceived enjoyment (whether the multimedia made lectures more enjoyable), and the retention of the content.

The first section of the questionnaire included questions about baseline data: (i) age, (ii) gender, (iii) grade point average (GPA) as a measure of academic achievement, and (iv) time since passing the course.

Questions assessed the outcomes; each was rated on a 4-point Likert scale (strongly agree, agree, disagree, and strongly disagree). Likewise, the perceived value of adding these memes and videos in students' learning was rated as: "highly valuable", "valuable", "somewhat valuable", and "not valuable at all". Lastly, Content retention was assessed by a Yes/No question asking whether participants remembered any of the multimedia or its linked scientific content, followed by an optional open-ended question inviting examples.

The questionnaire was adopted from previously published studies (8, 14). It was first tested on a pilot group of current students (n = 20). They reviewed the readability and clarity of the questions for content validity. Content validity was assessed by 10 experts in relevant fields using rating scale and method. The reported content validity index was 0.62. Test-retest reliability was evaluated by having the same group complete the questionnaire twice, with a 4-hour interval between responses, followed by assessing the difference in each individual's responses ($\kappa = 0.71$; *P-value = 0.02*). After passing the validity and reliability checks, the invitations to participate in the study were sent to former students. The complete questionnaire is provided in Supplementary Material-1.

Statistical methods: Data were analyzed using SPSS Statistics, version 26 (IBM, NY, USA). Categorical and ordinal variables were summarized as frequencies and percentages, while continuous data were presented as mean and standard deviation.

Due to the absence of a control group (e.g., traditional lectures) or a pre-intervention baseline, which was not feasible as students could not be assessed on SCD content before the course, the study focused on exploratory descriptive and correlational analyses. Subgroup analyses were conducted according to time since course completion (2.5 years, 1.5 years, 1 year, 9 months) to test retention trends over time, addressing the lack of pre-post data.

Associations between demographic variables and study outcomes were explored using the Mann–Whitney U test, Spearman's correlation, and Kruskal–Wallis test for gender, age, and GPA, respectively. Logistic regression was used to assess the impact of age, GPA, and gender on perceived appropriateness, learning experience, and retention outcomes. Chi-square test detected the statistical significance of the difference between graduates from different years and of both sexes regarding their retention of the content. Statistical significance level was specified at P-value<0.05.

Results

Participants: Of the 700 students invited, 108 (15.4%) participated in the survey. The participants had a mean age of 23.9 years. The time elapsed since completing the course ranged from 9 months to 2.5 years. The baseline characteristics of the participants are presented in Table 1.

Table 1. Baseline data of the participants

Variable	Value
Age (years) (Mean ± SD)	23.9 ± 1.1
Gender [n (%)]	
Males	64 (59.3%)
Females	44 (40.7%)
General GPA (Mean ± SD)	3.27 ± 0.46
Time since passing the course [n (%)]	
2.5 years	16 (14.8%)
1.5 years	52 (48.1%)
1 year	32 (29.6%)
9 months	8 (7.4%)

Outcomes: Table 2 shows the responses of participants to the survey questions.

Appropriateness of the method. More than 97% of participants considered the multimedia to be an effective method for teaching the content.

Value of the method on the learning experience.

Only 1.9% of participants considered the memes to be not helpful for their learning experience, while over 99% of participants reported that the videos enhanced their understanding. Despite the variation in opinions among participants regarding the value of using this multimedia in their learning experiences, none graded it as "not valuable at all." Overall, the perceived value of the intervention was distributed as follows: highly valuable (61.1%), valuable (32.4%), and somewhat valuable (6.5%).

Table 2. Answers to the survey questions

Variable	Strongly agree	Agree	Disagree	Strongly disagree
Memes were appropriate ways to teach special care dentistry.	87 (80.6%)	20 (18.5%)	1 (0.9%)	0 (0%)
Videos were appropriate ways to teach special care dentistry.	87 (80.6%)	19 (17.6%)	2 (1.9%)	0 (0%)
Memes were helpful for my learning of special care dentistry topics.	84 (77.8%)	22 (20.4%)	2 (1.9%)	0 (0%)
Videos improved my understanding of special care dentistry topics.	85 (78.7%)	22 (20.4%)	1 (0.9%)	0 (0%)
Adding memes and videos in special care dentistry lectures was fun.	84 (77.8%)	23 (21.3%)	0 (0%)	1 (0.9%)
	Highly valuable	**valuable**	**Somewhat valuable**	**Not at all valuable**
Memes and videos were … in my learning of special care dentistry.	66 (61.1%)	35 (32.4%)	7 (6.5%)	0 (0%)

The gender of the participants was found to pose a significant difference in their perception that videos improved understanding of topics (z=-2.241, p=0.025), with females reporting stronger agreement (mean rank=60.28) than males (mean rank=50.52). No significant gender differences were found for the appropriateness of memes (z = -0.829, p = 0.407), videos (z = -0.268, p = 0.789), or memes' helpfulness (z = -0.935, p = 0.350), as clarified by the Mann-Whitney U test.

On the other hand, Spearman's rank-order correlations revealed weak positive associations between general GPA and perceived appropriateness of the memes (ρ=0.200, p= 0.038), helpfulness (ρ=0.220, p=0.022), and perceived value (ρ=0.210, p=0.029). Furthermore, Kruskal-Wallis tests indicated significant differences across GPA categories (Low: <3.0, Medium: 3.0–3.5, High: >3.5) regarding appropriateness (H=6.789, p=0.034) and perceived value (H=6.123, p=0.047) with post-hoc tests suggesting stronger agreement among high-GPA students.

Perceived enjoyment. The multimedia added to the content was similarly approved by all participants except one. A statistically significant positive correlation (ρ = 0.499, p < 0.000) was detected between finding multimedia fun and considering it valuable for learning. However, there was no significant difference in the perceived fun of adding memes and videos by gender (p = 0.687).

Retention of the content. Logistic regression analysis identified GPA as a significant predictor of long-term content retention (β = 1.187, p = 0.029, OR = 3.276, 95% CI: 1.129–9.505). On the contrary, age (p = 0.671), gender (p = 0.762), and time since passing the course (p = 0.462) were not found to be significant predictors. The model demonstrated a good fit (Hosmer-Lemeshow p = 0.620) but modest explanatory power (Nagelkerke R^2 = 0.079, omnibus p = 0.386). For the logistic regression model, specify the pseudo-R^2 statistic reported (Cox–Snell or Nagelkerke). Model-fit claims should be interpreted alongside the model specification and other relevant diagnostics. (Table 3).

Table 3. Correlation between baseline data and the opinion of the effectiveness of the teaching method at one side and retaining the content on the other side

	Retention of the content	
	Regression coefficient	***P*-value****
Age	0.09	0.671
General GPA	1.18	0.029*
Gender	0.13	0.762
Time since passing the course		0.462
Memes were appropriate ways to teach special care dentistry	0.203	0.035*
Videos were appropriate ways to teach special care dentistry.	0.188	0.051
Memes were helpful for my learning of special care dentistry.	0.281	0.003*
Videos improved my understanding of special care dentistry.	0.155	0.11

*Significant at $p < 0.05$; **tested by logistic regression.

The results support exploratory subgroup analyses. The subgroup estimates should be interpreted cautiously, particularly for the group with only eight respondents, because the small sample size limits the precision and power of the comparisons (Table 4), as a proxy for trends in the absence of a control group; however, the low R^2 and small subgroup sizes warrant cautious interpretation.

Table 4 illustrates that 66.7% of participants remembered the content after passing the course. No statistically significant difference was found across groups based on time since completion (2.5 years, 1.5 years, 1 year, or 9 months; $p = 0.78$) or gender ($p = 0.898$). The reported retention reflects participants' self-perceived recall and should not be interpreted as an objective measure of learning or long-term knowledge retention.

Table 4. Retention of the content in different groups based on the time elapsed since passing the course

	Retention of the content		P-value**
	Yes	No	
Time since passing the course			0.776
2.5 years	9 (8.3%)	7 (6.5%)	
1.5 years	35 (32.4%)	17 (15.7%)	
1 year	22 (20.4%)	10 (9.3%)	
9 months	6 (5.6%)	2 (1.9%)	
Gender			0.898
Male	44 (40.7%)	20 (18.5%)	
Female	28 (25.9%)	16 (14.8%)	
Total	72 (66.7%)	36 (33.3%)	

*Significant at $p < 0.05$; **tested by Chi-square test.

Moderate-to-weak positive correlations were found between retaining the content and perceiving the multimedia as appropriate and valuable in the learning experience (Table 3).

These findings indicate that academic performance (GPA) and, to a lesser extent, gender influence perceptions of the multimedia intervention, while age has minimal impact.

Discussion

Effective teaching not only delivers critical information but also ensures that knowledge is retained over time through devices, techniques, and strategies (16). A constructive perspective of "edutainment" needs to be adopted, where students learn while having fun (13). Accordingly, the current study investigated the impact of incorporating seemingly unrelated video clips from movies, cartoons, and internet memes into lectures on special care dentistry on the educational experience of undergraduate dentistry students and their long-term retention of the studied material.

The findings confirmed that the multimedia used was both appropriate (97% of participants approved) and valuable (100% of participants approved) for teaching the content. Participants agreed that these tools added fun to the content and helped them retain it without needing to relearn the material. Female students perceived the videos as more helpful in their understanding; meanwhile, students with higher academic performance reported a greater appreciation of the multimedia's value and demonstrated better long-term retention of information.

During the lecture design stage, clips were placed every 10-15 minutes, based on the "dogma" that students' attention spans decline after this interval. Although recent evidence challenges this dogma, suggesting that students' attention relies mainly on the teacher's skills, rather than the lecture length (15, 17). Therefore, the clips and memes were strategically added, aiming to recapture the students' attention if they were distracted by lengthy, dull scientific discussions, and to add fun to the content, while hopefully reinforcing content retention for a more extended period (16).

The study's outcomes were assessed using online surveys, which were found to be cost-effective, paperless, and environmentally friendly. They also have fewer data entry errors and higher data management efficiency. Furthermore, web-based surveys offer quick and easy access to a large pool of potential respondents—especially participants who are geographically dispersed or otherwise inaccessible—encouraging easy participation (1, 18).

The average response rates to online surveys range from 25% to 30% (18). Consequently, the response rate in the current study (15.4%) is relatively low. Generally, low participation rates are attributed to privacy concerns or competing demands (18). However, the low participation rate in the current study may be due to the absence of platform notifications. So, the students were not informed of the sent invitation message unless they opened the application for any reason. Therefore, former students, who graduated years earlier and had used the platform only during their university years, but stopped using it since then, were not informed of the survey and thus had a low participation rate.

More than 97% of participants deemed the multimedia used to be appropriate for teaching the content, and none graded it as "not valuable at all." The multimedia used was considered helpful in enhancing the learning experience and improving the understanding of the majority of participants. These results align with previous studies, where students approved of the help provided by the videos in the lectures and found that the videos clarified the content and captured their interest during the lecture (8, 16, 19). Students generally prefer visual aids, such as animations, over reading a textbook (13).

In previous surveys, more than half of university students reported finding their lectures boring. This boredom was then linked to students missing future lectures, lower levels of understanding of the content, and lower GPAs. Therefore, the incorporation of videos has been shown to alleviate boredom and sustain attention (20). Likewise, medical students have expressed satisfaction with the inclusion of entertainment media, reporting improved learning experiences (21). Its effect has been intensely studied, and a review has shown broad support for integrating media clips in teaching. However, it is opposed by the opinion that the clips need to be meticulously selected to avoid ethical concerns or inaccurate scientific content (21).

Internet memes represent the rapid dissemination of a specific notion in the form of text, image, GIF, song, or video. Memes provide a medium to convey complex thoughts in a quick, engaging, and expressive way. This makes it a perfect method for communicating with today's students, who process information more quickly but have a shorter attention span (5, 14). Additionally, it adds fun to the material and increases the likelihood of remembering the content later on (5, 22). As memes are mostly screenshots from movies, students link the subject to the original stories of their favorite movies, increasing their engagement and enjoyment of the course. Therefore, they are favorably added to highlight key points in the course (23).

Cognitively, multimedia activates both the brain's left hemisphere (for verbal/linguistic processing) and right hemisphere (for visual/spatial processing). With the two hemispheres of the brain engaged, the verbal content is linked to a visual mental model, maintaining long-term retention of information (16). Memes and videos were chosen because they provide a sensory learning environment, allowing students to better understand and retain information. Some educators promoted videos as a powerful tool for providing the context or a starting point for learning. Videos integrate verbal, visual, and auditory methods of learning. Consequently, material is simplified and retained better than in conditions where a single information source is used, thereby improving learning outcomes (7, 16, 24). This is attributed to the creation of a memorable visual image (16).

The significant gender difference in the impact of videos on understanding ($p = 0.025$) suggests that female students may benefit more from visual multimedia in SCD learning, potentially due to differences in learning styles (25). However, the lack of gender effects on other outcomes indicates consistent benefits across groups.

Regarding retention of the content, 66.7% of participants recalled the multimedia used, along with its link to the scientific content, after completing the course, with no statistically significant difference based on the time since passing ($p = 0.78$). These results align with previous studies (16, 19, 21), in which students also reported that videos helped them remember the lecture better and for a longer period compared to traditional lectures.

Memory naturally declines over time following the "forgetting curve" model, where rapid initial loss is followed by a slower yet progressive phase (13). Most students retain only 25% of the learned information after one week and 21% after two to four weeks, in the absence of relearning; and these percentages are expected to decline further over time (13). Nonetheless, these percentages were found to be higher when using visual and audio methods in teaching, providing a better learning experience and higher long-term retention (13). The observed association between gender and self-reported perceived understanding should be considered exploratory and does not establish a gender difference in actual learning.

In the present study, a higher GPA significantly predicted better content retention ($\beta = 1.187$, $p = 0.029$, OR = 3.276, 95% CI: 1.129–9.505), suggesting that students with better academic performance were approximately three times more likely to recall multimedia-linked SCD content years after the course. This finding aligns with prior studies indicating that academically stronger students may exhibit greater cognitive engagement or employ more effective study strategies, enhancing their ability to form durable associations between humorous multimedia and complex scientific material (24). The significant GPA effect may reflect these students' capacity to leverage the intervention's visual and auditory cues, which facilitate deeper processing and long-term memory retention (16).

In contrast, no significant effects were observed for age ($\beta=0.090$, $p=0.671$, OR=1.095), gender ($\beta=0.130$, $p=0.762$, OR=1.139), or time since passing the course ($p=0.462$), suggesting broad applicability of the intervention, as it appears equally effective for younger and older students, males and females, and across different time intervals post-course (up to 2.5 years).

Overall, these findings support the intervention's potential to enhance long-term retention in SCD

education, particularly for high-performing students, while also highlighting the need for future studies to explore additional predictors and contextual factors to fully understand its impact across diverse student profiles.

Lastly, in the current study, the vast majority of participants confirmed that the multimedia brought fun to the content. The students' feedback in the current study aligns with that of a previous study (13), where students enjoyed the videos and memes used. Another previous survey (7) reported that young students enjoyed the idea of adding videos to lectures and benefited from it in their learning process. Video clips have been proven to add fun to learning, motivate students, and foster deeper learning (16).

Using humor during teaching has been confirmed to catch students' interest and maintain their motivation to learn (6, 26). By sharing challenging situations through jokes, humor is a generally used coping mechanism to relieve tension, setting students at ease. It has been proven to be effective in helping students understand and focus their attention, diffusing anger and stress, reducing anxiety, aiding memory, and creating a positive attitude towards the subject and instructor (6, 22, 26). Consequently, humor has been believed to create a more positive learning experience, especially when relevant to the subject material (6, 26, 27).

Nevertheless, humor may sometimes create an illusion of learning without genuine understanding (6). In this study, however, participants who reported satisfaction with the teaching methods also had moderate to high GPAs, suggesting genuine educational benefit.

One of the strengths of the current study is that it is the first to report on the experience of using non-traditional teaching methods for SCD education. However, the major limitation of the study is its single-arm design, which lacks a comparator control group (i.e., a standard pedagogical method with no multimedia added). Therefore, future controlled trials are recommended to quantify the effect of the used method.

Several limitations should be considered. First, only 108 of the 700 invited students responded (15.4%), raising the possibility of nonresponse bias and limiting generalizability. Second, the study used a single-group design without a concurrent comparison group or objective pre- and post-intervention assessment; therefore, causal effects on learning cannot be established. Third, retention was assessed through self-report rather than an objective longitudinal test. Finally, the questionnaire's content-validity evidence was limited (CVI = 0.62; the specific index and calculation method should be reported), and subgroup analyses should be interpreted cautiously where sample sizes were small.

Conclusion

In this single-group survey, respondents reported favorable perceptions of using comedy-based multimedia in special care dentistry lectures. These findings may support the acceptability of this approach, but they do not establish that it improves objective learning or long-term retention. The low response rate, absence of a comparison group, and reliance on self-reported outcomes warrant cautious interpretation. Controlled studies using validated objective assessments are needed to evaluate its educational effectiveness.

It should be noted that the reported retention of content is based on subjective self-reported perceptions rather than objective longitudinal assessments. Therefore, while memes and educational videos appear to serve as engaging supplementary tools for long-term reinforcement, future studies utilizing pre- and post-intervention objective tests are warranted to confirm actual knowledge retention.

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Original Article

Explaining Medical Students' Experiences on the Implementation of Team-Based Learning in Medical Semiology Course

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Abstract

Background: Today, innovative and active teaching methods such as Team-Based Learning (TBL) have attracted the interest of a large number of accrediting bodies, educators, and administrators. In this regard, exploring students' experiences and opinions to identify the benefits and challenges of these methods will help in the better and more effective use of these methods.

Objectives: Considering the above, this study attempted to explore the lived experiences of general medicine students regarding the implementation of TBL in the medical semiology course.

Methods: This study employed a qualitative approach and a descriptive phenomenological study to achieve its objectives. Data were collected through semi-structured interviews, with data saturation achieved after 10 interviews. The data were analyzed using the Colaizzi method.

Results: Data analysis revealed 187 initial codes, 33 subcategories, and 11 categories. The categories included: developing soft skills in students; continuity of learning; peer learning; the teacher as a learning facilitator; preparing for future teamwork; learning through formative assessment and feedback; attending active and dynamic of students in class; deep and sustainable learning; creating a favorable learning atmosphere in the classroom; challenges and limitations of implementing TBL; solutions for enhancing the quality of TBL. The findings indicated that the three categories — "preparation for future teamwork", "creating a favorable learning atmosphere in the classroom", and "developing soft skills in students" — had the highest frequency and codes.

Conclusion: The findings of this study demonstrated that the benefits and achievements of TBL outweigh its challenges and limitations. Nevertheless, it is essential to ensure its proper and planned implementation with adequate supervision. In addition, preparing and empowering instructors is crucial to ensure the success of this method and other interactive approaches.

Keywords: Education; Teaching; Student; Medicine; Medical

Background

Choosing an appropriate educational method to enhance learning and skills in medical students is of importance (1) and significantly impacts their learning outcomes. Nevertheless, evidence demonstrates that the predominant method in medical education is lectures. In this learning approach, students receive a large volume of information from the instructor, which typically does not result in deep learning, causing rapid forgetting and fatigue, with insufficient opportunities for discussion and Q&A (2, 3). Researchers believe that a significant portion of the ineffectiveness of the

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university education system emanates from the lack of student engagement in participatory activities (4).

In this context, innovative and active educational methods have garnered attention from various accrediting bodies, including general medical accreditation, educators, and administrators. In these methods, the learner's interests and abilities are at the center of focus, with the instructor striving to boost learners' skills and creativity. Various studies have discussed the benefits and drawbacks of each method. For instance, a study of postgraduate students indicated that interactive teaching methods can improve performance both in soft and hard skills. According to students, the use of these teaching methods resulted in deeper learning, the development of critical thinking, and enhanced motivation (5). Thus, by applying active teaching methods and enhancing the quality of teaching and learning, students' creative talents are also affected (6).

Team-Based Learning (TBL): One such active learning method is Team-Based Learning (TBL) (7, 8). The TBL method was implemented in 1998 by Dr. Michaelson to boost student motivation and engagement in active learning (9). This educational approach plays a key role in ameliorating problem-solving skills, interpersonal communication, and critical thinking (10). Team-Based Learning (TBL) is aligned with Vygotsky's constructivism theory and the influence of the social environment on the learning process. Vygotsky's theory encourages cooperative and collaborative learning between students and faculty members or peers (11). TBL also establishes an active and participatory learning environment, emphasizing individual and team accountability, group interaction, and motivation for participation in group discussions (12).

This method adheres to four essential principles: i) forming and maintaining groups, ii) holding students accountable for individual and group work, iii) providing timely feedback, and iv) designing team assignments to reinforce learning and team development (12). Numerous studies have explored the effectiveness of this method. For example, a study by Xie et al. indicated that use of the TBL method could enhance learning while ensuring student satisfaction. They stated that TBL education is compatible with current medical education and should be generalized to more classrooms (13). A scoping review by Sterpu et al. suggested that most published studies reported positive outcomes about student satisfaction and engagement in TBL. Nevertheless, the results were inconsistent across the knowledge domain. They stated that no definitive conclusions could be drawn about the value of implementing TBL for clinical disciplines. Thus, they recommended that further studies with rigorous methodologies be conducted (14).

Team-Based Learning (TBL) in Iranian Medical Classes: In Iran, the team-based learning method was officially considered for the revision of the medical curriculum at Tehran University of Medical Sciences in 2011. The aim of this program was to include a student-centered and integrated approach into the medical curriculum. Thereafter, it was considered in other universities as a class teaching methods, research projects, as well as teaching and learning scholarship (15).

Recently, owing to educational accreditation visits and the emphasis of standards on student-centered learning, the demand of a new generation of students (Z generation), consideration of student-centered approaches during the revision of medical science curricula, and support of the medical education study as well as development centers of universities in empowering professors to implement TBL, a suitable background has been provided at the national level for the implementation of interactive teaching approaches such as TBL.

Implementing TBL in the Medical Semiology Course: Given the above information, it is expected that by employing appropriate methods for teaching various courses and units, we would witness an improvement in learners' academic progress. Semiology (clinical signs) is one of the most significant courses in general medicine in Iran, which is part of the second stage of the four-stage general medical curriculum known as the pathophysiology phase. This educational stage lasts for one year and includes pharmacology, specific pathology, along with various internal medicine courses alongside semiology. According to the approved curriculum from 2017, this course needs to be undertaken in both theoretical and practical formats (training in skill labs or simulation centers). The semiology course serves as a bridge between basic science and clinical science to understand the signs and symptoms of disease as well as accurately diagnose and differentiate diseases in the Iranian medical curriculum. In the semiology course, students become familiar with skills in patient history taking and examination (16). Further, in this course, students should be trained in clinical reasoning, communication with the patient during history taking, and examination.

The Iranian medical curriculum also emphasized teamwork, group discussion, group assignments, and small group practice. Despite the importance mentioned, according to the researchers' studies, this

course at the Sari Medical School is mainly presented in a combined form, that is, in-person and virtual, with an emphasis on theoretical content. Based on the feedback of learners from previous courses, traditional methods based on theoretical content caused learners to become weak in clinical reasoning. Moreover, the level of peer interactions, teamwork skills, and motivation to learn decreased in them. Therefore, considering its constructivist learning philosophy, TBL is appropriate for teaching these subjects and can be a suitable answer to the above-mentioned issues.

In addition, the General Medical Accreditation Standards have emphasized the interactive teaching methods along with the development of communication and teamwork skills. Thus, the TBL method was employed to teach the medical semiology course in the first semester of the 2023-2024 academic year. Accordingly, a team of instructors (general internal medicine faculty and medical education specialists) designed and implemented the course based on TBL steps over several sessions with the presence of the Vice Dean of General Medicine.

Initially, students were grouped into teams of 7 to 8 based on their GPAs. Subsequently, after introducing the course plan, necessary information regarding this method was provided to students, where the educational content (including MP4 files of important points from each chapter of the textbook, along with educational images) was made available to students via a virtual network one week before each session. At the beginning of each session, a multiple-choice quiz (consisting of 15 to 20 scenario-based questions) was administered. The quiz questions were drawn from the main course content and were designed to be sufficiently challenging to encourage group discussion among team members. Following the individual quiz, the same quiz was administered as a team test. Along these quizzes, students discussed the questions within their teams, referring to the material they had previously studied to justify their answers and defend their responses. Following the quiz, team members could fill out an appeal form if they disagreed with the answers or how the responses were written. Next, with the participation and guidance of the instructor, feedback was provided for 25 minutes. Subsequently, all groups were assigned the same task, which involved designing a scenario based on the points learned in class. In this phase, students were allowed to use resources, and ultimately, they assessed their teammates. For the practical part of the course, training on examinations was performed on simulated patients in a workshop format at the medical school. Previously taught topics were practiced on a simulated patient who was healthy in every respect. Students were also asked to implement the techniques taught by the instructor on each other to familiarize themselves with examining that organ in a healthy individual. This phase was supervised by instructors across three stations, whereby necessary examination tools such as stethoscopes, sphygmomanometers, tuning forks, monofilaments, etc., were provided to the students. After completing the theoretical topics in the medical school, students, in coordination with the education department, attended the internal medicine ward in small groups to learn about abnormal cases.

Since evaluation of any educational program is essential to ensure its quality, it is important to identify the strengths and weaknesses of the course from the perspective of its main stakeholders. Hence, exploring what students have experienced firsthand in the semiology course based on the TBL approach will help in making decisions to modify or continue the above approach. In addition, it also provides valuable information for national and international researchers and planners to use team-based teaching methods for teaching history taking and medical examination, as well as future program planning.

Objectives

Regarding the above, the current study aimed to explore the experiences of general medicine students considering the use of the Team-Based Learning (TBL) method in the medical semiology course at Mazandaran University of Medical Sciences.

Methods

Study design: This applied research was undertaken as a qualitative study based on a descriptive phenomenology method. The participants in the study included general medical students in the first semester of the 2023-2024 academic year, who were selected via purposeful sampling with maximum variation regarding GPA, age, gender, and accommodation status (N=56). The inclusion criterion for participants was being present in the medical semiology class utilizing the TBL approach, while guest and transfer students with incomplete or minimal experience were regarded as exclusion criteria.

Instruments and Data Collection: Data were collected through semi-structured interviews. The interviews took place in a quiet location at a suitable time for participants, coordinated and approved in advance. Before initiating the interview, information on the study

design was provided to the participants in the form of a study information sheet, and their informed consent was secured. The interview guide consisted of open-ended questions that were developed through a review of literature and in consultation with an expert on the topic. Content validity of the instrument (interview guide) was determined by three experts (one PhD in medical education and two medical students). Prior to the interview, each participant was assigned a code. At the beginning of the interview, the purpose of the research was explained, and permission was obtained to record and take notes along the interview. The participants were also assured that their information would remain confidential and that the interview data would be published anonymously.

Next, the four main questions were asked (Table 1).

Table 1. The interview questions

The interview and probing questions
1. In your opinion, is the use of interactive teaching methods such as Team-Based Learning necessary in medical classes? Please explain.
2. Please share your experiences regarding the use of the Team-Based Learning method in the semiology course.
3. What challenges and advantages did you experience in implementing the Team-Based Learning method?
4. In your opinion, what outcomes has this approach achieved for learning? Please explain.
To accomplish the research objective, guiding questions were utilized. The guiding questions for the interview were as follows: 1. Can you provide an example if possible? 2. Could you elaborate more if possible?

The initial question was linked to participants' general impressions of the interactive teaching methods, such as TBL. Subsequently, follow-up questions were also employed for specific aspects (such as experiences regarding TBL in the semiology course, advantages, and probability challenges). The average duration of each interview was between 30 to 45 minutes, varying based on the responses of participants. Also, probing questions were asked when necessary to extract richer, more detailed narratives. Interviews were performed when participants were physically and mentally prepared and patiently answered questions. At the end of the interview, appreciation and thanks were expressed for their cooperation. The interviews were recorded in full, with important points also noted. Next, within 24 hours, the recorded conversations were transcribed verbatim. The interviews continued until the extracted data became repetitive whereby no new data emerged, reaching the point of data saturation.

Data analysis: For data analysis, the Colaizzi method was utilized, following seven steps to achieve the objective (17). In the first step, at the end of each interview and after recording field notes, participants' recorded statements were listened to repeatedly, and their remarks were transcribed verbatim by one of the researchers (M.B.). In order to understand the feelings and experiences of the participants, the text was read multiple times by two of the researchers (A.Z. & M.B.). In the second step, after reviewing all participants' descriptions, meaningful information associated with the phenomenon under discussion was highlighted by the same two previous researchers, thus identifying key sentences. The third step involved extracting formulated concepts, where an attempt was made to derive a concept from each statement that represented the meaning and essential part of the individual's thinking. It was also ensured that the relevance of the formulated meanings to the original statements was investigated to confirm the accuracy of the connection between them. Once the codes were extracted, the researchers carefully studied the formulated concepts and categorized them based on their similarities. This way, thematic categories of the formulated concepts were established. The next, based on the results of step four, a complete and comprehensive description of the phenomenon was written, creating broader categories. In the sixth step, a comprehensive description of the phenomenon under study (as clearly and unambiguously as possible) was provided. The researchers (A.Z. & M.B.) sent two other researchers (N.M. & S.M.) a copy of the results for validation and confirmation of the consistency between these categories and descriptions, whereby similar results were obtained. In the seventh step, through returning to each participant and conducting an individual interview, participants' opinions on the findings were solicited, with the final validation and accuracy of the findings carried out. The analysis process example is displayed in Figure 1.

To ensure the accuracy and robustness of the data, the four criteria of Guba and Lincoln were considered: credibility, confirmability, dependability, and transferability. For obtaining credibility, prolonged engagement and interaction with participants as well as an appropriate time for interviews, peer debriefing, and

member checks were employed. For transferability, a comprehensive description was provided about participants' characteristics and study context. Further, purposive sampling was utilized in the current study. To obtain conformability, reflexivity and audit trail was used along with reviewing the codes and categories extracted by two medical education experts (peer check). For dependability, all study details and information were described extensively to be easily audited by other researchers (inquiry audit).

The design, implementation, and reporting of this study adhered to the Consolidated Criteria for Reporting Qualitative Research (COREQ) checklist to ensure rigorous methodological transparency and comprehensive reporting of the research process.

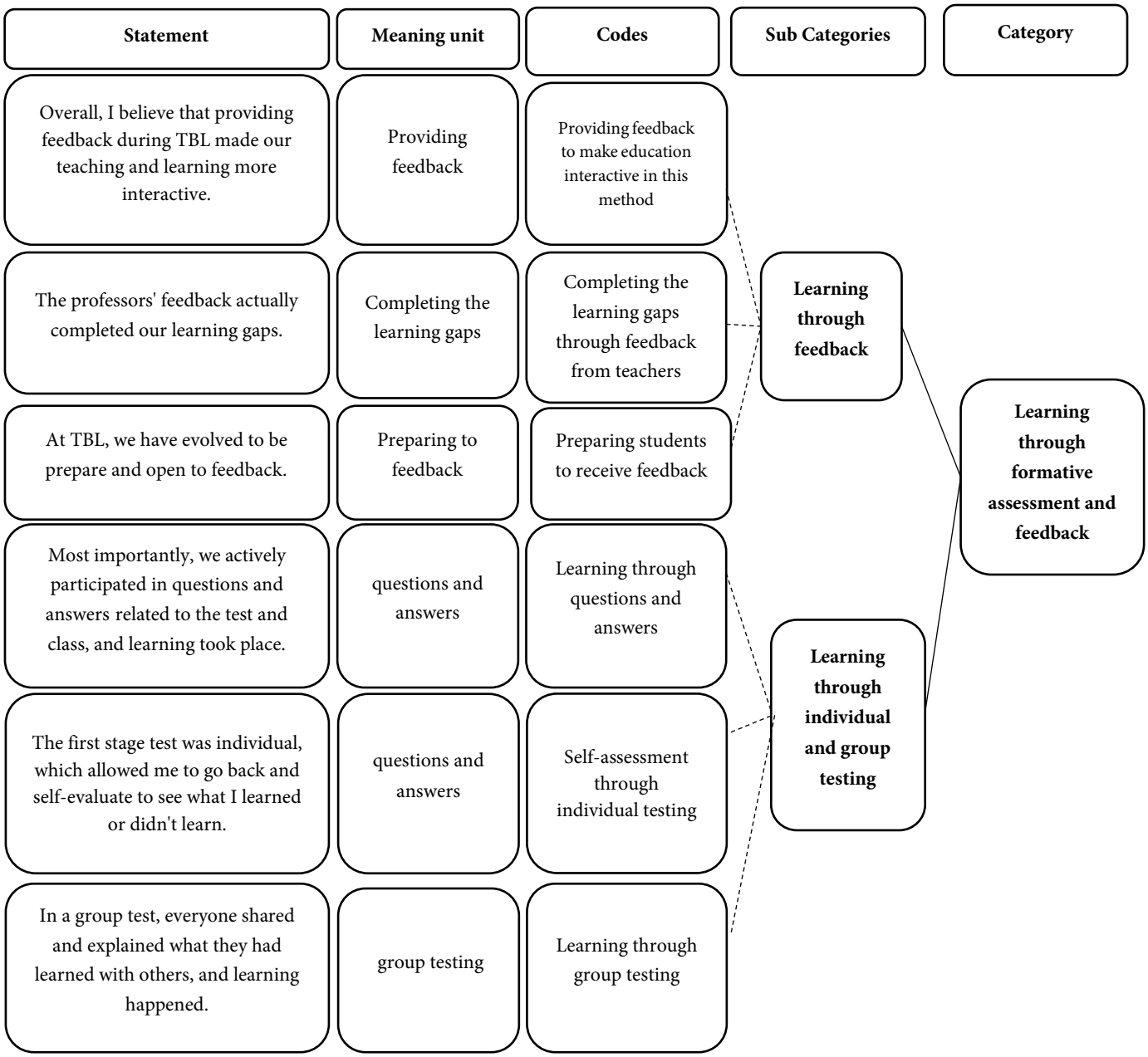

Figure 1. An example of the analysis process related to the category of "learning through formative assessment and feedback"

Results

In this study, data saturation was achieved with a total of 10 interviews. Since in qualitative studies, data analysis is performed concurrently with the data collection process, the results of the analysis revealed that the emergence of new data diminished from the seventh interview onwards, and most of the participants' conversations were repetitive. No new data were extracted after interviewing 10 students, leading to

thematic data saturation. In addition, two follow-up interviews were also conducted to ensure that no new information was added to the findings. Most participants were non-native (70%) and had an average age of 22.8 years (40%). The mean GPA of participants in the study was 16.30 (Table 2).

Table 2. Demographic Characteristics of Participants in the Study

Participant Code	Gender	Age	Native or non-native	GPA
P1	Male	21	Native	16.15
P2	Male	23	Non-native	16
P3	Female	23	Native	15.6
P4	Male	26	Non-native	15
P5	Female	23	Non-native	16.5
P6	Female	22	Non-native	18.20
P7	Female	22	Non-native	17.90
P8	Male	22	Native	16.70
P9	Female	22	Non-native	16
P10	Male	22	Native	14.32

Through the analysis of the interview texts, a total of 187 initial codes, 33 subcategories, and 11 categories were extracted. The categories are as follows: Developing soft skills in students (including five subcategories: strengthening clinical reasoning and creativity, increasing self-confidence, strengthening critical thinking skills, developing communication skill, practicing the leadership role); Continuity of learning before, during, and after class (including four subcategories: the evolutionary path of learning, creating mental preparation through pre-reading the material, repeatedly reviewing the material, consolidating the material through assignments); Peer learning (including two subcategories: learning through teaching, practicing teaching skills); The teacher as a learning facilitator (including one subcategory: reversal of the teacher's role); Preparing for future teamwork (including three subcategories: improving the morale of consulting, improving the ability to cooperate and work in groups, dividing tasks and promoting responsibility); Learning through formative assessment and feedback (including two subcategories: learning through feedback, learning through individual and group tests); Attending active and dynamic of students in class (including two subcategories: activating silent students, providing opportunities for active participation); Deep and sustainable learning (including three subcategories: correcting misunderstandings and mistakes, comprehensive understanding of the material, reviewing learning key points); Creating a favorable learning atmosphere in the classroom (including six subcategories: managing and redirecting classroom mischief and jokes, reducing educational anxiety, creating competition and motivation in learners, suitability of student seating format, positive impact of catering in the classroom); Challenges and limitations of implementing TBL (including three subcategories: time-consuming and energy-consuming this method, requires follow-up and monitoring, limitations of using TBL); Solutions for enhancing the quality of TBL (including three subcategories: TBL implementation requirements in the semiology course, the necessity of integrating TBL with other teaching methods, suitability of this method for interactive courses such as history taking and physical exams) (Table 3).

The data analysis indicated that some categories and subcategories played a more prominent role in the interviews owing to their higher frequency. In general, the three categories “preparation for future teamwork”, “creating a favorable learning atmosphere in the classroom”, and “developing soft skills in students” were more emphasized by students and were the most frequent, claiming the highest number of codes. Thus, they played a pivotal role in the final shaping of the experience. Further, the three subcategories of "improving cooperation and teamwork ability", "dividing tasks and promoting responsibility", and "creating competition and motivation in learners" were emphasized by all participants (10 people).

For example, P2 stated about “developing soft skills in students”: “*The main stage happened in the classroom itself. This was the reasoning and challenges that occurred in response to the scenarios. This is far more important than just reading and listening to the lesson. For me, this method was very effective.*”

P1 stated about the category of “creating a favorable learning atmosphere in the classroom”:

“In routine classes, students would spend their energy and time joking with others. But in the TBL class, the same energy and time were dedicated to learning and feedback. The same jokes in routine classes were hidden here in the form of exchanges between groups”.

Table 3. Analysis of interview text and extracted codes

Categories	Subcategories	Codes
Developing soft skills in students	Strengthening clinical reasoning and creativity	Strengthening clinical reasoning if the educational process continues with this method. Higher level questions required more reasoning. Strengthening clinical reasoning in students through asking case-based questions. Strengthening creativity in problem solving.
	Increasing self-confidence	Increasing self-confidence in students. Strengthening self-confidence in students to ask questions and communicate with professors. Increasing self-confidence during individual exams. Developing courage in the student's personality.
	Strengthening critical thinking skills	Strengthening the spirit of criticism. The possibility of criticizing each other's opinions. Paying attention to differences of opinion by re-reading the topics. Hearing the different opinions of the students. There are many differences of opinion in every subject because everyone thinks in a unique way.
	Developing communication skills	Strengthening communication skills in students. Developing interaction and empathy skills.
	Practicing the leadership role	Practicing leadership roles in groups. Increasing leadership power and managing conflict, pros and cons, and challenges. Choosing someone as a leader and team leader in each team. One person in the group became the leader. Practice leadership during teamwork.
Continuity of learning (before, during and after class)	The evolutionary path of learning	The learning period from before class to after class was formed for students. Pre-class path clarity. Step-wise learning. Student-centered and evolutionary learning path. Continuity of learning from before class to after class.
	Creating mental preparation through pre-reading the material	First, we read the contents ourselves and had a common mindset. Gaining an overview of the material due to previous study and pre-reading. Prerequisites stated before the first session. Mental readiness to accept new material. Creating an overview of the content before class. Pre-reading before class helps to learn faster.
	Repeatedly reviewing the material	Learning was more active through review, repetition, and challenge. Consolidation of material in long-term memory through review. Re-summarization of material repeatedly. Learning involved multiple stages and was repetitive. We were actually reviewing in class. Learning through writing and checking several times.
	Consolidating the material through assignments	Continuing learning after class through homework. Better consolidation and recall of material. Reviewing material through homework.
Peer learning	Learning through teaching	Learning from classmates in groups. Smarter students learning from weaker students in some specific cases. Providing the opportunity to learn from stronger students in groups. Providing the opportunity to learn from peers. Learning through teaching a group.
	Practicing teaching skills	Students being teachers to their friends. Practice teaching skills in students. Everyone taught the student at their own level of knowledge.
The teacher as a learning facilitator	Reversal of the teacher's role	The role of the teacher as a facilitator or challenger. The teacher as a learning facilitator. The change in the teacher's role compared to the traditional classroom. The appropriate approach of teachers and away from strictness.
Preparing for future teamwork	Improving the morale of consulting	Strengthening the spirit of consultation among students. Providing opportunities for consultation experience. Talking and consulting between groups at times.

Categories	Subcategories	Codes
	Improving the ability to cooperate and work in groups	Practicing preparation for teamwork in the clinic. Improving students' ability to cooperate and work in groups. Suitable grouping of students. Practice and repetition for medical teamwork for future performance. Creating balance in work teams. We were discussing within the group. Eliminating doubts and challenges during group work. Practice speaking, gathering information, and working on challenges in teams. Unintentionally guiding students to interact.
Preparing for future Teamwork (continue)	Dividing tasks and promoting responsibility	Creating a sense of responsibility due to the formation of a new work group, regardless of routine friendly groups. Student-centered teaching and giving students responsibility for learning. Students in groups could not easily say "I can't do it" and shrug. Positioning strong and weak students together in groups. Division and creation of new work groups.
Learning through formative assessment and feedback	Learning through feedback	Providing feedback to make education interactive in this method. Completing the learning gaps through feedback from teachers. Preparing students to receive feedback.
	Learning through individual and group testing	Learning through questions and answers. Self-assessment through individual testing. Learning through group testing.
Attending active and dynamic of students in class	Activating silent students	Dynamic and active silent students in the classroom. There were students who were silent and did not speak in normal teaching methods, but in this method, they spoke and had active participation. Active presence and not sleeping in class.
	Providing opportunities for active participation	All students participate in the TBL class from the beginning to the end. Involving all students. Encouraging other students to participate and learn through activity. Participating all students in the discussion.
Deep and sustainable learning	Correcting misunderstandings and mistakes	Awareness of flaws, errors, and misunderstandings. Learning through mistakes. Going back and reviewing and correcting mistakes. Having the opportunity to search and use references simultaneously in class.
	Comprehensive understanding of the material	Recounting mental blind spots in TBL. Helping to understand the subject. Learning more and not just relying on the teacher's material. Opportunity to use the Internet and mobile learning to understand the material. Consolidation of the learned material.
	Reviewing Learning key points	Learning the main and key points. Our learning was also increased. Preparing the background and reviewing the main content in class. Helping students reach a level of mastery in key content.
Creating a favorable learning atmosphere in the classroom	Managing and redirecting classroom mischief and jokes	Turning class jokes into group discussions. Directing class mischief in a positive direction. Incorporating humor and fun into the teaching process of our friends.
	Reducing educational anxiety	We didn't have much stress. Our anxiety was greatly reduced. Decreased class anxiety and answering questions during class. Reduced stress on test night.
	Creating competition and motivation in learners	The existence of hypothetical competition. The class was enjoyable. No feeling of fatigue. Improvement of motivation to learn in students. Increasing motivation of students by creating competition to solve questions. Competition is a double motivation for learning. Creating interest in students to continue the class even despite previous fatigue.

Categories	Subcategories	Codes
	Suitability of student seating format	The appropriateness of the students' meeting format for group interaction and discussion. The seating and class model was similar to European universities.
	Positive impact of catering in the classroom	Students' interest and excitement in being entertained during class Reception during the class as a strength. The good reception during the class.
Challenges and limitations of implementing TBL	The time-consuming and energy-consuming nature of the TBL method	The need for a lot of time and energy. This method is time-consuming and energy-consuming. Dedicating more time to teaching educational challenges.
	Requirement of follow-up and monitoring	The need for the teacher to follow up on students' homework. The need for supervision of students' previous study and their participation in groups.
	Limitations of using TBL	Inability to implement for all sessions and all lessons. TBL not applicable for memorization lessons. High number of students per entry. The method should be integrated and combined with the traditional method.
Solutions for enhancing the quality of TBL	TBL implementation requirements in the semiology course	The need to specify the algorithmic state of the class before implementing the method. The need to prioritize topics and assign the TBL method to priorities. The need to complete courses before implementing TBL for the semiology class. The need to develop and use a self-assessment checklist. The need to train based on more common cases. The need to create a culture for this method from the early years of the general medical course.
	The necessity of integrating TBL with other teaching methods	The method should be integrated and combined with the traditional method. I think this method should continue for the semiology course in a combination with the previous method. For easier lessons, it should be lecture and traditional, but for more practical issues, we should use this method.
	Suitability of this method for interactive courses such as history taking and physical exam	A course like history taking is good. History and physical exam which is an interactive course where you have to interact with the patient. For internal medicine courses can be very good.

P4 also stated about the category of "preparation for future teamwork": "*Medicine is more collaborative, meaning that in a clinical setting, there are different people, such as patients, residents, fellows, etc. So, there is teamwork. I think this method is pretty much in line with what happens in a hospital setting.*"

Nevertheless, the codes related to the three subcategories of "activating silent students", "managing and redirecting classroom mischief and jokes", and "the time-consuming and energy-consuming nature of the TBL method" were emphasized less by the participants (three participants) compared to the other subcategories.

For instance, P10 stated about the category of "the time-consuming and energy-consuming nature of the TBL method": "*This method is time-consuming because the students are not very familiar with this method, and it takes a lot of energy for them to adapt to it*".

P5 highlighted the category of "activating silent students": "*When I looked at the other groups or teams, I noticed that some of the* silent *students in other classes were talking more here and expressing their opinions. Overall, there was a more dynamic atmosphere than in regular classes.*"

P8 stated about the category of "Managing and redirecting classroom mischief and jokes": "*In TBL classes, there was no mischief or frequent class absences, since all teams focused on discussing and exchanging ideas to answer the questions correctly.*"

Further, by combining the findings of Table 2 and the demographic characteristics of the participants in the class, it was determined that the subcategories related to "activating silent students", " Managing and redirecting classroom mischief and jokes", and "increasing self-confidence" were more frequently expressed by male students. The subcategories "the necessity of integrating TBL with other teaching methods" and "requires follow-up and monitoring" were more frequently emphasized by students with high GPAs.

Participant P6 stated: "TBL is very good for courses and lessons such as history taking and general subjects, but for courses like physiology and hematology, which are extensive and there is no time to explain all the details... it is better to integrate it with other teaching methods".

Participant No. 7 stated: "If there is no follow-up and supervision, this method is useless because students will show up to class unprepared, which is useless."

Discussion

This study aimed to explore the lived experiences of medical students considering the implementation of Team-Based Learning (TBL) in the medical semiology course. Through analyzing the interview texts, a total of 187 initial codes, 33 subcategories, and 11 categories were extracted. Some of these categories and subcategories pertained to the achievements and advantages of TBL, while others addressed the challenges and limitations of this method.

The findings of our study are in accordance with theories of interactive learning, such as Vygotsky's theory. This theory emphasizes social interactions along with the role of the teacher as a facilitator in the learning process (11). The experiences of the participants in the current study also highlighted these two issues. Further, the learners in the current study emphasized the role of peers in their learning and the consolidation of their learning, which is in line with the concept of Vygotsky's zone of proximal development (ZPD).

The researchers of the current study believe that this is owing to the characteristics of the learners, the skilled and team-based nature of their future job, as well as the educational environment of medical universities. This signifies that we are faced with learners in medical universities who need team interactions to undertake their roles and tasks. At the same time, they are more inclined to practice medicine independently. Thus, they expect their professors to play a facilitating role.

A review of the existing literature in this field suggested that various studies, both domestic and international, have explored the benefits and achievements of the TBL method across different educational groups and levels. Although some of these studies have compared this method with other approaches, others have utilized it to design their classes and courses. For instance, Loncher et al. used TBL as a framework for interprofessional education in patient safety. According to their study, significant advancements were observed in "communication and teamwork" as well as "interprofessional learning." (18). This method was also well-received by students, concurring with the current study's findings regarding readiness for teamwork in the future and the creation of a favorable learning environment in the classroom as well as their subcategories. Ulfa et al. compared the impact of TBL and lecture-based learning on clinical reasoning and class participation. Their findings revealed that the clinical reasoning scores of students in the TBL group were higher than those in the lecture group, positioning TBL as an effective learning method for boosting students' clinical reasoning abilities and facilitating more independent and active learning (19). Elsewhere, having researched application of TBL for medical students, Jost et al. demonstrated that those in the TBL group significantly outperformed the other group in evaluating key characteristics of problems, thereby improving their clinical decision-making skills. These findings align with the category of developing soft skills and continuity of learning (before, during, and after class) (20). The results of Yang et al.'s study revealed that TBL improved participants' comprehension and enhanced their skills in assessing as well as meeting community needs. A comparison between the experimental and control groups demonstrated that the TBL group exhibited significantly greater performance, learning attitudes, and nursing competencies than the traditional method group. The findings of this study correspond with the extracted codes from the category of readiness for teamwork in the future (21).

Smeby et al. compared the TBL method with the lecture method for third-year medical students, reporting that students in the TBL group had a higher level of participation and satisfaction. They also noted that the understanding of challenging materials as well as the ability to engage in class and provide and receive feedback were higher in the TBL group, which is in accordance with the findings of the current study across various categories and subcategories (22). Branney et al. inspected the use of TBL in teaching applied pathophysiology to undergraduate nursing students. According to their study, student satisfaction was over 92%, with 76% of students preferring the utilization of TBL. Further, most participants expressed a strong desire to have meaningful participation in teams, whereby a clear connection existed between learning activities and teamwork experiences (23).

All of the above studies are consistent with the current study. The difference is that our study focused on the lived experiences of learners, whereas other studies have mainly been quantitative and based on

comparisons with other teaching approaches. Thus, our study is complementary to other studies.

Cremerius et al. conducted research to explore the influence of TBL on teaching musculoskeletal ultrasound skills compared to peer-assisted and conventional education. The results indicated a significant rise in theoretical knowledge for all students (p=0.001), and the performance of TBL learning groups was significantly higher in OSCE compared to others (p=0.001). This study demonstrated that TBL was superior to peer-assisted and conventional teaching methods (24). This study contrasts with the current one, as our findings suggest that peer learning is one of the advantages of the TBL method. In other words, peer learning is part of the approach and cannot be compared in isolation. Indeed, in the TBL method, the peer learning component is integrated with other techniques such as team formation, group work, feedback, and so on, boosting its overall effectiveness.

Nevertheless, since the current study implemented TBL for a large class (N:56) and without prior experience of implementing TBL, two categories emerged related to the challenges and limitations of TBL, which are considered as the contradictory and challenging data of the present study. In these two categories, the following were emphasized: the need for supervision and follow-up to prepare learners in advance, their active participation in team discussions, and completing homework after class.

The challenges and limitations of implementing TBL identified in this study have also been observed in other studies. For example, Liu et al. addressed the challenges and strategies related to developing team-based learning in medical education in China. They found that less than half of the medical schools in China utilized TBL in basic medical or internship courses. Among these, only 10% reported using TBL in both internship and basic medical courses. Their findings indicated that general awareness of TBL, infrastructure and executive support, professional training, resource sharing, and the integration of various disciplines are vital, while also discussing factors for facilitating the application of TBL. These findings align with the extracted codes in the categories of challenges and limitations of TBL implementation, as well as strategies for boosting TBL quality (25). In a study by Haley et al., which compared TBL and case-based learning among third-year dental students in the United States, the findings revealed that participants preferred case-based learning over TBL; however, the scores of students in the TBL group were higher than those in the other group. This study also demonstrated that, considering the development of resources and content, there were more infrastructures for the CBL method. Nonetheless, in TBL, instructors and students spent more time together. The findings of this study correspond with the current study regarding the necessity of integrating TBL with other teaching methods, as well as the time-consuming and energy-intensive nature of this method (26).

One of the limitations emphasized by participants in the current study was the time-consuming and energy-intensive nature of TBL. In the study by Smeby et al., modified TBL sessions were utilized to address the challenge of time consumption. In this approach, initial readiness tests were eliminated to shorten the class teaching time by half, allowing more time for clinical problem-solving. According to their study, shorter sessions may facilitate the implementation of TBL in the curriculum and allow for more frequent sessions, thus enhancing satisfaction with this method (22). In the current study, the participants suggested that TBL should be integrated with other approaches, particularly traditional ones, to save time and energy. Nawabi et al. also explored the integration of TBL with PBL in a package format for teaching dental students. Based on their study, students reported the positive aspects of the TBL experience as a more engaging format, collaborative learning, teamwork, and group competition. They stated that PBL ameliorated their research, presentation, and clinical reasoning skills. While they generally favored TBL, students ascertained the new PBL-TBL package as an optimal learning approach, which contrasts with the findings of this study emphasizing integration with traditional methods (27). One reason for this could be the learners' experiences; generally, the students participating in our study, being in the early clinical stage, had mostly been taught through traditional approaches such as lectures and Q&A sessions. They, therefore, had limited experience with PBL and other interactive teaching approaches, and TBL may have been the first structured and organized method they encountered. This could have influenced their positive experiences and outlook.

Thus, when deciding to use interactive and active approaches in medical classes it is recommended that policymakers, educators, and educational designers, pay attention to issues such as empowering students and professors to employ this method through holding workshops, examining the nature of the lesson or course in terms of the feasibility of implementing interactive approaches, consulting with educational experts, the number of students, and classroom space and facilities.

In cases where it is not possible to fully implement this method, they should modify it by applying educational design models and integrating this method with other teaching methods.

In addition, since the TBL method was implemented for the medical semiology course, and this course confronts similar challenges such as a large number of students and a short semester in most universities, the findings of the current study can be generalized to other medical schools for the semiology course with some adjustments based on the context and facilities of the course. Further, given the recent policies of Mazandaran University of Medical Sciences regarding the use of interactive approaches in teaching, it can also be generalized to other theoretical and practical classes.

Limitations: One of the limitations of the current research was the rather small statistical population in Mazandaran University of Medical Sciences and Sari Medical School. Further, the experiences and opinions of course instructors were not considered, which is another limitation. Finally, even though all interviews were conducted by a trained interviewer who had no previous experience in using TBL, other limitations of the current study included a small sample size and positive bias from the interventionists.

Conclusion

Overall, this research indicated achievements and advantages as well as challenges and limitations of TBL that included developing soft skills in students; continuity of learning-before, during, and after class; peer learning; the teacher as a learning facilitator; preparing for future teamwork; learning through formative assessment and feedback; attending active and dynamic of students in class; deep and sustainable learning; creating a favorable learning atmosphere in the classroom; challenges and limitations of implementing TBL; and solutions for enhancing the quality of TBL. The findings of this study elucidated that for the success of TBL, both students and instructors play an important role, and it is necessary to prepare instructors in different courses, and they should be empowered to use interactive teaching approaches as well as motivate students. Based on the findings of the current study, it is recommended that future research plan, implement, and ascertain the effectiveness of this method in the clinical stage as well.

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Conflict of interests: There is no conflict of interest.

Ethical approval: This research was approved by Mazandaran university of Medical Sciences Research Deputy (designed Code: 21911; ethics code: IR.MAZUMS.REC.1403.354). The research was carried out in accordance with guidelines and regulations stipulated in the Declaration of Helsinki. For participants' consent, we inserted written consent in the information sheet, with all participants giving informed consent before answering the questions. This written consent included information about confidentiality, data storage as well as audio recording security protocols (assignment a code to each student, permission to record the interviews or take notes from it). Participation in this study was voluntary.

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Original Article

Investigating the Factor Structure of the Hidden Curriculum Questionnaire in the Universities of Medical Sciences

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Abstract

Background: In recent years, increasing attention has been drawn to the role of the hidden curriculum in medical education, particularly regarding its influence on the professional development and identity formation of medical students. As an informal and often implicit component of medical training, the hidden curriculum plays a critical role in shaping students' values, behaviors, and perceptions, ultimately influencing their approach to patient care and professional conduct.

Objectives: Against this backdrop, the primary objective of this study was to investigate the factor structure of the Hidden Curriculum Questionnaire within medical universities.

Methods: The statistical population consisted of 5,086 students at Kerman University of Medical Sciences. A sample of 360 students was selected from this population using proportional stratified sampling to participate in the study by completing the questionnaire. The research instrument, a 33-item questionnaire developed by Rauf et al., was specifically designed to evaluate the hidden curriculum in medical institutions. To investigate the factor structure of the questionnaire, both first-order and second-order confirmatory factor analyses.

Results: The results revealed that three factors—communication and reform, student-centeredness and empowerment, and accountability and Inclusiveness—significantly elucidate the structure of the hidden curriculum from the perspective of medical students. Following the removal of five items, the revised questionnaire is deemed an effective instrument for assessing the hidden curriculum in Iranian medical universities. Furthermore, the factors of communication and reform, along with student-centeredness and empowerment, emerged as the most influential components in evaluating the hidden curriculum.

Conclusion: The findings of this study underscore the role of the hidden curriculum in shaping the educational experiences and professional development of medical students. The refined 28-item questionnaire, validated through rigorous confirmatory factor analysis, proves to be a reliable and effective tool for assessing the hidden curriculum in Iranian medical universities.

Keywords: Medical Education; Hidden Curriculum; Students; Medical; Confirmatory Factor Analysis; Psychometrics

Background

The concept of the hidden curriculum (HC) in medical education has recently generated significant discourse among scholars and practitioners. However, there remains a lack of consensus regarding its ongoing relevance, the specific components that constitute it, and the degree of its influence on medical training. Further empirical investigation is warranted to deepen our understanding and contribute meaningfully to this ongoing dialogue (1). The HC in medical education addresses the implicit methods through which knowledge and behavior are shaped, functioning outside the boundaries of a medical school's formal curriculum. It is especially significant due to the professional nature

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of the field, the diverse educational components, and the extensive learning environments, particularly in clinical settings. Essentially, the HC transmits the values, beliefs, and standard behaviors inherent in medical sciences (2, 3).

The definition of the hidden curriculum is currently a subject of debate. Some perceive it as encompassing the undesirable aspects of medical training, while others argue that it includes positive interactions and can be beneficial for both students and faculty (1, 4). The term "hidden curriculum" refers to the non-academic outcomes and by-products of education that are unexamined, covert, latent, unwritten, unplanned, and often invisible (5). Based on a definition, the HC represents a significant dimension of educational curricula, encompassing elements that extend beyond the formally established and informal curricula. Although unofficial, the HC can facilitate learning processes. In an alternative conceptualization, the HC is characterized by unarticulated expectations, unintended learning outcomes, implicit messages, and a curriculum shaped by students themselves. This encompasses the knowledge, ideas, perceptions, performance, and values that students acquire outside of their officially prescribed lessons. The impact of the hidden curriculum can result in enduring and influential educational outcomes (3). Hafferty has extensively explored the hidden curriculum in medical education, defining it as a collection of influences at both organizational and cultural levels. These influences encompass organizational policies, evaluation activities, resource allocation decisions, and intra-organizational policies (6, 7). Hafferty proposes that to uncover the hidden curriculum, one should examine four key phenomena: institutional policies, evaluation activities, resource allocation decisions, and institutional slang or nomenclature (8). The educational journey of medical students extends beyond the formal curriculum, encompassing a myriad of additional influences that shape their experiences and competencies. These influences, collectively referred to as the Hidden Curriculum, encompass a spectrum of values, behavioral norms, attitudes, skills, and implicit knowledge that students acquire throughout their training (9).

An examination of the scholarly literature in this domain reveals that a pivotal inquiry concerning hidden curricula in medical education pertains to their definition and the methodologies for measuring them using suitable and pertinent constructs. Consequently, various studies over the years have endeavored to delineate these elements and devise and validate appropriate instruments for their assessment.

Sarikhani et al. (9) identified ten primary components through a thematic content analysis approach, categorizing them into four distinct groups: structural factors, educational factors, cultural factors, and social factors. The sub-categories or main components of the hidden curriculum in medical education that they recognized are as follows: social factors, including student-instructor relationships, students' interpersonal relationships, role modeling from instructors, and role modeling from clinical staff; cultural factors, including organizational culture and students' cultural context. structural factors: organizational rules and structures, educational and clinical physical setting; educational factors: teaching methods, evaluation methods.

Pourbairamian et al. (6) identified the domains, impacts, factors, and components of the hidden curriculum in residency programs and proposed an initial conceptual framework. Through qualitative content analysis of selected studies, 55 codes were identified and categorized into seven themes and fourteen subthemes. The themes included organizational factors, sociocultural factors, professional factors, communication factors, educational factors, personal characteristics of residents, and educational characteristics of residents. Among these, educational factors and personal characteristics of residents were deemed most significant, while communication factors and educational characteristics of residents were considered least significant.

Yazdani et al. (5) employed thematic content analysis to capture the perspectives of key informants on the management of the hidden curriculum in medical education. Eleven interviewees contributed to the analysis, which identified five key themes: human resources, learning, organizational behavior, formal curriculum, and organization. The findings suggest that effectively managing these components can lead to better management of the hidden curriculum, enabling the planning of students' education based on required and desirable performance outcomes.

Andarvazh et al. (10) used the McKenna method for concept analysis to define the hidden curriculum in medical education. Researchers reviewed 561 English and 26 Persian references, narrowing the selection down to 125 abstracts and thoroughly studying 55 articles. The hidden curriculum is defined as a powerful, intrinsic, and sometimes contradictory message embedded in an organization's structure and culture, conveyed implicitly

through the learning environment by both structural and human factors. It includes cultural habits, norms, values, belief systems, attitudes, skills, desires, and social expectations, which can have both positive and negative effects. They concluded that the hidden curriculum contributes to reproducing existing class structures, socialization, and preparing learners for professional integration.

Rauf et al. (11) aimed to develop and validate a questionnaire to identify the characteristics of the hidden curriculum in medical education. Building on previous qualitative research, a panel of experts created a questionnaire, which was then verified through exploratory factor analysis (EFA) and quantitative methods. The initial 90-item questionnaire was refined to 39 items, and further validation resulted in a 33-item questionnaire with strong psychometric properties. The study identified three main factors of the hidden curriculum: accountability and equal opportunity, communication and stakeholder relationships, and student-centeredness and empowerment. These constructs collectively measure the hidden curriculum in medical institutes.

Studies show a lack of valid tools to measure the hidden curriculum in Iranian medical education. This study aims to develop a robust, locally validated instrument to address this gap. Specifically, this research investigates the factor structure of a 33-item questionnaire designed to assess the hidden curriculum in medical institutes, adopted from Rauf et al. (11), employing a confirmatory factor analysis methodology. Thus, this study represents a significant contribution to the field by examining, for the first time within an Iranian context, the factor structure and psychometric properties of the "Hidden Curriculum Questionnaire in Medical Institutes." This research provides the first validated instrument specifically designed to measure the hidden curriculum within the unique context of Iranian medical education. Additionally, by rigorously validating a tailored instrument, this study provides a novel and essential tool for future research on the hidden curriculum in Iran, addressing a previously unexplored gap.

This study validated the first- and second-order factor structures of the "Hidden Curriculum Questionnaire in Medical Universities" for Iranian medical education, demonstrating its reliability and applicability for assessing hidden curriculum components. The findings confirmed three first-order factors—Communication and Reform, Student Centeredness and Empowerment, and Accountability and Inclusiveness—while establishing The Hidden Curriculum as a second-order construct. Notably, student-centeredness and Empowerment played the most significant role. Despite the study's strong validity and reliability, it was limited to students from Kerman University of Medical Sciences, necessitating future research across broader populations and faculty perspectives to further refine the tool.

Objectives

Against this backdrop, the primary objective of this study was to investigate the factor structure of the Hidden Curriculum Questionnaire within medical universities.

Methods

Participants and Setting: The current study is descriptive and falls within the scope of evaluating the psychometric properties of a questionnaire. The statistical population consisted of students from Kerman University of Medical Sciences, totaling 5,086 individuals. A sample of 360 students was selected using the Krejcie and Morgan table, employing a proportional stratified sampling method across various faculties, including Health, Nursing and Midwifery, Medicine, Paramedical Sciences, Pharmacy, Dentistry, Iranian Medicine, and Medical Management and Information. Participants were selected from the research's statistical sample, with proportional allocation to each faculty. Upon arrival at each faculty, researchers engaged with available student groups in classrooms. Accordingly, some of the students in the classrooms were invited to participate in the study. The study protocol, including informed consent forms, data collection procedures, and measures to ensure participant confidentiality, was reviewed and granted formal approval by the Ethics Committee of Kerman University of Medical Sciences. Before the initiation of the study, all participants were comprehensively briefed on the research objectives, the confidentiality of their responses, and their right to withdraw from the study at any point. The anonymity of the participants was ensured throughout the implementation and analysis of the research data.

Measures: The primary instrument utilized in this research was the "Hidden Curriculum Questionnaire in Medical Institutes," which consists of 33 items (Appendix 1) and was developed and validated by Rauf et al. (11). This questionnaire encompasses three subscales: Communication and Reform, Student Centeredness and Empowerment, and Accountability and Inclusiveness. Respondents indicated their level of

agreement with each item using a five-point Likert scale, ranging from "strongly agree" to "strongly disagree". Before administration, the questionnaire was translated into Persian. The process involved independent translation and back-translation by two translators. This multi-step process included forward and back-translation, reconciliation by the researchers, and cognitive debriefing through pilot testing to ensure conceptual, semantic, and cultural equivalence within the target context. The resulting English version was compared to the original, verifying that the essential meaning of all items was retained. Additionally, in accordance with ethical research standards, the confidentiality of participants' responses was explicitly stated in the distributed questionnaires.

Statistical Analysis: After conducting a screening for outliers and missing data, the total number of questionnaires included in the statistical analyses was 360. The collected data were subsequently analyzed using the Statistical Package for Social Sciences (SPSS) version 26 and Analysis of Moment Structures (AMOS) version 24 software. The instrument's reliability was assessed utilizing the internal consistency method within SPSS, where Cronbach's alpha coefficients were calculated for both the overall scale of the instrument. All coefficients surpassed the critical threshold of 0.7 and were statistically significant, with the overall questionnaire achieving a Cronbach's alpha of 0.94. Furthermore, the Cronbach's alpha coefficients for the CR, SCE, and AI subscales were calculated as .87, .85, and .86, respectively, indicating strong internal consistency for each measure.

The analysis of the correlation coefficients among the various factors within the model, as well as their associations with the overarching construct of the hidden curriculum, reveals that all correlations among the model's factors are statistically significant at the 0.001 level. Notably, the correlation coefficients between the total scale score and the individual components—Communication and Reform, Student Centeredness and Empowerment, and Accountability and Inclusiveness—are 0.930, 0.883, and 0.907, respectively. These values suggest a robust internal validity for the instrument.

To elucidate the construct validity and analyze the factor structure of the "Hidden Curriculum Questionnaire in Medical Institutes," as well as to assess the second-order factor analysis model, Confirmatory Factor Analysis (CFA) was conducted using AMOS software, employing the maximum likelihood estimation method. First-order confirmatory factor analysis (CFA) tests whether observed variables load onto their respective latent factors, thus confirming the structure of the measurement model. Second-order CFA extends this approach by evaluating whether first-order factors load onto a higher-order latent construct, providing insight into broader underlying dimensions. Essentially, first-order CFA focuses on direct relationships between observed variables and factors, while second-order CFA examines hierarchical relationships among multiple latent constructs to determine if they create a more general overarching factor.

Two categories of fit indices were utilized to evaluate the proposed research model. The first index considered was the chi-square statistic (χ^2), which serves as a measure of goodness-of-fit; however, it is regarded as a "badness-of-fit" index, as higher values indicate weaker support for the theoretical model under examination (12). The application of the chi-square statistic necessitates data collection from a sample size ranging between 200 and 500 participants (13). In this study, a total of 360 completed questionnaires were analyzed, allowing for the appropriate use of the chi-square statistic to assess model fit. Furthermore, the ratio of the chi-square statistic to the degrees of freedom (CMIN/DF) was employed as an additional model fit index. This relative or normalized chi-square index is deemed acceptable when its value is less than three (14). Additional fit indices were classified into two groups: comparative and parsimonious goodness-of-fit indices. The Comparative Fit Index (CFI) and Tucker-Lewis Index (TLI) fall within the category of comparative indices (with the chi-square statistic also categorized among absolute fit indices). Values exceeding 0.95 for these indices are interpreted as indicative of an excellent fit, while values above 0.90 are considered acceptable (15). The parsimonious fit indices utilized in this analysis included the Parsimonious Normalized Fit Index (PNFI) and the Parsimonious Comparative Fit Index (PCFI), along with the Root Mean Square Error of Approximation (RMSEA). Generally, values above 0.5 are deemed appropriate for the first two indices. For RMSEA, a threshold of less than 0.06 is indicative of a very good model fit, while values below 0.08 are considered acceptable (15).

It is essential to note that, in addition to using these indicators to assess model fit, items with factor loadings below 0.5 were excluded from the model to enhance its conciseness, reliability, and validity. This threshold was selected based on established methodological guidelines in psychometric research, which suggest that factor loadings ≥0.5 (indicating at least 25% shared variance between the item and the latent factor) are considered

practically significant for retaining items in a scale (16, 17).

While the use of a factor loading cut-off of 0.5 is a conventional and well-justified criterion for item retention, the psychometric robustness of the scale could be further strengthened by also evaluating items based on their contribution to the scale's internal consistency (e.g., corrected item-total correlation > 0.3) and the absence of significant cross-loadings onto other factors. This multi-faceted approach helps ensure the final instrument is both parsimonious and conceptually sound.

Results

Table 1 outlines the faculty-wise distribution of participants (N = 360), with Medicine predominating (41.6%), trailed by Health Sciences (13.0%), Paramedical Sciences (12.5%), Nursing and Midwifery (10.5%), Pharmacy (9.7%), Dentistry (7.8%), Medical Management and Information (4.4%), and Iranian Medicine (0.6%). Based on this Table, the study comprised a total of 360 participants, with females representing the majority (n = 218, 60.7%), followed by males (n = 142, 39.3%).

Table 2 presents the reliability of the measurement scale and the item-total correlations. The corrected item-total correlations range from 0.369 to 0.718, reflecting varying item-construct associations, with higher values indicating stronger contributions. Cronbach's alpha remains stable (0.940–0.943) if any item is deleted, confirming high internal consistency unaffected by individual item removal. The scale means and variance analyses reveal response distribution patterns, with items such as q32 and q1 exhibiting notable variance.

Table 1. Demographic distribution of research participants by faculty and gender

Variable	Frequency	Percent
Faculty		
Medicine	150	41.66
Health	47	13.05
Nursing and Midwifery	37	10.28
Paramedical Sciences	45	12.5
Pharmacy	35	9.7
Dentistry	28	7.8
Iranian Medicine	2	0.55
Medical Management and Information	16	4.44
Total	360	100.0
Gender		
Female	218	60.7
Male	142	39.3
Total	360	100.0

Table 2. Reliability and item-total correlation analysis

Item	Mean	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
q1	3.2521	0.405	0.942
q2	2.5152	0.608	0.940
q3	3.3767	0.464	0.942
q4	2.2853	0.634	0.940
q5	2.6454	0.558	0.941
q6	2.6814	0.666	0.940
q7	2.8504	0.459	0.942
q8	2.2964	0.656	0.940
q9	2.7452	0.498	0.942
q10	2.3213	0.601	0.941
q11	2.5457	0.572	0.941
q12	1.9751	0.552	0.941
q13	2.5596	0.588	0.941
q14	2.3186	0.499	0.941
q15	2.6759	0.625	0.940
q16	2.2742	0.631	0.940
q17	2.6205	0.573	0.941
q18	2.2355	0.575	0.941
q19	2.1911	0.718	0.940
q20	2.8837	0.613	0.940
q21	2.9446	0.599	0.941
q22	2.7535	0.569	0.941
q23	2.7119	0.512	0.941

Item	Mean	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
q24	2.8809	0.439	0.942
q25	2.7175	0.589	0.941
q26	2.8199	0.440	0.942
q27	2.6981	0.554	0.941
q28	2.7922	0.599	0.941
q29	2.3352	0.602	0.941
q30	2.7452	0.651	0.940
q31	2.0831	0.572	0.941
q32	3.6648	0.369	0.943
q33	3.4044	0.536	0.941

Table 3 presents the fit indices associated with the factor model of the "Hidden Curriculum Questionnaire in Medical Institutes." The data indicate that all fit indices fall within the acceptable range, thereby validating the factor analysis model and confirming its suitability for the statistical population under study. The root mean square error of approximation (RMSEA) was calculated to be 0.057, which is below the conventional threshold of 0.08, indicating a good fit. Furthermore, the chi-square to degrees of freedom ratio (CMIN/DF) for this model was determined to be 2.159, reflecting an adequate level of fit . Moreover, the evaluation of additional fit indices reveals that the Tucker-Lewis Index (TLI = 0.90) and the Comparative Fit Index (CFI = 0.90) exceed the recommended benchmark, indicating a satisfactory model fit. The two parsimonious fit indices, namely the Parsimonious Normalized Fit Index (PNFI = 0.76) and the Parsimonious Comparative Fit Index (PCFI = 0.82), also surpass the criterion of 0.5, further affirming their adequacy.

Table 3. Fit indices of hidden curriculum within the first- and second-order factor model in medical sciences universities

Model	Fit indices								
	χ^2	df	χ^2/df (CMIN/DF)	P-value	CFI	TLI	RMSEA	PNFI	PCFI
First-order	738.307	342	2.159	<0.001	0.90	0.90	0.057	0.76	0.82
Second-order	765.595	343	2.232	<0.001	0.90	0.90	0.059	0.75	0.81
Standard values	-	-	<3	<0.05	>0.90	>0.90	<0.08	>0.5	>0.5

Table 4 and Figure 1 present the factor loadings for each parameter associated with the identified factors, along with the standard regression weights for each factor within the factor model. The data indicate that all parameters corresponding to the sub-factors of the model exhibit positive and statistically significant factor loadings in relation to their respective latent factors. However, following the initial application of the factor analysis model, parameters 1, 3, 7, 24, and 32 were excluded from the model because their factor loadings fell below the threshold of 0.5. These parameters were excluded to purify the measurement model, retaining only items with strong, statistically significant relationships to the underlying latent factors.

This Table also presents the fit indices associated with the second-order factor model of the "Hidden Curriculum Questionnaire in Medical Institutes." The data indicate that all fit indices fall within the acceptable range, thereby validating the factor analysis model and confirming its suitability for the statistical population under study. The root mean square error of approximation (RMSEA) was calculated to be 0.059, which is below the conventional threshold of 0.08, indicating a good fit.

Furthermore, the chi-square to degrees of freedom ratio (CMIN/DF) for this model was determined to be 2.232, reflecting an adequate level of fit. Moreover, the evaluation of additional fit indices reveals that the Tucker-Lewis Index (TLI = 0.90) and the Comparative Fit Index (CFI = 0.90) exceed the recommended benchmark, indicating an acceptable model fit. The two parsimonious fit indices, namely the Parsimonious Normalized Fit Index (PNFI = 0.75) and the Parsimonious Comparative Fit Index (PCFI = 0.81), also surpass the criterion of 0.5, further affirming their adequacy.

Table 5 and Figure 2 present the second-order factor loadings for each parameter associated with the identified constructs, along with the standard regression weights for each factor within the proposed model.

The findings indicate that all sub-factors of the model—namely, Communication and Reform, Student

Centeredness and Empowerment, and Accountability and Inclusiveness—exhibit positive and statistically significant factor loadings corresponding to their respective latent construct, the Hidden Curriculum. Specifically, the factor representing Student Centeredness and Empowerment demonstrates the highest regression weight of 0.965 in relation to the latent factor of the Hidden Curriculum. In contrast, the Communication and Reform is associated with the lowest regression weight of 0.875 regarding its influence on the Hidden Curriculum latent construct. Furthermore, Accountability and Inclusiveness contribute to the elucidation of the Hidden Curriculum latent factor, exhibiting a regression weight of 0.943.

Table 4. Factor load and significance level of the parameters in the first-order factor model

Component	Item	Standardized Regression Weights	Critical Ratio	p-value
Communication and Reform	2	0.617	-	-
	4	0.697	10.965*	<0.001
	5	0.600	9.720*	<0.001
	6	0.684	12.920*	<0.001
	8	0.696	10.950*	<0.001
	9	0.511	8.537*	<0.001
	10	0.664	10.414*	<0.001
	11	0.594	9.555*	<0.001
	12	0.593	9.563*	<0.001
	13	0.625	9.940*	<0.001
	14	0.519	8.576*	<0.001
Student centeredness and Empowerment	15	0.656	-	-
	16	0.695	11.586*	<0.001
	17	0.638	10.782*	<0.001
	18	0.659	10.932*	<0.001
	19	0.785	12.642*	<0.001
	20	0.663	11.099*	<0.001
	21	0.650	10.852*	<0.001
Accountability and Inclusiveness	22	0.599	-	-
	23	0.569	9.084*	<0.001
	25	0.627	9.569*	<0.001
	26	0.505	8.219*	<0.001
	27	0.610	9.568*	<0.001
	28	0.671	10.134*	<0.001
	29	0.673	10.015*	<0.001
	30	0.708	10.852*	<0.001
	31	0.630	9.554*	<0.001
	33	0.518	8.325*	<0.001

*p<0.001

Table 5. Factor load and significance level of the parameters in the second-order factor model

Component	Item	Standardized Regression Weights	Critical Ratio	p-value
Hidden Curriculum	CR	0.943	-	-
	SCE	0.965	9.695	<0.001
	AI	0.875	8.805	<0.001
Communication and Reform	2	0.615	-	-
	4	0.696	10.946*	<0.001
	5	0.610	9.822*	<0.001
	6	0.685	13.026*	<0.001
	8	0.694	10.926*	<0.001
	9	0.520	8.660*	<0.001
	10	0.664	10.426*	<0.001
	11	0.595	9.580*	<0.001
	12	0.601	9.671*	<0.001
	13	0.625	9.947*	<0.001
	14	0.541	8.866*	<0.001

Component	Item	Standardized Regression Weights	Critical Ratio	p-value
Student centeredness and Empowerment	15	0.657	-	-
	16	0.695	11.612*	<0.001
	17	0.637	10.790*	<0.001
	18	0.659	10.950*	<0.001
	19	0.784	12.665*	<0.001
	20	0.663	11.119*	<0.001
	21	0.651	10.893*	<0.001
Accountability and Inclusiveness	22	0.591	-	-
	23	0.568	9.036*	<0.001
	25	0.653	9.805*	<0.001
	26	0.509	8.248*	<0.001
	27	0.626	9.705*	<0.001
	28	0.689	10.274*	<0.001
	29	0.698	10.213*	<0.001
	30	0.704	10.392*	<0.001
	31	0.628	9.511*	<0.001
	33	0.508	8.179*	<0.001

*p<0.001

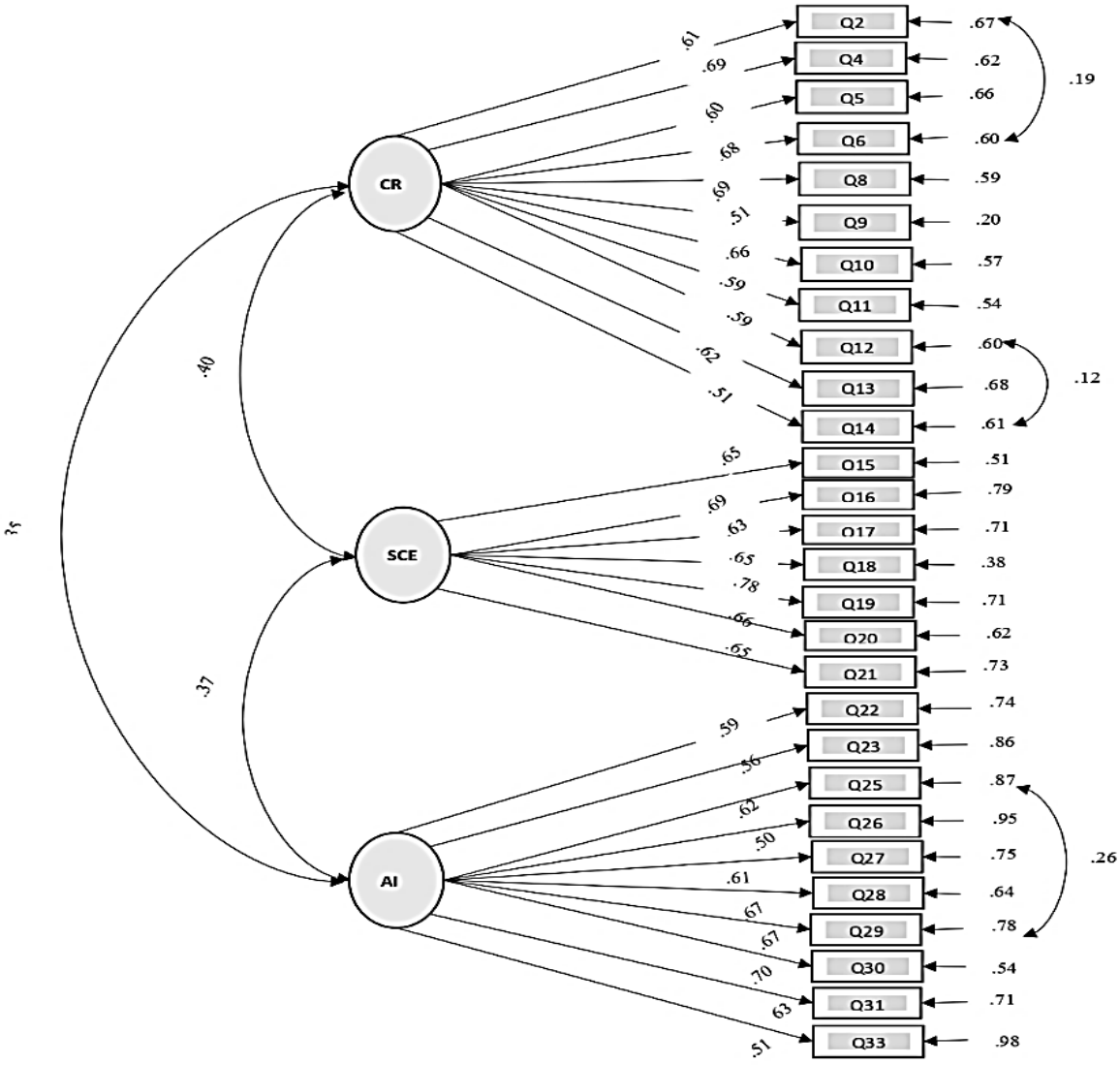

Figure 1. First-order confirmatory factor analysis model validating the hidden curriculum measurement scale in medical education

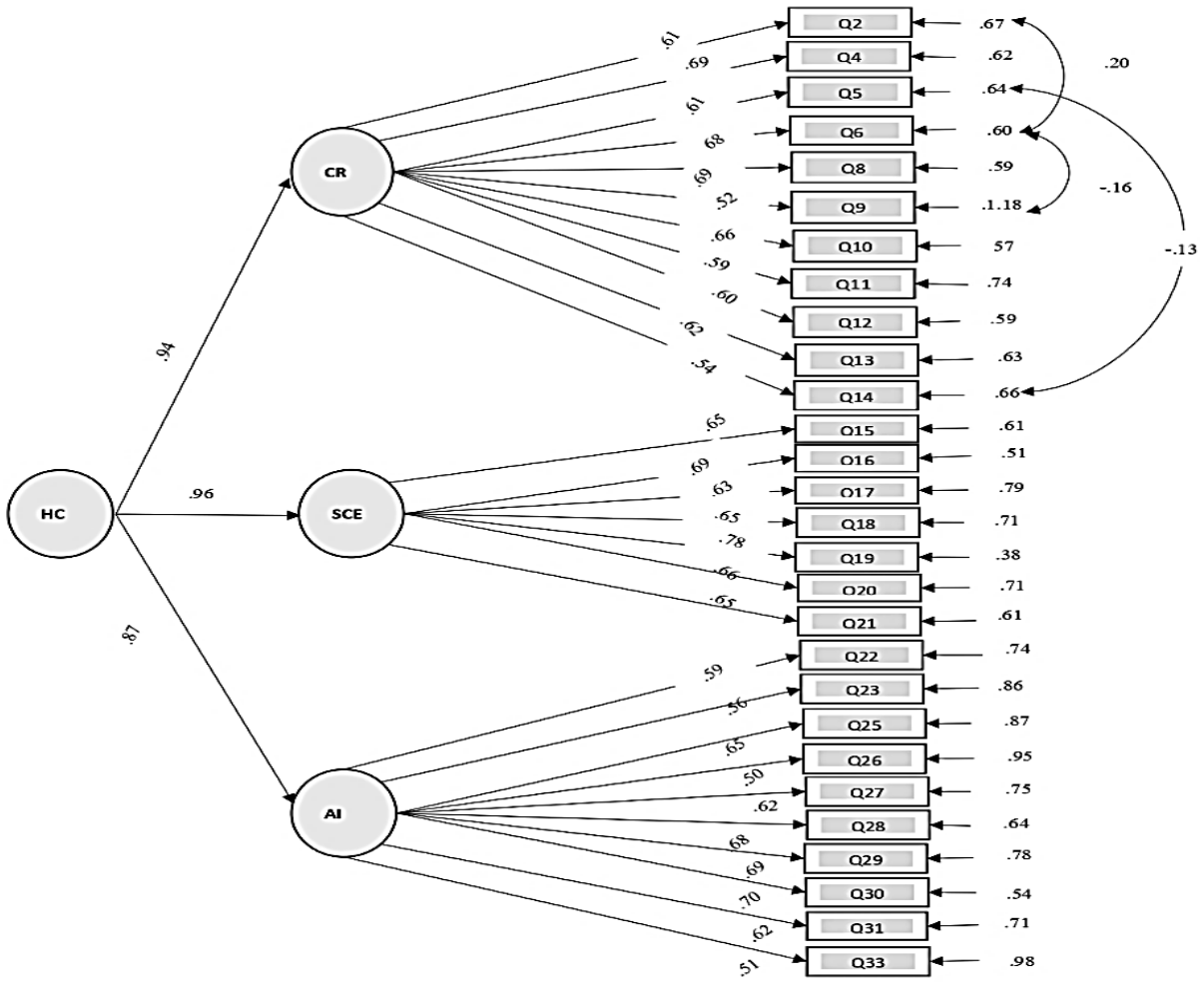

Figure 2. Second-order confirmatory factor analysis model validating the hidden curriculum measurement scale in medical education

Discussion

Brown's typology (18) delineates four distinct categories of curriculum: the formal curriculum, encompassing published syllabi linked to curriculum policy documents, often referred to as the explicit curriculum; the enacted curriculum, which pertains to the curriculum that is delivered in practice; the hidden curriculum, which encompasses unintended learning experiences encountered by students; and the null curriculum, which consists of content that is absent from the formal curriculum yet ought to be included. According to this typology, the curriculum within educational institutions encompasses values and expectations that may not be explicitly articulated in the formal curriculum but are nonetheless assimilated by learners through their experiences in educational settings. Eisner (19) refers to this dimension of the curriculum as the implicit or hidden curriculum. This definition suggests that the hidden curriculum encompasses a range of issues, including social control, covert and unacknowledged activities, as well as the non-scientific implications of educational practices.

Based on the empirical evidence reviewed in this study, there is a lack of a suitable and standardized instrument to evaluate the status of the hidden curriculum in Iranian medical higher education. Such an instrument is necessary to assess the components and structural elements that define the nature and essence of the hidden curriculum within medical education. This study aimed to validate the first and second-order factor structures of the "Hidden Curriculum Questionnaire in Medical Institutes" within the Iranian context.

This measurement instrument, consisting of a 33-item questionnaire developed by Rauf et al. (11), was specifically designed to assess components of the hidden curriculum in Pakistan. The findings indicated that both the first and second-order factor models demonstrated a good fit, thereby establishing this instrument as a standard tool for evaluating various aspects of the hidden curriculum in Iranian medical education institutions. The analysis confirmed three first-order

factors: Communication and Reform, Student Centeredness and Empowerment, and Accountability and Inclusiveness.

Additionally, the overarching construct of The Hidden Curriculum was identified as a second-order factor. These structural components are essential for effectively measuring the Hidden Curriculum Questionnaire in Medical Institutes. Notably, the dimension of Student Centeredness and Empowerment was found to exert the most significant influence on the hidden curriculum index. It shows that all factors were strong contributors, with Student Centeredness and Empowerment being the strongest roles in elucidating the hidden curriculum within medical education institutions. These findings align with previous research conducted by Neve and Collett (20), Yazdani et al. (5), Li et al. (21), Shakerinejad et al. (22), and Parekh et al. (23).

Furthermore, the results indicated that removing five items from the original instrument resulted in a refined questionnaire that retains essential constructs pertinent to the hidden curriculum, thus rendering it a suitable tool for measuring this phenomenon in Iranian higher medical education. However, it is important to note that the definitive application of this questionnaire and its proposed items should not be based solely on the results of this study.

The reliability analysis revealed satisfactory internal consistency for both the overall scale and its constituent subscales within the sample utilized. The Cronbach's alpha coefficient for the complete questionnaire was 0.94, with each subscale exceeding the critical threshold of 0.7. These reliability estimates are consistent with those reported in prior studies; Rauf et al. (11) reported an overall instrument reliability of 0.96, with subscale values above 0.80. In the Iranian sample, the reliability coefficients for each subscale ranged from 0.85 to 0.88.

The findings of this study have significant implications for educational practices in Iranian medical institutions by providing a validated instrument for assessing the hidden curriculum. This tool allows faculty and administrators to identify unintended influences on student learning, including social norms, institutional expectations, and covert educational practices. By recognizing these factors, educators can implement targeted reforms to enhance inclusivity, student empowerment, and communication within medical training. Practical changes could include revising teaching methods to promote active student engagement, integrating discussions on implicit biases in medical education, and establishing policies to address curriculum gaps. The tool enables administrators to monitor the impact of institutional practices on students' professional development, ensuring a more transparent and equitable learning environment. Additionally, expanding its application across diverse medical institutions will provide further insights into the broader effects of the hidden curriculum, guiding future policy development in Iranian medical education.

Conclusion

Given the validation of the first and second-order factor structure of the "Hidden Curriculum Questionnaire in Medical Institutes" within Iranian higher medical education, it is recommended that scholars in medical education employ this instrument. Its validity and exceptional conciseness enhance its applicability in research on the hidden curriculum in medical education.

However, the study's limitations include its restriction to students of Kerman University of Medical Sciences. Future research should therefore evaluate this instrument across a broader statistical population with diverse backgrounds. Additionally, the study's statistical population comprised medical students from various scientific disciplines. Due to the limited number of these subgroups, it was not feasible to conduct comparative analyses for tool validation. Consequently, it is advised that this tool be administered to larger statistical samples to facilitate subgroup analyses. Moreover, it is suggested that future researchers develop and validate similar tools based on the constructs of this questionnaire to explore faculty members' perspectives on the hidden curriculum in medical sciences. The utilization of this validated instrument enables institutions to quantitatively assess the hidden curriculum, thereby facilitating its strategic management to enhance student development and optimize educational outcomes.

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Conflict of interests: There is no conflict of interest.

Ethical approval: This research was conducted in compliance with the ethical guidelines and received approval from the ethics committee of Kerman University of Medical Sciences Code: IR.KMU.REC.1403.450. Before the initiation of the study, all participants were comprehensively briefed on

the research objectives, the confidentiality of their responses, and their right to withdraw from the study at any point. The anonymity of the participants was ensured throughout the implementation and analysis of the research data.

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Appendix 1. Hidden Curriculum Questionnaire in Medical Institutes (adopted from Rauf et al. [11])

	Items
1*	I have a good relationship with my teachers.
2	The teachers and staff of our institute are highly supportive.
3*	The confidentiality of our personal and academic records is respected and maintained.
4	The vision of our institutes is progressive.
5	There is open access to all relevant information.
6	Teachers, students, and staff work closely together in collaboration.
7*	Cultural diversity in our institutes is highly respected.
8	Our institute's policies and procedures encourage diversity, equity, and inclusion.
9	I am highly motivated to excel in this institute because I have the power to make a difference in how things are done in my class.
10	Alternative approaches to learning are encouraged in my institute.
11	The learning activities at my institute are intellectually challenging.
12	Our curriculum reforms are in line with the best international practices.
13	Administrative functioning is organized.
14	We are made aware of progressive curricula and driven to explore better opportunities internationally.
15	Co-curricular activities at our institute foster a healthy and friendly environment.
16	Our medical institute takes active measures to provide admission to a diverse candidate pool.
17	Our institute gives us equal and open opportunities to participate in various physical activities.
18	Our extracurricular activities are highly organized and popular among students.
19	Our institute provides support and empowerment to students in all aspects of their academic and non-academic growth.
20	My association with this institute will help me to do well in the future.
21	Academic achievement is highly rewarded and recognized in this institute.
22	The teacher's attitude encourages students to ask questions.
23	Teachers' marking is fair and objective.
24*	Teachers do not show bias toward selected students.
25	All students have an equal opportunity to participate in and excel at academic and non-academic activities, irrespective of their gender and cultural background.
26	Teachers inform students about any changes to plans regarding assignments and tests well in advance.
27	Teachers allow students to explain their points of view without judging them.
28	Teachers treat us equally.
29	There is no gender disparity in our medical institute.
30	Teachers and administration respect individuals and value their differences.
31	I believe the administration will take appropriate action in response to incidents of discrimination or bias.
32*	I am empowered to make important decisions regarding my learning.
33	I am empowered to make my own choices to achieve my goal. I believe that I am capable of achieving my goals at this institute.

*In the validated version tailored for the Iranian context, items marked with an asterisk were excluded.

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Original Article

Developing a Roadmap for Achieving Scientific Supremacy in Pharmaceutical Sciences Groups in Iran

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Abstract

Background: To attain and consolidate scientific supremacy, academic communities must actively foster cultural transformation and build scientific capacity within society through fundamental change. This study aims to develop a roadmap for Iran's scientific supremacy across all branches of pharmaceutical sciences. This roadmap will be a practical step toward Iran attaining global leadership in pharmaceutical knowledge and provide a model for similar roadmaps in other medical science disciplines.

Objectives: This study aims to develop a roadmap for scientific supremacy in Iranian pharmaceutical sciences by assessing current scientific momentum, evaluating researchers' academic standing, and identifying discipline-specific indicators through expert consultation.

Methods: This study employed a multi-phase, descriptive design conducted sequentially between January and December 2024. All pharmaceutical science groups active in Iranian medical universities were included (13 Disciplines). Phase One: Calculating Scientific Capability and Competitive Advantage of Pharmaceutical Sciences Groups. Phase Two: Determining Academic Reputation and Excellence of Pharmaceutical Sciences Groups and Phase Three: Identifying Discipline-Specific Indicators for Achieving Scientific Supremacy in Pharmaceutical Sciences.

Results: The findings of this study categorized Iran's pharmaceutical science groups into three categories, including flagship (Pharmacology, Pharmaceutics, Pharmaceutical Chemistry, Medicinal Toxicology, Pharmacognosy, Pharmaceutical Biotechnology), pioneer (Pharmaceutical Nanotechnology, Traditional Pharmacy, Clinical Pharmacy, Drug Control), and emerging (Biopharmaceuticals, Nuclear Pharmacy, Drug Economics and Management) groups. A tiered roadmap was developed, directing flagship groups toward networking and internationalization, while leading and emerging groups must first achieve foundational goals in quality improvement and capacity building, respectively. In addition, before reaching the areas mentioned above, necessary measures must be taken for the pioneer groups to achieve the goals of quality improvement, capacity building, culture building, and stewardship. Ultimately, the emerging group must take steps toward focused planning, ensuring alignment, and developing before reaching the status of flagship and pioneer groups.

Conclusion: This study provides a strategic, evidence-based model for systematically advancing Iran's pharmaceutical sciences globally, which can be adapted for other scientific disciplines. It is recommended that the general principles of the strategic plan for scientific authority for each pharmaceutical science group be formulated and communicated through legal channels to pave the way for implementation and achieving scientific authority gradually.

Keywords: Scientific Supremacy; Pharmaceutical Sciences Groups; Scientific Leadership; Roadmap

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Background

Scientific supremacy refers to exerting a pivotal influence on the current standing and shaping the future trajectory of a scientific discipline. The starting point for an academic institution to move toward scientific supremacy can be its competitive academic advantage over peer institutions. This advantage grants the institution the confidence and courage to compete with rival academic entities, holding a winning edge to achieve a superior position through dedicated effort. A competitive academic advantage encompasses the unique characteristics that elevate an institution above similar entities. These characteristics may relate to infrastructure, capital and resources, accessibility and connections, reputation, personnel, processes, and outstanding academic functions (1). Essentially, competitive advantage is the degree to which an organization is more attractive than its competitors from the perspective of customers; it is the distinctiveness in features or dimensions that enables an organization to provide superior services compared to its rivals (2).

To achieve a competitive advantage, organizations must consider both their external positioning and internal capabilities (3). Accordingly, organizations should seek sustainable competitive advantages. Creating and sustaining such advantages requires competencies that leverage organizational capabilities to generate customer value. Organizational resources—including financial assets, capabilities, processes, information, knowledge, etc.—must be controlled in ways that develop and implement value-creating strategies (3). Generally, higher education institutions pursue educational quality, identification of research and development domains, innovation, and societal engagement. These institutions have evolved beyond traditional roles into hubs for knowledge dissemination, production, and commercialization of research outputs, significantly contributing to national economic development (4).

A deeper examination of scientific supremacy reveals that current global examples stem from foundational, long-term transformations at philosophical and theoretical levels of scientific development. Achieving scientific supremacy requires universities and academic centers to excel globally in education, research, technology, theory development, being reference points, responsiveness, currency, leadership, and innovation. Meanwhile, Iran's pharmaceutical industry demonstrates that innovation among Iranian drug manufacturers differs from that of global pharmaceutical companies. This difference indicates that a significant portion of global experiences regarding innovation and its enhancement may not apply to Iran's pharmaceutical industry, necessitating specialized solutions tailored to the context of Iranian pharmaceutical companies (5). In Iran, research aimed at identifying dimensions of distinction among medical universities through specialized protocols determined competitive advantages and academic capabilities in clinical specialties and subspecialties (6).

Scientific leadership is a cornerstone of progress and innovation in the pharmaceutical sciences, driving the discovery, development, and delivery of life-saving medications and therapies. In an era of rapid technological advancement, complex health challenges, and the growing demand for novel treatments, effective leadership is essential for fostering a culture of innovation, interdisciplinary collaboration, and strategic foresight within research groups and industry (7, 8). Visionary leadership propels scientific breakthroughs and ensures that research efforts align with societal needs, regulatory requirements, and global health priorities (9).

Despite constraints and limited resources over the past two decades, Iran has achieved remarkable growth in research article quantity and joined the top 20 countries in global scientific rankings (10). However, output metrics alone are insufficient to sustain scientific excellence. Establishing enduring research prominence requires a structural transformation within academic ecosystems—one that strengthens national research capacity and fosters an equitable scientific culture (11). Given the emphasis on achieving scientific supremacy in higher-level health policy documents, Iran must reach a position in pharmaceutical sciences where global stakeholders reference the achievements of Iranian researchers and scientists to meet their needs for pharmaceutical knowledge, innovation, and access to scientific advancements. This study aims to develop a roadmap for Iran's scientific supremacy across all branches of pharmaceutical sciences. This roadmap will be a practical step toward Iran attaining global leadership in pharmaceutical knowledge and provide a model for similar roadmaps in other medical science disciplines.

Objectives

The study objectives are:

1. Determining the current scientific momentum of pharmaceutical science disciplines toward scientific supremacy by calculating scientific capability and

research competitive advantage indices to identify competitive advantages of medical universities in pharmaceutical sciences.

2. Determining the academic standing of researchers and faculty members in pharmaceutical science disciplines.

3. Identifying discipline-specific indicators for achieving scientific supremacy in pharmaceutical sciences based on expert opinions and higher-level policy documents.

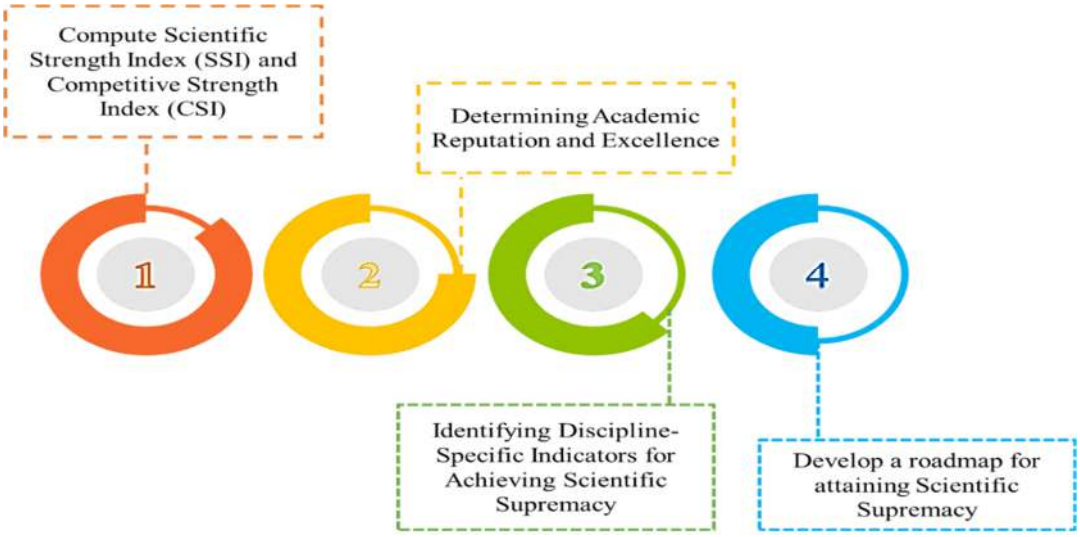

Figure 1. Semantic model of the study of determining the path to achieving scientific authority in pharmaceutical science groups

Methods

This study employed a multi-phase, descriptive design conducted sequentially between January and December 2024. All pharmaceutical science groups active in Iranian medical universities were included (n=13 disciplines) (Figure 1).

Participants: All pharmaceutical science groups active in Iranian medical universities were included, covering: Pharmaceutics, Pharmaceutical Chemistry, Pharmacology, Pharmaceutical Toxicology, Pharmaceutical Biotechnology, Pharmacognosy, Clinical Pharmacy, Nanopharmaceutical Technology, Nuclear Pharmacy, Drug Control, Traditional Pharmacy, Pharmaceutical Economics and Management, and Biopharmaceuticals.

Phase One: Calculating Scientific Capability and Competitive Advantage of Pharmaceutical Sciences Groups

Phase one analyzed the momentum of scientific output, capability, and research competitive advantage in the pharmaceutical sciences. Data were collected using the Faculty Members Scientometrics System (isid.research.ac.ir), based on Scopus data. Formulas and indices for calculating competitive advantages utilized the *h*-index and the *h2*-index. These indices were used to compute the Scientific Strength Index (SSI) and ultimately the Competitive Strength Index (CSI) for each pharmaceutical sciences group (Table 1).

The formulas for calculating the Scientific Strength Index (SSI) and Competitive Strength Index (CSI) (Figures 2 and 3) (Appendix 1).

The final composite score for scientific supremacy was calculated for each discipline as the average of three normalized indicator scores (research advantage, number of top scientists, and student training capacity), where each indicator was scaled from 0 to 100 relative to the highest-performing group. In Phase Three, the initial indicators were derived from a literature review and prior research (6, 12). Questionnaires were sent to the examination boards of all 13 disciplines, achieving a response rate of 90%. The responses were analyzed descriptively and thematically to finalize the discipline-specific indicators (Table 1).

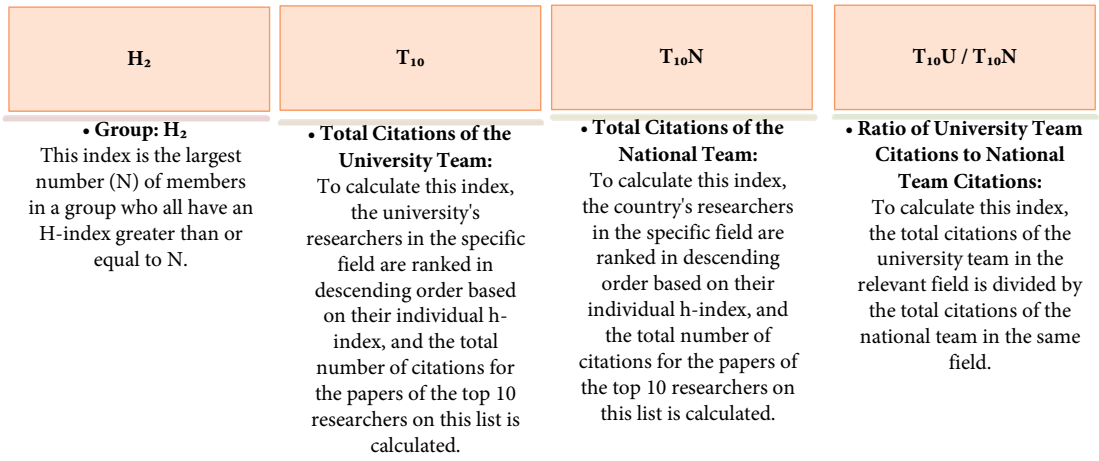

Figure 2. Formula for determining competitive advantage in pharmaceutical sciences

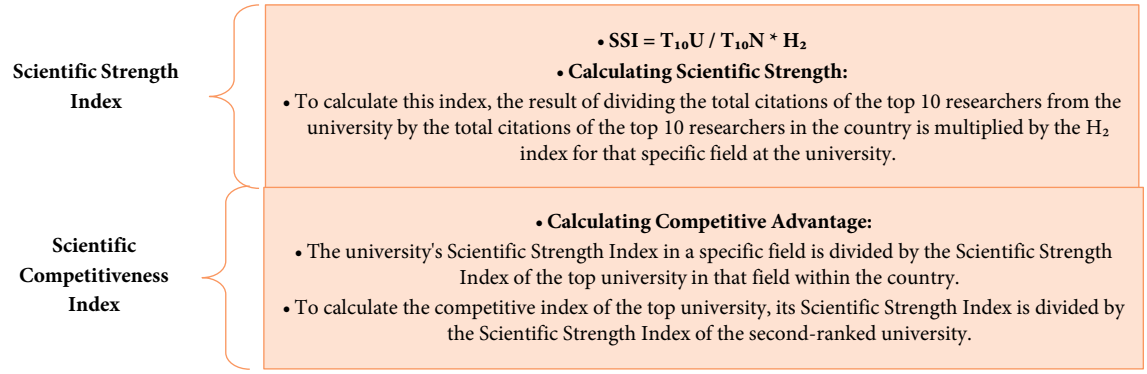

Figure 3. A formula for calculating the scientific power of the competitive advantage of pharmaceutical science groups

Table 1. Assumptions Used in Calculating Scientific and Competitive Strength of Pharmaceutical Sciences Groups

Core Component	Specific Criteria and Procedures
Necessities and Prerequisites for Determining Competitive Advantages of Medical Universities in Pharmaceutical Sciences	Utilization of scientometric indicators for faculty members. Extraction of research data from the scientometrics system. Performance of calculations for all pharmaceutical sciences disciplines. Execution of calculations for individual medical schools/universities.
Optimization of the Methodology for Determining Competitive Advantages of Medical Universities in Pharmaceutical Sciences	Conducting calculations based on the *h*-index from the Scopus database. Calculation performance for all pharmaceutical sciences disciplines. Ranking faculty members according to their *h*-index. Conducting calculations for disciplines with faculty members present in more than one university.
Valuation Criteria for Competitive Advantages of Medical Universities in Pharmaceutical Sciences	A Competitive Strength value above 5.0 is classified as an "Exclusive Advantage." A Competitive Strength value between 0.3 and 5.0 is classified as a "Highly Competitive Advantage." A Competitive Strength value between 0.1 and 0.3 is classified as a "Moderate Competitive Advantage." A Competitive Strength value below 0.1 is classified as "No Competitive Advantage."
Index for Determining Scientific Supremacy Groups in Pharmaceutical Sciences	A Scientific Supremacy Modeling Score of 60-100 designates a "Flagship Group." A Scientific Supremacy Modeling Score of 30-59 designates a "Pioneer Group." A Scientific Supremacy Modeling Score of 10-29 designates an "Emerging Group."

Phase Two: Determining Academic Reputation and Excellence of Pharmaceutical Sciences Groups

Global excellence was assessed using the 2023 list of the world's top scientists published by *PLOS Biology*. The number of Iranian pharmaceutical scientists in this

list was recorded for each group (13). Educational excellence was evaluated based on PhD student enrollment capacity using data from Iran's Medical Education Assessment System (www.sanjeshp.ir) for 2024(Table 2).

Table 2. Educational and Research Information Related to Pharmaceutical Science Disciplines

Row	Group Name	Number of Scientists*	Postgraduate Student Admissions**
1.	Pharmaceutics	10	11 Universities (37 Students)
2.	Pharmaceutical Chemistry	12	6 Universities (22 Students)
3.	Pharmacology	11	11 Universities (43 Students)
4.	Pharmaceutical Toxicology	6	9 Universities (33 Students)
5.	Pharmaceutical Biotechnology	6	7 Universities (28 Students)
6.	Pharmacognosy	5	9 Universities (30 Students)
7.	Clinical Pharmacy	0	7 Universities (44 Students)
8.	Pharmaceutical Nanotechnology	4	10 Universities (28 Students)
9.	Nuclear Pharmacy	0	2 Universities (6 Students)
10.	Drug Control	2	6 Universities (18 Students)
11.	Traditional Pharmacy	2	10 Universities (27 Students)
12.	Drug Economics and Management	0	2 Universities (5 Students)
13.	Biopharmaceuticals	1	4 Universities (13 Students)

*Number of discipline scientists in the list of top world scientists. **University admission capacity relates to the year 2023-2024 (Iranian calendar year 1402).

Phase Three: Identifying Discipline-Specific Indicators for Achieving Scientific Supremacy in Pharmaceutical Sciences

Following calculations from previous phases, groups' positions on the roadmap were determined using a scientific supremacy index developed in prior research (1). Questionnaires based on identified indicators were emailed to examination and evaluation boards of 13 pharmaceutical disciplines. Follow-ups ensured questionnaire completion over three intervals. Completed questionnaires were collected and analyzed by group, and discipline-specific indicators were finalized (Table 3).

Table 3. Modeling Calculations for Determining the Roadmap to Achieve Scientific Authority in Pharmaceutical Sciences

Discipline Name	Research Advantage	Research Advantage Score	Number of Student-Training Universities*	Educational Advantage Score	Number of Top Scientists*	Top Scientists Score
Pharmacology	26	96.3	11	100	11	91.7
Pharmaceutics	27	100	11	100	10	83.3
Pharmaceutical Chemistry	26	96.3	6	54.5	12	100
Pharmaceutical Toxicology	23	85.2	9	81.8	6	50.0
Pharmacognosy	21	77.8	9	81.8	5	41.7
Pharmaceutical Biotechnology	22	81.5	7	63.6	6	50.0
Pharmaceutical Nanotechnology	13	48.1	10	90.9	4	33.3
Traditional Pharmacy	9	33.3	10	90.9	2	16.7
Clinical Pharmacy	15	55.6	7	63.6	0	0
Drug Control	9	33.3	6	54.5	2	16.7
Biopharmaceuticals	6	22.2	4	36.4	1	8.3
Nuclear Pharmacy	11	40.7	2	18.2	0	0
Drug Economics and Management	7	25.9	2	18.2	0	0

*Data pertains to the Iranian academic year 1402 (2023-2024).

Analysis

To determine key nodes (indicators) for scientific supremacy in each discipline, modeling is incorporated:

- Scientific capability and competitive advantages
- Number of group scientists among the world's top scientists
- Number of universities training specialized students (Table 3).

The highest values among these indicators were used as benchmarks for full scores.

Results

The final index was normalized to a maximum score of 100 for each indicator. For instance, in research advantage, the pharmaceutics group demonstrated the highest value and was thus assigned the benchmark

score of 100. Other groups received proportionally lower scores based on their performance relative to this benchmark.

Among the groups, the pharmacology and pharmaceuticals groups had the most significant number of universities training specialized students, which were assigned a score of 100.

Additionally, the Pharmaceutical Chemistry group had the highest number of scientists among the world's top scientists, and was also assigned a score of 100. Finally, the final score was considered based on the average of the three indicators. According to the indicators (Table 1) of the group comparison results, a score above 60 was considered for the flagship groups. Pharmacology, pharmaceutics, Pharmaceutical Chemistry, medicinal toxicology, pharmacognosy, and pharmaceutical biotechnology groups were included in this category. In the pioneer group, which received a score between 30 and 59, the categories of pharmaceutical nanotechnology, traditional pharmacy, clinical pharmacy, and drug control were included. The third group, which received a score of 10 to 29, was considered an emerging group, comprising the biopharmaceuticals, nuclear pharmacy, and drug economics and management groups (Tables 4 and 5).

Table 4. Identification of Scientific Authority Attainment Groups in Pharmaceutical Sciences

Discipline Name	Group Research Advantage	Number of Specialist Student-Training Universities	Number of Top Iranian Scientists Worldwide	Final Score	Group Categorization
Pharmacology	26	11	11	96.0	Flagship Groups
Pharmaceutics	27	11	10	94.4	
Pharmaceutical Chemistry	26	6	12	83.6	
Pharmaceutical Toxicology	23	9	6	72.3	
Pharmacognosy	21	9	5	67.1	
Pharmaceutical Biotechnology	22	7	6	65.0	
Pharmaceutical Nanotechnology	13	10	4	57.5	Pioneer Groups
Traditional Pharmacy	9	10	2	47.0	
Clinical Pharmacy	15	7	0	39.7	
Drug Control	9	6	2	34.9	
Biopharmaceuticals	6	4	1	22.3	Emerging Groups
Nuclear Pharmacy	11	2	0	19.6	
Drug Economics and Management	7	2	0	15	

Table 5. Classification of Pharmaceutical Science Groups Based on Scientific Supremacy Index

Category	Score Range	Disciplines
Flagship Groups	60-100	Pharmacology, Pharmaceutics, Pharmaceutical Chemistry, Medicinal Toxicology, Pharmacognosy, Pharmaceutical Biotechnology
Pioneer Groups	30-59	Pharmaceutical Nanotechnology, Traditional Pharmacy, Clinical Pharmacy, Drug Control
Emerging Groups	10-29	Biopharmaceuticals, Nuclear Pharmacy, Drug Economics and Management

Based on the calculations and modeling carried out in this study, a roadmap for achieving Scientific Supremacy for pharmaceutical science groups was developed, so that the flagship groups were considered in the areas of networking, internationalization, value creation and expansion of action and access, and the planning of these groups in these areas should be in line with achieving Scientific Supremacy. In addition, before reaching the areas mentioned above, necessary measures must be taken for the pioneer groups to achieve the goals of quality improvement, capacity building, culture building, and stewardship. Then, steps should be taken towards achieving Scientific Supremacy in line with the areas of the flagship group. To develop a roadmap for attaining Scientific Supremacy, the areas of focused planning were considered, ensuring alignment.

After achieving the goals of these areas, they targeted quantitative development for the emerging group, which was considered for the areas intended for the pioneer and flagship groups in line with attaining scientific supremacy (attachment of the Scientific Supremacy map of pharmaceutical science groups) (Appendix 2).

Discussion

Scientific supremacy refers to exerting a pivotal influence on the current standing and shaping the future trajectory of a scientific discipline. The starting point for

an academic institution to move toward scientific supremacy can be its competitive academic advantage over peer institutions (1). In examining Chinese universities' performance, Lu & Qin (2012) found that enhancing effective university functions significantly impacts entrepreneurship and high-tech industry development (8). Salazar & Wang (2009) prioritized improving educational quality and revising curricula/programs for competitive advantage at the University of Houston-Victoria (14). Harper (2004) identified key internal/external factors affecting the University of Texas, highlighting strengths like enrollment growth, quality programs, research expansion, community engagement, faculty-student interaction, student activity, security, and external funding (15).

While competitive advantage positions an institution favorably initially, it does not guarantee ultimate success. Competitors starting from lower positions can overturn outcomes through targeted planning and effort—termed the "Red Ocean Strategy" (competing in existing crowded markets) (16). Disciplines can be prioritized for scientific supremacy based either on competitive advantage (Red Ocean Strategy) or national priorities (1). Conversely, a discipline may be nationally vital yet lack domestic competitors. The first institution entering this space can leverage the "first-mover advantage" (over "best-in-class") to rapidly become the national hub for that discipline. Organizations struggle to grow parallel to rivals in competitive environments, necessitating strategies that create new value or markets—the "Blue Ocean Strategy" (17). Competing organizations vie for service share; crowded competition ("Red Oceans") stifles growth and becomes destructive (16). While competitive (Red Ocean) strategy is necessary for superior performance, it is insufficient. Institutions must address factors beyond competition to ensure growth and survival—this is the essence of the "Blue Ocean Strategy" (18). Achieving scientific supremacy in pharmaceutical sciences offers transformative benefits for Iran, including Enhanced Public Health: Leadership in pharmaceutical research enables the development of advanced therapies and improved access to essential medicines, directly impacting population health outcomes (19, 20). Economic Growth and Export Potential: Scientific excellence fosters a competitive pharmaceutical industry capable of exporting high-value products, generating revenue, and creating quality jobs for scientists and researchers (21, 22).

Global Influence and Collaboration: Supremacy in pharmaceutical sciences positions Iran as a regional and global leader, opening avenues for international partnerships and collaborative innovation despite external constraints (21, 22).

Sustainable Innovation Ecosystem: A robust scientific environment supports continuous innovation, resilience against external shocks, and the capacity to address emerging health challenges (7). By addressing these core components, the roadmap seeks to empower Iranian pharmaceutical sciences groups to overcome current challenges, harness their full potential, and attain a position of scientific leadership both regionally and globally.

For policymakers, a key recommendation is to formally incorporate this evidence-based roadmap into national science and health policy to guarantee a long-term and structured commitment. Support should be strategically tailored: flagship groups require funding for international networking and high-impact projects; pioneer groups need investment in quality improvement and infrastructure; and emerging groups benefit from seed funding and capacity-building initiatives. Furthermore, policies should promote collaboration between industry and academia, revise academic incentives to prioritize impact over sheer quantity, and bolster scientific diplomacy to enhance Iran's global pharmaceutical standing.

Future research should concentrate on refining methodologies by developing broader metrics for excellence, encompassing innovation and societal impact, in addition to traditional bibliometrics. Researchers should also undertake in-depth studies to identify the specific challenges faced by each group tier, including barriers to internationalization for flagship groups. Longitudinal studies are essential to evaluate the roadmap's effectiveness over time, and subsequent work should integrate diverse data sources beyond Scopus to provide a more comprehensive and inclusive assessment of Iran's scientific output.

While this article has several strengths, it also has limitations. One key limitation is its reliance on Scopus data, which, although extensive, may miss high-quality research published in reputable regional or national journals that are not indexed in this database. Additionally, there is a potential for non-response bias in the expert questionnaires, as well as inherent subjectivity involved in weighting and finalizing the indicators for the supremacy index. Future research could benefit from incorporating a wider range of databases and utilizing Delphi techniques to achieve greater consensus on the indicators.

Conclusion

The successful execution of this roadmap is contingent upon addressing underlying infrastructural and policy challenges. Therefore, it is recommended that the strategic principles of this roadmap be formally adopted into national science and health policy to enable a structured and resourced journey toward global scientific leadership in pharmaceutical sciences.

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Appendix 1. Research Competitive Strength and Scientific Strength of Pharmaceutical Sciences Groups in Iranian Universities of Medical Sciences

Discipline	University	Scientific Strength	Competitive Research Strength	Type of Research Advantage
Pharmaceutical Toxicology	Tehran	15.84	4.30	Highly Competitive Advantage
	Mashhad	3.69	0.23	Highly Competitive Advantage
	Shahid Beheshti	2.86	0.18	Highly Competitive Advantage
	Shiraz	2.68	0.17	Highly Competitive Advantage
	Tabriz	1.88	0.12	Highly Competitive Advantage
Nanopharmaceutical Technology	Tabriz	7.46	2.67	Highly Competitive Advantage
	Zanjan	2.08	0.38	Highly Competitive Advantage
	Mashhad	1.98	0.27	Highly Competitive Advantage
	Kermanshah	1.13	0.15	Highly Competitive Advantage
	Tehran	0.91	0.12	Highly Competitive Advantage
Drug Control	Tabriz	4.18	1.84	Highly Competitive Advantage
	Tehran	2.28	0.54	Highly Competitive Advantage
	Mashhad	2.18	1.52	Highly Competitive Advantage
Pharmacognosy	Mashhad	8.11	1.32	Highly Competitive Advantage
	Tehran	8.38	0.76	Highly Competitive Advantage
	Isfahan	6.98	0.63	Highly Competitive Advantage
	Shahid Beheshti	4.89	0.44	Highly Competitive Advantage
	Tabriz	4.27	0.38	Highly Competitive Advantage
	Shiraz	3.20	0.29	Moderate Competitive Advantage
	Jahad Daneshgahi	2.91	0.26	Moderate Competitive Advantage
	Kerman	2.43	0.22	Moderate Competitive Advantage
	Iran	1.99	0.18	Moderate Competitive Advantage
	Mazandaran	1.37	0.12	Moderate Competitive Advantage
Pharmaceutics	Tehran	15.23	1.16	Highly Competitive Advantage
	Tabriz	11.13	0.86	Highly Competitive Advantage
	Mashhad	7.60	0.50	Highly Competitive Advantage
	Shiraz	6.34	0.30	Highly Competitive Advantage
	Isfahan	4.58	0.30	Highly Competitive Advantage
	Shahid Beheshti	3.80	0.25	Moderate Competitive Advantage
	Zanjan	2.46	0.16	Moderate Competitive Advantage
	Mazandaran	2.07	0.14	Moderate Competitive Advantage
	Kerman	1.96	0.13	Moderate Competitive Advantage
Pharmaceutical Chemistry	Tabriz	15.55	1.22	Highly Competitive Advantage
	Tehran	12.79	0.82	Highly Competitive Advantage
	Mashhad	6.97	0.45	Highly Competitive Advantage
	Mazandaran	5.94	0.38	Highly Competitive Advantage
	Shiraz	3.85	0.25	Moderate Competitive Advantage
	Shahid Beheshti	3.78	0.24	Moderate Competitive Advantage
	Isfahan	2.41	0.16	Moderate Competitive Advantage
Biopharmaceuticals	Kermanshah	4.55	4.52	Highly Competitive Advantage
	Tehran	1.01	0.22	Highly Competitive Advantage
Clinical Pharmacy	Tehran	2.31	2.42	Highly Competitive Advantage
	Shahid Beheshti	0.95	0.41	Highly Competitive Advantage
	Isfahan	0.65	0.28	Highly Competitive Advantage
	Tabriz	0.55	0.24	Highly Competitive Advantage
	Mazandaran	0.46	0.20	Highly Competitive Advantage
	Mashhad	0.45	0.19	Highly Competitive Advantage
	Hamadan	0.44	0.19	Highly Competitive Advantage
	Shiraz	0.43	0.19	Highly Competitive Advantage
	Iran	0.25	0.11	Highly Competitive Advantage

Discipline	University	Scientific Strength	Competitive Research Strength	Type of Research Advantage
Pharmaceutical Economics and Management	Tehran	5.95	13.37	Exclusive Advantage
Pharmacology	Mashhad	15.84	1.43	Highly Competitive Advantage
	Tehran	6.11	0.70	Highly Competitive Advantage
	Shahid Beheshti	8.77	0.55	Highly Competitive Advantage
	Iran	5.21	0.33	Highly Competitive Advantage
	Isfahan	4.21	0.27	Moderate Competitive Advantage
	Tabriz	3.99	0.25	Moderate Competitive Advantage
	Shiraz	3.98	0.25	Moderate Competitive Advantage
	Jahad Daneshgahi	2.50	0.16	Moderate Competitive Advantage
	Babol	2.06	0.13	Moderate Competitive Advantage
	Kerman	1.93	0.12	Moderate Competitive Advantage
Pharmaceutical Biotechnology	Tehran	15.23	1.16	Highly Competitive Advantage
	Tabriz	13.11	0.86	Highly Competitive Advantage
	Mashhad	7.60	0.50	Highly Competitive Advantage
	Shiraz	4.63	0.30	Highly Competitive Advantage
	Isfahan	4.58	0.30	Highly Competitive Advantage
	Shahid Beheshti	3.80	0.25	Moderate Competitive Advantage
	Zanjan	2.46	0.16	Moderate Competitive Advantage
	Mazandaran	2.07	0.14	Moderate Competitive Advantage
	Kerman	1.96	0.13	Moderate Competitive Advantage

Appendix 2. Roadmap for Achieving Scientific Supremacy in Pharmaceutical Sciences

Domains for Achieving Scientific Supremacy	Strategies
Focused Planning	Forming a consensus on a differentiated mission
	Developing a differentiated strategic roadmap
	Developing a differentiated strategic plan
Ensuring Alignment	Designing and establishing an academic monitoring and governance system
	Providing and allocating mission-based financing with an emphasis on focal areas
Targeted Quantitative Development	Developing faculty members in the discipline with special attention to focal areas
	Developing infrastructure and equipment related to focal areas
	Developing disciplines and degrees related to focal areas
	Providing student scholarships related to focal areas
	Developing scientific institutions, research centers, service delivery centers, think tanks, incubators, science and technology parks
	Recruiting students relevant to the discipline
Quality Improvement	Process management
	Revising curricula related to the discipline
	Standardizing relevant processes
	Evaluation and auditing
	Obtaining accreditation
	Benchmarking
	Receiving quality certifications
	Organizational quality improvement (CQI, TQM)
	Improving standing in ranking systems
Capacity Building	Team building
	Targeted recruitment
	Empowerment
	Staff training
	Decentralization and delegation
	Postgraduate education for faculty members
Culture Building	Organizing festivals
	Awarding prizes

Domains for Achieving Scientific Supremacy	Strategies
Stewardship	Developing national curriculum standards for the discipline
	Developing national service standards related to the discipline
	Developing national strategies for the discipline
	Developing professional ethical codes for the discipline
	Facilitating relevant accreditations for the discipline
	Conducting national foresight studies for the discipline
	Planning the expansion of the discipline at the national level
	Planning the workforce for the discipline at the national level
	Playing a key role in professional associations
Internationalization	Educating international students
	Offering international degrees and certifications
	Implementing faculty exchange programs
	Implementing student exchange programs
	Training international personnel
	Implementing cross-border educational programs
	Implementing joint research projects
	Implementing language learning programs
	Obtaining international program accreditation
	Producing international curriculum content
	Offering and receiving international grants
	International networking with top researchers
	Creating opportunities for travel and mobility
	Degree equivalency and transfer
Networking	Establishing national and international virtual networks
	Launching national forums
Value Creation	Developing innovation
	Entrepreneurship
	Establishing knowledge-based companies
	Service/Product development
	Branding
	Market creation
	Revenue generation
Expansion of Action and Access	Pioneering: Conducting cutting-edge research
	Pioneering: Developing advanced technology
	Leadership: Publishing the most articles
	Leadership: Publishing the most books
	Leadership: Training and employing the most researchers
	Leadership: Collaborating with the most institutions
	Leadership: Highest number of registered innovations and inventions
	Impact: Hosting global conferences
	Impact: Networking with global researchers
	Impact: Launching global forums
	Quality: Establishing and upgrading global journals with the highest Impact Factor (IF)
	Quality: Authoring global reference books
	Quality: Training the best scientists
	Quality: Achieving top institutional positions in global rankings
	Quality: Providing the best services/products
	Application: Conducting applied studies
	Application: Conducting studies supporting innovations and inventions
	Application: Highest economic value-added from knowledge
	Authority: Hosting headquarters of global scientific institutions
	Authority: Conducting global accreditation
	Authority: Conducting global scientometrics
	Authority: Determining international research priorities

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Original Article

Effect of the Flipped Classroom on the Patient Education Knowledge and Skill of Nursing Students: A Quasi-Experimental Study

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Abstract

Background: Strengthening patient education skills in students will improve the quality of future nursing care. With the advancement of technology, the tendency to use blended methods such as flipped classrooms has increased. This study was conducted to determine the effect of flipped classrooms on the patient education knowledge and skills of nursing students.

Objectives: This study aimed to investigate the effect of flipped classrooms on the patient education knowledge and skills of nursing students.

Methods: The present study employed a quasi-experimental design with a control group and a posttest-only format, conducted in 2024 at Birjand University of Medical Sciences. The study population consisted of 52 nursing students selected using a census method. The intervention group was trained using the flipped classroom method. While in the control group, the routine method was used. After the intervention, the patient education skills of both groups were assessed while interacting with a standard patient, utilizing an observation checklist. Data were analyzed in SPSS 16 software using Mann-Whitney, Chi-square, and two-way analysis of variance ($p < 0.05$).

Results: The mean score of student patient education skill (based on 20) was 15.1 ± 1.71 in the control group and 16.6 ± 1.97 in the intervention group. Results showed a statistically significant difference in the mean scores of patient education skill between the two groups ($p=0.009$).

Conclusion: It seems that the use of the flipped classroom approach can lead to the improvement of patient education skills of undergraduate nursing students. Therefore, it is recommended to prioritize the use of this approach in the practical unit of the training process for students.

Keywords: Active Learning; Patient Education; Nursing; Student

Background

Patient education is an important dimension of nursing care and a key role of nurses in providing healthcare services (1). Nurses spend a lot of time with patients and have a closer relationship with them. Therefore, most of the necessary training should be provided by nurses to patients (2). But many nurses do not have enough knowledge and skills about the methods and principles of patient education (3). Meanwhile, patient education is offered to nursing students and future nurses at the undergraduate level (4). Increasing knowledge and skill fills the gap between science and practice. Therefore, it is important to find suitable training methods for training future nurses. Traditional educational methods are mostly passive and teacher-oriented and do not lead to active learning.

On the other hand, modern teaching methods are active and improve students' learning (5). One of the best sources for new and active training is the use of blended teaching approaches that can improve the quality of clinical training (6). The "flipped classroom" approach is rapidly gaining popularity in health care

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education disciplines to facilitate student participation in the learning process (7-9). Key elements of the flipped classroom include pre-class content, in-class activities, post-class evaluation, and student-generated questions (7, 10). To create a successful flipped classroom, students' intrinsic motivation is a key element in achieving desired learning outcomes. In the digital age, educators often combine computer technology with face-to-face classroom activities to increase student participation in pre-class learning tasks and post-class assignments (7, 8, 11). Another advantage of this teaching strategy is its proprietary nature, which allows each student to learn concepts at their own pace.

Students have the flexibility to play and pause lecture videos based on their preferences and can watch them multiple times if needed. In addition, this method allows students and nurses to learn the material at their desired time and place and turns it into a flexible educational strategy (12). Several studies have shown that students prefer the blended course structure and this type of learning can be effective in improving knowledge, decision-making skills, satisfying thinking abilities and reflections related to clinical practice (8, 13-17). However, Bingen et al. (2019) evaluated the impact of the flipped classroom on a nursing physiology course and found that many students relied heavily on direct physical and social interactions with their instructor. Furthermore, some students were not yet prepared to take responsibility for independent, self-directed learning outside the classroom. Therefore, more time should be provided to allow students to adapt to this instructional approach (18). The flipped classroom is particularly well-suited for teaching practical skills like patient education because it separates knowledge acquisition from skill application. Students first learn theoretical content at their own pace before class, which frees up class time for active, hands-on practice, discussion, and problem-solving. This active engagement enhances skill development, critical thinking, and confidence, which are essential for practical tasks. In contrast, theoretical subjects like physiology primarily require knowledge retention and comprehension, which can be effectively addressed through traditional lecture methods.

In addition, the effects of the flipped classroom on students' skills are uncertain (19). Abeysekera and Dawson (2015) argue that this teaching arrangement has not been sufficiently studied and that there is a lack of empirical evidence for its effectiveness (20). Considering the importance of patient education in the provision of medical and health services and the limited research in new teaching methods in nursing, this study was conducted to determine the effect of the flipped classroom method on the patient education skills of nursing students.

Objectives

This study aimed to investigate the effect of flipped classrooms on the patient education knowledge and skills of nursing students.

Methods

Design and Setting: The present study was a quasi-experimental design with a control group and a posttest-only format, conducted at the Birjand University of Medical Sciences, Eastern Iran, in 2024. In this study, the participants were students who were enrolling in the *patient education* course for the first time, meaning they had no prior formal knowledge or training in this subject. Since the course was entirely new to them, their baseline knowledge and skills in patient education were assumed to be minimal or nonexistent before the intervention. Therefore, administering a pre-test would not have provided meaningful data, as all students started from a similar (near-zero) baseline. For this reason, we focused on assessing their knowledge and skills after the training (post-test) to evaluate the effectiveness of the educational intervention. This approach is consistent with studies involving novice learners in a completely new subject area.

Participants and Sampling: The study population was 52 second-semester nursing students, recruited through a census method, who took the patient education process unit. After obtaining permission from the ethics committee of Birjand University of Medical Sciences (ethics code IR.BUMS.REC.1402.495), and obtaining informed consent the researcher started the study. The inclusion criteria included willingness to participate in the study, absence of clinical work experience, and absence of participation in similar courses in the last few months. The exclusion criteria included unwillingness to continue participating in the research and absence of more than one educational session. The sample population was non-randomly divided into an intervention group (n=23) and a control group (n=29).

Intervention: Before the intervention, a briefing session was held to familiarize the students with the flipped classroom method. The steps of implementing the flipped classroom were as follows:

Before the class: one week before the start of the classes, materials and videos related to the principles of

teaching patients with hypertension (including nutrition and activities of patients with blood pressure) and diabetes (definition of the client, nutrition, and care activities from foot and insulin injection) were uploaded in LMS for students to study.

The educational videos were prepared by students from previous semesters under the supervision of the relevant professor. After receiving approval from the nursing professors of the faculty, they were given to the students of the intervention group. The duration of the videos was between 5-10 minutes.

In class: During the face-to-face sessions, which consisted of two two-hour sessions, the teacher discussed and resolved any issues and answered students' questions in the intervention group. Film criticism, role-playing, and small group work were also used.

In the control group, routine teaching, including lectures, was done.

After one month, a practical test was held, in which the scenario was provided to the students and their patient education skills were assessed in dealing with a standard patient (SP) and using an observation checklist. The evaluator was the teacher of patient education. The teacher who assessed the skills (who was also the instructor) was not blinded to the students' group assignment. It should be noted that before the intervention, the SP was trained on how to play his role. Two scenarios were designed, one for SP and the other for students, which were approved by the nursing faculty members. Also, students' knowledge was evaluated by multiple-choice questions (MCQs).

Tools

Data collection was done using the following tools:

A) Personal Information Questionnaire: This questionnaire included age, gender, place of residence, grade point average (GPA), and interest in nursing, which the students completed.

B) The written test included 20 Four-Option Multiple-Choice Questions. If the question is answered correctly, the score will be one; if the answer is wrong, the score will be zero. The total knowledge score of the studied subjects was obtained by summing the scores of the questions, with the score ranging from 0 to 20. The reliability of the written test was confirmed using test-retest in a pilot study (n=20). After two weeks, they were given a written test, and the Pearson correlation coefficient (r=0.85) was calculated.

C) The patient education checklist included 13 items about patient education skills. This tool was designed based on a literature review and completed by the observer. If the item is performed correctly, the score is one; if the item is performed incorrectly, the score is zero. Therefore, the obtained score was in the range of 0 to 13. For ease of expression, the score was calculated based on a scale of 20. The reliability of the observation checklist was confirmed by the observer agreement method, with two observers simultaneously scoring 10 student clients using the checklist for student skills. Then the kappa coefficient was 0.54. To enhance agreement, all assessors received standardized training sessions before data collection to ensure consistent application of the evaluation criteria. Despite these efforts, the moderate agreement observed is considered acceptable given the study context.

Data Analysis: In the present study, SPSS version 16 software was used for data analysis. To check the normality of the main research variables, Smirnov's Kolmogorov-Smirnov test was used. Chi-square test and Fisher's exact test were used to compare the frequency distribution of demographic variables, including gender, marital status, and residential status, between the two study groups. Also, to compare the mean variables of age and Grade Point Average (GPA) between two groups, the Mann-Whitney U test and the T-test were used. The Patient education skill score was assessed for normality using Smirnov's Kolmogorov-Smirnov test, which showed non-normal distribution ($p < 0.05$). Therefore, the Mann-Whitney U test was used. Since there was a significant difference in the frequency distribution of age in the control and intervention groups, two-way analysis of variance was also used. The analysis of the main research variables was done using an independent t-test and a Mann-Whitney U test at a significance level of $P<0.05$.

Results

The age range of students participating in the study was between 18 and 35 years. The mean age in the control group was 20.5±3.31, and in the intervention group, it was 20.1±1.57 years. The result of the Mann-Whitney statistical test showed that the two groups have a significant statistical difference in terms of mean age and are not homogeneous. The GPA in the control group is 16.3±1.09, and in the intervention group, it is 15.1±1.61. The results of the independent t-test showed that the two groups were homogeneous, as the difference in GPA was not statistically significant (p=0.193) (Table 1).

The majority of research units in both control (56.5%) and intervention (58.6%) groups were female. The results of the Chi-square test showed that there is no statistically significant relationship between the

group and gender, and the two groups are homogeneous in terms of this variable (p=0.879). The majority of the research units in both control (95.7%) and intervention (82.8%) groups were native. The results of Fisher's exact test showed that there is no statistically significant relationship between the group and the place of residence, and the two groups are homogeneous in this respect (p=0.210). In the majority of research units in both the control (56.5%) and intervention (75.9%) groups, interest in nursing was high. The result of the Mann-Whitney statistical test showed that the two groups have no statistically significant difference in their interest in nursing and are homogeneous (p=0.125) (Table 1).

Table 1. Comparison of demographic characteristics in intervention and control groups

Variable	Group		P-value
	Control	Intervention	
Age, Mean (SD)	20.5(3.31)	20.1(1.57)	0.046*
GPA, Mean (SD)	16.3(1.09)	15.1(1.61)	0.193**
Gender, N(%)			0.879***
Male	10 (43.5)	12 (41.4)	
Female	13 (56.5)	17 (58.6)	
Residence, N(%)			0.210****
Native	22(95.7)	24(82.8)	
Non-native	1(4.3)	5(17.2)	
Interest in nursing, N(%)			0.125*
High	13(56.5)	22(75.9)	
Medium	9(39.1)	7(24.1)	
Low	1(4.3)	0(0.0)	

*Mann-Whitney, **T-test, *** chi-square, **** Fisher's Exact

The mean score of student patient education skill (score out of 20) was 15.1±1.71 in the control group and 16.6±1.97 in the intervention group. The result of the Mann-Whitney test showed that there is a statistically significant difference between the two groups in terms of the mean score of patient education skill. The mean score of the students' patient education knowledge (score out of 20) was 10.6±2.61 in the control group and 13.0±3.05 in the intervention group. The result of the independent t-test showed that there is a statistically significant difference between the two groups regarding the mean knowledge of patient education. The effect size for knowledge and skill scores of the students under study, based on Cohen's d formula, is greater than 0.80 (Table 2).

Table 2. Comparison of the mean knowledge and skill scores of the students under study in the two control and intervention groups

Variable	Group		P-value	Effect size
	Control (mean (SD))	Intervention (mean (SD))		
Knowledge of patient education (score out of 20)	10.6(2.61)	13.0(3.05)	0.004**	0.85
Patient education skill (score out of 20)	15.1(1.71)	16.6(1.97)	0.009*	0.82

*Mann-Whitney, **T-test

Since there was a significant difference in the frequency distribution of age in the control and intervention groups, a two-way analysis of variance test was used, and the mean score of patient education skill after the intervention was compared according to group and age, and the results are presented Table 3.

As the results of the two-way analysis of variance in Table 3 show, the mean score of patient education skill after the intervention in the students of the two control and intervention groups was significantly different (p=0.017). However, no significant difference was observed in the mean score of patient education skill after the intervention based on age (p=0.258), and no interaction between group and age was found (p=0.917) (Table 3).

Table 3. The comparison of the mean score of patient education skill after the intervention in the students of the two control and intervention groups according to age

Source of changes	Sum of squares	df	Mean square	F	p
Group	23.82	1	23.82	6.12	0.017
Age	5.09	1	5.09	1.31	0.258
Group and Age	0.039	1	0.039	0.01	0.917

Discussion

The current study investigated the effect of the flipped classroom method on the patient education skills of nursing students. The research findings revealed that the intervention group achieved a significantly higher mean score in patient education skills compared to the control group. Although the results are promising, the non-randomized design means the observed differences, while statistically significant, cannot be definitively attributed to the intervention. Confounding factors may be involved. These results are consistent with various studies involving different statistical populations and educational content. The findings of the present study, with the studies of Kugler, et al. (2019) in the field of drug therapy (19), Kang, et al. (2021) in the field of general health care of nursing students (21), Park, et al. (2018) is consistent in the field of adult health nursing education (22). Fan et al. (2020) conducted a semi-experimental 18-week flipped classroom in an adult health nursing course on 485 nursing students. Their results have shown that the flipped classroom teaching approach positively affects students' clinical skills, communication, and responsibility, and helps them learn better in the adult nursing course. They also acknowledged that the flipped classroom with blended methods is a suitable and effective learning strategy for the nursing expert so that she can properly face nursing challenges (8)

The results of the Soltaninejad study (2024) showed that the mean score of physical examination skills was higher in the flipped classroom group than in the control group (23). In the study of Chikeme et al. (2024), self-directed learning readiness and learning achievements of the flipped classroom model approach were investigated in the research method class. Their results indicated a positive effect of the flipped classroom educational model on the preparation of nursing students for self-directed learning and learning outcomes in the research period (24). In addition, Dong et al. (2021) found that the flipped classroom is effective in improving students' academic performance and promoting the development of higher-level thinking abilities (25). The results of the above studies are consistent with the present study.

However, in another study, Bingen et al. studied the effect of the flipped classroom on the physiology course of nursing students. Their results showed that many nursing students are dependent on physical and social interaction with the teacher and may not be ready to accept new educational methods. Perhaps one reason for the lack of effect of the flipped classroom in this study is the nature of the physiology course (18). In the study by Cotta et al., students who preferred the traditional classroom reported that watching the video took more time, resulting in an intervention duration of more than one hour (26). But in the present study, the duration of the films was less than 10 minutes. In the present study, a blended teaching method was used. Before starting the class, the students watched educational videos related to teaching the patient and then critiqued them in class. The use of educational videos is a relatively new method, which is claimed to improve education from low levels of knowledge learning to higher levels of deep learning (27). In this regard, Rourke et al. conducted research comparing the effectiveness of educational programs using educational videos versus traditional methods on learning midwifery examination skills in nursing students. Their results have shown that students who were exposed to the video-assisted educational program had more skills (28). However, in the study by Roman Sanchez et al., male students were not as motivated to watch the movie as female students. This is because female students are more likely to seek supplementary resources as teaching aids, such as video-based learning, than male students (29).

It is important to choose a suitable teaching method to improve learners' learning and performance. In nursing education, having theoretical knowledge alone is not enough. Experts have suggested training in environments closer to reality to acquire and improve skills. The lecture method is suitable for learning at the cognitive level and for learning at higher levels than the cognitive field. Additionally, new educational methods, such as role-playing, should be used to enhance attitude and performance (30, 31). Considering that role playing creates a safe and stress-free

environment for gaining experience in a clinical environment, this is a suitable method for improving performance (32). In the present study, after reviewing the films, the students engaged in classroom activities related to the selected topic. Delnawaz et al. (2018) acknowledged that the role-playing method was effective on students' knowledge and performance in triage education (33). The results of this study are also in line with the present study. In Sheng-Miauh Huang's study (2023), it was shown that role playing improves nursing students' caring behavior (34). In the study by Jasmi et al. (2021), the effectiveness of the role-playing method on speech in moral performance is also mentioned (35). This study has limitations that make it difficult to generalize the results.

This study has some limitations that affect the generalizability of the results, notably that it was conducted solely on nursing students. Given the limited research in this area, we recommend conducting similar studies in other disciplines and curricula using larger and more diverse samples to enhance the applicability of the findings to a wider population. In addition to the influencing factors in the present study, other factors affecting students' education should also be considered. The use of a census sampling method combined with non-random allocation into groups represents a significant limitation, as it introduces a high risk of selection bias. To mitigate this issue in future research, probabilistic sampling and random assignment methods are recommended to enhance representativeness and reduce bias. The teacher who assessed the skills was also the instructor and was not blinded to the students' group assignments. This lack of blinding poses a potential risk of performance and detection bias. To minimize this limitation in future studies, it is recommended to use blinded assessors who are independent of the intervention delivery to ensure objective evaluation and reduce bias. A Kappa value of 0.54 indicates moderate interrater agreement, which is concerning as it suggests only a fair level of consistency between observers. Despite standardized training efforts, this moderate reliability limits confidence in the accuracy of skill measurements. This is raised as a limitation of the study, and it is acknowledged that values below 0.60 may weaken the robustness of the observation checklist results and indicate cautious interpretation.

Conclusion

Despite limitations such as non-random allocation and the lack of blinded assessment, our findings suggest that the flipped classroom approach may improve patient education skills of undergraduate nursing students. Therefore, further research with more robust designs (randomized controlled design and blinded outcome assessments) is recommended, but this approach shows promise for integration into practical nursing education.

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Conflict of interests: There is no conflict of interest.

Ethical approval: Following the principles of research ethics, this study has been approved by the ethics committee (code: IR.BUMS.REC.1402.495). The ethical principles have been fully observed in this study. Participants were allowed to withdraw from the study at any time. Also, all participants were aware of the research process. Their information was kept confidential.

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Original Article

MBTI Personality Types and Medical Specialty Preferences among Medical Students

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Abstract

Background: Selecting a residency specialty is a critical decision for physicians, and it is essential to understand whether and how personality types influence this choice. The purpose of this study was to assess the relationship between medical students' personality types and their tendency towards specialties through the standard Myers-Briggs Type Indicator (MBTI).

Objectives: This study investigates the relationship between medical students' personality types and their specialty preferences, highlighting how self-awareness and personality–career alignment can enhance decision-making and future professional success.

Methods: This cross-sectional study was undertaken in 2018 at Shahid Sadoughi University of Medical Sciences, involving all medical students in the internship phase. Data were collected via a self-administered MBTI-based questionnaire and further analyzed using SPSS software version 21.

Results: Among 185 participants (53% female, 47% male), 48.1% were extroverted and 51.9% introverted, with ISTJ being the most common type (20%). Preference of specialties based on personal interest included general surgery, cardiology, and internal medicine, while job conditions favored radiology, dermatology, and ophthalmology. Specialty preferences varied significantly by gender (p=0.001), as well as by personality type when career factors were considered (p=0.001). In contrast, when choices were solely based on personal interest, preferences remained significantly associated with gender (p=0.001) but not with personality type (p=0.698), with no differences found between scholarship and self-funded students.

Conclusion: The findings indicate that personality type heavily influences specialty choice. Personal interests lead students towards certain specialties, while job conditions such as work-life balance affect other preferences.

Keywords: Specialty Selection; Personality Type; MBTI; Medical Residency; Iran

Background

The Myers-Briggs Type Indicator (MBTI) is a widely utilized psychometric tool designed to measure individual preferences in understanding the world and decision-making, based on Carl Jung's theories (1). Developed during World War II, the MBTI classifies psychological differences into four dimensions, resulting in 16 personality types. It is extensively applied in psychology and business for hiring, team building, and career selection, helping individuals perform better in various environments (2).

Understanding psychological types is crucial for recognizing conscious tendencies. and these tendencies may be strongly linked to career choices. For instance, extroverted intuitive types may succeed in management or business but perform poorly in artistic fields, while introverted thinking types may thrive in mathematics or library sciences but find it challenging to adapt to careers involving high levels of social interaction (1).

In medical education, choosing a specialty is one of the most critical decisions faced by students, as it directly shapes their professional and personal lives. Numerous studies have examined the relationship

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between personality types and specialty preferences among medical students. Jafrani et al. (2017) evaluated the relationship between personality type and the choice of specialty among 400 medical students from public and private universities in Karachi. They found that the most common personality type among students was ESFP and that personality type would significantly influence students' specialty preferences (3). In contrast, Yang et al. (2016) in a study of 835 psychiatry residents in U.S. universities found no correlation between the students' personality types and their tendency towards psychiatry (4). Similarly, Poursaberi (2016) explored the relationship between personality type and academic achievement among students at Tabriz University of Medical Sciences, indicating a significant inverse relationship between extroversion and academic achievement (5). Stilwell et al. (2000) studying 3,987 medical students across 12 schools, also reported that personality dimensions affect specialty choice: male students with Thinking (T) and Judging (J) profiles preferred surgical specialties, while female students with Introverted (I) and Feeling (F) profiles showed greater tendency toward family medicine (6).

In Iran, several studies have inspected factors influencing specialty choices, but most have focused on non-psychological determinants. Alizadeh et al. (2013) reported that economic factors, especially the job market, alongside individual factors such as personal interest were most influential in specialty choice (7). Shakurnia et al. (2013) found a significant correlation between gender and the capacity of specialty programs (8), whereas their later study (2016) underscored the most important priorities included better work performance, enhanced knowledge and personal interest, with ease, lack of stress, and comfort being least influential (9). Khoroosh et al. (2012) highlighted that 45.4% of residents chose specialties solely due to personal factors, 14.9% owing to external factors, and 39.74% based on both (10). Zarghami et al. (2003) further noted that the most influential factors were the desire to help people and the scientific content of the specialty (11). Nevertheless, despite these findings, very few Iranian studies have examined the role of personality type in the choice of specialty and none have been reported in Yazd.

Given this gap, the present study was designed to explore the relationship between personality types, as measured by the MBTI, and specialty preferences among students at Shahid Sadoughi University of Medical Sciences in Yazd. This issue is particularly important since selecting a specialty not only shapes the physician's career path but also influences the distribution of the healthcare workforce. Beyond individual skills, aligning psychological traits with the chosen field is likely to contribute to greater professional satisfaction and effectiveness.

Based on previous international findings (6), we hypothesized that personality type would significantly influence specialty choice, particularly when career-related factors were excluded.

Objectives

This study investigates the relationship between medical students' personality types and their specialty preferences, highlighting how self-awareness and personality–career alignment can enhance decision-making and future professional success.

Methods

This cross-sectional study was conducted in 2018 using a census sampling method involving all eligible medical students in their internship phase at Shahid Sadoughi University of Medical Sciences (N=185). Data were collected in stages using self-administered questionnaires. Of the 185 initial participants, 176 students completed all parts regarding career/job-related specialty preferences (N=176), and 175 students completed the personal interest-based preference section (N=175). Nine students withdrew after the first section due to not intending to pursue a residency program, and one additional student did not complete the final section. Consequently, the analytic sample size varies slightly across tables, and percentages are calculated based on the valid completed responses for each specific analysis. Ethical approval was obtained from the National Committee for Ethics in Biomedical Research, under the code IR.SSU.MEDICINE.REC.1397.16.

Data collection: The study included all medical students in their internship (both scholarship and self-funded) in 2018, totaling 200 individuals at Yazd University of Medical Sciences, with no sampling conducted. The exclusion criteria were lack of consent from students to participate in the study or incomplete questionnaires. After explaining the research objectives, confidentiality, and the exclusive use of findings for research purposes, one of the authors distributed the paper questionnaires among the students. Students were then asked to carefully read and answer all questions in the questionnaire as well as to ask the researcher any questions if they faced any ambiguities. Incomplete questionnaires were excluded from the study.

MBTI Questionnaire: To ascertain personality types, the Myers-Briggs Type Indicator (Form M) was employed, which is an internationally recognized questionnaire with confirmed validity and reliability

(12). The MBTI was selected for its widespread use and practicality in educational and career-related research. Despite some limitations, it provides a structured and accessible approach to exploring personality preferences, making it suitable for examining potential links with medical specialty choice among students. The validity and reliability of the Persian translation of this questionnaire, which is also utilized in the current study, have been examined by Poursabri (5). Similar to several other studies, Poursaberi referred to Yaghoubi Beglar's (2007) master's thesis for the validation and reliability of the questionnaire. He reported construct validity as confirmed and reliability coefficients for the subscales ranging from 0.45 to 0.87 in the long form and 0.66 to 0.89 in the short form (13). This questionnaire tests four bipolar personality types (Extraversion - Introversion, Sensing - Intuition, Thinking - Feeling, and Judging - Perceiving) on a continuous scale, ultimately presenting 16 personality types (Table 1). The questionnaire consists of 93 questions split into four sections. In the first and third sections, the individual selects the option that best represents their dominant state, while in the second and fourth sections, they would select the option they prefer in terms of meaning and concept, without considering their current state. Scoring was carried out according to the standard MBTI guidelines. Responses for each item were assigned to one of the two opposing preferences E or I, S or N, etc. The number of responses indicating a preference for Extraversion, Sensing, Thinking, and Judging were then summed up separately to determine the dominant preference for each dichotomy.

Table 1. Abbreviations of Personality Types

Extroverted -Sensing Types	Introverted -Sensing Types	Extraverted -Intuitive Types	Introverted -Intuitive Types
ESTJ	ISTJ	ENTJ	INTJ
ESTP	ISTP	ENTP	INTP
ESFP	ISFP	ENFP	INFP
ESFJ	ISFJ	ENFJ	INFJ

In these 16 personality types E stands for Extraversion, S represents Sensing, T reflects Thinking, J denotes Judgment, I stands for Introversion, N shows iNtuition, F represents Feeling, and P stands for Perception.

Data Analysis: The collected data were entered into SPSS software version 21 and analyzed using appropriate statistical methods, including descriptive statistics (frequency indices and relative percentage) as well as a suitable statistical test (Chi-square test). A significance level of 0.05 was considered.

Results

A total of 185 students participated, with 53% being female and 79.5% being scholarship students. Among them, 147 (79.5%) were scholarship students and 38 (20.5%) were self-funded. The majority of the participants were from the entry years 2013 (32.6%), 2012 (29.3%) and 2011 (28.7%).

Considering personality dimensions, 48.1% were extroverted and 51.9% introverted; 35.7% intuitive and 64.3% sensing; 53% thinking and 47% feeling; and 68.1% judging and 31.9% perceiving. The most frequent personality types were as follows: ISTJ (20%), ESTJ (12.4%), and ESFJ (8.1%).

Of the 185 students who initially entered the study, 176 completed all three series of questionnaires. Nine students withdrew after completing only the first series (personality type) as they stated that they did not intend to pursue a specialty program. One student also withdrew following the second series without responding to the third. Hence, the number of participants included in the analyses has not been identical across all sections of the results. When asked about future career paths, 124 students (67%) chose the clinical path, 15 (8.1%) the educational path, and 21 (11.4%) the managerial path, with 25 (13.5%) being indecisive.

When career factors such as income and status were taken into account, the most frequently chosen specialties were radiology (17.8%), dermatology (14.6% and ophthalmology (12.4%). Male students predominantly chose surgery, orthopedics, and ophthalmology, while female students favored radiology and dermatology. A significant association was found between specialty choice and personality type (p=0.001) (Table 2).

When choices were based solely on personal interest, the most common specialties included general surgery (15.7%), cardiology (10.8%), and internal medicine (9.7%). Male students mostly selected general surgery, cardiology, and orthopedics, while female students opted for internal medicine, cardiology, and gynecology. No significant correlation was found between personality type and specialty preference based on personal interest ($p = 0.698$) (Table 3).

Nevertheless, no significant gender differences were observed in the distribution of personality types or dimensions ($p > 0.05$). Ultimately, no significant differences emerged in specialty preferences between scholarship and self-funded students ($p > 0.05$). The distribution of career path choices by personality types has been presented in Table 4.

Table 2. Frequency distribution of specialty choices considering job-related factors by personality type

Personality Type n ()/Chosen Specialty	ENFJ	ENFP	ENTJ	ENTP	ESFJ	ESFP	ESTJ	ESTP	INFJ	INFP	INTJ	INTP	ISFJ	ISFP	ISTJ	ISTP	Total
	9 (5.11)	11 (6.25)	8 (4.54)	3 (1.70)	15 (8.52)	12 (6.81)	22 (12.5)	7 (3.97)	9 (5.11)	8 (4.54)	11 (6.25)	3 (1.70)	11 (6.25)	7 (3.97)	34 (19.31)	6 (3.40)	176
Radiology	2 (6.1)	2 (6.1)	1 (3.0)	-	1 (3.0)	2 (6.1)	3 (9.1)	1 (3.0)	2 (6.1)	2 (6.1)	3 (9.1)	-	5 (15.15)	3 (9.1)	5 (15.2)	1 (3.0)	33 (18.75)
Dermatology	-	3 (11.1)	1 (3.7)	-	5 (18.5)	5 (18.5)	2 (7.4)	-	1 (3.7)	-	2 (7.4)	-	1 (3.7)	1 (3.7)	6 (22.2)	-	27 (15.34)
Ophthalmology	1 (4.3)	-	2 (8.7)	-	3 (13.0)	1 (4.3)	4 (17.4)	3 (13.0)	1 (4.3)	-	1 (4.3)	-	2 (8.7)	-	3 (13.0)	2 (8.7)	23 (13.06)
General Surgery	-	2 (14.3)	-	-	-	1 (7.1)	3 (21.4)	1 (7.1)	-	2 (14.3)	-	1 (7.1)	-	-	3 (21.4)	1 (7.1)	14 (7.95)
Cardiology	1 (7.7)	1 (7.7)	-	1 (7.7)	1 (7.7)	1 (7.7)	2 (15.4)	-	2 (15.4)	-	3 (23.1)	-	-	-	1 (7.7)	-	13 (7.38)
Orthopedics	1 (8.3)	-	-	-	1 (8.3)	-	-	-	1 (8.3)	1 (8.3)	-	-	-	1 (8.3)	5 (41.7)	2 (16.7)	12 (6.81)
Physical Medicine	-	-	-	-	-	1 (9.1)	3 (27.3)	1 (9.1)	1 (9.1)	-	-	1 (9.1)	2 (18.2)	1 (9.1)	1 (9.1)	-	11 (6.25)
Obstetrics & Gynecology	-	-	1 (16.7)	-	2 (33.3)	-	3 (50.0)	-	-	-	-	-	-	-	-	-	6 (3.40)
Neurology	-	-	1 (16.7)	-	1 (16.7)	-	-	-	1 (16.7)	-	-	-	1 (16.7)	1 (16.7)	1 (16.7)	-	6 (3.40)
Internal Medicine	-	1 (20.0)	-	-	-	-	-	-	-	1 (20.0)	-	-	-	-	3 (60.0)	-	5 (2.84)
Psychiatry	1 (20.0)	1 (20.0)	-	-	1 (20.0)	-	-	-	-	1 (20.0)	1 (20.0)	-	-	-	-	-	5 (2.84)
Urology	-	-	-	2 (40.0)	-	-	-	1 (20.0)	-	-	-	-	-	-	2 (40.0)	-	5 (2.84)
Pathology	-	-	1 (33.3)	-	-	1 (33.3)	-	-	-	-	1 (33.3)	-	-	-	-	-	3 (1.70)
Pediatrics	3 (100)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3 (1.70)
Neurosurgery	-	-	-	-	-	-	-	-	-	-	-	1 (50.0)	-	-	1 (50.0)	-	2 (1.13)
Traditional Medicine	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2 (100)	-	2 (1.13)
Otolaryngology (ENT)	-	-	-	-	-	-	1 (50.0)	-	-	-	-	-	-	-	1 (50.0)	-	2 (1.13)
Occupational Medicine	-	-	1 (100)	-	-	-	-	-	-	-	-	-	-	-	-	-	1 (0.56)
Nuclear Medicine	-	1 (100)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1 (0.56)
Emergency Medicine	-	-	-	-	-	-	1 (100)	-	-	-	-	-	-	-	-	-	1 (0.56)
Genetics	-	-	-	-	-	-	-	-	-	1 (100)	-	-	-	-	-	-	1 (0.56)

In these 16 personality types E stands for Extraversion, S reflects Sensing, T represents Thinking, J denotes Judgment, I shows Introversion, N indicates intuition, F stands for Feeling, and P represents Perception.

Table 3. Frequency distribution of specialty choices solely based on personal interest by personality type

Personality Type n ()/Chosen Specialty	ENFJ	ENFP	ENTJ	ENTP	ESFJ	ESFP	ESTJ	ESTP	INFJ	INFP	INTJ	INTP	ISFJ	ISFP	ISTJ	ISTP	Total
	9 (5.14)	11 (6.28)	8 (4.57)	2 (1.14)	15 (8.57)	12 (6.85)	22 (12.57)	7 (4)	9 (5.14)	8 (4.57)	11 (6.28)	3 (1.71)	11 (6.28)	7 (4)	34 (19.42)	6 (3.42)	175
General Surgery	-	2 (6.9)	1 (3.4)	1 (3.4)	2 (6.9)	5 (17.2)	3 (10.3)	2 (6.9)	2 (6.9)	1 (3.4)	1 (3.4)	1 (3.4)	1 (3.4)	2 (6.9)	3 (10.3)	2 (6.9)	29 (16.57)
Cardiology	2 (10.0)	2 (10.0)	1 (5.0)	-	3 (15.0)	1 (5.0)	3 (15.0)	-	2 (10.0)	1 (5.0)	3 (15.0)	-	-	-	1 (5.0)	1 (5.0)	20 (11.42)
Internal Medicine	2 (11.1)	2 (11.1)	1 (5.6)	-	1 (5.6)	1 (5.6)	2 (11.1)	1 (5.6)	1 (5.6)	2 (11.1)	1 (5.6)	-	-	-	4 (22.2)	-	18 (10.28)
Obstetrics and Gynecology	2 (20.0)	-	1 (10.0)	-	1 (10.0)	-	2 (20.0)	-	-	-	-	-	1 (10.0)	1 (10.0)	2 (20.0)	-	10 (5.71)
Dermatology	-	2 (20.0)	-	-	2 (20.0)	1 (10.0)	4 (40.0)	-	-	-	-	-	1 (10.0)	-	-	-	10 (5.71)
Pediatrics	1 (10.0)	1 (10.0)	1 (10.0)	-	1 (10.0)	-	1 (10.0)	-	-	-	-	-	3 (30.0)	-	2 (20.0)	-	10 (5.71)
Ophthalmology	-	-	1 (11.1)	-	1 (11.1)	-	1 (11.1)	1 (11.1)	-	-	2 (22.2)	-	2 (22.2)	-	-	1 (11.1)	9 (5.14)
Neurology	-	-	-	-	-	1 (11.1)	1 (11.1)	-	1 (11.1)	-	-	-	1 (11.1)	1 (11.1)	4 (44.4)	-	9 (5.14)
Physical Medicine	-	-	-	-	-	-	2 (28.6)	1 (14.3)	-	-	-	-	1 (14.3)	1 (14.3)	2 (28.6)	-	7 (4)
Radiology	-	1 (14.3)	-	-	1 (14.3)	2 (28.6)	-	-	-	-	-	-	1 (14.3)	-	2 (28.6)	-	7 (4)
Pathology	-	-	2 (28.6)	-	-	-	-	1 (14.3)	1 (14.3)	1 (14.3)	2 (28.6)	-	-	-	-	-	7 (4)
Neurosurgery	-	-	-	-	1 (16.7)	-	-	-	-	1 (16.7)	-	1 (16.7)	-	-	2 (33.3)	1 (16.7)	6 (3.42)
Orthopedics	-	-	-	-	-	-	-	-	-	-	1 (16.7)	-	-	1 (16.7)	3 (50.0)	1 (16.7)	6 (3.42)
Emergency Medicine	-	1 (20.0)	-	-	1 (20.0)	-	2 (40.0)	-	-	-	-	-	-	-	1 (20.0)	-	5 (2.85)
Infectious Diseases	1 (20.0)	-	-	-	-	-	-	-	-	-	-	1 (20.0)	-	1 (20.0)	2 (40.0)	-	5 (2.85)
Psychiatry	1 (25.0)	-	-	-	-	-	-	-	1 (25.0)	1 (25.0)	1 (25.0)	-	-	-	-	-	4 (2.28)
Occupational Medicine	-	-	-	-	1 (33.3)	-	-	-	-	-	-	-	-	-	2 (66.7)	-	3 (1.71)
Otolaryngology (ENT)	-	-	-	-	-	1 (33.3)	1 (33.3)	-	-	-	-	-	-	-	1 (33.3)	-	3 (1.71)
Urology	-	-	-	1 (33.3)	-	-	-	1 (33.3)	-	-	-	-	-	-	1 (33.3)	-	3 (1.71)
Social Medicine	-	-	-	-	-	-	-	-	1 (50.0)	-	-	-	-	-	1 (50.0)	-	2 (1.14)
Traditional Medicine	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1 (100)	-	1 (0.57)
Genetics	-	-	-	-	-	-	-	-	-	1 (100)	-	-	-	-	-	-	1 (0.57)

In these 16 personality types E stands for Extraversion, S reflects Sensing, T represents Thinking, J denotes Judgment, I indicate Introversion, N shows intuition, F stands for Feeling, and P represents Perception.

Table 4. Frequency distribution of gender and career path selection by personality type

Personality type	Female 98 (52.97%)	Male 87 (47.03%)	Clinical 124 (67.03%)	Educational 15 (8.10%)	Managerial 21 (11.35%)	Undecided 25 (13.51%)	Total 185
ISTJ	16 (43.2%)	21 (56.8%)	22 (59.5%)	4 (10.8%)	4 (10.8%)	7 (18.9%)	37 (20%)
ESTJ	12 (52.2%)	11 (47.8%)	15 (65.2%)	2 (8.7%)	3 (13.0%)	3 (13.0%)	23 (12.43%)
ESFJ	10 (66.7%)	5 (33.3%)	14 (93.3%)	-	-	1 (6.7%)	15 (8.10%)
ESFP	8 (66.7%)	4 (33.3%)	9 (75.0%)	-	2 (16.7%)	1 (8.3%)	12 (6.48%)
ISFJ	8 (66.7%)	4 (33.3%)	10 (83.3%)	-	1(8.3%)	1 (8.3%)	12 (6.48%)
ENFP	5 (45.5%)	6 (54.5%)	10 (90.9%)	-	1 (9.1%)	-	11 (5.94%)
INTJ	7 (63.6%)	4 (36.4%)	8 (72.7%)	1 (9.1%)	1 (9.1%)	1 (9.1%)	11 (5.94%)
ENFJ	7 (70.0%)	3 (30.0%)	8 (80.0%)	1 (10.0%)	1 (10.0%)	-	10 (5.40%)
INFP	3 (30.0%)	7 (70.0%)	2 (20.0%)	2 (20.0%)	2 (20.0%)	4 (40.0%)	10 (5.40%)
INFJ	2 (22.2%)	7 (77.8%)	5 (55.6%)	1 (11.1%)	3 (33.3%)	-	9 (4.86%)
ENTJ	7 (87.5%)	1 (12.5%)	5 (62.5%)	1 (12.5%)	1 (12.5%)	1 (12.5%)	8 (4.32%)
ISFP	4 (50.0%)	4 (50.0%)	4 (50.0%)	2 (25.0%)	-	2 (25.0%)	8 (4.32%)
ESTP	4 (57.1%)	3 (42.9%)	4 (57.1%)	1 (14.3%)	-	2 (28.6%)	7 (3.78%)
ISTP	2 (33.3%)	4 (66.7%)	5 (83.3%)	-	-	1 (16.7%)	6 (3.24%)
ENTP	2 (66.7%)	1 (33.3%)	1 (33.3%)	-	1 (33.3%)	1 (33.3%)	3 (1.62%)
INTP	-	3 (100%)	2 (66.7%)	-	1 (33.3%)	-	3 (1.62%)

In these 16 personality types E stands for Extraversion, S represents Sensing, T stands for Thinking, J shows Judgment, I denote Introversion, N indicates intuition, F reflects Feeling, and P stands for Perception.

Discussion

This study aimed to explore the relationship between personality types and the tendency towards specialized fields among medical students at Shahid Sadoughi University of Medical Sciences in 2018. In conclusion, this study of 185 students indicated that general surgery, cardiology, and internal medicine were the most preferred specialties based on personal interest, while radiology, dermatology, and ophthalmology were favored when considering job-related factors such as income and status.

The most common personality types among the students were ISTJ, ESTJ, and ESFJ. Significant correlations were found between gender and specialty preferences, both for personal interest and job-related factors. Further, a significant correlation existed between personality types and specialty preferences based on job-related factors, but not for personal interest. No significant differences were found between self-funded and scholarship students in their specialty preferences.

Comparing these findings with previous studies, Shakurnia et al. (2013) reported a significant correlation between male and female residents' specialty preferences at Jundishapur University of Medical Sciences (8). This is in accordance with the gender-related findings of the present study. Jafrani et al. (2017), in a study on MBTI and specialty choice among students in Karachi, concluded that personality type significantly affects students' specialty preferences (3). While this study also found a significant correlation between career paths and the personality dimensions of students, the present study did not. This difference may reflect variations in job conditions across clinical, educational, and managerial paths in Iran, with clinical paths promising better income and job status.

Stilwell et al. (2000) examined 3987 medical students across 12 medical schools. They found correlations between personality dimensions and specialty choice (6), which is in line with the present findings regarding job-related specialty preferences. Yang et al. (2016) reported no correlation between personality type and preference for psychiatry among US residents (4), which is in accordance with our findings regarding personal-interest-based choices but not with job-factor-based choices. This consistency could be explained by the significant role of personal interest in selecting a specialty among U.S. residents. Note that in this study the most preferred specialties considering job-related factors (income, status, leisure, ease) were radiology, dermatology, and ophthalmology, whereas the most preferred specialties based solely on personal interest were general surgery, cardiology, and internal medicine. This discrepancy highlights the importance of job-related factors in specialty selection among students and reveals that many students choose their specialty contrary to their personal interests (14).

Freeman developed a guideline for selecting medical specialties based on personality types (15). A comparison of this study's findings with Freeman's guideline indicates that the specialty preferences of

individuals with the following four personality types were consistent with the guideline:

- 41.7% of individuals with the ESFP personality type chose General Surgery.
- 28.6% of individuals with the ESTP personality type chose General Surgery.
- 22.2% of individuals with the INFJ personality type chose Cardiology, and another 22.2% chose General Surgery.
- 18.2% of individuals with the ISFJ personality type chose Ophthalmology.

The limited alignment between students' specialty preferences and Freeman's MBTI-based guideline warrants further contextual interpretation. This discrepancy may be attributable to cultural norms, structural constraints in specialty training availability, as well as strong economic or social incentives that overshadow personality fit. Further, lack of systematic career counseling and limited exposure to personality-guided decision-making frameworks may contribute to this misalignment in the Iranian medical education context.

The marked divergence between specialty choices based on personal interest and those influenced by career-related factors reflects a paradox. While students may initially prefer specialties aligned with their interests and potentially their personality traits, practical considerations seem to override these preferences. This suggests that systematic pressures and future job conditions significantly shape specialty decisions, sometimes contrary to students' intrinsic motivations.

This study demonstrated that medical students' specialty preferences are influenced by a complex interplay of personality types, gender, and career-related factors. The findings highlight the significance of implementing structured career counseling programs and incorporating personality assessments (such as the MBTI) into medical education. This is particularly important along the early clinical years, in order to enable students to make more informed specialty choices based on a clearer understanding of their abilities, interests, and the realities of the job market. Further, the development of personalized decision-support tools tailored to the cultural context and healthcare system of Iran could facilitate more deliberate specialty selection. Such interventions may ultimately contribute to greater job satisfaction and enhanced workforce productivity in the long run.

Limitations: One limitation of this study was the use of the Myers-Briggs Type Indicator (MBTI), which despite its popularity in educational and career guidance contexts, has faced criticism regarding its psychometric robustness. Another limitation of the study was related to the validity and reliability of the Persian questionnaire, which had been established in previous studies; some subscales revealed a low reliability coefficient (0.45).

Although this study employed a census approach and included all medical students at the university, the single-center design may restrict the generalizability of the findings. Nevertheless, the alignment of this study's findings with those of other studies may indicate the validity of the obtained results.

Conclusion

This study examined the relationship between personality types and specialty preferences among medical students at Shahid Sadoughi University of Medical Sciences in 2018. According to the findings, general surgery, cardiology, and internal medicine were the most preferred specialties based on personal interest, while radiology, dermatology, and ophthalmology were favored for job-related factors such as income and status. The most common personality types among the students were ISTJ, ESTJ, and ESFJ.

Significant correlations were observed between gender and specialty preferences, both for personal interest and job-related factors. Further, a significant correlation existed between personality types and specialty preferences based on job-related factors, but not for personal interest. No significant differences were noted between self-funded and scholarship students in their specialty preferences.

Comparison of these results with previous studies highlight the complex interplay between personality, gender, and career-related considerations in shaping specialty choices. The study emphasizes the importance of students understanding their interests, abilities, and future job conditions to make informed decisions. Thus, students may make use of available tools to better understand their personality and make decisions accordingly. Medical students can also benefit from systematic counseling programs that help them integrate self-awareness of their personality and interests with practical considerations about job market. Such support can promote informed decision-making, improve professional satisfaction, and ultimately boost the quality of healthcare workforce.

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Original Article

Identifying and Explaining the Motivational Keys for Physicians' Teaching: A Synthesis Study

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Abstract

Background: Understanding factors that shape physicians' motivation to teach is essential for optimizing educational outcomes in medical education.

Objectives: This research aimed to synthesize qualitative evidence to uncover how individual, interpersonal, cultural, and structural elements influence teaching engagement among physicians.

Methods: A qualitative evidence synthesis of 26 peer-reviewed articles was performed using a three-phase thematic synthesis approach (data extraction and coding, thematic grouping, and abstraction). Studies were identified via a systematic search of PubMed, Scopus, Web of Science, SID, Magiran, and Google Scholar for publications in English or Persian from 2000 onwards. Articles focusing on clinical physicians' teaching motivation and available in full text were included, whereas non-research formats and studies on other professionals were excluded. Methodological quality was ascertained using the CASP checklist to ensure rigor and transparency.

Results: The synthesis yielded five interrelated themes: i) personal characteristics, ii) student-related factors, iii) cultural and social values, iv) organizational and managerial influences, and v) educational structural conditions. Among these, personal characteristics including intrinsic motivation, pedagogical commitment, and altruistic values emerged as the most prominent drivers of teaching motivation. Further, students' performance and feedback, societal appreciation for educators, as well as institutional leadership and reward systems were identified as reinforcing elements.

Conclusion: Physicians' motivation to teach is a dynamic construct influenced by a complex interplay of personal, cultural, and institutional factors. Establishing academic environments that foster growth, recognize contributions, and implement supportive policies is critical for sustaining teaching motivation. These insights can inform targeted interventions and policy reforms aimed at strengthening the educational mission of medical institutions.

Keywords: Motivation; Teaching; Physicians; Faculty; Medical; Education

Background

Today, higher education is considered the foundation for economic, social, political, and cultural development (1). Medical education is critical given its direct link to community health (2), with clinical education serving as a critical phase where students apply learned concepts in practice. It includes learning-facilitating activities that contribute to measurable changes in students' clinical performance (3). A significant challenge is the gap between theoretical knowledge and practical skills (4, 5). Advanced clinical education bridges this gap and underpins medical science education (6), aiming to prepare professionals capable of delivering high-quality, evidence-based care (7). Therefore, educational quality is crucial, especially regarding the fact that in today's fast-paced healthcare environment, continuous learning and curricular reforms are essential (8-10). Such reforms also affect faculty roles, often creating challenges, as good teaching heavily impacts students' knowledge and performance (11, 12).

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This study, therefore, focuses on physicians as clinical teachers as well as the factors influencing their motivation to teach. Motivation, though complex, is broadly defined as the energy driving individuals to act (13). Williams and Burden distinguished two aspects of motivation: the initiation of motivation, which pertains to the reasons for performing something and the decision to act, along with sustained motivation, which refers to the effort to continue or maintain an activity (14).

Various theories including those of Maslow, Herzberg, Vroom, Adams, and Skinner provide foundational frameworks for understanding motivation (15). Among these, Herzberg's two-factor theory (16), and Vroom's expectancy theory have been particularly influential. Since the late 1990s, research on teacher motivation has expanded, with a major milestone being the 2008 special issue that linked motivational theories to teaching practice (17). Sinclair defines teacher motivation as what attracts individuals to teaching, sustains their training, and supports professional engagement (18). The CanMEDS Framework also underscores physicians' role in lifelong learning and knowledge dissemination (19, 20).

Since teaching often lacks financial rewards and may even impede promotion, understanding faculty motivation is essential for sustaining a strong educational workforce (21). Faculty motivation is associated with participation in development activities as well as best practices, both critical for integrated curricula reforms (22, 23). Studies indicate physicians are mainly driven by intrinsic factors such as altruism, intellectual satisfaction, skill development, and shaping future physicians (24-26), while extrinsic motivators include career advancement, salary, and academic requirements (27-29). Intrinsic motivation is often stronger than extrinsic (30), though barriers such as lack of compensation, time, and confidence remain (24). Note that organizational structure, curriculum design, and leadership further influence motivation (31).

Several studies have explored physicians' teaching motivation, the findings remain scattered and fragmented. Nevertheless, there remains a lack of understanding of the various intrinsic and extrinsic factors as well as the contextual conditions influencing physicians' engagement as clinical teachers. In order to address this gap, synthesizing the available qualitative evidence can provide a more integrated and thorough insight into these factors. By focusing on physicians' teaching motivation, this study aims to advance research on the underlying determinants of engagement in clinical teaching. The results may also offer valuable guidance for curriculum designers, educational leaders, and academic administrators. The purpose of this qualitative evidence synthesis (QES) is thus to systematically synthesize the existing evidence to identify as well as examine the factors affecting physicians' motivation to teach.

Objectives

This research aimed to synthesize qualitative evidence to uncover how individual, interpersonal, cultural, and structural elements influence teaching engagement among physicians.

Methods

Design

This study has been a synthesis of qualitative evidence. QES was chosen for this review as it utilizes an interpretive process that aims to expand understanding of a phenomenon through identifying themes and constructs in qualitative studies (32). The purpose of this qualitative evidence synthesis was to explore factors influencing physicians' motivation to teach. Following the thematic synthesis approach described by Thomas and Harden (33), the analysis involved open coding of qualitative findings, grouping codes into categories, and developing analytical themes, the main stages of which are summarized in Table 1.

Table 1. Process of Completing the study approach

Step	Description
Research question	What are the motivational keys for physicians' teaching?
Database search	PubMed, Web of Science, Scopus, ScienceDirect
Screening and eligibility	After 2004, English/Persian, peer-reviewed
Data extraction	Codes developed from texts
Thematic synthesis	Codes → Subthemes → Themes

Information Sources: A systematic search of the databases PubMed, Scopus, Web of Science, and ScienceDirect was undertaken after consultation with a medical information specialist to retrieve the most relevant studies. PubMed was employed to broaden the scope of health-related journals included in the search. Scopus was searched as it includes educational research that may not be indexed in traditional health databases such as PubMed. Since the topic was not strictly biomedical or health-related but also encompassed education and social sciences, Scopus was relevant. The Persian databases SID and Magiran were also explored. Google Scholar was additionally searched to guarantee a comprehensive search. The search was restricted to studies published in English or Persian from 2004 onwards.

Search Strategy: A comprehensive search strategy was developed and iteratively adapted for each database in consultation with a medical information specialist. We combined controlled vocabulary (e.g., MeSH in PubMed) and free-text keywords, applying Boolean operators, truncation, and parentheses to maximize sensitivity and specificity. For instance, the PubMed search combined MeSH and text-word terms as follows:

("Teaching"[Mesh] OR teach*[tiab] OR "clinical teaching"[tiab]) AND ("Motivation"[Mesh] OR motivat*[tiab] OR "teaching motivation"[tiab]) AND ("Physicians"[Mesh] OR physician*[tiab] OR doctor*[tiab] OR clinician*[tiab]).

Searches were performed in PubMed, Scopus, Web of Science, SID, Magiran, and Google Scholar, and were limited to English and Persian publications from 2000 onwards. The full search strings for PubMed and Scopus as well as the adapted strategies for the other databases are provided in Appendix A for ensuring transparency and reproducibility.

Study Selection: Following the search, all references were imported into Zotero, with duplicates removed. Both authors applied the inclusion and exclusion criteria in two stages: 1. title and abstract screening, and 2. full-text review. Articles were included if they had:

- focused on teaching motivation and its influencing factors/ focused on clinical physicians/ were published in English or Persian/ were published after 2000 / had full-text access available

Articles were excluded if they had focused on:

- other health professionals/ motivation in areas other than teaching

Formats such as editorials, letters to the editor, book chapters, conference proceedings, or publication types other than a research article. Any disagreements between the authors were discussed, with a final decision made through consensus. A manual search of the reference lists of included articles was performed to identify any missed studies. Identified articles from the reference lists were also subjected to title and abstract screening as well as full-text review.

Article Screening and Data Extraction

The PRISMA statement (34) guided the documentation of the search and selection process. Following identification, both authors conducted a critical appraisal and extracted key characteristics for all articles, which were entered into a spreadsheet. The reliability and methodological rigor of the included studies were ascertained using the Critical Appraisal Skills Program (CASP) tool for qualitative studies (35), providing a systematic, criterion-based, and transparent method for evaluating research articles (36). Each study was independently appraised by two reviewers across the CASP domains (e.g., clarity of aims, appropriateness of methodology, recruitment strategy, data collection, reflexivity, ethical considerations, rigor of data analysis, and value of findings). Based on these criteria, studies were classified as high, moderate, or low quality. Any discrepancies in judgment between the two reviewers were resolved through discussion until consensus was reached, thereby ensuring reproducibility of the appraisal process (Supplementary).

Data Synthesis: The key themes of the articles were identified using thematic analysis, via an inductive process in order to generate key ideas and aggregate findings to establish a set of final themes (37). Both authors reviewed the themes, with discussions were to reach consensus on the final themes**.** In order to ensure the credibility of the findings, a medical education expert outside the research team reviewed the initial codes and categories. In cases where discrepancies arose between researchers, the team would hold iterative discussions to compare interpretations and clarify meanings. Disagreements were resolved through consensus meetings in which all members presented their reasoning, with final decisions made when full agreement was reached. The external expert provided additional feedback during this process, whereby adjustments were incorporated accordingly.

Results

A total of 926 records were identified through the database. After removing duplicates, following title and abstract screening as well as full-text review, 26 articles were included in the final analysis. Figure 1 displays the PRISMA flow diagram, visually depicting the search, screening, and selection process. The detailed characteristics of the included studies are provided in Appendix B.

The analysis of the codes derived from the synthesis of the articles demonstrates that five factors influence physicians' teaching motivation:

1. Personal Characteristics
2. Characteristics and Professional Performance of Students
3. Cultural Factors with Social Values in Teaching
4. Managerial and Organizational Factors

Educational Structure

1. Personal Characteristics

The analysis of the codes derived from the synthesis of the articles reveals that five factors related to individual characteristics affect teacher motivation: Personal Interests, Professional Experience, Intrinsic Motivation, Teaching Skills and Competence, and Altruistic Values, as outlined in Table 2.

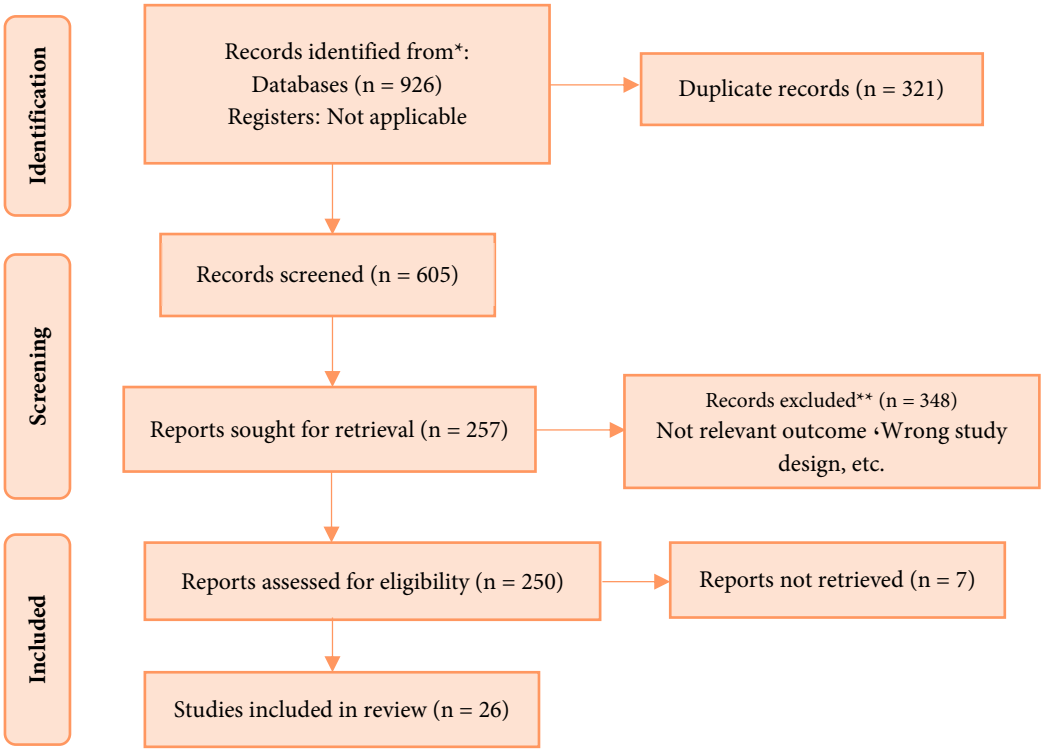

Figure 1. PRISMA Flow Diagram of the Study Selection Process

Table 2. The process of analyzing and coding the theme of Personal Characteristics

Main Category	Subcategories	Open Code (Source)
Competence	Pedagogical Competence	Preparedness (38), Personal Skills (24), Improving Confidence in Teaching Abilities (39), Lack of Adequate Teaching Qualifications (40)
	Instructor's Academic Competence	Sufficient Knowledge of Teaching Challenges (41), Understanding the Subject Matter Being Taught (42)
Experiences	Negative and Positive Experiences During Education	Gaining Positive Experience During My Practice, Negative Experiences During My Training (40)
Interests	Exchange of Experiences and Learning Opportunities	Understanding of Roles by Peers (41), Sharing of Expertise (43), Mutual Knowledge Exchange Willingness to Share Knowledge and Promote Future Physicians (44), Knowledge Sharing (45), Desire to Transfer Knowledge, Concern About the Effectiveness of Teaching (46), Knowledge Transfer as a Duty of Physicians (31), Willingness to Convey Information, Knowledge Transfer (42), Knowledge Sharing and Benefits from Shared Knowledge (40)
	Desire for Personal and Professional Growth	Desire to Update Clinical Knowledge, Opportunity to Transfer Skills and General Knowledge (47), Staying Current (43), Opportunity to Keep Up with the Latest Knowledge, Further Education (44), Truth-Seeking (24), Need to Maintain and Expand Knowledge Base (48), Improving One's Own Knowledge (26), Enjoying One's Own Learning (46), Impact of Teaching on Personal Growth as a Clinical Educator (49), Enrichment of Medicine Through Teaching (25), Desire for Further Teaching (39), Staying Updated on Medical Information, Facilitating Access to Evidence-Based Information (40)
	Passion for Teaching	Desire to Provide Better Education, Personal Interest (41), Interest in Clinical Teaching (50), Enjoyment of Teaching (47), Personal Satisfaction from Teaching (48), Intrinsic Joy of Teaching (26), Enjoyment, Ambition to Work as a Medical Educator (45), Interest in Collaboration (51), Pleasure in Teaching (52), Strong Interest and Anticipation for the Next Unit, Joy in Teaching, Sense of Identity and Authenticity through Teaching (25), Pleasure in Teaching (53), Actively Shaping the Teaching Environment (42), Enjoyable Nature of Education, Intrinsic Desire to Educate Values and Beliefs Integrated into the Educator, Feeling of Altruism, Connection with

Main Category	Subcategories	Open Code (Source)
		Academic Groups/Colleagues, Motivation for Appreciation Forms of Appreciation Including Public Recognition (39), Disinterest in Teaching and Training Medical Students, favoring enjoyment (40)
	Interest in the Specialty Field	Interest in the Subject Matter (52), Importance of Course Content (25)
Beliefs	Commitment to Treatment	Finding Time for Teaching (54), Insufficient Time Owing to Committed Performance in Treatment (40)
	Concern About Neglecting Patients	Concern About Inability to Treat the Same Number of Patients, Potential Disruption in Surgical Practice (44), Treating Fewer Patients Due to Teaching (40)
	Teaching as a Tool for Academic Career Advancement	Professional Advancement (43), Support for Academic Career (26), Career Progression (52), Achieving Career Goals, Value of the Teaching Profession, Career Promotion (25), Academic Teaching as a Means to Improve Job Status (40)
Individual Values	Educating the Next Generation	Feeling of Responsibility Toward the Profession and Society (47), Responsibility for Educating Future Physicians (48), Responsibility Toward Students (26), Helping Others, Improving Education (45), Opportunity to Help Others, Providing Services in the Field of Dermatology (52), Interest in Student Growth (46), Responsibility for Educating the Next Generation (49), Contributing to Students Becoming Good Physicians in the Future, Teaching as a Duty (25), Sense of Duty, Need to Transfer Ideas and Cultivate Future Talent in the Field (53), Reward for Supporting Others (42), Training the Next Generation (43), Altruism (39), Altruism and Intellectual Satisfaction (24)

These findings suggest that physicians' personal traits are fundamental in shaping their engagement in teaching. For instance, those with a strong intrinsic interest in education and relevant professional experience are more likely to invest time and effort in pedagogical activities.

Competence in teaching skills and a commitment to altruistic values further reinforce motivation, demonstrating that personal characteristics provide both the initial drive and sustained commitment required for effective clinical teaching.

2. Characteristics and Professional Performance of Students

The analysis of the scientific evidence also exhibited that learners can impact physicians' motivation to teach. Factors including student competence, their interaction styles with instructors, and the feedback they provide can either boost or diminish physicians' motivation to engage in teaching (Table 3).

Table 3. The process of analyzing and coding the theme of Characteristics and Professional Performance of Students

Main Category	Subcategories	Open Code (Source)
Characteristics and Professional Performance of Students	Positive Feedback from Students	Importance of Student Feedback, Student Feedback (46), Improvement of Student Evaluation, External Motivation, Public Recognition, Feedback from Supervisors, and Enhanced Student Evaluations (39)
	Motivation and Competence of Students	Potential Negative Views of Instructors Regarding the Abilities and Needs of Trainees to Participate in Educational Activities (55, 56), Good Student Performance Leading to Job Satisfaction (55)
	Cultural Characteristics of Students	Disruption of Practice Management by Students (40)
	Interaction with Students (Lifelong Positive Professional Relationships with Learners)	Interaction with Students, Connection with Students (43), Strengthening Lifelong Positive Professional Relationships with Learners (48), Strong Desire to Establish Teacher-Learner Relationships (46)

Overall, students' characteristics and professional performance play a key role in shaping physician educators' motivation. Competent and engaged students who actively participate as well as provide constructive feedback tend to reinforce physicians' commitment to teaching. Conversely, challenging

interactions or a lack of preparedness can lower motivation, highlighting that effective teaching depends on both the instructor's and the learners' active involvement.

3. Cultural Factors with Social Values in Teaching

The findings suggest that the value of cultural factors, or the social values of teaching, significantly affects physicians' motivation to teach. These factors include the respect that patients have for physicians who adopt teaching roles, the significance of helping peers as well as educating the next generation, and viewing teaching as a form of advocacy. Further, effective communication and networking with colleagues would provide valuable opportunities that further enhance motivation (Table 4).

Table 4. The process of analyzing and coding the theme of Cultural Factors with Social Values in Teaching

Main Category	Subcategories	Open Code (Source)
Social Value of Teaching	Respect for Patients for Physicians with Teaching Roles	Respect from Patients (43), Increased Competence Perceived by Patients as a Teacher, Enhanced Patient Satisfaction, Patient Discontent with Frequent Encounters with Students (40)
	Teaching as Advocacy	The Act of Academic Teaching as My Advocacy (40), Increased Credibility and Legitimacy as an Educator (39)
Communication and Networking with Colleagues	Good Opportunities for Communication with Colleagues and Networking	Contact with Colleagues (44), Interest in Building Relationships (46), Teaching for the Sake of Colleagues (25), Increased Communication with Other Faculty Members (39), Good Opportunities for Communication and Networking with Colleagues, Career advancement and recognition for my work, connectedness (39)

Overall, social and cultural values strongly shape physicians' engagement in teaching. Recognition and respect from patients, the desire to support peers and mentor future generations, as well as the perception of teaching as a socially responsible activity all reinforce motivation. Further, opportunities for professional networking and effective communication with colleagues enhance physicians' commitment to education, indicating that cultural and social factors provide both intrinsic and extrinsic encouragement for teaching activities.

4. Managerial and Organizational Factors

The appreciation of universities for educational services significantly impacts teaching motivation, including the valuation of educational activities on par with clinical services along wioth the effectiveness of the reward system. The necessary issues include a supportive structure within the university, characterized by a hierarchical framework that facilitates teaching, the utilization of effective educational leaders, as well as the strengthening of organizational commitment. Further, an impartial and fair reward system, alongside the alignment between educational and financial rewards, plays a critical role. The provision of necessary facilities and resources, such as aligning educational activities with financial compensation, as well as ensuring adequate human resources, space, and facilities, also contributes to enhancing physicians' motivation to teach (Table 5). In summary, managerial and organizational factors function as key drivers of physicians' motivation to teach. Institutional recognition of teaching efforts, effective leadership, fair and transparent reward systems, and the availability of adequate resources all reinforce educators' commitment. Together, these elements establish an environment where teaching is valued, supported, and aligned with both professional and financial incentives, thereby maintaining motivation over time.

5. Educational Structure

One of the findings from the synthesis of the research demonstrates that effective policy-making plays a key role in influencing physicians' motivation to teach. This includes the flexibility of educational programs, establishment of clear policies regarding the instructor's educational role, and alignment of educational credits for promotion with teaching workload and time. Further, it is essential to maintain a balance between a heavy clinical workload and educational responsibilities.

This involves considering factors such as clinical Workload, time management, clinical supervision systems, as well as the presence of supervisory and feedback mechanisms. Further, the standardization of national medical education policies and procedures, along with clear educational guidelines, significantly contributes to the professional development of educators, thereby boosting their motivation to engage in teaching. (Table 6).

In summary, the structure of educational programs and institutional policies plays a central role in motivating physicians to teach. Flexibility in scheduling, precise role definitions, fair alignment of promotion

criteria with teaching effort, as well as the presence of supportive supervision and feedback mechanisms collectively enable educators to strike a balance between clinical and educational responsibilities. In addition, standardized national policies and clear educational guidelines provide a framework for professional growth, reinforcing physicians' commitment to teaching. Based on the thematic synthesis of the extracted codes, a conceptual model was developed to demonstrate the key motivational factors influencing physicians' teaching, as presented in Figure 2.

Table 5. The process of analyzing and coding the theme of Managerial and Organizational Factors

Main Category	Subcategories	Open Code (Source)
University Appreciation for Educational Services	Valuation of Educational Activities on Par with Clinical Services	Importance of Clinical Care Compared to Education (56), Recognition by the University (43), Lack of Explicit Recognition of Teaching Excellence and Specific Development Budget (57)
	Reward System	Rewarding Good Teaching (57), Appreciation for Educational Activities (53), Increased Financial Inequality Compared to Direct Patient Care Delivery (54)
Existence of Supportive Structure within the University	Hierarchical Structure Facilitating Teaching	Long-term Planning and Available Educational Materials to Enhance Teaching Appeal (51), Hierarchical Structure of the Health System (49)
	Utilization of Effective Educational Leaders	Teaching for the Sake of Supervisors, Meeting Supervisors' Expectations, Avoiding Conflicts with Supervisors (25)
	Strengthening Organizational Commitment	Organizational Commitment (58)
Impartial and Fair Reward System	Development of a Fair Reward System	Financial (50), Distribution of Hospital Performance Payments (59), Receiving Rewards (38), Work rewards (39)
Alignment Between Education and Financial Rewards	Existence of a Reward System	Mismatch Between Educational Activities and Rewards (55), Minimal Importance of Financial Compensation (45), Increase in Income, Financial Considerations as Significant Incentives (52), Understanding of Rewards (42), Financial Compensation (51)
Provision of Facilities and Resources	Alignment of Educational Activities with Financial Compensation	Low Income from Education Compared to Treatment, Mismatch Between Educational Activities and Rewards (55), Reduction in Productivity, Financial Compensation Relative to Treatment, Increase in Income, Financial Considerations as Significant Incentives (49, 51)
	Human Resources	Human Resources (49), Excellence in Teaching through Attracting Good Educators (57)
	Space and Facilities	Facilities (49), Increasing Educational Resources (52), Shortage of Resources (49), Availability of Space (47), Teaching in Personal Medical Offices, Insufficient Space (44)

Table 6. The process of analyzing and coding the theme of Educational Structure

Main Category	Subcategories	Open Code (Source)
Policy Making	Flexibility of Educational Programs	Proposed Facilitators Include Enhancing Program Flexibility (52)
	Clear Policy Regarding the Educational Role of the Instructor	Lack of Strong Intervention in Course Design (24), Absence of Clear Policy Regarding the Educational Role of the Instructor, Unclear Educational Roles, Lack of Any Clear Policy Regarding the Physician's Role as an Educator (49)
	Alignment of Educational Credit in Promotion with Workload and Teaching Time	Mismatch Between Time Allocated for Teaching in Promotion and Pressure on Faculty Members at University Medical Centers (55)
	Adjustment of the Instructor's Multiple Roles	Multiple Roles (49)
Existence of a Balance Between Heavy Clinical Workload and Education	Clinical Workload	Conflict Between Heavy Workload of a Clinical Rotation (41), Workload (47), Clinical Workload (38), Heavy Clinical Burden or Sense of Wasted Time (24), Limited Time for Teaching and Involvement in Treatment (55)

Main Category	Subcategories	Open Code (Source)
	Time	Time (47), Lack of Time (51); Time Constraints (45), Time Limitations (51), Significant Barriers (Limited Time for Travel, Teaching, and Certification (52)
Clinical Supervision System	Existence of Supervisory Mechanisms and Feedback System	Having a Supervisor (41), Monitoring of Teaching [43], Feedback (42) Feedback from Supervisors, Assessment and Feedback on Teaching (39), Evaluation and Awarding of Educational Grants (59)
Standardization of National Medical Education Policies and Procedures	Clear Educational Policies and Procedures	Need for Establishing and Standardizing National Medical Education Policies and Procedures, Existence of Such a National Policy for Medical Education (49)
Professional Development	Professional Development Planning	Establishing Employee Development Programs (57), Reduction of Organizational Efforts for Teaching Methods (53), Responsibility for Improvement but Lack of Participation in Faculty Development (FD) (39)

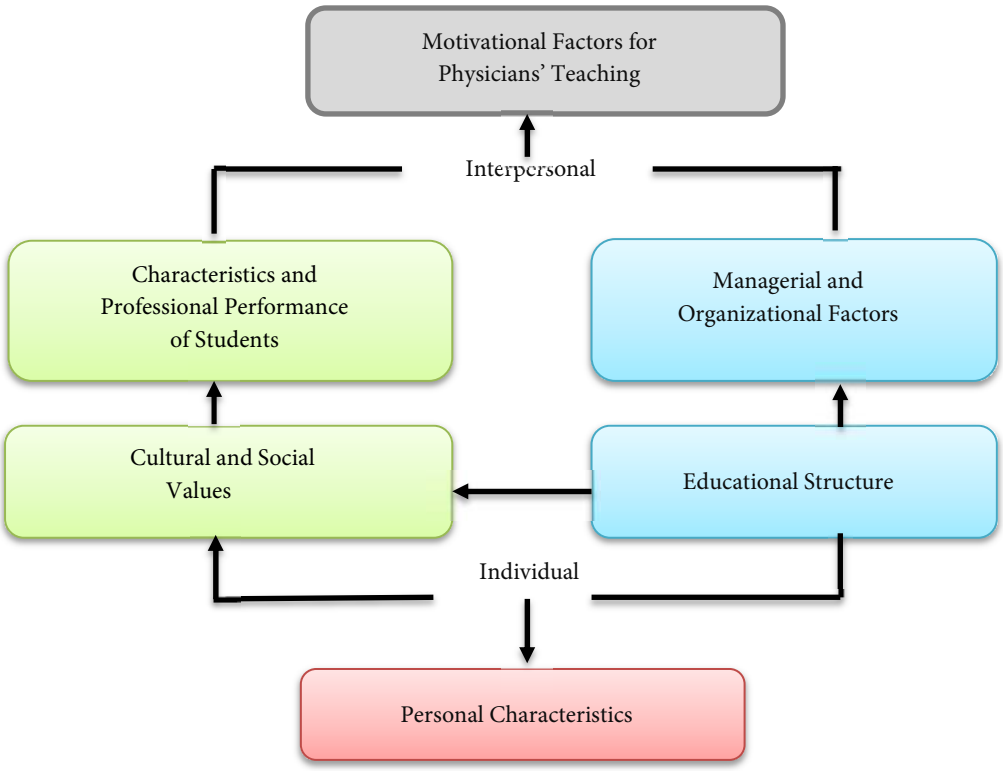

Figure 2. The key motivational factors influencing physicians' teaching

Discussion

This study advances a nuanced and integrative perspective on the multifactorial nature of physicians' teaching motivation. Moving beyond fragmented or unidimensional explanations, our synthesis indicates how individual, interpersonal, and structural elements interact dynamically to shape medical educators' engagement. Rather than isolating motivation as a fixed personal trait, the findings highlight its malleability within specific educational, organizational, and sociocultural contexts.

Contrary to the conventional view of intrinsic motivation as fixed, physicians reshape their motivation through via experiences, recognition of educational roles, and student feedback. This highlights the dynamic nature of personal motivation as well as its potential for development through targeted interventions. Personal characteristics such as intrinsic motivation (53), professional experience, and altruistic values play a key role in fostering a commitment to teaching. These attributes can be promoted during medical training (40), with the hidden curriculum shaping teaching motivation (60). Physicians who are passionate about

their subject matter and with strong teaching skills [38] tend to inspire students and engage meaningfully in educational activities.

Students also play an active role in shaping physicians' motivation to teach. The quality of student-teacher interactions, student feedback, and student attitudes directly influences engagement. Positive feedback (39) and collaborative interactions foster enthusiasm, while negative experiences may lower motivation. Thus, it is essential to equip students with strong communication skills and create systems for constructive bidirectional feedback (43). The societal valuation of medical teaching, as reflected in respect from patients, colleagues, and the wider community, is a critical yet underexplored source of motivation. This recognition shapes physicians' professional identity and engagement in teaching. Cultural and social factors, such as patients' esteem for physicians who teach (40), intrinsic satisfaction gained from mentoring and training future healthcare professionals (49), and supportive peer networks (44), would further reinforce motivation by creating positive feedback loops.

A novel contribution of this study lies in its analysis of organizational structures, especially the alignment between educational efforts and rewards, as well as the availability of tangible support mechanisms. Symbolic recognition alone is insufficient; reward systems need to align with actual teaching; they create an environment where teaching is prioritized. Whereas financial incentives are important, recognition, supportive leadership, and structured organizational frameworks are often more valued (50).

Leadership plays a particularly central role. Effective leaders understand team members' needs and tailor motivational strategies accordingly. They balance respect, courage, supportiveness, passion, and relationship-building skills, establishing an environment where physicians feel valued and motivated (41, 49).

Another structural determinant is the lack of clear policies regarding educational roles as well as the misalignment between teaching effort and professional recognition. This misalignment, as highlighted by Zidjali & Moosa (2022), diminishes motivation and undervalues teaching (49). National-level policy reforms are required to clarify roles, align workload with credit, and enhance flexibility in teaching programs (52). Balancing clinical and educational duties is vital for sustained motivation. Supervisory practices modeled following clinical frameworks should emphasize consistent, constructive feedback (61), ameliorating both teaching quality and learning outcomes. Our findings align with recent developments in medical education assessment, such as the REFLECT scale, which underscores the importance of structured feedback mechanisms in fostering a supportive educational environment as well as enhancing teaching motivation among physician educators (62)

The conceptual model in Figure 1 integrates five key dimensions influencing physicians' teaching motivation: personal characteristics, student-related factors, cultural and social values, managerial and organizational factors, and educational structure. Personal attributes such as pedagogical and clinical knowledge, teaching skills, and intrinsic interest in education establish the basis for student interaction and engagement, while buffering adverse effects of weak organizational structures or heavy workloads. Competent and engaged students, constructive feedback, respect from patients, social responsibility, and the desire to mentor the next generation further boost motivation. Effective leadership, fair and transparent reward systems, and adequate resources also promote a supportive environment.

Overall, the model indicates that teaching motivation emerges from the dynamic interplay of individual, social, and organizational factors. Physicians' personal and professional attributes moderate limiting factors, highlighting that fostering intrinsic skills and interests boosts resilience and commitment to teaching, even under structural challenges.

In spite of efforts to comprehensively review the literature, some unpublished or grey literature may not have been captured, which could have offered additional insights. Recognizing this gap is essential for proper interpretation of the findings and guiding future research on physicians' motivation to teach. To address this issue, future studies should actively include unpublished, grey, and non-English/Persian literature, in addition to published studies, in order to provide a more comprehensive understanding. Employing mixed-methods approaches that integrate both qualitative and quantitative data can further augment the validity and generalizability of the findings. Ultimately, fostering closer communication with physicians and creating opportunities for sharing experiences can deepen understanding of the challenges and motivations associated with teaching in this profession.

Conclusion

This study offered a comprehensive examination of the multifaceted nature of physicians' teaching

motivation, highlighting the dynamic interactions among personal characteristics, student-related factors, cultural and social values, managerial and organizational influences, as well as educational structures. The findings demonstrated that teaching motivation extends beyond individual traits, being profoundly shaped by the broader educational, organizational, and sociocultural contexts in which physicians operate. Our analysis revealed that motivation arises from a complex interplay of individual, interpersonal, and structural factors. Notably, this study introduced an integrated model that would elucidate the interrelationships between these dimensions and identify potential targets for policy interventions. The results underscore that strategies to boost teaching motivation should not focus solely on personal attributes; they must also involve the development of supportive institutional frameworks, implementation of targeted policy reforms, and promotion of cultural and professional recognition of physicians' educational roles.

Implications for key stakeholders

- **Educational development center directors** should organize practical training programs for faculty with a focus on teaching skills, effective teacher-student communication, and instructional strategies. These programs should start during residency training and continue throughout the faculty career, ensuring that educators are well-prepared to engage students and deliver high-quality education.
- **Educational leaders** should foster supportive mentorship, establish transparent feedback mechanisms, and create a positive environment that recognizes pedagogical contributions. Leaders should tailor motivational strategies to individual faculty needs, facilitating engagement even under challenging workloads.
- **Academic administrators** should implement fair and transparent reward systems that value teaching on par with clinical services, provide necessary resources, and institutionalize recognition of educational efforts to promote long-term commitment.

Future Research: Future studies should adopt mixed-method designs and include diverse geographic as well as cultural contexts to capture systemic and cultural determinants of physicians' teaching motivation. Such research can further validate the integrated model presented in this study and guide evidence-based policy along with practice interventions.

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Appendix A. Search strategy and databases used in the qualitative evidence synthesis

Database	Search Strategy
PubMed (searched on October 20, 2024)	("Teaching"[Mesh] OR "clinical teaching"[tiab] OR teach*[tiab]) AND ("Motivation"[Mesh] OR motivat*[tiab] OR "teaching motivation"[tiab]) AND ("Physicians"[Mesh] OR physician*[tiab] OR doctor*[tiab] OR clinician*[tiab]) Filters: Publication date from 2000/01/01; Languages: English, Persian
Scopus (searched on October 20, 2024)	(TITLE-ABS-KEY("teaching motivation" OR motivat* AND (teach* OR "clinical teaching"))) AND (TITLE-ABS-KEY(physician* OR doctor* OR clinician*)) AND (PUBYEAR > 1999) AND (LIMIT-TO(LANGUAGE, "English")
Web of Science (searched on October 20, 2024)	TS=("teaching motivation" OR motivat* NEAR/3 teach* OR "clinical teaching") AND TS=(physician* OR doctor* OR clinician*) Refined by: Document types=(Article) Timespan: 2000–2025; Languages: English
ScienceDirect (searched on October 20, 2024)	Timespan: 2000–2025; Languages: English TITLE-ABSTR-KEY("medical education" OR "clinical teaching" OR "academic teaching") AND TITLE-ABSTR-KEY("motivation" OR "reward" OR "recognition") AND TITLE-ABSTR-KEY("faculty" OR "physician" OR "clinician")
SID (Scientific Information Database, searched on October 20, 2024)	("استاد بالینی" یا "دکتر" یا "پزشک") AND ("انگیزش یاددهی" یا "انگیزش آموزش" یا "انگیزش تدریس")
Magiran (searched on October 20, 2024)	("استاد بالینی" یا "دکتر" یا "پزشک") و ("انگیزش آموزش" یا "انگیزش تدریس")
Google Scholar (searched on October 20, 2024)	Allin title: ("teaching motivation" OR "motivation to teach") physician OR doctor OR clinician Custom range: 2000–2025; Languages: English, Persian

Appendix B. The detailed characteristics of the included studies

Author/Year	Country	Aim of Study	Participants	Method	Key Findings
Adarkwah et al., 2019	Germany	Develop a questionnaire to measure GPs' motivation for teaching	General practitioners (rural)	Questionnaire survey (MoME-Q)	Identified intrinsic and extrinsic motivators (e.g., professional satisfaction, support needs)
Budden et al., 2017	Australia	Explore why surgeons teach	Excellent surgical educators	Qualitative Grounded theory interviews	Teaching driven by altruism, professional identity, and role-modelling
Cantillon et al., 2019	UK	Understand identity formation of clinical teachers	Clinical teachers	Qualitative study	Teacher identity shaped by context, recognition, and personal values
Chapman et al., 2016	Australia	Examine motivations of junior doctors to teach	Junior doctors	Online survey	Motivations included altruism, learning reinforcement, and career development
Cochran Ward et al., 2013	Australia	Explore motivations/constraints of emergency physicians	Emergency physicians	Mixed methods (survey + interviews)	Identified enthusiasm for teaching but time/organizational barriers

Author/Year	Country	Aim of Study	Participants	Method	Key Findings
Dahlstrom et al., 2005	Australia	Investigate motivations of senior clinicians	Senior clinicians	Questionnaire survey	Found intrinsic motivation, professional duty, and enjoyment as drivers
Daunert et al., 2023	Germany	Assess GP practices' motivation to host students	General practitioners	Questionnaire survey	Motivated by professional responsibility; workload and logistics as barriers
Delgado et al., 2023	USA	Explore motivators/barriers of dermatology volunteer faculty	Volunteer dermatology faculty	Survey	Motivated by giving back; barriers included lack of time and recognition
Deutsch et al., 2019	Germany	Explore GPs' willingness, incentives, remuneration	General practitioners	Cross-sectional survey	Financial and structural incentives influence teaching motivation
Dotters-Katz et al., 2016	USA	Identify residents' motivation to teach	Medical residents	Questionnaire survey	Residents motivated by self-improvement, knowledge reinforcement, and altruism
Dybowski & Harendza, 2015	Germany	Validate Physician Teaching Motivation Questionnaire (PTMQ)	Physicians	Questionnaire validation study	Confirmed multidimensional structure of teaching motivation
Engels et al., 2021	Germany	Explore peer teachers' intrinsic motivation/rewards	Medical students (peer teachers)	Survey	Peer teachers motivated by intrinsic rewards and recognition
Ingham et al., 2015	Australia	Explore motivations of rural GP supervisors	GP supervisors (rural)	Qualitative interviews	Motivated by community service, professional duty, and teaching satisfaction
Lochner et al., 2012	Germany	Study intrinsic motivation of physicians to teach	Physicians/health professionals	Qualitative interviews	Intrinsic motivation dominant; sense of responsibility and enjoyment important
May et al., 2012	Germany	Assess family physicians' motivation to teach	Family physicians	Survey	Motivated by student interaction and professional duty; remuneration secondary
Olmesdahl, 1997	South Africa	Explore rewards for teaching excellence	Medical school faculty	Survey	Recognition and career advancement key motivators
Schulz et al., 2022	Germany	Investigate outpatient teaching in specialist practices	Specialist doctors	Qualitative interviews	Teaching shaped by structural, institutional, and individual factors
Snook et al., 2019	Iceland	Compare motivation of temporary vs. tenure-track faculty	Health sciences faculty	Survey	Temporary staff motivated by identity and career needs; tenure staff by stability
Sulistiyana et al., 2024	Indonesia	Analyze drivers of clinical teaching performance	Clinical teaching doctors	Survey	Performance linked to intrinsic motivation and institutional support
Tariq & Ali, 2014	Pakistan	Assess clinical faculty motivation for teaching	Clinical faculty	Survey	Positive attitudes toward teaching but hindered by workload
Thampy et al., 2013	UK	Explore registrars' motivation to teach	GP registrars	Qualitative interviews	Registrars motivated by altruism and professional identity

Author/Year	Country	Aim of Study	Participants	Method	Key Findings
Thomson et al., 2014	Australia	Explore GPs' motivation to teach	General practitioners	Qualitative interviews	Motivated by professional satisfaction, altruism, and student interaction
Watt et al., 2024	Australia	Identify barriers/enablers using PTMQ	Clinical educators	Questionnaire survey	Barriers: workload, time; Enablers: recognition, personal satisfaction
Xiang et al., 2016	China	Develop evaluation system for clinical teachers	Clinical faculty	Survey	Proposed performance system linking teaching to motivation
Zidjali & Moosa, 2022	Oman	Explore motivation of doctors to improve teaching	Clinical doctors	Qualitative realist study	Motivation shaped by personal commitment and contextual constraints

GPs: General Practitioners

PTMQ: Physician Teaching Motivation Questionnaire

MoME-Q: Motivation of Medical Educators Questionnaire

Note. *All included studies employed qualitative, survey-based, or mixed-methods designs focusing on clinical teaching motivation, without reporting quantitative meta-analytic effect sizes.* This table summarizes the detailed characteristics of the studies included in the review, detailing the author/year, country, study aim, participants, methodology, and key findings. The table continues on the following page with the remaining included studies and consistent column headers.

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Original Article

Impact of Morningness-Eveningness Chronotype on Sleep Quality and Test Anxiety Levels among Medical Students at Ahvaz Jundishapur University of Medical Sciences

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Abstract

Background: Circadian rhythms determine individual chronotypes as morning, evening, or intermediate. Evidence shows evening types are more susceptible to sleep disorders and higher levels of anxiety. Sleep quality and test anxiety are issues associated exams' failure.

Objectives: The study aimed to investigate the impact of chronotypes on sleep quality and test anxiety, taking into account the established relationship between general and test anxiety.

Methods: The study included medical students at Ahvaz Jundishapur University of Medical Sciences, who were assessed using demographic information and questionnaires to evaluate test anxiety, morningness-eveningness patterns, and sleep quality. The questionnaires were translated into Persian, and their validity and reliability were previously verified. Significance level was $P < 0.05$.

Results: The results revealed 23 morning-type, 126 intermediate, and 74 evening-type participants. Regarding sleep quality, 197 participants reported poor sleep, while 26 reported good sleep. The mean test anxiety was 44.13 ± 10.67. Male students exhibited significantly higher test anxiety compared to female students ($P = 0.041$). Test anxiety varied significantly across the chronotype groups ($P = 0.009$). A significant inverse correlation was observed between sleep quality and test anxiety ($r = -0.342$, $p < 0.05$). This relationship may differ by chronotype, indicating the need to consider individual characteristics in sleep interventions.

Conclusion: Our findings indicated that morning types had higher levels of test anxiety, likely due to incongruence with afternoon exam schedules. Tailoring examination schedules and class timings to accommodate diverse chronotypes highlights the importance of evening courses and adjustments to enhance well-being and academic performance, despite logistical challenges persisting.

Keywords: Morningness-Eveningness Preference; Anxiety; Sleep Quality; Students; Education

Background

Human behavior is significantly influenced by circadian rhythms, resulting in distinct chronotypes. Morning-type individuals tend to prefer early wake times and sleep periods, accompanied by a corresponding decline in daytime alertness. Evening types exhibit the opposite pattern, favoring later wake and sleep times and experiencing increased alertness in the afternoon and evening. Intermediate chronotypes display a moderate circadian phase alignment, reflecting a balance between these two extremes (1, 2). In humans, dysfunction or misalignment of the circadian clock disrupts the sleep-wake cycle, resulting in various circadian rhythm sleep disorders (3).

Sleep quality has deteriorated among adults and adolescents in recent years. While 'sleep quality' lacks a universal definition, it's generally understood as an individual's satisfaction with their sleep, encompassing sleep duration, continuity, and restorative feeling (4). Critically, short sleep duration—less than 9 hours for

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children (6-12), 8 for adolescents (13-18), and 7 for adults (18-60)—affects over 50% of the U.S. population. A survey of university students from 26 countries, categorized by income level, found that the combined prevalence of sleep durations less than 6-8 hours and greater than 9 hours was 39.2% in low-income countries, 46.9% in middle-income countries, and 13.9% in high-income countries (4). Socioeconomic factors, including job requirements, housing conditions, access to healthcare services, and social networks, likely play a role in determining sleep duration among countries with varying income levels (4). Sleep health disparities among adolescents are strongly linked to parental socioeconomic indicators. Low parental income, low-income family socioeconomic status, and low parental education are associated with more sleep disorders among adolescents. Lower education levels predict an increased risk of sleep disorders in adults. Low socioeconomic status is associated with high sleep disorders in adults and the elderly. Low income and full-time employment were significantly associated with short sleep among adults and the elderly. As a result, sleep health should be an important public health goal (5).

Studies have reported that poor sleep quality is prevalent among students, affecting over half of the student population (6, 7). Low sleep quality has thus become a significant issue among students (4, 6-8). A confluence of factors contributes to the high prevalence of sleep problems among university students. Academic and social demands, irregular schedules, active social engagement, and the unfettered autonomy of university life, which can promote unhealthy behaviors such as smoking, collectively undermine sleep quality and lead to sleep disorders (4). Factors contributing to reduced sleep quality in students include caffeine consumption, mobile phone addiction, and anxiety (4). Evening chronotypes exhibit greater sleep debt and daytime sleepiness than morning chronotypes, reflecting their increased susceptibility to sleep problems (9). Previous evidence indicates that evening chronotypes exhibit a higher prevalence of unhealthy behaviors, including increased smoking rates, poorer dietary habits, and delayed bedtimes (10). Furthermore, there is a correlation between individuals with different chronotypes and the severity of depression (11).

Attending university can be a full-time stressor for many students, as the healthcare needs of college students have increased dramatically. Young people and students frequently experience sleep disturbances, which research indicates are strongly correlated with poor mental health (12-14). Anxiety symptoms are prevalent among university students, exhibiting a reciprocal relationship with sleep quality (15, 16). Anxiety has been reported as a factor that affects the sleep-wake cycle, and it appears that university schedules and academic demands contribute to sleep-wake cycle irregularity, which, in turn, may elevate anxiety levels. While low to moderate anxiety can enhance cognitive function, elevated anxiety negatively impacts attention, memory, and problem-solving. Furthermore, a significant correlation exists between sleep disturbances, including abnormal daytime sleepiness and inadequate total sleep hours, and diminished academic performance. Consequently, prioritizing sleep quality and anxiety management is crucial for students' optimal physical, mental, and emotional well-being (17).

Test anxiety is one of the educational challenges that many students find difficult to cope with, which can lead to failure in exams (18). Test anxiety in students is characterized by anxious behaviors that result from procrastination, ineffective study, and a lack of necessary skills to take the exam. This anxiety can be a serious obstacle to students' educational success (19). Test anxiety is a set of emotions accompanied by worry and fear, dissatisfaction with personal thoughts, and physical symptoms that occur during exams. It can be problematic for a large number of students and can have negative effects on the academic abilities of many people who suffer from it (20, 21).

Contributing factors to test anxiety include inadequate preparation, situational discomfort despite content mastery, or misconceptions regarding test-taking strategies (22). A previous study showed that students who experience test anxiety perceive tests as threats, triggering task-irrelevant thoughts and negative emotions such as fear, helplessness, and anticipated failure (22).

Chronotype may influence the relationship between sleep quality and anxiety because individuals whose time preference did not align with their class schedule experienced lower sleep quality and higher anxiety (17). Consequently, test anxiety can hinder the performance of otherwise capable students (22).

Although previous studies have examined general anxiety and sleep patterns in college students, few have specifically examined the predictors and consequences of test anxiety in relation to students' chronotypes. This gap highlights the need for research that examines

differences in test-related anxiety among students with different chronotypes. Therefore, we examined the prevalence of test anxiety, sleep quality, and chronotype (Morningness-Eveningness) among medical students at Ahvaz Jundishapur University of Medical Sciences, and explored the interrelationships between these variables.

Objectives

The study aimed to investigate the impact of chronotypes on sleep quality and test anxiety, taking into account the established relationship between general and test anxiety.

Methods

This descriptive-analytical study involved 223 medical students in their first to fourth semesters (academic year 2023-2024) at the School of Medicine, Ahvaz Jundishapur University of Medical Sciences (AJUMS). The sample size was calculated using the formula for comparing two means, based on the results of Issazadegan et al. (2011) ($\bar{x}_1$ =39.31, $\bar{x}_2$ =42.84, s_1 =9.58, s_2 =7.41, α=0.05, β=. 0.2) (23). Specifically, taking into account a significance level of α=0.05 and a statistical power of 80% (β=0.20), the required sample size for each subgroup was determined. To account for potential attrition or incomplete responses, the final sample size was adjusted accordingly.

$$n = \frac{\left(Z_{1-\frac{\alpha}{2}} + Z_{1-\beta}\right)^2 (\delta_1^2 + \delta_2^2)}{(\mu_1 - \mu_2)^2}$$

A simple random sampling method was employed to select the participants from the student roster. Participants were included if they provided voluntary consent and reported no history of mental illness or current use of psychotropic medications. Informed consent was obtained following a thorough explanation of the study and assurance of data confidentiality. With the endorsement of the Vice-Chancellor for Research, as evidenced by a letter of introduction, and the active participation of officials from the Faculty of Medicine, data collection commenced. Participation was voluntary, and all data were collected anonymously and kept confidential. Participants whose questionnaires were considered incomplete were excluded from the study. A questionnaire was defined as incomplete if more than 10% of the total items were missing or if any of the key scales, including the anxiety and circadian typology scales, were not fully completed. The following instruments were used to collect the data: 1) a demographic information form (gender, age), and 2) standardized questionnaires measuring test anxiety, Morningness-Eveningness (Horne and Östberg, 1976), and sleep quality.

The questionnaires were made available to students through the Porsline online system. The Morningness-Eveningness Questionnaire (Horne and Östberg, 1976), comprising 19 items, was employed to assess participants' circadian typology. The internal consistency of the questionnaire, as measured by Cronbach's alpha, was 0.77, which is considered acceptable. Recognized for its high validity across numerous studies, it is considered a leading instrument in this domain. Scores ranged from 16 to 86, where higher scores represented a stronger morning preference and lower scores a stronger evening preference (24).

The Pittsburgh Sleep Quality Index (PSQI) was used to assess the sleep quality of the students. PSQI evaluates seven components of sleep, each scored from 0 (no problem) to 3 (severe problem). The sum of these component scores yields a global score, where higher scores indicate poorer sleep quality. A cutoff score of 5 was used to categorize participants, with scores above 5 denoting poor sleep quality and scores below 5 denoting good sleep quality. The PSQI demonstrated strong internal consistency, with a Cronbach's alpha of 0.83 (25).

Test anxiety was assessed by the Friedman and Jacob Test Anxiety Questionnaire. It consists of 23 questions and aims to measure various dimensions of test anxiety. The response spectrum is of the Likert type. The reliability of the questionnaire, as measured by Cronbach's alpha, was 0.91 (26). The questionnaire was administered to students at the end of the term, three weeks before examinations (27). The face validity and reliability of the questionnaires were calculated and confirmed in previous studies on Iranian samples after translation (28-30).

Statistical Analysis: The normality of data distribution was assessed by the Kolmogorov-Smirnov test. As the variables did not conform to a normal distribution, non-parametric tests, including the Chi-Square and Kruskal-Wallis tests, were employed to examine relationships between variables. To examine the linear association between PSQI and test anxiety scores, Spearman's correlation coefficient was employed. The results were indicated as means±standard deviation (SD). All analyses were done in SPSS version 23 at a significance level of $p < 0.05$.

Results

The study population consisted of 223 medical students, comprising 114 males (51.1%) and 109 females (48.9%). The age of participants varied from 18 to 33 years (mean age: 21 ± 2.74 years). The mean Morningness-Eveningness score was 46.84 ± 9.69. The circadian preference distribution revealed that 23 students (10.3%) had a morning pattern, 126 students (56.5%) had an intermediate pattern, and 74 students (33.2%) had an evening pattern. The most frequent circadian rhythm pattern observed among the students was the intermediate pattern, with 67 female (61.5%) and 59 male students (51.8%) having this pattern. The Morningness-Eveningness pattern in medical students at Ahvaz Jundishapur University of Medical Sciences did not show a statistically significant difference based on student gender (P =0.309).

The mean sleep quality score of the students was 9.24 ± 3.10, with scores ranging from 2 to 18. Table 1 presents the scores for the Pittsburgh Sleep Quality components.

Table 1. Mean Sleep Quality Scores

Components of Sleep Quality	Mean (SD)
Sleep Latency	2.55 (1.67)
Sleep Duration	1.55 (1.12)
Sleep Disturbances	1.08 (0.43)
Use of Sleeping Medication	0.33 (0.77)
Daytime Dysfunction	1.14 (0.9)
Sleep Sufficiency	0.74 (1.18)
Global Sleep Quality	1.21 (0.73)

SD: Standard deviation

Based on PSQI categorization, 88.3% (n= 197) of students reported poor sleep quality, while 11.7% (n = 26) showed good sleep quality. Specifically, poor sleep quality was observed in 89.5% (n = 102) of male students and 87.2% (n = 95) of female students. Sleep quality did not differ significantly across morning, intermediate, and evening circadian preference groups (P = 0.082) (Table 2).

Participants were nearly equally divided into high (n=111, 49.8%) and low (n=112, 50.2%) test anxiety categories. The overall mean test anxiety score was 44.13 ± 10.67. Male students exhibited a significantly higher mean test anxiety score (45.55 ± 11.42) compared to female students (42.65 ± 9.66; P = 0.041) (Table 3).

Table 2. Differences in Student Sleep Quality Based on Morningness-Eveningness Chronotype

Morningness-Eveningness Chronotype	Poor Sleep Quality Frequency (Percentage)	Good Sleep Quality Frequency (Percentage)	P value
Morning Chronotype	21 (91.3%)	2 (8.7%)	0.082
Intermediate Chronotype	110 (87.3%)	16 (12.7%)	
Evening Chronotype	66 (89.2%)	8 (10.8%)	
Total	197	26	

Table 3. Mean Test Anxiety Scores of Medical Students Based on Gender

Gender	Number	Mean (SD)	P value
Female	109	42.65 (9.66)	0.041
Male	114	45.55 (11.42)	
Total	223		

SD: Standard deviation

Differences in test anxiety scores across morning, intermediate, and evening circadian preference groups were assessed using the Kruskal-Wallis test. The mean test anxiety level showed a statistically significant difference among students with morning, evening, and intermediate patterns (H-value=9.32, P =0.009) (Table 4).

Table 4. Mean Test Anxiety Scores of Medical Students Based on Morningness-Eveningness Chronotype

Gender	Number	Mean (SD)	P value
Morning	23	50.69 (9.89)	0.009
Intermediate	126	43.65 (10.93)	
Evening	74	42.91 (9.85)	
Total	223		

SD: Standard deviation

There was a significant difference between morning and intermediate students (Test statistic = 41.33, P =0.014) and between morning and evening students (Test statistic= 45.517, P =0.009) (Table 5).

Table 5. Dunn's Post hoc Test Results for Significant Differences between Groups

Morning	Groups	Mean Difference	SD	95% Confidence Interval		Test Statistic	P-value
				Lower Bound	Upper Bound		
	Intermediate	7.04	2.37	1.43	12.65	41.33	0.014
	Evening	7.77	2.5	1.87	13.68	45.51	0.009

SD: Standard deviation

To investigate the relationship between sleep quality and test anxiety in medical students at AJUMS, Spearman's correlation coefficient (r =-0.342) was used at an error level of 0.05. Sleep quality had a statistically significant inverse relationship with test anxiety in medical students, meaning that as anxiety increased, students' sleep quality decreased (P =0.001) (Figure 1).

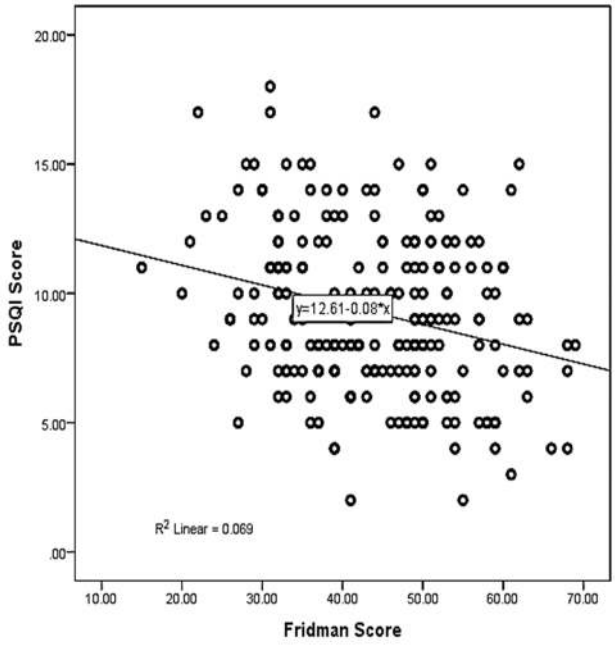

Figure 1. Relationship between Sleep Quality and Test Anxiety

Discussion

Most female (61.5%, n=67) and male (51.8%, n=59) medical students exhibited an intermediate circadian preference. Despite the observed numerical differences, gender had no significant association with Morningness-Eveningness patterns within the student population at AJUMS. Student sleep quality was generally poor, and no significant differences in sleep quality were observed across morning, evening, or intermediate circadian patterns. The study population was nearly evenly distributed between high (49.8%, n=111) and low (50.2%, n=112) test anxiety categories. The overall mean test anxiety score was 44.13 ± 10.67. Significant gender differences were observed in mean test anxiety scores, and scores also varied significantly across morning, intermediate, and evening circadian preference groups. Furthermore, a significant inverse correlation was found between sleep quality and test anxiety among medical students, indicating that higher test anxiety scores were associated with poorer sleep quality. These results indicate that interventions such as sleep hygiene education and stress management help improve students' sleep quality and reduce their anxiety (31).

Furthermore, aligning the timing of classes and exams with students' chronotypes can improve academic performance. Designing and implementing these interventions with gender differences in mind can help promote the mental health and academic performance of medical students (32). Chapell et al. observed an inverse relationship between general anxiety levels (Spielberger) and grade point average (GPA) among undergraduate and graduate students in non-medical fields. Female undergraduate students with low anxiety had higher GPAs compared to female undergraduates with high anxiety. However, male undergraduates with low and high anxiety showed no significant GPA differences. Female graduate students exhibited both higher anxiety and higher GPAs compared to their male counterparts, and a similar pattern was observed among undergraduates (33).

Contrary to the findings of Chapell et al. (33), the present study revealed a higher mean test anxiety score (Friedman and Bandas Jacob) among male students compared to female students. This discrepancy could stem from methodological differences, such as the assessment of test-specific versus general anxiety, cultural field, or variations in the studied academic disciplines. However, aligning with our results, another study reported test anxiety levels among dental students exceeding the average (34).

An interesting finding from the present results was that the mean test anxiety score differed significantly across morning, evening, and intermediate circadian patterns. This significant difference was observed between students with morning and intermediate patterns, as well as between students with morning and evening patterns. Notably, the mean test anxiety score was significantly higher among students with a morning chronotype.

A previous study examining the personality styles of chronotypes reported that both thinking and behavioral styles are associated with Morningness-Eveningness patterns. Specifically, morning individuals are associated with a thinking style that prioritizes trust in direct experience over inference or abstraction, as well as a preference for processing knowledge through logic and analysis rather than emotions and personal values. Therefore, the high-test anxiety levels observed in morning chronotype medical students in this study may be attributed to their logical decision-making and behavioral characteristics (33).

Previous studies have shown that personality traits and cognitive styles are related to chronotype, such that

morning-type individuals tend to base their decision-making and information processing on direct experience, logic, and analysis, paying less attention to personal feelings and values (25). Therefore, high test anxiety in morning-type students may stem from their logical behavior and misaligned exam timing (13:00) with their peak cognitive performance. Interventions like stress management and adjusting exam schedules by chronotype may help reduce their anxiety.

Given that examinations at the School of Medicine of AJUMS are scheduled between 12:30 PM and 2:00 PM, the observed higher test anxiety in morning chronotype students may reflect a mismatch between their preferred cognitive performance times and the exam schedule.

In this study, test anxiety was found to be higher in morning-type students compared to intermediate and evening-type students. One possible explanation is that the exams were held between 12:30 and 14:00, which does not align with the peak cognitive performance time for morning-type individuals.

Our data do not provide direct evidence for the role of (logical decision-making style) in explaining this difference. Therefore, we focus on timing mismatch as the most plausible explanation, which aligns with previous research on the impact of circadian rhythm alignment on performance and anxiety. Chronotype studies have shown that morning-type individuals tend to perform best in the early morning, while evening-type individuals perform better in the late afternoon or evening. Therefore, the time of the exam may have contributed to the increased anxiety in morning-type students. These findings have implications for academic planning, suggesting that aligning exam times with students' chronotypes can help reduce test anxiety and optimize performance.

A study at a Brazilian university, where classes started at 7:00 AM, reported higher general anxiety levels in evening chronotype students compared to morning chronotype students (17). This suggests that the timing of academic schedules significantly influences anxiety levels, requiring students to align their biological rhythms with social study cycles. Consequently, the observed higher anxiety in evening chronotype students in that context may result from a desynchronization between their endogenous rhythms and the imposed social schedule (17). Prior research has demonstrated a significant association between chronotype and cognitive performance in student populations. Specifically, individuals tend to exhibit enhanced performance on cognitive tasks, including theoretical and practical assessments, as well as seminar participation, when the timing of these activities aligns with their preferred chronotype (35).

Previous studies have shown that aligning academic activities with students' chronotypes improves performance. A Brazilian study found that evening-type students had more anxiety when classes started at 7:00 AM. These findings highlight the impact of scheduling on anxiety and suggest that future research should investigate adjusted exam times by chronotype. Such interventions could provide a practical solution for reducing chronotype-related anxiety and improving academic performance (17).

This study also assessed student sleep quality, revealing a prevalence of poor sleep among participants.

Our findings showed that 88.3% of medical students have poor sleep quality, which is significantly higher than the rates reported in other regions. Almojali et al. (2017) found that about 57% of medical students had poor sleep quality, citing factors such as lifestyle and academic stress, with a significant association between high stress levels and poor sleep quality. Given the vital role of sleep in cognitive performance, memory consolidation, and mental health, these findings highlight the urgent need for interventions to improve sleep quality among medical students (36).

Notably, we did not find any significant association between sleep quality and Morningness-Eveningness chronotypes. These findings are consistent with Schlarb et al. (37), who also reported low sleep quality in a student population. University students undergo significant life transitions, including leaving home, navigating increased independence and new social environments, and managing academic responsibilities (38). Approximately 90% of university students share living accommodations, and within this group, 41% report nighttime awakenings by noise from their roommates (39). These disruptions, along with the inherent stressors of student life, significantly impact sleep quality. Over half of university students report poor sleep, experiencing issues such as insomnia and nightmares (7, 40). A previous study showed that sleep problems are associated with decreased academic success and lead to lower GPAs (40). Another study found that evening chronotype students had poorer sleep quality and were more prone to psychiatric disorders compared to morning chronotype students (41). A significant finding in this study was the inverse relationship between sleep quality and test anxiety

levels. The significant inverse relationship between sleep quality and test anxiety observed in our study suggests that interventions aimed at improving sleep or reducing anxiety can enhance the overall well-being and academic performance of students. Possible strategies include holding workshops on stress management and anxiety reduction, providing sleep hygiene education and counseling services, and adjusting educational scheduling to accommodate students' chronotypes (42, 43). A study showed that students with poor sleep quality exhibited higher general anxiety levels (44).

Limitations: Some limitations of the present study included a small statistical population due to time constraints, which limited the scope of our conclusions. Moreover, we were unable to examine more diverse samples (students in different levels and fields) and account for several potential confounders of volunteer anxiety, including the impact of academic workload, social isolation, substance use, residential changes, electronic devices, and financial stressors.

In addition to the mentioned limitations, the study's cross-sectional design is also a significant limitation, as it does not allow for the determination of a causal relationship between anxiety and sleep quality. In other words, it is unclear whether anxiety causes poor sleep or poor sleep leads to higher anxiety.

Conclusion

Based on the findings of this study, it is recommended that exam schedules and, to some extent, class timetables be adjusted according to students' different chronotypes. This approach could reduce student anxiety and improve academic performance. Therefore, considering morning and evening preferences as physiological and individual traits is important. Allocating class hours and exam times to cognitive needs during periods that align more closely with students' circadian rhythms, while avoiding challenging classes early in the morning or late in the afternoon, can help reduce anxiety and improve sleep quality. However, implementing such a program in a university setting faces practical constraints and challenges, including coordinating classes and instructors, space limitations, and administrative complexities. Pilot programs, multiple exam sessions, or flexible options could serve as initial steps to assess feasibility and gradually implement this approach. Additionally, incorporating sleep hygiene education and stress management as practical modules into new student orientation programs can raise awareness and promote healthy sleep habits. Ultimately, paying attention to students' chronotypes and morning-evening preferences can guide improvements in academic planning and university management decisions.

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Conflict of interests: There is no conflict of interest.

Ethical approval: The study was approved by the Human Ethics Committee of Ahvaz Jundishapur University of Medical Sciences (IR.AJUMS.REC.1403.229). Participants entered the study after receiving the necessary explanations and gaining confidence in memorizing the information contained in the questionnaire, providing written informed consent. The present researchers confirm that all methods were performed in accordance with the relevant guidelines, regulations, and of Declaration of Helsinki.

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Original Article

Artificial Intelligence Training Program in Research Based on Social-Cognitive Theory: Design and Validation

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Abstract

Background: The goal of research in any country is scientific growth, with a key focus on empowering students to conduct high-quality research. This requires keeping pace with the latest advancements in the world, but in a principled manner by increasing students' motivation as their driving force for conducting research. This can only be achieved through proper training in utilizing these advancements, relying on the researcher themselves.

Methods: Initially, the opinions of at least 10 artificial intelligence experts were collected using the Delphi method over three rounds, along with the opinions of 10 psychology experts over two rounds. The points obtained from the open-ended questions in the first round were transformed into questionnaires for each field, and this process continued until consensus was reached. Subsequently, based on the results from the previous stage and the theoretical foundations of social-cognitive theory, a five-session protocol was developed and confirmed by 10 experts from both fields for face and content validity.

Results: The results obtained from the Delphi rounds contained 34 points regarding the training of using artificial intelligence tools, including a general introduction to the concept of chatbots and language models, introduction of general and specialized tools, correct and principled prompt writing, displaying errors, and cross-checking with scientific texts. It also included creating a proper culture regarding artificial intelligence as a research assistant rather than a research author, accepting ethical and content responsibility by the researcher, stating the policies of reputable global journals, and the necessity of adhering to them. Additionally, 44 points related to aligning education with social-cognitive theory, such as step-by-step training with visuals and personalization, the necessity of goal-setting and planning, utilizing the experiences of capable role models, and applying the taught materials were identified, along with 15 tools such as Chat GPT, Scopus AI, NotebookLM, and Scite AI. Despite the high content validity of this protocol (via 10 experts, CVR and CVI), the credibility of the Delphi results depends on the scientific credibility of its members. Since all participants in this research were faculty members of reputable universities, the high credibility of the obtained results can be emphasized.

Conclusion: This educational program, considering the foundations of social-cognitive theory and its goals of self-regulation, self-efficacy, and research engagement of graduate students, can serve as a promise as a supportive strategy for the future of research in the country, in line with global advancements and their proper utilization.

Keywords: Research; Delphi technique; Validation study; Social-cognitive theory; Artificial intelligence

Background

Artificial intelligence is a broad field of computer science that aims to make computers intelligent enough to think, learn, and perform human tasks, cognitive functions, and human communications, thereby helping individuals to enjoy a better life without hard work (1). Universities, or higher education in general, are among the areas where artificial intelligence has penetrated, and despite its numerous advantages in education (2, 3), it has also assisted students in research. Research, as a

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significant factor in increasing and solidifying knowledge, is a process that involves a series of steps for collecting and analyzing information (4). A clear example of this can be seen in the final research report of graduate students titled a thesis, where timely completion is economically significant and holds personal satisfaction and other considerations (5). Delays or failure to complete it also bring about financial and psychological issues (6). However, a significant percentage of students have a negative attitude towards research (7) due to various challenges, such as research anxiety (8), writing problems (9), reading articles and conducting research (10), access to databases (11), lack of time and knowledge (12, 13), which makes appropriate training necessary to create a positive attitude (13).

In this context, numerous studies have shown that AI-based tools possess features such as plagiarism detection, literature review, finding related articles (14), language correction tools, and time savings (15). However, challenges such as dependency on these tools, devaluation of traditional skills (16), originality and quality of authorship, blurring the lines between human and machine creative work, and ethical considerations (17) also exist. Using AI tools is not academic misconduct but a modern method of writing (16). However, it is crucial to note that artificial intelligence is a complementary tool and does not replace the researcher and their cognitive and creative processes (18). As mentioned, many barriers to conducting research also relate to the researcher themselves and their motivation and knowledge. Therefore, considering the importance of the individual, it is necessary to view the researcher and research, which is a type of behavior, from a psychological framework as well.

One of the most important theories in psychology is Bandura's social-cognitive theory, which considers human behavior and performance as the result of the reciprocal interaction of behavior, person, and environment, referred to as reciprocal determinism. This theory attributes a significant portion of behavior to the individual themselves. It states that the influence of the environment on the person and behavior is not solely through experiences in social or physical environments but can also occur through observation, which is referred to as observational learning. Another important construct is self-regulation, which indicates that individuals have the capability for self-direction and play a crucial role in regulating and determining their behavior. To achieve their goals, they must choose close and self-motivating plans and guidelines (19). Zimmerman also believed that personal factors, including self-efficacy; behavioral factors, such as self-observation, self-judgment, and self-reaction; and environmental factors, including social support and contextual structure, influence self-regulation (20). Self-efficacy is another important construct that is central to human agency (19). This means that, in addition to having knowledge and skills, an individual's judgment about their ability to perform a specific task and achieve goals is also important. This relates to the individual's judgment with any skill, which is influenced by four sources: actual experiences, vicarious experiences, verbal persuasion, and physiological states (19, 21). According to this theory, being influenced by more than three pillars, or in other words, any factor affecting behavior, including self-regulation and self-efficacy, leads to greater engagement and more active participation in that activity (19).

Therefore, according to social-cognitive theory in the realm of research regarding personal factors, one can refer to motivations, critical thinking, self-efficacy, self-regulation, and even emotional states such as stress; environmental factors include deadlines, feedback, citation databases, libraries, laboratories, and behaviors related to searching for articles, summarizing, collecting and analyzing, writing, and reporting findings. Also, one can learn through observing professors, peers, and even reading articles from other researchers instead of through trial and error. Furthermore, a study on self-regulation indicated that all stages of research require planning and reviewing potential outcomes (22), which can be understood as the motivational, behavioral, metacognitive, and environmental capabilities of the researcher in starting work and employing strategies such as organizing, monitoring, and self-assessing to achieve their goals (23). Self-efficacy, another important factor in research (24), is defined as the individual's trust, belief, and confidence in their ability to successfully perform research-related tasks (25). Research engagement refers to active cognitive, behavioral, and emotional involvement in research, characterized by experiences of energy, selflessness, and immersion in studies (26).

Studies have shown that artificial intelligence can enhance self-regulation through ideographic methods (27), support metacognitive, cognitive, and behavioral processes (28), and utilize its strategies (29). Increased self-efficacy in programming (30) and writing, as well as positive emotional experiences, have also been other

impacts of artificial intelligence (31), leading to increased engagement and motivation among learners (32-34). However, these studies have often focused on education, with limited research in the area of research.

For instance, studies have pointed to the application of tools such as Chat GPT (35), Perplexity, Grammarly (36), and Semantic Scholar (37) in conducting research, but these studies often focus on the capabilities and limitations of these tools or their mere application. Additionally, several studies have indicated that texts generated by these tools lack depth (36), may contain fabricated references (38), pose a risk of dependency on them (39), and thus require review and editing (40), and should not replace the researcher's judgment (35), emphasizing that maintaining the accuracy and objectivity of the researcher is vital (41). Moreover, studies that have employed AI-based tools in the form of experimental research often lack a theoretical framework (31).

In summary, considering the importance of research, it is essential to align it with the latest global advancements. On the other hand, a significant portion of research is conducted by students, who must possess the necessary capabilities. However, due to a lack of sufficient knowledge and skills, ignorance of ethical principles, challenges posed by these tools, dependency on them, and the diminishing role of the researcher, as well as barriers to conducting research that relate to individual factors, it is essential to use this technology within a structured educational program emphasizing the role of the researcher. In this regard, no studies were found based on the conducted search, and most studies focused on education rather than research. Therefore, the present study is novel in its application of a theoretical framework and the use of the latest supportive tools in conducting research. The aim of this research was to develop a program for utilizing artificial intelligence in research based on Bandura's social-cognitive theory.

Objectives

The aim of this research was to develop and validate an artificial intelligence training program in research based on social-cognitive theory.

Methods

The present study was qualitative in nature, with applied-developmental objectives. Given the lack of available valid tools prior to conducting quantitative work, the researcher proceeded with intervention design and exploration. Additionally, due to the novelty of using generative artificial intelligence in research and the absence of validated intervention programs on one side, and the unique expertise of specialists from the fields of psychology and computer science on the other, this research initially began with a Delphi study to gather opinions from experts in these two domains. The Delphi method aims to achieve reliable consensus among specialists and experts through a process involving repeated questionnaires and controlled feedback (42). This flexible and systematic approach is utilized when the issue is complex, new, and has limited evidence, allowing experts to anonymously collaborate and reach a consensus on the matter (43). Typically, two to three rounds of Delphi are sufficient to achieve consensus (44), and literature recommends having 10 to 18 participants in each panel, with one of the requirements being the selection of qualified experts (45). Among the advantages of this method are providing feedback on the collected information to each member, allowing each member to revise their judgments (46), and obtaining rich information due to the repetition and review of responses (45). In this study, the classic Delphi design was employed, characterized by the anonymity of participating experts, data collection through successive rounds, feedback provision to members, and group analysis of responses (47). The steps of the study can be seen in Figure 1.

Phase One (Delphi Study)

This research was conducted with the ethical code IR.UM.REC.1403.277, which was conducted in the first phase based on the Delphi design. Initially, a targeted number of 18 computer science specialists and 15 psychology specialists were invited. The specialists invited were from Ferdowsi University of Mashhad, Birjand University, the University of Tehran, and Shahid Beheshti University in Tehran. Among them, professors from Ferdowsi University of Mashhad and Birjand University accepted the invitation to participate in the research.

The criteria for selecting specialists included holding at least a PhD in computer science and training in the application of AI-based tools (for the computer science group) and holding a PhD in psychology or educational psychology with familiarity and teaching experience in social-cognitive theory (for the psychology group), being a faculty member in the same field at a public university, willingness to participate in the research, and availability. Subsequently, personalized invitations were presented to each faculty member in person, tailored to

their respective fields and specialties, detailing the objective and topic, the required duration, the number of potential rounds, and signed by the research team. For those professors located in other cities, the invitations were sent via email. Among the invitees, 13 faculty members from the computer science group, including 4 professors, 8 associate professors, and 1 assistant professor, as well as 12 faculty members from psychology, including 1 professor, 2 associate professors, and 9 assistant professors, accepted the invitation and entered the Delphi study. It is worth noting that the reason for selecting computer science specialists was that the main focus of the work was the use of artificial intelligence, which falls under the domain of computer science. The reason for choosing specialists from the fields of psychology and educational psychology instead of cognitive psychology or psychometrics is that social-cognitive theory is a comprehensive theory within psychology. Moreover, in terms of education, the greatest use and application of this theory is with educational psychology. On the other hand, cognitive psychology focuses more on memory, attention, and similar areas, while the present study is centered on motivation, and the aim of this research was not to design a questionnaire or similar items, making the presence of psychometric specialists unnecessary.

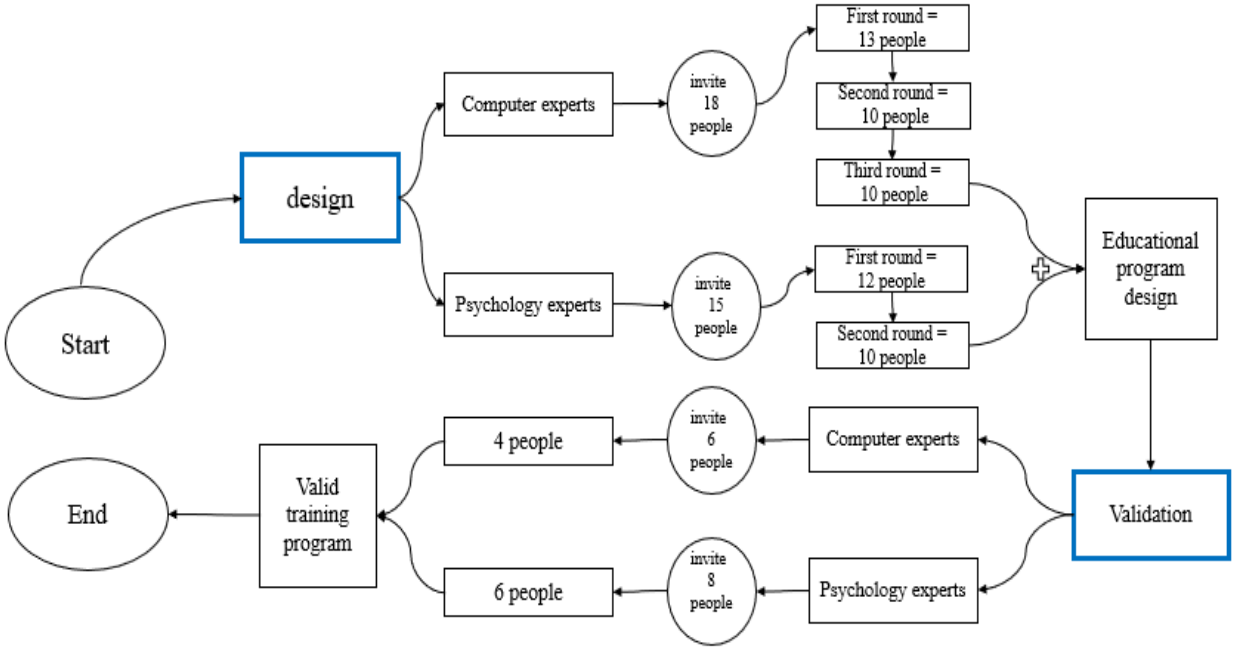

Figure 1. Flowchart of the steps taken in the research

Initially, in the first round, a questionnaire with open-ended questions was provided to the members. This questionnaire was tailored to the specialties of the two different groups, such that the questionnaire for the computer science specialists contained 6 open-ended questions, while the psychology specialists had 1 open-ended question regarding the content of the training and how to present this content (Table 1). The questionnaires were sent to the university emails of all specialists, but responses were collected according to the convenience of each specialist, either via email, structured in-person interviews, or voice messages in messaging apps (one computer science specialist).

It is worth noting that the interviews and voice messages were transcribed in writing. The reason for having 6 questions for the computer science group, as opposed to just one for the psychology group, is that various AI-based tools are continuously advancing, and new tools are emerging. Therefore, familiarity with, utilization, and application of these tools may differ among members of the computer science group. Additionally, given the unique knowledge of specialists in this field, who are more informed about the foundational basis of these tools than any other group, more detailed questions regarding the application of these tools in various aspects of research were deemed necessary.

However, for psychology specialists, one question seemed sufficient since it pertained to social-cognitive theory, with which they were fully familiar, and this was evident in the lack of need for a third round of Delphi for this group.

Table 1. Questions from the first round for specialists in computer science and psychology

Field of Specialists	Questions from the First Round
Computer	1. In your opinion, in what areas (such as topic selection, abstract, introduction, background, quantitative/qualitative research methods, findings, discussion, conclusion, plagiarism, etc.) can artificial intelligence assist graduate students in a research project, including writing articles or theses? 2. What content and materials do you believe should be taught in various sections of research work for training in the use of artificial intelligence? 3. What tools, software, or AI chatbots do you recommend for teaching this content? Please provide your reasons. 4. For each of the tools mentioned in your previous answer, for which components of the research work do you recommend them? 5. In your opinion, how or through what means can the necessary content be taught using artificial intelligence tools? 6. What important aspects should be considered for an artificial intelligence training program in research that were not addressed in the questions?
Psychology	1. In your opinion, how should an educational program using AI tools be designed to enhance self-regulation, self-efficacy, and research engagement among graduate students?

Subsequently, in the second round, the responses obtained from the specialists were summarized and compiled with further explanations, and a questionnaire with a 7-point Likert scale (ranging from strongly agree to strongly disagree) was provided again to the specialists to indicate their level of agreement with the questionnaire that was formulated based on the analysis of the responses from the first round. At this stage, 10 individuals from each field completed and returned the questionnaires. The reduction of 3 and 2 participants, as noted through follow-up, was primarily due to a lack of sufficient time and the specialists' emphasis on the knowledge and skills of the supervising and advising professors. The responses collected in the second phase were analyzed, and the upper median of the responses was considered as the consensus among the specialists. Items that were very close to the median or additional items suggested by specialists at this stage were resent to the specialists with explanations and reasons. This process continued in the same manner until consensus was reached among the specialists, thus achieving agreement among the computer science specialists after 3 rounds and among the psychology specialists after 2 rounds.

Phase Two (Protocol Development and Validation)

Based on the results obtained from the previous phase and the key themes derived from the theoretical foundations (19), a protocol consisting of 5 sessions of 90 minutes each (and extending to 120 minutes if necessary) was developed and presented to 14 specialists from the psychology and computer science groups, who were purposefully selected for validity assessment. The criteria for selecting specialists from the psychology group included holding at least a PhD in psychology or educational psychology and having at least 3 years of teaching experience in social-cognitive theory. For the computer science group, the criteria included holding at least a PhD in computer science with a focus on artificial intelligence and having a minimum of 6 years of teaching experience in theoretical and practical aspects of artificial intelligence. After selecting the specialists, a validity form was sent, which included definitions, objectives, methods for developing the intervention, implementation procedures, assignments, a summary of session content, and the duration of each session, enabling them to assess face validity and provide their comments and suggestions, as well as evaluate the content validity of the protocol using the CVR index to assess the necessity of the content and the CVI index to evaluate the relevance, simplicity, and clarity of the content. Following a one-month follow-up, 10 specialists completed and returned the form, of whom 8 (80%) were male and 2 (20%) were female. Additionally, among this group, 4 (40%) were associate professors and 6 (60%) were assistant professors from five different universities.

Results

The results of the present study in the first round of Delphi were summarized based on the responses of faculty members to the open-ended questions, which were categorized into two different groups. The demographic information of the Delphi members is presented in Table 2.

Table 2. Demographic information of Delphi project experts

Field name	Delphic rounds	Number of participants	Role	Gender
Computer	First	13 people	Professor (4 people)	Male
			Associate Professor (8 people)	Male
			Assistant Professor (1 person)	Male
	Second	10 people	Professor (2 people)	Male
			Associate Professor (7 people)	Male
			Assistant Professor (1 person)	Male
	Third	10 people	Professor (2 people)	Male
			Associate Professor (7 people)	Male
			Assistant Professor (1 person)	Male
Psychology	First	12 people	Professor (1 person)	Male
			Associate Professor (2 people)	Male
			Assistant Professor (9 people)	Male (6 people)/Female (3 people)
	Second	10 people	Associate Professor (1 person)	Male
			Assistant Professor (9 people)	Male (6 people)/Female (3 people)

Based on the responses obtained from 13 specialists in the computer science group, a questionnaire containing 28 items on educational content, 14 items on application and permissible use, 5 items on limitations and principles of use, and 32 AI-based tools including chatbots and similar resources was designed. This questionnaire was provided to the members in the second round to indicate their level of agreement on a 7-point Likert scale. The choice of a 7-point scale was intended to increase the range of options and the accuracy of the specialists' responses, as this scale is often preferred over 9-point or 5-point scales in research (47, 48). It is important to note that the Kendall's coefficient of concordance is used for ranked data; thus, given that the data collected in this research utilized a Likert scale, which is an ordered categorical measurement level, there was no need to calculate Kendall's coefficient. Additionally, most studies have not calculated this coefficient, and the commonly used criterion for evaluations has often been the median (49). The reason for not using the interquartile range was that, according to the formula for this index, the difference between the third and first quartiles for an item scored as 7 and 6 is the same as for an item scored as 3 and 2. This indicates that while the first item shows high agreement among specialists regarding its usefulness, the other item indicates high agreement among specialists regarding its lack of usefulness, thus making this index unsuitable. Furthermore, studies have stated that there is still no agreed-upon guideline in this regard (50).

Among the specialists, 10 completed and returned the questionnaire. By analyzing the data obtained from the questionnaire using SPSS-26 software, the median scores for each item were calculated, and a median score of 5.5 or higher was set as the criterion for selecting each item. Based on this criterion, a total of 13 general items and 5 tools were eliminated due to discrepancies. Among the tools, only 11 were definitively agreed upon by most specialists, while 16 others were slightly below the criterion score. Additionally, 3 new tools were suggested by specialists in the comments section of the second questionnaire. Therefore, a third round was conducted to reach consensus among specialists for a total of 19 tools mentioned, with the reasons for their selection provided by the members. Based on the results from this round, 4 tools reached the required threshold for approval and were included in the main plan. Among the summarized remaining points based on the opinions of the computer science specialists were the need to create a proper culture regarding artificial intelligence as a supportive tool for researchers rather than a replacement, the necessity of review and validation, general training on artificial intelligence concepts and the concept of chatbots and language models, showcasing examples of errors made by these tools, the necessity for professional prompt writing, the complete acceptance of ethical and content responsibility for what is derived from these tools, critiquing AI responses, introducing general and specialized tools, setting limits on their use, emphasizing their role as guides in working with data analysis software rather than conducting the analysis themselves, the necessity of having a supervising professor with knowledge and experience alongside the student for topic selection, and the usefulness of these tools for

translation and correcting the linguistic structure of texts, along with the need for clarification on how and to what extent they should be used and the policies of reputable global journals.

A similar process was carried out for the psychology specialists. Based on the opinions provided by 12 psychology specialists in response to the questions from the first round, a total of 49 items were extracted and then presented in a questionnaire format in the second round. Based on the median criterion of 5.5 or higher and from the returned questionnaires from 10 specialists in this field, a total of 5 items were eliminated due to discrepancies, while the remaining items with higher scores were accepted, thus negating the need for a third Delphi round for this group. Among the summarized remaining points based on the opinions of the psychology specialists were the need for step-by-step, flexible, and personalized training, the necessity of planning and goal-setting for conducting research work, presenting short documentary and video clip, leveraging the experiences of capable role models in this field, the necessity of practical exercises for what has been taught, assessing student needs, providing examples and addressing issues, the necessity of motivational statements from the instructor and their verbal encouragement, the instructor's competence in this field, comparing a sample written by the researcher and AI and identifying similarities and differences, and discussing the applications of these tools at each stage of the research.

The tools that reached consensus in the final stage included Chat GPT, DeepSeek, Gemini, Copilot, Semantic Scholar, Scopus AI, Connected Paper, Perplexity, ResearchRabbit, SciSpace/Typeset, NotebookLM, Grammarly, iThenticate, GPTZero, and Scite AI. The discussions included specialists' opinions on which stages of the research process these tools would be most beneficial, as well as the distinction that general tools are more suitable for broader tasks while specialized tools offer greater capabilities for specific sections.

It is important to note that the reason for selecting a score of 5.5 as the criterion was that the median score of 7 is 4; however, most of the responses obtained were above 5. Additionally, in the computer science group, since 16 tools received a median score of 5, training on all 16 tools would have been somewhat impractical. Thus, efforts were made to select tools with greater consensus among the specialists. However, tools with a median score of 5 were not discarded; rather, they were presented to the specialists in the third round to select the best among them for inclusion in the research. Moreover, studies have shown that an appropriate percentage of agreement for Delphi studies falls within the range of 70% to 80% (50, 51), with around 75% being ideal (52). This percentage of agreement, considering the 7-point scale, is greater than 5 and less than 6, making the median selected in this research appropriate. For the psychology group, due to the greater consensus among the professors, a third Delphi round was not necessary. The questionnaires obtained from the Delphi rounds can be found in Appendices A.1, A.2, and B.1. Additionally, the process of maintaining, eliminating, and adding points obtained from the Delphi study is illustrated in Figure 2.

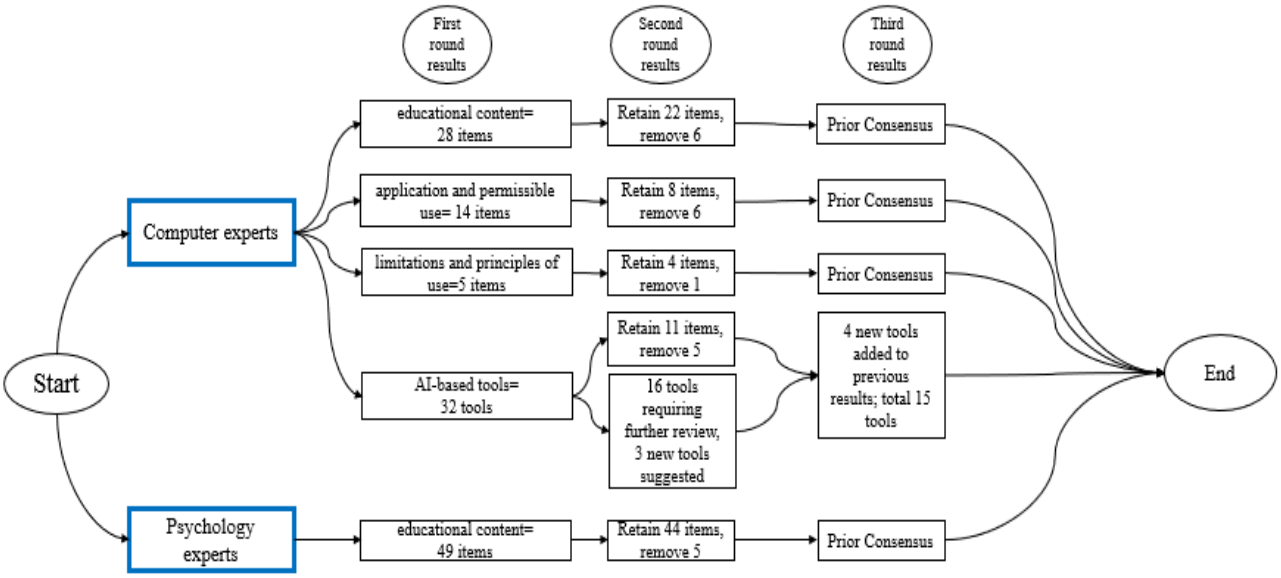

Figure 2: Flowchart of the Steps to Obtain Items in the Rounds

In the following, based on the results and insights obtained from the specialists in the Delphi study, as well as a review of the foundations of social-cognitive theory, a protocol consisting of 5 sessions of 90 minutes each was developed, as shown in Table 3.

As mentioned, the computer science faculty were asked about the content (What), while the psychology faculty were asked about the teaching methods (How). Thus, the integration of results from both groups was structured such that the content and tools suggested by the computer science specialists were included in the sessions, and the presentation methods were tailored to empower the researcher based on the psychology specialists' feedback. Furthermore, there were no significant disagreements between the specialists, except regarding the tools, which is why consensus was reached after three rounds for the computer science specialists and two rounds for the psychology specialists. It is also noteworthy that the integration of results was conducted by the research team, composed of an associate professor in educational psychology and an associate professor in computer science, along with a master's student in educational psychology, a member of the National Elite Foundation, and holding a certificate for over 30 hours of training on the use of AI tools in research, offered by the most reputable universities in the country. Additionally, no specific contradictions were observed in the integration of opinions between the computer science and psychology specialists, with similar points such as simple and step-by-step training, practical exercises, personalized programs, the necessity of required research skills, showcasing AI errors, usage cases, and limits being evident.

Table 3. Intervention developed based on the results of the Delphi study and theoretical foundations

Objectives	Content	Assignments	Implementation Method
Session 1: Introduction to Artificial Intelligence in Research and How to Enter It	Introduction, definition of artificial intelligence and its evolution, brief explanation of key AI concepts, discussion of the requirements and necessity of using AI in line with global scientific growth, advantages of using AI in reducing time wastage and aiding scientific development, applications of AI, short video or documentary on the importance of research, sharing experiences from professors and students, assessing participants' knowledge about working with AI and specifically chatbots, discussing necessary research skills, the importance of self-identifying strengths and weaknesses, emphasizing the need for sufficient knowledge in one's academic field, how to access and use AI, particularly chatbots, principles of effective prompt writing, and the role of AI tools in knowledge management through organization and summarization.	Accessing AI tools, especially chatbots, and using them, writing a professional prompt	Providing examples, practical application of all discussed items, verbal encouragement, evoking positive emotions, addressing questions, predicting outcomes, feedback from the instructor and the chatbot, setting deadlines until the next session, presenting new and reliable information, introducing session tools and their capabilities and limitations. (Explanatory method and group discussion, Q&A, video screening, and practical exercises) (Chat GPT, DeepSeek, Gemini, Copilot) Key Components: Observational learning, Mastery experience, Vicarious experience, Verbal persuasion; Forethought and Self-observation; verbal instruction and feedback
Session 2: Training on Designing a Personalized Program for Conducting Research, Using AI Tools and Chatbots to Identify Research Gaps and Select Topics and Titles	Review of the previous session, analysis of assignments (quality, quantity, etc.), creating a planning table and setting SMART goals, prioritizing short-term and long-term goals, the importance of topic and title selection in research and the role of chatbots in this process, familiarization with leading experts in the relevant scientific field and networking, identifying research gaps with chatbots and determining content and time allocation for each topic, clearly defining standards.	Each individual will create a planning table using AI and chatbots for their research project, exploring topics within their field and identifying at least three new topics through AI, and identifying prominent experts in that area.	Providing examples, practical application of all discussed items, verbal encouragement, evoking positive emotions and anxiety-reducing strategies, addressing questions, predicting outcomes, feedback from the instructor and the chatbot, setting deadlines until the next session, presenting new and reliable information. (Explanatory method and group discussion, Q&A, and practical exercises) (Chat GPT, DeepSeek, Gemini, Copilot, Semantic Scholar) Key Components: Observational learning, Mastery experience, Verbal persuasion; Forethought, Self-Observation, Goal-setting and Performance; Verbal instruction and Feedback

Objectives	Content	Assignments	Implementation Method
Session 3: Training on Smart Searching Skills, Finding Articles, and Writing Research with AI Tools (Identifying Strategies, Solutions, and Recommended AI Software)	Review of the previous session, discussing the necessity and components of the introduction and background, how to gather relevant articles, examining their comprehensiveness and validity, verification, paraphrasing and rewriting, translating, organizing, and summarizing them using AI tools.	Finding articles related to the topics selected in previous sessions, translating, summarizing, rewriting, and organizing them through AI.	Providing examples, practical application of all discussed items, verbal encouragement, evoking positive emotions, addressing questions, predicting outcomes, feedback from the instructor and the AI, verification and referencing, showcasing examples of AI errors, setting deadlines until the last session, presenting new and reliable information, introducing session tools and their capabilities and limitations. (Explanatory method and group discussion, Q&A, and practical exercises) (Scopus AI, Connected Paper, Perplexity, ResearchRabbit, Semantic Scholar, SciSpace/Typeset) Key Components: Observational learning, Mastery experience, Verbal persuasion, Performance and Self-judgment; Verbal instruction and Feedback
Session 4: Training on Using AI Tools in Methodology, Designing Instruments, and Research Results	Review of the previous session, using AI tools to monitor the designed program from previous sessions and their application in methodology and discussion/conclusion, monitoring the progress based on individual plans, using AI in quantitative and qualitative methodologies, creating charts and diagrams to summarize results, evaluating article quality.	Interacting with AI tools to select a quantitative or qualitative method relevant to the topic and research work, understanding how to work with software for each method, providing a small dataset for practice, using feedback tools, designing a 10-item questionnaire.	Providing examples, practical application of all discussed items, verbal encouragement, evoking positive emotions, addressing questions, predicting outcomes, feedback from the instructor and the AI, verification and referencing, showcasing examples of AI errors, providing new and reliable information, introducing session tools and their capabilities and limitations, and introducing tracking tools and setting alerts to monitor completed activities. (Explanatory method and group discussion, Q&A, and practical exercises) (NotebookLM, Chat GPT) Key Components: Observational learning, Mastery experience, Verbal persuasion, Performance and Self-judgment; Verbal instruction and Feedback
Session 5: Training on Using AI Tools in Source Review, Work Evaluation, Plagiarism Detection, and Presenting Research Results	Review of the previous session, correcting linguistic structure, ethical principles required with the introduction of AI, detecting plagiarism and AI-generated texts, reviewing and analyzing the policies of reputable journals worldwide, usage cases, how to use and limits of use, providing a sample abstract and problem statement by individuals and AI tools, examples of unintentional plagiarism, mental imagery, emphasizing the culture of proper use of AI tools, stressing the complete acceptance of the use of AI tools by the author, awareness of potential shortcomings of AI, presenting research results and summarizing.	Writing a short text both by participants and AI tools and reviewing its validity, creating a short presentation file.	Providing examples, practical application of all discussed items, verbal encouragement, evoking positive emotions, addressing questions, predicting outcomes, feedback from the instructor and the AI, providing new and reliable information, introducing session tools and their capabilities and limitations. (Explanatory method and group discussion, Q&A, and practical exercises) (NotebookLM, Grammarly, iThenticate, SciSpace/Typeset, GPTZero, Scite AI) Key Components: Observational learning, Mastery experience, Verbal persuasion; Performance, Self- reflection, and Self-reaction; Verbal instruction and Feedback

This protocol, along with the content validity form, was sent to 14 specialists from both the computer science and psychology groups to evaluate and provide their opinions on its face and content validity. The demographic information of the specialists at this stage is presented in Table 4.

In total, 10 specialists returned the submitted forms, and the results obtained from the CVR and CVI index calculations for each session are shown in Table 2. As observed, the content validity ratio (CVR), according to Lawshe's criterion (53), which is 0.62 for 10 specialists, was high in all sessions except for the fourth session. It is worth noting that two specialists who evaluated this session as useful were from the AI group and stated that research methods vary by discipline, and in computer science, which relies on simulation, the quantitative and qualitative methods used in the humanities do not apply.

Additionally, according to one specialist's comments on this session, methodology should be derived from articles, and AI should merely serve as an intermediary

rather than a provider of methods, thus data should be handled by human intelligence and the researcher according to the specific methodology required for that research. Therefore, given the explanations provided and the fact that there is only a 0.02 difference from the main index, this can be considered somewhat acceptable. Moreover, according to Waltz and Bausell (54), the acceptable value for the CVI index should be above 0.8, and as shown in Table 5, all values exceeded this threshold, indicating that the content across all sessions was relevant, simple, and clear.

Table 4. Demographic information of specialists in the validation phase

Field name	Number of Participants	Role	Gender
Computer	4	Associate Professor	Male
Psychology	6	Assistant Professor	Male (4), Female (2)

Table 5. Results of the content validity ratio (CVR) and content validity index (CVI) study

Session number	CVR Index	Index CVI		
	Necessity	Relevance	Simplicity	Clarity
First	1 (10 essential)	1	1	1
Second	0.8 (9 essential and 1 useful)	1	1	0.9
Third	0.8 (9 essential and 1 useful)	1	1	1
Fourth	0.62 (8 essential and 2 useful)	0.9	1	1
Fifth	0.8 (9 essential and 1 useful)	1	1	1

Discussion

Within the framework of social-cognitive theory, and emphasizing its key concepts this theory (19), an educational program in the field of research was developed. In this process, insights from computer science specialists regarding the best current artificial intelligence tools to assist in conducting research and their proper and principled use were utilized. Additionally, feedback from psychology specialists was incorporated to better design this program in accordance with the concepts of social-cognitive theory, merging all viewpoints from both groups of specialists with scientific foundations. Thus, this educational program aimed to encompass the core and significant concepts of social-cognitive theory, such as reciprocal determinism, observational learning, sources of self-efficacy, and stages of self-regulation.

These concepts can be effectively integrated into a workshop environment that provides access to systems for practical training, articulates the importance and advantages of conducting research in general, and discusses the benefits and challenges of using AI tools in research tasks. The program emphasizes building self-efficacy through experience and practical exercises by participants, addressing questions and providing feedback from instructor, aligning with what the instructor presents or demonstrates, and observing examples that the instructor performs. It also highlights the insufficiency of self-belief and the necessity of having a well-structured plan and goal-setting for timely research completion using these tools. The program includes strategies for achieving these goals, such as translation, rewriting, finding relevant articles, and creating concept maps of article content through AI tools, monitoring completed tasks using these tools, and allowing participants to evaluate themselves after participating in the program through descriptive responses, short answers, or oral assessments. This program was designed in five 90-minute sessions and was conducted in a group format, including in-session assignments and the use of tools, as well as tasks outside of the sessions. Based on the literature review, no study was found that designed and implemented an educational program in this manner specifically in the field of research, thus precluding a comparison of the current program's alignment with other similar studies.

However, studies abroad have explored the training of AI tool usage within the framework of self-regulation according to social-cognitive theory, particularly in areas such as academic progress and education rather than research, which aligns with the present program. For instance, Huang and colleagues (55) conducted an experimental study with 75 incoming programming students to investigate the impact of using an AI tool in an experimental group compared to a regular teaching assistant in aiding the performance of students in the

control group. They designed their training program based on the need for incoming students to develop self-regulation according to Zimmerman's framework (56), which is rooted in social-cognitive theory. Initially, in the Forethought stage, they emphasized goal-setting and planning, and in the Performance stage, they taught strategies such as note-taking, highlighting, and diagramming using the AI tool, as well as personalized responses from the tool, displaying examples, and practicing. In the Self-reflective stage, they summarized concepts and completed assignments. Their research results indicated that the group utilizing the AI tool not only achieved higher scores in the coding course compared to the other group but also experienced reduced cognitive load and improved self-regulation, particularly in terms of intrinsic goal orientation and task value related to motivation, and metacognitive self-regulation, leading to deeper engagement in their programming activities.

Another study highlighted the necessity of integrating new technologies in blended classrooms and examined the impact of these tools on self-regulated learning and higher-order thinking skills among students. This study utilized Chat GPT for its extensive information resources and immediate feedback, but due to challenges such as learner dependency on these tools, the educational program was designed and implemented based on self-regulation stages to enhance students' problem-solving skills. In the first week, they focused on goal-setting and learning planning according to the first stage of Zimmerman's self-regulation framework. In weeks two through nine, students were encouraged to use these tools when faced with problems and challenges and to engage in group discussions. Week ten was dedicated to self-reflection, which involved recalling concepts learned throughout the course. To assess their results, they designed a GCLA tool that guides learners to derive answers themselves rather than providing direct responses like Chat GPT. Their findings showed that both tools enhanced self-regulation and higher-order thinking skills, but the newly designed tool significantly increased self-regulation, particularly in terms of self-efficacy, intrinsic motivation, cognitive and behavioral engagement, while reducing disengagement. It also promoted higher-order thinking, especially critical thinking and problem-solving (57).

Research has also been conducted within the country, although these studies have not specifically focused on the impact of artificial intelligence or on research itself. However, they are mentioned here because the educational programs they utilized were based on social-cognitive theory. For example, Badakhshian and colleagues (58) demonstrated in their study that their rehabilitation program, grounded in social-cognitive theory, was able to enhance the self-efficacy of individuals with spinal cord injuries. In their educational program, after highlighting the importance of this issue, they employed modeling through familiarization and interviews with a successful individual with this injury, positive feedback, motivational video screenings, goal-setting, identifying challenges and obstacles, and teaching necessary skills. Additionally, a study involving 60 students examined the impact of counseling based on this theory, focusing on perceptions of academic self-efficacy. The intervention implemented in this research addressed past experiences and their consequences, positive role models for vicarious reinforcement, and similar topics. The results indicated an increase in self-efficacy within the experimental group (59).

Hashemian and colleagues (60) also investigated the impact of an intervention based on this theory on increasing physical activity among 246 learners. They applied the constructs of this theory in their intervention sessions. For instance, in the knowledge discussion, they defined and explained the importance of physical activity; in the expected outcomes and its value discussion, they elaborated on the effects of physical activity. They utilized planning and goal-setting for self-regulation and modeling for self-efficacy. They also incorporated observational learning, another prominent component of this theory, through video clips and participant involvement in the program. Their research results indicated that, in addition to improving physical activity, the self-efficacy and self-regulation of the members of the experimental group also experienced significant increases.

Regarding the validity of the educational program utilizing AI tools in research based on social-cognitive theory, and based on the feedback from specialists in both computer science and psychology, the results from the two content validity indices and the content validity ratio indicated that all sessions possessed desirable content validity. In other words, the computer and psychology specialists deemed the training package necessary, relevant, simple, and clear. This aligns with the psychology specialists' views on the consistency of session content with the framework of social-cognitive theory and its concepts (19), in combination with

research, as well as the computer specialists' perspective on the appropriate use of the best available tools during this time frame. However, the results for the fourth session were somewhat different. It's noteworthy that two specialists who evaluated this session as useful were from the AI field and stated that research methods vary by discipline, and in computer science, which is simulation-based, the quantitative and qualitative methods used in the humanities do not apply. Furthermore, one specialist noted in their comments on this session that "methodology should be extracted from articles, and AI should merely serve as an intermediary, not a provider of methods. Therefore, data must be handled by human intelligence and by the researcher according to the specific methodology required for that research." Overall, given the explanations provided and the fact that there was only a 0.02 difference from the main index, this can be considered somewhat acceptable. As mentioned, there were no similar studies to compare the alignment of the current program with them; however, this program is consistent with Bandura's social-cognitive theory and its concepts (19), and it aligns with other somewhat similar programs (55, 57). This program aimed to innovatively combine the important concepts of social-cognitive theory in the realm of research and to appropriately leverage the most significant technology of the day, which is artificial intelligence. The integration of insights from computer science specialists, who have greater knowledge of this emerging technology and its underlying structures, capabilities, and limitations, enhances the value of the content. However, despite its value, this content needs to be presented and taught correctly, maintaining the prominent role of the researcher and enhancing their motivation. This underscores the importance of the perspectives of psychology and educational psychology specialists, who are more connected to motivation and education, thereby highlighting the need for a practical, structured, and interdisciplinary program.

It is important to note that this research faced several limitations, including the lengthy and time-consuming nature of the Delphi process, which led to decreased participation from faculty members as the number of rounds increased and fatigue set in. Additionally, the AI tools available in the intervention may change over time, potentially being replaced by more advanced tools, but usually this progress includes all tools to some extent.

The gender composition of the Delphi participants, which was predominantly male, also posed a limitation. Furthermore, given that the nature of the Delphi process relies on consensus among specialists, the opinions of some experts, which were significant but did not align with others, may have been overlooked. The lack of familiarity of some members with certain tools proposed by other specialists and their selection of the "Neither agree nor disagree" option can also be considered a limitation. Another limitation was the reduction in the number of specialists in the Delphi rounds, which somewhat decreased the stability of responses. However, since the minimum required number of specialists was maintained, with 10 specialists remaining from each field, this was deemed acceptable. Although the overall process of conducting research is somewhat common across different disciplines, the specific requirements of each field should be adapted accordingly. Therefore, the use of the program, especially in the fourth session for engineering disciplines, should be approached with caution. Additionally, the number of specialists in the final round was 10 for each field, and it is recommended that this research be repeated with a larger number of specialists. Moreover, this study only developed an intervention, and it is essential to evaluate its effectiveness on self-regulation, self-efficacy, and research engagement among students. Implementing the developed program with doctoral students and comparing the results with those of master's students is also suggested. Developing an educational program based on other significant psychological theories, such as self-determination theory, and comparing it with the social-cognitive program of this study is another recommendation. It is also necessary to ensure that the content is updated according to the latest versions of the tools for any future implementation of the program. Higher education institutions should provide educational units for using AI-based tools in research for graduate students or arrange practical workshops for them. Establishing regulations for ethical compliance and precise disclosure of the use of these tools is also essential. Conducting structural equation modeling studies, particularly case studies or systematic reviews regarding the use of AI-based tools in research and studies conducted in this area, is another subsequent recommendation.

Conclusion

This research introduced a validated educational program for using artificial intelligence based on social-cognitive theory, aimed at enhancing self-regulation, self-efficacy, and research engagement among graduate students. The program sought to demonstrate the framework for the correct and principled use of

contemporary technologies to graduate students, while also contributing to empowering the dimensions of Bandura's reciprocal determinism, emphasizing the role of the individual and, in general, empowering the research capabilities of graduate students. Furthermore, given the increasing proliferation of artificial intelligence tools with diverse capabilities, another important advantage of this study was the identification of a limited set of necessary and practical tools—recommended by leading experts in the field—that assist researchers while preventing overload and confusion amid the vast array of available options Implementing and comparing the current program across different levels of graduate education or developing a program based on another psychological theory and comparing it with this program will further contribute to the knowledge in this field.

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Conflict of interests: There is no conflict of interest.

Ethical approval: All participating specialists voluntarily participated in the research through invitations and were allowed to withdraw from the research process at any time. The anonymity of all participants was maintained, and only the aggregated results of each field were shared with the specialists without naming individuals in each round. It is worth mentioning that this research was derived from the master's thesis of the first author and was conducted under the ethical code IR.UM.REC.1403.277 obtained from Ferdowsi University of Mashhad.

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Original Article

How Character Strengths Promote Flourishing in Medical Students: The Mediating Role of Resilience

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Abstract

Background: Medical students often face considerable psychological challenges, jeopardizing their well-being. Character strengths and resilience are key constructs in positive psychology that may enhance flourishing, yet their underlying mechanisms require further investigation in medical education contexts.

Objectives: This study aimed to examine the relationship between character strengths and flourishing among Iranian medical students, focusing on the mediating role of resilience.

Methods: A total of 387 medical students were selected through multi-stage cluster sampling. Participants completed the Brief Strengths Test (BST), the Connor-Davidson Resilience Scale (CD-RISC-10), and Rashid & Seligman flourishing inventory. Data were analyzed using structural equation modeling (SEM) and bootstrapping procedures.

Results: SEM revealed that character strengths had a significant direct effect on flourishing (β = 0.425, P < 0.01) and an indirect effect through resilience. Bootstrapped analyses confirmed a significant partial mediation, indicating that resilience accounts for a meaningful portion of the link between character strengths and flourishing (indirect effect β = 0.204, P < 0.01).

Conclusion: These findings underscore the dual role of character strengths in promoting flourishing directly and indirectly by enhancing resilience. Strengths-based educational interventions and resilience-building programs may foster sustainable well-being in medical students, especially within demanding academic environments.

Keywords: Flourishing; Character Strengths; Resilience; Medical Students

Background

Medical education is globally recognized as a high-pressure training environment that places students at significant risk for psychological distress. Large-scale meta-analyses report that approximately 44% of medical students experience burnout, with anxiety and depression affecting around one-third of trainees worldwide (1, 2). High levels of stress and resilience-related challenges have been observed in diverse regions, further underscoring the global pervasiveness of this issue (3). Recent multinational studies have further confirmed that psychological distress among medical trainees remains a widespread concern across Asia, Europe, and North America, suggesting that such challenges are not merely culturally bound but structurally embedded in medical education systems (2, 4).

Iranian medical students mirror this global trend. A national study reported prevalence rates of 37.5% for depression, 41.1% for anxiety, and academic burnout ranging between 9–23% among medical students (5). Moreover, a broader survey of Iranian students found that over 77% scored positively on a general mental health screening instrument, indicating widespread well-being concerns (6). These findings highlight the urgent need to identify promotive factors that sustain well-being rather than focusing solely on psychopathology. These patterns align with those observed in other Middle Eastern countries (7), pointing to both global and regional stressors such as rigorous curricula, competitive admission processes, and sociocultural stigma around mental health. Comparable findings from Western and East Asian contexts highlight that excessive academic workload and perfectionistic expectations are universal predictors of

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burnout and mental distress among medical students (7, 8).

Medical training universally involves heavy academic workloads, high-stakes evaluations, and emotionally demanding clinical rotations (9). However, in Iran, these pressures are compounded by contextual factors including large class sizes, rigid hierarchical structures, limited student autonomy, financial uncertainty, and cultural stigma around seeking help (10, 11). Thus, Iranian medical education provides a distinctive context to examine how internal psychological strengths can buffer distress and promote flourishing. Despite these challenges, most existing efforts in Iranian medical programs have focused on deficit-based individual interventions—such as stress management and symptom reduction—while relatively neglecting strengths-based frameworks that aim to cultivate positive psychological resources. The current study addresses this conceptual gap by examining character strengths and psychological resilience—not merely as individual traits but as promotive assets that contribute to sustainable well-being in this demanding context.

Theoretical foundations suggest that medical education can benefit from a more holistic approach rooted in positive psychology. Positive psychology, with its focus on strengths, resilience, and flourishing, offers an alternative framework to traditional deficit-oriented approaches (12). Flourishing, conceptualized through Seligman's PERMA model (positive emotion, engagement, relationships, meaning, and accomplishment), extends well-being beyond symptom relief (13). In medical education, flourishing has been tied to greater engagement, empathy, and reduced burnout (14, 15). International research further supports this view. For instance, a longitudinal study across 12 European medical schools found that well-being initiatives emphasizing meaning, relationships, and autonomy substantially improved students' flourishing and professional identity formation (16). Similarly, evidence from different cultural settings shows that flourishing functions as a universal protective factor against academic burnout and emotional exhaustion (17, 18).

Nonetheless, little is known about the psychosocial processes by which positive traits promote flourishing, particularly within non-Western medical student populations. Although several mediation studies have examined the links between character strengths, resilience, and well-being, the vast majority of this work has been conducted with Western student samples, and there is little published evidence on whether the same mechanisms operate in Iranian or other Middle Eastern medical education contexts. Therefore, examining these constructs within a non-Western, high-stress academic setting offers novel insight into the cross-cultural generalizability of positive psychological models.

According to the Character Strengths and Virtues (CSV) framework proposed by Seligman and Peterson, character strengths are organized into six principal virtues: wisdom, courage, humanity, justice, temperance, and transcendence. These 24 character strengths are regarded as universally valued and are believed to promote optimal functioning and human flourishing. For example, the virtue of wisdom includes creativity, curiosity, and love of learning—traits especially relevant in educational settings. Research suggests that students who actively apply their character strengths demonstrate greater motivation, persistence, and engagement (19, 20) , which are crucial for navigating the challenges of medical education. The VIA classification of character strengths has been linked to academic engagement and life satisfaction across diverse student groups (21). Meta-analyses confirm that signature strengths interventions enhance well-being and academic outcomes in general populations (22). Among medical trainees, traits such as grit and self-regulation have been associated with lower emotional exhaustion and improved well-being (23). Furthermore, empirical evidence indicates that strengths such as perseverance, curiosity, social intelligence, and gratitude foster positive emotions and adaptive coping, thereby contributing to flourishing (24, 25). However, such studies are almost exclusively conducted in Western contexts, leaving significant gaps in research among Iranian medical students.

A key mechanism through which character strengths may foster flourishing is resilience, defined as the ability to adapt and thrive amid adversity (26). Longitudinal research indicates that higher resilience in medical students is associated with reduced burnout and increased life satisfaction, and it mediates the relationship between academic stress and well-being (3, 27). Recent research has shown that certain strengths such as hope and perseverance promote adaptive coping and emotional balance following interpersonal loss (28), while other studies have found that strengths like zest and gratitude are associated with greater resilience and academic achievement among university students (29). Moreover, evidence from populations exposed to chronic conflict indicates that character strengths can buffer the

adverse effects of prolonged stress and contribute to sustained well-being (30). Yet, most resilience research remains cross-sectional, with limited focus on mediation and scant inclusion of positive personality traits in models of flourishing. Thus, identifying the mediating function of resilience within the strength–flourishing link may illuminate a key pathway for sustainable adaptation among medical students.

Recent empirical studies offer preliminary support for these theoretical propositions. For instance, Martínez-Martí et al. (31) found that character strengths significantly predicted increases in well-being during the highly stressful period of the COVID-19 lockdown. Similarly, de la Fuente et al. (32) identified resilience as a key mediating mechanism linking character strengths to flourishing.

Furthermore, resilience is best understood as a dynamic, interactive process. The Social-Ecological Resilience Theory posits that resilience emerges not only from individual resources but also from contextual factors such as mentoring, peer support, and institutional structures (33). In Iranian medical schools, where the curriculum is highly standardized and hierarchical, factors like mentorship quality and peer cohesion may significantly influence students' resilience. Moreover, Self-Determination Theory (SDT) asserts that the fulfillment of fundamental psychological needs—autonomy, competence, and relatedness—facilitates intrinsic motivation, enhances resilience, and supports overall well-being (34). Research in medical contexts has demonstrated that need-supportive climates—particularly those fostering autonomy—enhance resilience and psychological health. For example, instructor autonomy support indirectly improves student well-being via increased satisfaction of psychological needs (35). Additionally, satisfaction of basic needs—especially competence—predicts greater resilience and better psychological well-being among medical students (36).

Integrating these theoretical lenses provides a comprehensive rationale for the current model. PERMA explains the multidimensional nature of flourishing, SDT clarifies how need satisfaction underpins resilience, the Social-Ecological perspective situates resilience within contextual supports, and Conservation of Resources (COR) theory explains how psychological strengths and resilience function as personal resources that protect against loss and promote gain spirals in well-being. Together, these complementary perspectives justify an integrative model linking character strengths, resilience, and flourishing in demanding educational contexts.

Despite the overlapping importance of character strengths, resilience, and contextual need supports, the extant literature remains fragmented. Few studies incorporate character strengths as predictors of resilience, and even fewer test comprehensive mediation models in medical student populations. In particular, while interventions targeting character strengths—such as identifying and cultivating students' signature strengths—have shown promise in educational settings (22, 37), their specific application in medical education remains underexplored.

Accordingly, this study represents the first known attempt to test a structural equation mediation model examining the indirect effect of character strengths on flourishing via resilience among Iranian medical students. This research not only extends positive psychology theory to a non-Western educational context but also integrates multiple theoretical perspectives into a single empirically testable model—thereby advancing both conceptual understanding and applied practice in medical education.

The present study aims to address these gaps by examining whether resilience mediates the effect of character strengths on flourishing among Iranian medical students. Drawing on PERMA, Social-Ecological Resilience Theory, SDT, and Conservation of Resources theory (38), we propose a model wherein strengths such as perseverance and gratitude both enhance resilience and directly contribute to flourishing. We hypothesize:

1. Character strengths will positively predict flourishing.
2. Resilience will mediate the relationship between character strengths and flourishing.

It is important to note that the present study conceptualizes character strengths as a higher-order latent construct reflecting the overall pattern of positive traits rather than examining the unique predictive weight of each individual strength. This approach aligns with prior structural models in positive psychology that emphasize the synergistic function of character strengths as integrated resources rather than isolated attributes. Accordingly, the study aims to test a general mediation mechanism rather than the relative contribution of specific strengths. By empirically testing this integrative model in a non-Western sample, we contribute to theoretical advancement and provide evidence for interventions—like strengths-based curricula, resilience training, and autonomy-supportive

faculty development—designed to promote sustainable well-being in demanding educational contexts.

Objectives

This study aimed to examine the relationship between character strengths and flourishing among Iranian medical students, focusing on the mediating role of resilience.

Methods

Participants and procedure: The present research employed a descriptive correlational design. The study population consisted of all students enrolled at Kashan University of Medical Sciences during the winter of 2024 (N = 3560). The sample size was determined according to established guidelines for structural equation modeling (SEM). Following the commonly cited N:q rule (39), which recommends 5 to 10 participants per free parameter, and given the number of free parameters in the present model, an adequate sample would range between approximately 245 and 490 participants. The present study recruited 387 students were recruited.

A stratified multi-stage cluster sampling method was employed to ensure representativeness across faculties and academic levels. In the first stage, the main faculties of the university (Medicine, Nursing and Midwifery, Health, Paramedical Sciences, and Dentistry) were identified as strata. In the second stage, classes were randomly selected from each faculty in proportion to the number of students enrolled in that faculty. Within each selected class, students were invited to participate voluntarily. This approach ensured that both undergraduate and professional doctoral students were proportionally represented. The gender distribution of the final sample was approximately balanced, reflecting the actual composition of the student body. Eligibility criteria comprised enrolment at Kashan University of Medical Sciences and the provision of voluntary consent to participate. Exclusion criteria included unwillingness to participate and incomplete questionnaire responses. All participants were fully informed about the anonymous and confidential management of the data, and informed consent was obtained prior to study participation.

The data collection instruments included a demographic form (recording age and gender) and three validated scales measuring character strengths, resilience, and flourishing. Questionnaires were administered in person during class sessions, and participants were allotted approximately 15-20 minutes to complete them.

Measures

Flourishing: Flourishing. Flourishing was assessed using the 25-item PERMA-based Flourishing Inventory (Rashid & Seligman, 2018). Respondents indicated their agreement on a 5-point Likert scale (1 = *never* to 5 = *always*). The scale measures five dimensions of well-being: (a) Positive Emotion (e.g., "*I feel happy*"), (b) Engagement (e.g., "*I engage in activities that require the application of my strengths*"), (c) Relationships (e.g., "*I feel a sense of belonging with my loved ones"),* (d) Meaning (e.g., "*I feel my life has a purpose*"), and (e) Accomplishment (e.g., "*I have accomplished many things well in my life*"). Higher summed scores on each subscale and the total indicate greater perceived flourishing. The instrument has demonstrated satisfactory factorial validity and internal consistency across non-clinical and populations in multiple cultural contexts, where previous studies have supported the structural equivalence of the PERMA dimensions in university samples. Previous Iranian research has examined PERMA-based measures of flourishing and confirmed their psychometric soundness in student populations (α = 0.89) (40). In the present study, the Rashid and Seligman PERMA-based Flourishing Inventory demonstrated satisfactory internal consistency, with Cronbach's alpha coefficients of 0.837 for Positive Emotion, 0.754 for Engagement, 0.853 for Relationships, 0.871 for Meaning, and 0.859 for Accomplishment, indicating good reliability in the current medical-student sample.

Character strength: The Brief Strengths Test (BST) is a psychometric tool designed to assess individual character strengths, encompassing six core components: wisdom and knowledge (e.g., "*I enjoy exploring new ideas.*"), courage (e.g., "*I face challenges with determination.*"), humanity (e.g., "*I am considerate and kind to others.*"), justice (e.g., "*I treat all people fairly.*"), temperance (e.g., "*I am disciplined and self-controlled.*"), and transcendence (e.g., "*I feel a sense of purpose in life.*"). The original scale developed by Peterson and Seligman (41) included 48 items, while the abbreviated version consists of 24 items rated on a five-point Likert scale from 1 (*strongly disagree*) to 5 (*strongly agree*), yielding total scores between 24 and 120, with higher scores indicating a greater presence of character strengths. In the original development by Peterson and Seligman (41) internal consistency (Cronbach's alpha) for the six subscales ranged from 0.70 to 0.73.

Although prior Iranian research has employed character strengths measures, such as the Farsi version of

the VIA-Y-96 in adolescents (42) and the VIA-IS-48 in adults (α = 0.98), no published study has specifically examined the psychometric properties of the BST-24 in an Iranian medical-student sample. The present findings therefore extend the evidence base by demonstrating both construct validity via CFA and good internal consistency in this population. In the present study, Cronbach's alpha coefficients demonstrated satisfactory internal consistency across all subscales: 0.850 for wisdom and knowledge, 0.873 for courage, 0.750 for humanity, 0.738 for justice, 0.870 for temperance, and 0.885 for transcendence. These results indicate high reliability of the BST in the current sample.

Resilience: Resilience was measured by adapting 10 items from The Connor-Davidson Resilience Scale – 10-Item Version (CD-RISC-10), which is a concise self-report instrument designed to assess resilience, defined as the ability to thrive in the face of adversity. Each item is rated on a 5-point Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*), yielding total scores between 0 and 40, with higher scores indicating greater resilience. The scale includes items such as "*I am able to adapt to change*" and "*I tend to bounce back after illness or hardship*". The original 25-item CD-RISC was developed by Connor and Davidson (43) to measure resilience across various populations. Recognizing the need for a more efficient assessment tool, Campbell-Sills and Stein (44) refined the scale to a unidimensional 10-item version, demonstrating robust psychometric properties, including high internal consistency (Cronbach's alpha = 0.85) and construct validity. Subsequent studies have validated the CD-RISC-10 across diverse populations, reinforcing its reliability and utility as a measure of resilience. Rezaeipandari et al. (45) indicated that this version has satisfactory psychometric properties, including high internal consistency (Cronbach's α = 0.89) and good construct validity, supporting its use in Persian-speaking populations. In the current sample, Cronbach's alpha was .885, indicating acceptable reliability.

Data Analysis: Data analyses were performed using SPSS (Version 22) and AMOS (Version 22), with parameters estimated via maximum likelihood estimation. Preliminary screening procedures assessed the presence of missing values, outliers, and adherence to assumptions of multivariate normality. Based on the results of Little's test, the data were missing completely at random (MCAR) ($\chi^2_{(719)} = 698.60$, $p = 0.702$). We used Expectation Maximization (EM), which is a robust and suitable estimation technique for SEM (46), to evaluate the missing data. EM is an iterative algorithm used to restore the complete data matrix by maximum likelihood estimation (47).

Next, univariate outliers were investigated by Z-standardized values and scatter plots while multivariate outliers were examined by Mahalanobis distances (D^2). Two univariate outliers were winsorized. Skewness and kurtosis values between -2 and +2 indicate no substantial departure from normality (48). Thus, the univariate normality assumption was not violated in the present study (Table 1).

Table 1. Descriptive statistics and correlations between the variables

Variables	Character strength	Resilience	Flourishing
1) Character strength	1		
2) Resilience	0.421** (95% CI [0.330, 0.503])	1	
3) Flourishing	0.394** (95% CI [0.317, 0.467])	0.493** (95% CI [0.420, 0.560])	1
Range	50-112	18-48	49-110
Mean	84.127	33.001	82.686
SD	13.814	6.6	14.021
Skewness	-0.601	-0.278	-0.277
Kurtosis	-0.113	-0.611	-0.858

Values in parentheses represent 95% bias-corrected and accelerated (BCa) bootstrap confidence intervals based on 2000 resamples. *$P < 0.05$; **$P < 0.01$

Furthermore, based on Meyers, Gamst, and Guarino's (49) recommendation, Mahalanobis distances were computed to evaluate multivariate outliers for each case. The results of Mahalanobis distance indicated no multivariate outliers. Accordingly, data from 387 participants were included in the analyses (49.6% male, n = 192; 50.4% female, n = 195; M age = 23.1 years).

To ensure the appropriateness of the measurement instruments for application across specific contexts, three independent confirmatory factor analyses (CFAs) were conducted to evaluate construct validity, all of which

demonstrated satisfactory model fit (Table 2). Subsequently, Structural Equation Modeling (SEM) was employed to test the mediating role of resilience in the association between character strength and flourishing.

Table 2. CFA results and reliability coefficients for the measurement instruments

	CMIN	DF	CMIN/DF	P	CFI	RMSEA	SRMR	α
Character strength	375.782	237	1.586	<0.001	0.969	0.039	0.032	0.918
Resilience	96.265	33	2.917	<0.001	0.957	0.070	0.038	0.885
Flourishing	407.120	265	1.536	<0.001	0.966	0.037	0.041	0.917
Acceptable value	CMIN/DF<5		< 0.05		≥0.90	< 0.08	< 0.08	≥0.70

Results

Descriptive statistics, including the means and standard deviations for the three study variables, are presented below: Flourishing (82.64 ± 14.01 for males & 82.72 ± 14.06 for females), character strength (84.05 ± 13.65 for males & 84.19±14 for females), and resilience (32.98±6.41 for males & 33.01±6.79 for females). The results of independent samples *t* tests indicated no statistically significant differences between males and females in terms of flourishing (t=-0.55, p=0.956), character strength (t=-0.102, p=0.919), and resilience (t=-0.047, p=0.962). Table 2 demonstrates the results of first-order CFAs conducted using Maximum Likelihood Estimation method in Amos software and the reliability indices of flourishing, character strength, and resilience scales. As shown in Table 2, all three measurement models met the recommended cutoffs proposed by Hu and Bentler (50), with excellent fit indices (CFI values between 0.957 and 0.969, RMSEA values between 0.037 and 0.070, and SRMR values between 0.032 and 0.041), indicating that the measurement structures were adequately specified and psychometrically sound.

Table 1 reports the descriptive statistics (means, standard deviations, skewness, and kurtosis) as well as the Pearson correlation coefficients among the study variables.

As shown in Table 1, both character strength and resilience were positively and significantly correlated with flourishing, indicating that higher levels of character strength and resilience are associated with greater flourishing among students.

To further test these relationships, Structural Equation Modeling (SEM) was employed to examine the mediating role of flourishing in the link between character strength and resilience. SEM is particularly well suited for simultaneously modeling latent constructs with multiple indicators while accounting for measurement error. In addition, the mediating effect of resilience was examined using a nonparametric bootstrapping procedure with 2,000 resamples and 95% bias-corrected confidence intervals. The indirect effect of character strength on flourishing through resilience was statistically significant (standardized indirect effect = 0.204, 95% CI [0.134, 0.289]), as the confidence interval did not include zero. This result supports the hypothesized mediation model, indicating that resilience partially transmits the effect of character strengths on students' flourishing. The fit of the structural equation model was evaluated using multiple fit indices, which indicated that the proposed model demonstrated an acceptable level of fit. (χ^2/df = 1.922, GFI= 0.918, CFI=0.945, TLI=0.936, IFI=0.946, RMSEA=0.049, SRMR=0.051). Concerning RQ1, the findings revealed a positive and direct relationship between character strength and both flourishing (β = 0.380) and resilience (β = 0.659). Furthermore, resilience showed a positive association with flourishing (β = 0.549). In response to RQ2, character strength was indirectly linked to flourishing via resilience (β = 0.374). Table 3 presents both the direct and indirect effects, along with their corresponding 95% confidence intervals, for the structural model.

Table 3. Direct and indirect effects and 95% confidence intervals for the structural model

Model pathways	B	SE	*β*	P	95% CI	
					Lower bound	Upper bound
Direct effects						
Character strength ⟶ Flourishing	0.590	0.103	0.425	0.001	0.301	0.539
Character strength ⟶Resilience	0.131	0.019	0.549	0.001	0.435	0.644
Resilience⟶Flourishing	2.160	0.386	0.371	0.001	0.246	0.491
Indirect effect						
Character strength ⟶Resilience ⟶Flourishing	0.283	0.061	0.204	0.001	0.134	0.289

Discussion

The current study investigated the relationship between character strengths and flourishing among medical students, by assessing the mediating role of resilience. The findings confirmed the first hypothesis, indicating that character strengths significantly and positively predict flourishing among medical students. This aligns with prior research suggesting that individuals who actively use their personal strengths are more likely to experience higher levels of well-being, meaning, and engagement (24, 25).

Character strengths such as perseverance, curiosity, social intelligence, and gratitude are known to promote positive emotions, facilitate adaptive coping, and foster a sense of purpose—all of which are essential components of flourishing.

In the context of medical education, where students are exposed to chronic stress and performance pressures, drawing upon one's personal strengths may act as a psychological buffer, enhancing motivation, academic satisfaction, and emotional resilience (31). By engaging their strengths in everyday academic and interpersonal situations, students may cultivate a greater sense of competence and autonomy, which are central to sustained well-being.

These findings are further supported by positive psychology theories, such as the broaden-and-build theory (51), which posit that strengths contribute to the development of enduring personal resources. Accordingly, activating one's strengths may not only yield momentary positive emotions but also build cumulative psychological capacities conducive to long-term flourishing.

Beyond their direct association with flourishing, the findings reveal that character strengths also exert an indirect effect on flourishing through resilience, thereby supporting the hypothesized mediating role. This result is consistent with theoretical perspectives suggesting that character strengths are foundational resources that foster resilience by promoting adaptive cognitive, emotional, and behavioral responses to adversity (32, 52).

Resilience enables individuals to maintain psychological equilibrium in the face of challenges and setbacks, which is particularly crucial for medical students navigating a high-stress academic environment. Character strengths such as self-regulation, perseverance, and hope may empower students to persist despite obstacles, reinterpret stressors constructively, and sustain motivation under pressure—key components of resilient functioning. Empirical evidence also supports this mechanism. For example, research shows that individuals with higher levels of strengths are more likely to engage in positive reappraisal, emotional regulation, and proactive coping—all of which contribute to greater resilience and, ultimately, flourishing (28-30).

In this regard, resilience may serve as a psychological conduit through which strengths are translated into long-term well-being. The partial mediation observed in our model suggests that while strengths can directly enhance flourishing, their beneficial effects are partly channeled through students' resilient capacities. This highlights the value of strength-based educational and psychological interventions aimed at not only identifying students' character strengths but also cultivating their resilience as a complementary pathway to sustained flourishing. These mediation results can also be theoretically interpreted through the broaden-and-build framework of positive emotions (51). According to this model, activating personal strengths generates positive emotional experiences that broaden individuals' thought–action repertoires, thereby enabling the development of enduring psychological resources such as resilience. In turn, resilience functions as a built resource that facilitates adaptive coping and sustained well-being, explaining how strengths indirectly foster flourishing over time. This theoretical linkage underscores that the emotional and cognitive expansion initiated by strengths use serves as a mechanism through which resilience mediates the relationship between character strengths and flourishing in medical students. These findings should also be interpreted in light of the Iranian cultural context, which is characterized by strong collectivistic values, family cohesion, and a sense of interdependence. In such social environments, personal strengths often manifest through communal engagement and moral responsibility rather than through individual achievement. This cultural orientation may amplify the mediating role of resilience, as adaptive coping in collectivist cultures is frequently reinforced by shared emotional resources, social support, and collective meaning-making. The emphasis on virtues such as gratitude, humility, and perseverance within Iranian cultural narratives aligns closely with the moral dimensions of character strengths, facilitating their translation into psychological resilience and flourishing. Consequently, the observed mediation pattern may reflect not only universal mechanisms proposed by positive psychology but also culturally embedded pathways through which moral and relational virtues contribute to enduring well-being.

This study tackles an important gap in the literature—namely, the limited integration of positive psychology and resilience research within non-Western medical education contexts. While many investigations document high distress among medical trainees (1, 2), few have tested mediation models explaining why strengths lead to better outcomes. Our findings suggest that strengths-based curricula—which teach students to identify and apply their signature strengths—could simultaneously foster resilience and flourishing. Concrete applications could include structured "signature strengths workshops" during orientation, peer-mentoring programs that emphasize appreciation of others' strengths, and brief reflective writing assignments that link personal strengths to clinical challenges. Embedding these modules into core professionalism or clinical reasoning courses would enable students to practice strengths use within authentic learning contexts, enhancing both psychological and academic outcomes (13, 14). This study provides a novel contribution to the literature in two important ways. First, to our knowledge, it represents the first empirical test of a structural equation mediation model linking character strengths, resilience, and flourishing among Iranian medical students. Second, it integrates multiple theoretical frameworks within positive psychology—specifically, the broaden-and-build theory of positive emotions, the character strengths approach, and resilience theory—to explain the dynamic mechanisms through which personal strengths translate into enduring well-being. By combining these perspectives within a single analytical model, the present research advances a more comprehensive understanding of flourishing in educational contexts characterized by high psychological demands.

Despite its contributions, several methodological limitations should be considered more explicitly. First, the cross-sectional design precludes causal inference. Although mediation analysis provides insight into indirect pathways, longitudinal or experimental studies are needed to confirm directionality. Future research should employ prospective designs or randomized controlled trials of strength interventions to establish causality. Second, employing self-report instruments may give rise to common method bias and social desirability effects, particularly considering the ethically positive nature of constructs such as "character strengths." Future research could triangulate self-reports with behavioral or observer-based assessments (e.g., peer evaluations of strengths use or resilience behaviors). Third, the single-institution sample limits generalizability, as the participants were recruited from one Iranian medical school. Cultural factors, including norms around hierarchy, collectivism, and mental health stigma in Iran could influence the observed relationships; replication in diverse contexts (e.g., other Middle Eastern, or low resource settings) would clarify cross-cultural applicability. Fourth, the exclusive use of self-report instruments introduces potential issues related to common method variance and social desirability bias. Incorporating mixed methods approaches—such as peer ratings of observed strengths or qualitative interviews—could mitigate bias and enrich understanding of how students enact strengths and resilience in real-world settings.

Building on our results, future studies could (a) implement and evaluate strengths-based interventions (e.g., signature-strengths workshops) with pre-post assessments of resilience and flourishing; (b) conduct subgroup analyses to examine whether certain strengths are especially potent mediators; (c) explore organizational factors (e.g., faculty autonomy support, peer mentoring programs) as moderators of the strengths–resilience pathway, guided by Self-Determination Theory (34) and Social-Ecological Resilience Theory (33); and (d) integrate physiological or behavioral indicators of stress and coping to triangulate self-report findings.

Conclusion

In summary, this study contributes to a deeper understanding of how and why medical students flourish despite stress. By revealing how resilience mediates the impact of strengths on well-being, our findings suggest that educational interventions should go beyond stress management and incorporate strengths-based components into the curriculum. Specifically, structured programs such as signature-strengths workshops, resilience-building modules, or reflective writing exercises on personal strengths could be embedded into orientation programs or longitudinal professionalism courses. At the institutional level, medical schools might also integrate strength-based mentorship systems, where faculty advisors help students align clinical learning goals with personal strengths, or implement resilience rounds for group reflection during demanding rotations. These applied strategies are not only low-cost and scalable but also contextually sensitive to the challenges of medical education in non-Western settings. Faculty development initiatives can also train instructors to

recognize and reinforce students' character strengths during feedback, mentoring, and clinical supervision. These applied strategies are low-cost, scalable, and well-aligned with existing competency frameworks in medical education. Ultimately, integrating strengths-based practices may help mitigate burnout risk and enhance students' adaptive capacity, well-being, and long-term professional identity formation.

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Original Article

The CIPP Evaluation Model Scale: Development, Reliability and Validity of Evaluation Scale for "Medical Etiquette Courses" in Iranian Medical Curriculum

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Abstract

Background: Over the years, medical schools worldwide have sought to enhance the learning experience of their students through curriculum updates and diverse teaching methodologies. In this regard, Iranian medical schools have incorporated Medical Etiquette Courses to foster the development of professional skills and behaviors among medical students. Continuous evaluation of these courses is essential to ensure and improve their effectiveness.

Objectives: The purpose of this research was to identify the validity and reliability of a researcher-made evaluation scale, grounded in the principles of Stufflebeam's CIPP Evaluation Model, for assessing "Medical Etiquette Courses" in the Iranian undergraduate medical curriculum.

Methods: A questionnaire was developed according to the CIPP model of evaluation. The face and content validity of the questionnaire were assessed by an expert panel of 10 faculty members with specialties in medical education and medical ethics. The reliability of the questionnaire was measured through internal consistency using Cronbach's alpha coefficient. Construct validity was evaluated via confirmatory factor analysis using goodness of fit indices. In the pilot study, 171 medical students in the clerkship period who had completed "Medical Etiquette Courses" at Kerman and Shahid Beheshti Universities of Medical Sciences answered the 32-item questionnaire. The data were analyzed using SPSS version 22 and Lisrel 8.8.

Results: The content validity index and content validity ratio were determined as 0.97 and 0.96, respectively. The Cronbach's alpha coefficient of the whole questionnaire was 0.89. Construct validity was confirmed by confirmatory factor analysis. In fact, this model had good fit indices.

Conclusion: The findings from the exploratory and confirmatory factor analyses revealed that the questionnaire is a valid and reliable instrument for assessing the quality of "Medical Etiquette Courses" across the four CIPP dimensions: Context, Input, Process, and Product. By incorporating continuous feedback, the CIPP model facilitates evidence-based decision-making and promotes sustainable educational development.

Keywords: Medical Ethics; Education; Medical Students; CIPP Model

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Background

The process of becoming a physician and developing a professional identity is a complex and multifaceted process. The initial years of medical school are particularly challenging and can significantly influence this developmental path (1, 2). During this period, students must navigate new social networks, environments, and responsibilities, including adjusting socially to peers and roommates, acquiring essential academic skills like time management and problem-solving, familiarizing themselves with the culture, policies, and expectations of the university and medical profession, and taking responsibility for self-care, among many other demands (3). To thrive in medical school, incoming students need to rapidly adapt to an educational culture and learning environment that differ substantially from their previous experiences (4). Furthermore, due to the interpersonal nature of the medical profession, which requires ongoing communication with patients and their families, medical students and physicians need to develop a range of social and emotional skills (5), including effective communication, conflict resolution, and negotiation, as well as higher-order abilities such as decision-making, clinical reasoning, and critical thinking (6). However, the selection of medical students is typically based primarily on academic and scientific criteria, often overlooking non-academic skills (7). Consequently, medical schools admit students from diverse social and economic backgrounds, with varying personality traits, psychological characteristics, and non-academic competencies (8). In the early years of medical education, students encounter significant stress due to multiple simultaneous challenges. These include fear of academic failure, concerns about ridicule or negative feedback, feelings of alienation, peer and parental pressures, and the need to adjust to dormitory life (8, 9). Additionally, students must manage the substantial increase in the scope and rigor of the medical curriculum compared with secondary education, limited understanding of academic expectations, heavy workloads, and insufficient time for rest. Altogether, these factors make the initial years of medical training particularly demanding and stressful for many students (2). Thus, one of the key responsibilities of colleges and universities is to help students navigate these challenges and prepare them for a successful academic path (10). Over the past few decades, rising concerns about the quality of medical care and health services have drawn the attention of educational policymakers and curriculum developers to innovative approaches in medical education worldwide. In this context, alongside disciplinary knowledge and technical skills, the development of soft skills and competencies essential for effective professional practice has become a central focus for medical education planners (11). Consequently, curricular interventions have been implemented internationally to ensure that the range of competencies necessary for professional performance and effective interaction within healthcare settings is systematically incorporated into undergraduate medical education (12-14). Iran is not exempt to this global trend. Consequently, starting in the first semester of the 2015-2016 academic year, Medical Etiquette Courses were incorporated into the basic sciences phase of the undergraduate medical curriculum. With the introduction of new educational programs, however, important questions arise regarding their quality, learner satisfaction, and educational effectiveness. Educational evaluation is a complex and structured process involving the collection and analysis of relevant information to make informed judgments about the quality and value of an educational program. Such evaluations enable identification of curricular strengths and weaknesses and assess program effectiveness and efficiency after implementation. Based on these assessments, decisions can be made about revising, continuing, or expanding the program. In educational settings, evaluation is carried out through the use of structured criteria designed to determine the value, quality, utility, performance, and overall significance of a program (15). Several models have been proposed for evaluating educational programs. In this study, the CIPP evaluation model, one of the most recognized and influential frameworks, was employed. Developed in the 1970s by Stufflebeam at the Center for Studies in Evaluation at Ohio University (16), the Context, Input, Process, and Product (CIPP) model provides a comprehensive and systematic approach to program evaluation, serving as the theoretical foundation for this research. By assessing the design, implementation, and outcomes of educational programs, the CIPP model helps educators and policymakers determine how well programs achieve their objectives while highlighting strengths and areas for improvement. Accordingly, this study aimed to examine the validity and reliability of a researcher-developed evaluation instrument based on the CIPP model for assessing Medical Etiquette Courses in the undergraduate medical curriculum at Kerman

University of Medical Sciences and Shahid Beheshti University of Medical Sciences in Iran.

Objectives

The purpose of this research was to identify the validity and reliability of a researcher-made evaluation scale, grounded in the principles of Stufflebeam's CIPP Evaluation Model, for assessing "Medical Etiquette Courses" in the Iranian undergraduate medical curriculum.

Methods

Study design: This descriptive study was conducted at two Iranian universities of medical sciences with the aim of developing a valid and reliable evaluation instrument, based on the CIPP evaluation model, for assessing Medical Etiquette Courses within the undergraduate medical curriculum in Iran.

Setting: Two medical schools, Kerman University of Medical Sciences, Kerman, Iran, and Shahid Beheshti University of Medical Sciences, Tehran, Iran, collaborated in the development of the evaluation scale. At both institutions, Medical Etiquette Courses are implemented into the basic sciences phase of the undergraduate medical curriculum. Since the study aimed to examine the psychometric properties of the scale, the sample size was determined using a ratio of approximately five participants per item (17). Ultimately, 171 medical students in their clerkship phase, who had previously completed the Medical Etiquette Courses during the basic sciences phase, were included. The study was conducted in the following steps:

Step 1: Questionnaire item generation

To develop the questionnaire items, initially, the literature related to curriculum and course evaluation was reviewed, and then based on the latest Stufflebeam model (18) and the general specifications of the "Medical Etiquette Courses" in undergraduate medical curriculum of Iran, appropriate items were designed for each domain of questionnaire by the research team. Then, through three sessions of group discussion, the research team reached a consensus regarding the content, structure, order and sequence, and the number of items in each domain. In this way, 32 items were compiled for four evaluation domains: context (7 items), input (5 items), process (9 items), and product (11 items).

Step 2: Internal consistency

A pilot study was conducted with 20 medical students to assess the internal consistency using Cronbach's alpha. According to Jerry Sigudla and Jeanette E. Maritzany (19), value above 0.8 is a good reliability, between 0.6 and 0.8 is an acceptable reliability, and a Cronbach's alpha coefficient value below 0.6 is an unacceptable reliability for exploratory research. These students were incorporated into the main study.

Step 3: Face validity

Five medical students were independently asked to review the translated questionnaire and provide feedback on the clarity, appropriateness, and relevance of the items. Based on their feedback, several items were reworded to improve clarity; however, no items were removed.

Step 4: content validity

At this step, the questionnaire was evaluated by ten faculty members in medical education and medical ethics from both universities, all of whom had experience teaching medical etiquette and medical ethics courses. The experts assessed the relevance of the items, and the Content Validity Index (CVI) and Content Validity Ratio (CVR) were subsequently calculated. In addition, the research team conducted a group discussion during which each item was systematically reviewed and refined with respect to level of difficulty, appropriateness, and potential ambiguity, as well as the need for item deletion, modification, or consolidation.

Step 5: convergent validity

Convergent validity was evaluated to determine whether items that are theoretically related are also empirically correlated. Composite Reliability (CR) values greater than 0.7 supports the convergent validity of the instrument.

Step 6: Construct validity

To assess the adequacy of the sample size and the suitability of the data for factor analysis, exploratory factor analysis (EFA) was conducted using the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's test of sphericity. A KMO value of 0.80 or higher was considered indicative of adequate sampling, and a significant Bartlett's test ($P < 0.05$) supported the factorability of the data. Although EFA was used to confirm the suitability of the data (e.g., KMO, Bartlett's test, item correlations), the number of factors retained was determined based on a theoretical framework and expert panel review, rather than statistical criteria such as eigenvalues or scree plots. Subsequently, confirmatory factor analysis (CFA) was performed to evaluate the fit of this theory-driven model, and relevant goodness-of-fit indices were calculated (20). Following

Stone (21), reporting a balanced set of indices, one absolute fit index, one incremental fit index, one parsimonious fit index, and the χ^2 statistic, was considered sufficient to provide a robust evaluation of model fit.

Statistical Analysis: Data analysis was performed using SPSS version 22. Descriptive statistics, including mean, standard deviation, frequency, and percentage, were used to summarize the data. Both exploratory and confirmatory factor analyses were conducted. To enable comparison across different domains, item scores were transformed to a 0–100 scale, resulting in domain scores ranging from 0 to 100. Based on previous research (21), scores were categorized as follows: ≤50 as undesirable, 51–70 as fairly desirable, and 71–100 as desirable. Chi-square tests were used to compare these frequencies across groups, with a significance level set at $p \leq 0.05$. Confirmatory factor analysis was conducted using LISREL version 8.8.

Ethical considerations: After obtaining ethical approval with the code IR.NASRME.REC.1400.173, the questionnaires were administered anonymously and voluntarily. It took participants approximately 15-20 minutes to complete the questionnaire, and the researcher was present during this time to guide the students if needed.

Results

A total of 171 medical students participated in the study. Their mean age was 20.88 ± 1.32 years, and the majority were male (55.4%), from Shahid Beheshti University of Medical Sciences (63.7%), and in their third year (86.9%).

As mentioned earlier; after shaping the item pool and conducting three focus group discussions, 32 items were developed across four domains: context (7 items), input (5 items), process (9 items), and product (11 items).

Validity of the instrument

1. Content validity: Ten faculty members from both universities, experienced in teaching medical etiquette and medical ethics, assessed the instrument's items for relevance. The Content Validity Ratio (CVR) was 0.96, and the Content Validity Index (CVI) was 0.97, both falling within the acceptable range.

2. Construct validity: In exploratory factor analysis, the Kaiser-Meyer-Olkin (KMO) measure was 0.96, indicating a satisfactory sample size, and Bartlett's test of sphericity was statistically significant (df = 496, χ^2=2246.75, P<0.001), confirming the appropriateness of factor analysis. The average variance explained (R^2) for the four constructs ranged from 24% to 34%, with an overall average of 29%, demonstrating that the model provides a reasonable and acceptable explanation for the observed variables. Confirmatory Factor Analysis (CFA) was performed to assess the fit of a theoretical model recommended and refined by our expert panel. All items in the CFA had factor loadings above 0.3. Items with loadings between 0.3-0.4 were theoretically justified and did not compromise the scale's integrity in other analyses, such as item analysis.

Factor loadings and composite reliability are presented in Table 1. In the structural equation method, statistically significant correlations (Figure 1) were found and almost all fit indices of the model were in the acceptable range (Table 2). Although the RMSEA value of 0.08 lies at the upper bound of the acceptable threshold (≤0.08), it still indicates a reasonable and acceptable overall model fit according to standard SEM guidelines.

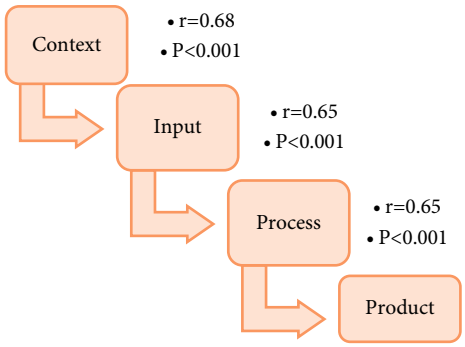

Figure 1. The path analysis of the questionnaire used to evaluate the current state of teaching medical etiquette courses by using the CIPP model

Table 3 shows the central and dispersion statistics and the level of desirability of different domains of CIPP model for evaluating the current state of teaching medical etiquette courses in medical students.

The frequency of the desirability levels in different domains of the CIPP model did not show a statistically significant difference based on gender. (P>0.05) This frequency did not show any significant statistical difference based on the university, except for the context, in which, the frequency of the desirable level was significantly higher in Kerman University (71%) than Shahid Beheshti (47.7 %) (P=0.009).

Among fourth year students, the frequency of the undesirable, relatively desirable, and desirable levels of input domain were 13.6 %, 31.8 %, and 54.5 % in fourth-

year students, and 44.5 % ,21.9 %, and 33.6 % in third year students, which were statistically significant (P=0.02). The other three dimensions of the model had no statistically significant difference in this regard.

Table 1. Factor Loadings of Items, Cronbach's Alpha, and Composite Reliability (CR) for evaluating the current state of teaching medical etiquette courses by using the CIPP Model

Factor	Item	Loading	alpha	CR
Context	This course aids in understanding the attributes of a competent and proficient doctor.	0.79	0.75	0.83
	Observing doctors' performance in medical practice contributes to developing a more realistic comprehension of the doctor's role.	0.42		
	This course facilitates creating a sense of belonging to the profession in medical students.	0.72		
	This course serves as a valuable tool for fostering reflection and critical thinking regarding learning experiences. It facilitates the analysis and evaluation of these experiences, promoting deep learning outcomes.	0.69		
	The content covered in this course aids in reducing stress and enhancing the adaptability and flexibility of medical students in managing student life.	0.70		
	This course helps promote collaboration among medical students.	0.69		
	This course wastes medical students' time.	0.42		
Input	Students have the opportunity to actively engage in teaching the content of this course.	0.76	0.65	0.78
	The volume of coursework assigned corresponds to the content covered in the course.	0.59		
	The quality of the coursework corresponds to the depth and complexity of the course content.	0.58		
	The implementation of this course is designed to enhance students' motivation and capability to engage in group work effectively.	0.65		
	Effective time management by professors in each session of this course facilitates the efficient transmission of key concepts.	0.63		
Process	Engaging in practical work during the course positively influences the acquisition of the expected skills.	0.67	0.75	0.82
	The practical work offered in this course enhances students' motivation to learn.	0.59		
	The content presented in the course is engaging and noteworthy.	0.65		
	The course materials and content are suitable for the student's level of knowledge.	0.65		
	The duration of the course aligns with the amount of content covered and the expectations set for the course.	0.59		
	Educators are well-equipped to create an engaging and supportive learning environment.	0.64		
	Sufficient exercises are conducted for each new topic throughout the course.	0.60		
	This course enables the active participation of students in classes.	0.30		
	Instructors and professors possess the requisite teaching skills to effectively guide students' group activities.	0.51		
Product	Learning how to communicate information effectively to the public.	0.70	0.85	0.88
	These courses help us: Learn to respect the differing opinions of others and facilitate opportunities for them to express their views openly and easily.	0.77		
	These courses help us: Learn to articulate my opinions on various topics verbally and effectively.	0.64		
	These courses help us: Learn how to think about my own behavior in personal and educational environments.	0.34		
	These courses help us: Identify active participants in group discussions.	0.71		
	These courses help us: Learn to receive feedback from peers gracefully and with a positive attitude.	0.74		
	These courses help us: Learn how to give constructive feedback to your peers.	0.73		
	These courses help us: Learn effective strategies for planning academic activities and managing personal life.	0.35		
	These courses help us: Learn techniques for maintaining composure during crises.	0.68		
	These courses help us: To understand the roles and responsibilities of medical students across various clinical stages.	0.67		
	These courses help us: To familiarize ourselves with the hospital environment, different departments, and their personnel, in order to gain a more realistic understanding of the concepts being learned.	0.59		

Table 2. Appropriate fit indicators for evaluating the current state of teaching medical etiquette courses by using the CIPP model

Goodness of Fit Statistics	Results	Accepted range
χ2 /df	2.13	1-5
Root Mean Square Error of Approximation (RMSEA)	0.08	≤0.08
Normed Fit Index (NFI)	0.96	>0.9
Non-Normed Fit Index (NNFI)	0.92	>0.9
Comparative Fit Index (CFI)	0.92	>0.9
Incremental Fit Index (IFI)	0.92	>0.9

Table 3. Central and dispersion statistics and the level of desirability of different domains of the model

	Context	Input	Process	Product
Mean	68.22	61.61	61.05	63.08
Standard Deviation	25.62	27.45	27.90	29.43
Median	71.42	60.00	66.66	68.18
Level of desirability N (%)				
Undesirable	45(26.3)	70(40.9)	60(35.1)	54(31.6)
Relatively desirable	30(17.5)	40(23.4)	47(27.5)	39(22.8)
Desirable	96(56.1)	61(35.7)	64(37.4)	78(45.6)

Discussion

The present study investigated the psychometric characteristics of the researcher-made questionnaire based on the CIPP model for evaluating the "Medical Etiquette Courses" of the undergraduate medical curriculum. The findings from both exploratory and confirmatory factor analyses indicated that the questionnaire is suitable for assessing the quality of Medical Etiquette Courses across the four CIPP dimensions: Context, Input, Process, and Product.

The instrument demonstrated acceptable validity and reliability to gather students' perspectives on their experiences in Medical Etiquette Courses. To the best of our knowledge, the CIPP model has not been used for evaluating Medical Etiquette Courses or other soft skills programs in Iran. Nevertheless, several studies have employed alternative tools or approaches to assess soft skills training and have reported their experiences and outcomes.

Soft skills encompass both interpersonal and intrapersonal abilities (22, 23) and complement scientific and technical competencies (24). Intrapersonal skills relate to an individual's capacity to manage personal success, including time and stress management and creative thinking. Interpersonal skills involve managing relationships with others to enhance performance and include competencies such as motivation, leadership, and effective communication (25). Various educational strategies have been employed to develop soft skills in higher education, particularly in medical education. Among these, problem-based learning (PBL) has been widely implemented as a curriculum innovation (26). By engaging students in problem-solving activities, PBL fosters critical thinking, idea generation, and the acquisition of knowledge, skills, and behaviors essential for competent medical practice (27, 28). Moreover, research has shown that communication skills training can enhance empathy among medical students (29). Together, these findings highlight the importance of not only teaching soft skills but also systematically evaluating them within medical education programs (30). A study investigating and prioritizing soft skills in the dental profession, based on their relevance to professional success and quality, found that both faculty and students considered six key areas essential: moral-professional values, artistic skills, communication skills, interpersonal skills, and technical expertise (31). Similarly, in the present study, the product domain which reflects the perceived usefulness of the course from the students' perspective indicated that students recognized the teaching of soft skills as important and relevant to their future professional roles.

One study found that first-year students demonstrated the greatest improvement in awareness, particularly when exposed to early soft skills training. The results showed significant enhancement in students' communication skills and confidence in interacting with patients following the training. Similar findings have been reported in other studies as well (32). The Faculty of Medical Sciences at the University of Malaysia (USM)

launched the Community and Family Case Study Program (CFCS) in 1981 (33), which has been continuously developed since its inception. The CFCS is a community-based educational initiative that combines research methods with community engagement, aiming to equip students with the knowledge, values, and skills necessary to become competent and ethical medical professionals (33). In a related study, a series of active learning activities were conducted in 2016 for third-year medical students, involving 330 participants. The study aimed to evaluate whether these interventions could enhance students' soft skills. Students completed a self-assessment questionnaire, and their performance was additionally evaluated by four peers. These studies highlight the importance of student-centered approaches in teaching soft skills. Similarly, the process domain of our questionnaire evaluated medical students' perspectives on the teaching strategies employed. In our study, only about 37% of students reported satisfaction with the teaching methods, indicating a need for further improvement in this area. Supporting this, a study at the University of Malaysia found that cultivating personal skills and values provides a meaningful learning experience and promotes the development of personal competence (34).

A study at the University of Pretoria examined the professional development of medical students, focusing on physician–patient interaction skills and professional socialization. Using Grounded Theory, researchers explored students' perspectives on the role of mentors in developing soft skills. Data were collected via focus groups, in-depth and personal interviews, and biographical drawings, then analyzed inductively. The results showed no significant differences between student groups. Students described effective role models as physicians who are clinically and academically skilled, prioritize patient care, demonstrate strong interpersonal abilities, and inspire others. Conversely, weak role models were seen as negatively impacting students and undermining the ethical climate and learning environment (35). In the United Kingdom, a simulated training program was created to prepare medical students with the non-technical skills needed for their roles as junior doctors. A study evaluating the program assessed students' perceptions of teaching quality, key learning factors, and readiness for future clinical duties. Using a mixed-methods design with questionnaires and focus groups, the study emphasized the benefits of simulated learning environments, especially those that closely mirror real clinical settings and allow students to practice essential skills (36). Students who participated in the Medical Etiquette Courses at Kerman and Shahid Beheshti Universities of Medical Sciences showed improvements in eleven areas based on peer evaluations: information presentation, technological skills, creativity, communication, leadership, life-planning, adaptability, self-reliance, humility, and punctuality. The authors concluded that, even without a formal soft skills curriculum, the active learning activities implemented during the pre-clinical phase effectively enhanced multiple essential competencies for medical professionals. They therefore recommended incorporating such active learning approaches into the undergraduate medical curriculum (37). The CIPP evaluation model has been widely used to assess various educational programs, including several studies in Iran. For instance, it has been applied to evaluate the doctoral program in reproductive health (38) and the educational curriculum at Kerman Medical School (39). The model has also been applied in the development and assessment of evaluation tools for medical ethics education (40). In this study, we created a questionnaire based on the CIPP framework to evaluate the effectiveness of the Medical Etiquette Course in promoting soft skills among Iranian medical students. Our results further suggest that students generally perceive the course positively in terms of its impact on their professional development.

Limitations: One limitation of this study is the sample size of fewer than 200 participants. This is partially offset by the relatively simple model, which includes multiple indicators per factor, no missing data, and mostly factor loadings above 0.6. Another limitation is the use of convenience sampling, which may increase the risk of selection bias and limit the generalizability of the findings. Additionally, reliance on self-report measures could introduce social desirability bias or inaccuracies. Despite the instrument showing acceptable psychometric properties, two points deserve attention: first, several items were retained despite low factor loadings, reflecting a compromise between theoretical completeness and statistical robustness, suggesting future research might refine or reword these items; second, other forms of validity assessment, such as discriminant validity, were not evaluated in this study.

Conclusion

The psychometric evaluation of the CIPP-based instrument for Medical Etiquette Courses showed acceptable reliability and validity, supporting its use for assessing these training programs. The CIPP model thus provides a strong framework for systematically and meaningfully evaluating the quality of medical etiquette

education. By incorporating continuous feedback, this approach facilitates evidence-based decision-making and promotes sustainable educational development. Future research could apply this instrument across multiple academic centers with larger, randomly selected cohorts and explore its use for longitudinally assessing improvements in the medical etiquette curriculum.

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Conflict of interests: There is no conflict of interest.

Ethical approval: All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with ethical code: IR.NASRME.REC.1400.173.

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Original Article

Comparison of Knowledge and Attitudes of Medical Students in Externship and Internship Phases toward Persian Medicine at Hamadan University of Medical Sciences

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Abstract

Background: The growing use of complementary and traditional medicine in recent years entails a greater emphasis on this topic within medical education. Thus, it is essential to ascertain and enhance the knowledge and attitudes of medical students towards these therapeutic approaches throughout their education.

Objectives: This study aims to compare the knowledge and attitudes of medical students at Hamadan University of Medical Sciences in their externship and internship stages considering Persian Medicine.

Methods: This descriptive cross-sectional study was undertaken in 2023. The participants were 220 medical students (n=220) in their externship and internship years. The follow-up interval lasted 6-12 months. Data on their knowledge and attitudes were collected via a self-administered questionnaire, which was validated by professors and experts in Persian Medicine and Medical Education. Statistical analysis was performed using SPSS software, version 20, with all comparisons tested at a significance level of $p<0.05$.

Results: Regarding knowledge, the mean score for the externship group was 5.83±1.43, while for the internship group, it was 7.06±1.88 ($p=0.004$). In terms of attitudes, the mean score for the externship group was 43.90±7.690, and for the internship group, it was 38.27±10.466. This difference was statistically significant ($p<0.001$).

Conclusion: The findings suggest that an increase in students' knowledge does not necessarily lead to a corresponding rise in their positive attitudes. Suggesting factors such as clinical exposure, influence of senior physicians, or the mode of education may significantly affect attitudes.

Keywords: Persian Medicine; Knowledge; Attitude; Medical Students

Background

In recent years, the use of Complementary and Alternative Medicine (CAM) has increased for various reasons, with a reported prevalence of 9.8% to 76% of people across different societies (1). This may be attributed to high treatment costs, physicians' high reliance on technology, perceived ineffectiveness of conventional medicine for certain diseases, drug side effects, as well as the accessibility and cultural compatibility of Traditional Medicine. In order to mitigate the risks associated with unguided use, since 2002, the WHO has promoted and advocated for the usage of Traditional and Complementary Medicine based on scientific evidence (2). Similar to trends observed in many countries, many in Iran choose Traditional Medicine, known as Persian Medicine, over conventional medicine at different stages of treatment (3, 4). Almost half of Iranian patients apply CAM methods as an initial part of their usual treatment (5, 6). Another study also revealed that slightly more than 50% of cancer patients used CAM therapies between 2009 and 2018 (7). Thus, given the societal need for this field, it is essential for physicians to be well-educated in it so that they can apply this knowledge to ameliorate health outcomes. For this reason, the integration of Persian Medicine into medical education

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has been undertaken, and since 2017, Persian Medicine (PM) has been included in the curricula of some fields, including medicine, pharmacy, and nursing (8, 9). This education is delivered through both virtual and in-person methods. Given the relatively recent integration of this course unit, a limited number of studies have ascertained these educational initiatives. A study exploring the perspectives of students who had completed this virtual course at Smart University indicated student satisfaction with the educational method and a significant improvement in their attitude toward Persian Medicine (10). Another study at Shiraz University of Medical Sciences observed similar student satisfaction and improved attitudes, particularly among nursing students, following the virtual delivery of the course (11). Further, a 2020 study on the knowledge, attitudes, and practices (KAP) of pharmacy students at Guilan University of Medical Sciences considering traditional and complementary medicine found that students who had completed the Traditional Medicine and Pharmacy unit had significantly greater knowledge than other students (12). Studies undertaken to date have inspected the short-term impact of these trainings immediately after the completion of the course. Since the Persian medicine curriculum is currently offered along the externship period, this study was conducted to compare the perspectives of interns who had completed the virtual Iranian medicine course during their externship with those of externs who had not yet taken the course. This was performed to explore the long-term impact of the training.

Objectives

The purpose of this study is to appraise long-term retention of knowledge and evolution of attitudes following the PM course and compare with externship students.

Methods

Study design and participants: This descriptive-analytic cross-sectional study was conducted in 2023. The participants consisted of medical students at Hamadan University of Medical Sciences in the externship and internship stages. A total of 110 internship students and 110 externship students were selected through convenience sampling. Participation was voluntary. All internship students had completed the virtual Persian Medicine course, while none of the externship students had taken the course.

Data collection: Data were collected by the researcher during in-person visits at the hospitals from intern students and at the medical school following classes from extern students using a self-developed questionnaire. All students who received the questionnaires completed them thoroughly and handed them in simultaneously. The study included interns who had completed the course and externs who had not, in case they consented to participate. Guest students and those who had previously failed the course were excluded from the study.

Ethical considerations: This study, under the code IR.UMSHA.REC.1401.091, was approved by the research ethics committee of Hamadan University of Medical Sciences. All participants signed an informed consent form to approve their participation.

Instruments

Data were collected using a knowledge and attitude questionnaire developed by the researchers. Ten Persian Medicine and Medical Education faculty members at Hamadan University of Medical Sciences confirmed the content validity of the checklist along with its scoring. The questions were based on the methodology of KAP studies about Persian Medicine performed in Iran. A self-developed questionnaire was employed owing to a scarcity of existing literature on the KAP of university students considering Persian medicine. The questionnaire's validity was confirmed by specialists and instructors of this curriculum. The reliability of the questionnaires was confirmed with a Cronbach's alpha coefficient of 75%. The attitude questionnaire was adapted from a study by Naghibi, originally utilized to appraise the attitudes of medical students and residents (13). Its validity and reliability were confirmed by experts and by applying Cronbach's alpha with a reliability rate of 89%. The questionnaire consisted of two sections: the first for ascertaining demographic information and the second for questions about the students' knowledge as well as attitudes. The knowledge assessment questionnaire contained 11 questions, each with three options: "I agree," "I have no opinion," and "I disagree". Correct answers were assigned 1 point, while incorrect answers received zero points. Thus, for questions 1, 2, 3, 10, and 11, selecting "agree" was assigned one point, while other options received no points. For questions 4, 5, 6, 7, 8, and 9, selecting "disagree" was assigned one point, with no points given for other options. Knowledge questions are outlined in Appendix 1. The maximum possible knowledge score was 11, while the minimum was zero. The attitude questionnaire listed in Appendix 2 consisted of 13 questions graded on a Likert scale from 1 (completely disagree) to 5 (completely agree). The total attitude score ranged between 13 and 65. Questions 1, 2, and 4 were reverse-scored for analysis.

Statistical Analysis: The collected data were recorded in SPSS version 20 statistical software for analysis. Descriptive statistics were employed for variables, and frequencies were presented as percentages, means, and standard deviations in tables. Data analysis was performed using inferential statistics, including the Chi-square test, t-test, Mann-Whitney U test, and Pearson test. The normality of data distribution was appraised using the Shapiro-Wilk test. Accordingly, the independent t-test was applied for parametric variables and the Mann-Whitney U test for non-parametric variables. The Chi-square test was used to determine subgroup differences. The Pearson test was utilized to determine the correlation between variables. All comparisons were conducted at a significance level of 0.05.

Results

The mean age of the participants was 24.52 ± 2.4 years. Of the participants, 45.9% were female and 54.1% were male. Demographic and basic information are reported in Table 1.

The average knowledge score of the internship group was significantly higher than that of the externship group (p = 0.004). Conversely, the average attitude score of the internship group was significantly lower (p < 0.001).

Table 1. Demographic information of participants

	Students		P value
	Internship stage	Externship stage	
Mean age	25.52±2.4	23.25±3.6	<0.001*
Gender			
Female	46(41.8%)	55(50%)	0.086**
Male	64(58.2%)	55(50%)	

*by using t-test, **by using Chi-square test

No significant differences were found between genders within either group regarding the average knowledge score (p = 0.703) and the average attitude score (p = 0.081). Table 2 outlines the average scores for each group.

There was a significant but weak direct relationship between knowledge and attitude in both the externship and internship groups (r=0.227, p=0.017 and r=0.281, p=0.003, respectively) as determined by the Pearson's test.

Table 2. The average scores of students' knowledge and attitudes in different groups

Group	Externship stage group	Internship stage group	P value
Knowledge score (out of 11)	5.83±1.43	7.06±1.88	0.004
Attitude score (out of 65)	43.9±7.69	38.27±10.46	<0.001

Discussion

The results of this study indicated that the knowledge of the internship students was significantly more developed than that of the externship students. The greater knowledge among interns can be assigned to the Persian Medicine course they had completed. As studies by Naghibi Harat et al. in 2008 and Banaiyan et al. in 2007 have demonstrated, medical students and physicians previously had a low level of knowledge as they had not been educated in Persian Medicine (13, 14). Nevertheless, the studies by Parvinroo et al. in 2020 and Zohalinejad et al. in 2024 revealed that students who had enrolled in the Persian complementary medicine course had significantly greater knowledge than other students (11, 12). A study by Naghibi Harat et al. in 2017 at Tehran University indicated that the knowledge and attitudes of fifth-year medical students and first-year medical assistants toward Persian Medicine were low, and they would not use or recommend it to their patients (13). When compared to the assistants, the students had greater knowledge and were more likely to apply therapeutic methods of Iranian Medicine, which suggests that the further students get from the course in terms of years, the less likely they might apply it to patients (13). Also, our study revealed that the attitude of the internship students was considerably more negative than that of the externship students, despite completing the Persian Medicine course. In contrast to our study, the studies by Habibi et al. and Zohalinejad et al. in 2024 noted that students had favorable attitudes toward the virtual course on Persian & Complementary Medicine at Smart University of Medical Sciences (10, 11). This difference may arise from the fact that their studies were performed immediately after the completion of the course. Our study, however, was conducted between 6 and 12 months after the course was completed. Within this time frame, they may have encountered negative effects from the incorrect usage of Persian Medicine, which is often prescribed by non-physicians. Moreover, an unmeasured but potential influential factor could be the negative attitudes of some attending physicians and residents. Soleimani et al. concluded that residents' attitudes toward Persian Medicine were more negative than those of medical students (15). Knowing that one of the limitations of this study has been its convenience sampling, which could lead to selection bias, our results by revealing a decline in attitude after a virtual course, indirectly support the call for more interactive, in-person formats. As other studies suggest, attitudes would be better modified if the course were held in

person rather than virtually (16). Presumably, face-to-face education is more efficient and can bring about a significant reduction in educational challenges.

Conclusion

This study demonstrated that the two-unit virtual course had significant long-term efficacy in enhancing students' knowledge. Nevertheless, their attitude, when compared to the extern group who had not yet taken the course, not only failed to become more positive but actually became more negative. Hence, based on these findings, it is recommended that this course be continued in the internship period for a short duration. It should also be taught in person via active educational methods such as small group teaching and flipped classrooms. If the course continues to be offered virtually, it is suggested that the use of active, controlled educational methods should be a priority. A key strength of our study is that it was undertaken 6-12 months after the Persian Medicine course, allowing for the evaluation of the long-term effects of this education on students' knowledge, which were found to be admirable, while the long-term effects on students' attitudes were found to be insufficient. The cross-sectional design and convenience sampling were the main limitations of our study.

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Conflict of interests: There is no conflict of interest.

Ethical approval: This study, under the code IR.UMSHA.REC.1401.091, was approved by the research ethics committee of Hamadan University of Medical Sciences.

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Appendix 1. The relative frequency of students' views about each of the knowledge questions in different groups

Knowledge questions	Externship stage group (%)		Internship stage group (%)		P value*
	Correct	Incorrect	Correct	Incorrect	
The main resolution of Persian Medicine is reinforcement of body's natural powers.	40	60	60	40	0.002
Lifestyle modification is the most struggle in Persian Medicine.	62	38	70	30	0.025
Soda (Melancholic) temperament equals for Cold and Dry.	22.7	77.3	42.7	57.3	0.001
The Four Elements is the substructure of Chinese and Persian Medicine.	70	30	61.8	38.2	0.128
The most important principle of Persian Medicine lifestyle is diet.	46.4	53.6	43.6	56.4	0.393
One of Persian Medicine instructions is dairy forbiddance in any conditions.	82.7	17.3	93.6	6.4	0.010
By Ehtebas in lifestyle principles, it means overcoming anger and wrath.	80	20	81.8	18.2	0.432
Estephraq equals for vomiting.	67.3	32.7	73.6	26.4	0.188
Phlebotomy, wet-cupping and leech therapy are the priorities of treatment in Persian Medicine.	80	20	87.3	12.7	0.101
Hijamat equals for wet-cupping.	24.5	75.5	49.1	50.9	<0.001
Acupuncture spots are located on Meridian canals.	12.7	87.3	42.7	57.3	<0.001

*by using Chi-square test

Appendix 2. The relative frequency of students' views about each of the attitude questions in different groups

Attitude questions	Externship stage group (%)			Internship stage group (%)		
	Agree	Neutral	Disagree	Agree	Neutral	Disagree
The effect of Persian Medicine is mostly a placebo effect.	20	66.4	13.6	41.9	23.6	34.5
Persian Medicine is pseudo-science, so it should not be discussed in scientific societies.	30	18.2	51.8	38.2	20	41.8
The use of Persian Medicine methods must be with official permission.	86.3	8.2	5.4	80	8.2	11.9
Academic Persian Medicine is a threat to society's health.	13.6	29.1	57.3	38.8	20.9	47.3
Persian Medicine should be treated scientifically and academically.	66.7	20	13.6	53.7	20.9	25.5
Persian Medicine has fewer complications for the patient.	31.9	25.5	42.8	10.9	24.5	64.6
The tendency of people towards Persian Medicine methods is due to its compatibility with the culture of Iranian people.	60.9	27.3	11.8	52.8	20.9	26.3
Patients prefer this treatment due to more access to Persian Medicine methods.	46.4	20	33.7	48.2	15.5	36.4
The reason for people's tendency towards Persian Medicine is the ineffectiveness of common medicine in the treatment of some diseases.	27.2	21.8	50.9	20.9	19.1	60
Persian Medicine is less expensive for the patient than conventional medicine.	57.2	20.9	21.9	33.7	25.5	40.9
Persian Medicine schools have ideas that mainstream medicine can benefit from	65.4	22.7	11.9	39.1	28.2	32.7
I would like to increase my studies and experiences in Persian Medicine field.	58.2	19.1	22.7	34.6	16.4	49.1
I will use the recommendations of Persian Medicine in my future work.	47.3	29.1	23.6	30.9	20.9	48.2

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Original Article

E-Learning in Medical Education: Unveiling Students' Perspectives and Key Interactive Predictors of Success at an Iranian University

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Abstract

Background: The pedagogical potential of interactive e-learning is significant, yet numerous challenges remain.

Objectives: This study explored students' experiences of e-learning challenges at Hormozgan University of Medical Sciences (HUMS) while also identifying independent predictors of these challenges.

Methods: A descriptive-analytical study was undertaken online in 2023. A total of 162 HUMS students completed a questionnaire comprising demographic information, interactive techniques, and common e-learning challenges. The instrument's validity was established through expert review (CVI=0.92, CVR=0.89) and exploratory factor analysis, whereas reliability was confirmed using Cronbach's alpha (α=0.88). Voluntary sampling was employed, with participants invited from all faculties to lower the selection bias. Informed consent was obtained electronically. Data were coded and analyzed in SPSS-22 using descriptive statistics and logistic regression to determine independent predictors.

Results: Major e-learning challenges (Mean >3.0 on a 5-point scale) included difficulties with the home learning environment, completing assignments, managing large volumes of content, engaging in practical courses, and adapting to online platforms. Logistic regression indicated that active participation in virtual small groups and peer discussions in virtual forums significantly predicted greater educational exposure, with adjusted odds ratios of 1.68 (95% CI: 1.32–2.13, P = 0.001) and 1.05 (95% CI: 1.03–1.07, P = 0.024), respectively.

Conclusion: Findings suggest that incorporating virtual small groups and forums can enhance students' learning experiences by ameliorating engagement and exposure to diverse perspectives. In spite of the study's limitation of relying on self-reported data from a single institution, the results highlight practical strategies for optimizing e-learning, especially in resource-constrained settings. Future research should involve multi-center cohorts in order to validate these outcomes.

Keywords: Learning; Interactive; Online Education; Perspective; Medical Students

Background

Information and communication technologies (ICTs) have revolutionized the landscape of higher education through fostering educational growth and enabling the implementation of innovative, learner-centered pedagogies across institutions worldwide (1). One such paradigm is e-learning, defined as the usage of digital technologies to facilitate learning experiences independent of time and place, while also complementing or replacing traditional face-to-face instruction. Prior to the COVID-19 pandemic, e-learning in most educational contexts, including medical education, was primarily regarded as a supplementary tool utilized to reinforce in-person instruction (2). Nevertheless, the pandemic served as a catalytic event, prompting an abrupt and global transition to fully online or blended educational formats (3), particularly in medical sciences where instruction heavily relies on interactive, hands-on, and clinical experiences (4).

The enforced shift to virtual learning underscores the urgency for pedagogically sound and technologically

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supported methods of instruction. Within this context, interactive teaching techniques have emerged as a cornerstone of effective e-learning. These techniques include various synchronous and asynchronous strategies—ranging from live lectures and discussion forums to breakout groups and formative assessments—which aim to replicate the dynamism and engagement of traditional classrooms in virtual settings. Crucially, the presence of meaningful interaction—whether between student and instructor, student and content, or student and peer—is a determining factor in the success of digital learning environments (5). Platforms such as Google Meet, Zoom, Microsoft Teams, and institutional Learning Management Systems (LMS) have made it possible for students to attend virtual classes, engage in Q&A sessions, complete assessments, as well as access a diverse range of educational resources remotely (6, 7).

Beyond the access to content, modern e-learning platforms support interactive learning ecosystems through which students can take part in collaborative projects, simulate clinical scenarios, as well as receive peer and instructor feedback. This multi-level interactivity not only enhances learner autonomy and cognitive engagement but also fosters a virtual academic community that is conducive to deeper learning and personal development (8). Among the multiple forms of interaction, student-content interaction is consistently considered as the most critical determinant of academic success, especially when paired with active student participation and reflection (9).

Nevertheless, despite considerable pedagogical advantages of interactive e-learning is significant, numerous challenges have been documented in its implementation. These include, but are not limited to, lack of sufficient digital infrastructure, inconsistent access to high-speed internet, insufficient interactivity in course design, low levels of digital literacy among both learners and instructors, and obstacles in adapting practical and clinical instruction to online formats (10-12). These challenges are especially pronounced in medical education, where learning outcomes are tightly coupled with in-person clinical exposure and hands-on experience. Although virtual simulations and video demonstrations provide partial substitutes, they rarely replicate the full scope of experiential learning required for achieving clinical competence (13, 14).

In the context of Iranian medical universities, the urgency of the transition to online education was amplified along the COVID-19 pandemic. Universities had to rapidly implement e-learning systems without adequate preparation in terms of infrastructure, faculty training, or curriculum redesign (15). These systemic limitations, combined with the stressors imposed by the pandemic itself, established a complex environment in which interactive teaching strategies became both more necessary and more difficult to execute effectively.

Against this backdrop, the present study examines the challenges associated with interactive e-learning techniques as perceived by students at Hormozgan University of Medical Sciences (HUMS). The study further explores which specific interactive experiences contribute most significantly to students' perception of educational effectiveness. Through identifying the key barriers and enablers in this context, the research seeks to offer practical insights for the design and deployment of more engaging, interactive, as well as learner-centered online medical education programs.

Objectives

The aim of this study was therefore to inspect the experiences of medical sciences students regarding interactive teaching techniques in e-learning, appraise the major challenges they confront, and identify the independent predictors of perceived e-learning effectiveness.

Methods

Design and Setting: A descriptive-analytical study was undertaken at Hormozgan University of Medical Sciences (HUMS), Iran. The online survey was administered to students from the faculties of medicine, dentistry, pharmacy, health, nursing, midwifery, and paramedicine.

Participants: The target population comprised all 3,020 students enrolled at Hormozgan University of Medical Sciences (HUMS) in 2023 who had completed at least two semesters of online education, including both theoretical and practical courses. An online questionnaire was distributed via official university email lists and through faculty coordinators across the schools of medicine, dentistry, pharmacy, health, nursing, midwifery, and paramedicine. Data were collected over a four-week period in March–April 2023. Participation was voluntary, and no incentives were provided.

Although an a priori power analysis was not performed, the study included 162 participants, of whom 70 (43.2%) were classified as having high educational exposure (outcome = 1). Sample adequacy was appraised in relation to established recommendations for logistic regression, considering the number of outcome events relative to the predictors included in the model. The available number of events

was sufficient to meet commonly recommended criteria for stable model estimation.

A total of 162 students accessed and completed the survey. As the questionnaire was distributed through open faculty platforms, the exact number of students who viewed the invitation could not be determined; thus, a conventional response rate was not calculated. All submitted questionnaires were complete at the respondent level (completion rate: 100%), with no cases excluded owing to incomplete submission.

Item-level missing values were minimal (less than 2% across variables) and were handled through listwise deletion when required for regression analyses. The sampling strategy was voluntary convenience sampling, in accordance with the exploratory nature of the study.

Measures

The questionnaire consisted of demographic items, 14 interactive technique items, and 35 e-learning challenge items. Challenge items were rated on a 5-point Likert scale ranging from "very high" to "very low."

Content validity was appraised using the Content Validity Ratio (CVR = 0.89) and Content Validity Index (CVI = 0.92), based on expert review by specialists in medical education. Face validity was also confirmed qualitatively. Finally, internal consistency reliability was acceptable (Cronbach's $\alpha = 0.88$).

Exploratory factor analysis (EFA) was carried out to examine the internal structure of the questionnaire within the current sample. Items with factor loadings ≥ 0.40 were maintained. The extracted factors explained approximately 56% of the variance in the interactive techniques section and 61% in the challenges section.

Since the instrument was adapted from previously validated questionnaires and the study was exploratory in nature, confirmatory factor analysis (CFA) was not performed (12, 17).

The selection of variables pertained to interactive techniques and e-learning challenges was informed by established findings in the e-learning literature emphasizing the central role of learner–content, learner–instructor, and learner–learner interactions in virtual education (5, 7-9). These perspectives underscore the fact that meaningful interaction shapes students' engagement and perceived learning effectiveness in online environments.

Accordingly, the interactive items included in our questionnaire were selected as indicators of key dimensions of student engagement frequently discussed in prior research. The instrument was employed for exploratory assessment within the present sample rather than for formal testing of a single predefined theoretical model (18).

Data Analysis: Data were coded and analyzed using SPSS version 22. Descriptive statistics, including means, frequencies, and percentages, were utilized to summarize the data.

Logistic regression analysis was undertaken to identify independent predictors of high educational exposure. For logistic regression analysis, the four original response categories (Never, Occasionally, Often, and A lot) were dichotomized into Never/Occasionally and Often/A lot. Candidate independent variables were first examined in bivariate analyses, and those with $p < 0.20$ were considered for inclusion in the multivariable model. A multivariable logistic regression model was then developed using the enter method to estimate adjusted associations.

Given the limited number of predictors retained in the final model and their distinct conceptual domains, substantial multicollinearity was considered unlikely. Model fit was ascertained using the Hosmer–Lemeshow goodness-of-fit test, which indicated acceptable agreement between observed and predicted values ($p > 0.05$). The ratio of outcome events to predictors fulfilled commonly recommended criteria for stable model estimation.

Ethical Consideration: The study protocol was reviewed and approved by the Ethics Committee of Hormozgan University of Medical Sciences. Participation was voluntary, with informed consent obtained electronically before the students accessed the survey. Anonymity and confidentiality of all participants were strictly maintained throughout the study.

Results

A total of 162 HUMS students participated in the questionnaire survey. All of them underwent their regular academic sessions through online teaching, at least two courses for two semesters. Table 1 details the demographic data of the participants indicating existence of appropriate diversity in the field of study of the participants and their faculties.

Table 1. Demographic characters of participants

Variables	Categories	Frequency (Percent)
Sex	Female	109 (67.28)
	Male	53 (32.72)
Faculties	Health	41 (25.47)
	Pharmacy	6 (3.70)
	Medicine	18 (11.11)
	Nursing and midwifery	11 (6.79)
	Paramedicine	74 (45.68)
	Dentistry	12 (7.41)
Academic Level	Master	14 (8.64)
	Doctorate	31 (19.14)
	Bachelor	117 (72.22)

Based on the findings presented in Table 2, a high percentage of students stated that they often or frequently experienced interactive teaching methods in electronic education.

Among the interactive techniques employed, three techniques were found to be the most prevalent: "showing slides" (70.99%, n=115), "question and answer sessions" (68%, n=110), and "sharing teaching materials" (51%, n=83). Meanwhile, 16% of the students stated that they had no experience talking with teachers and classmates in the virtual chat room.

The findings also demonstrated that teachers occasionally provided opportunities for students to participate in formative assessment and scenario-based learning (39% and 44.4%, respectively).

Table 2. The status of students' participation in the experience of interactive techniques in E-learning

Experiences	Frequency (%)			
	Never	Occasionally	Often	A lot
I've had the experience of introducing myself to other people in my room and my teacher in the virtual course.	7 (4.32)	12 (7.41)	58 (35.80)	85 (52.47)
I've had the "scenario" based learning experience provided by the professor	14 (8.64)	76 (46.92)	29 (17.90)	43 (26.54)
I've had practical experience with other students in small virtual groups that the professor had formed.	21 (12.96)	42 (25.93)	62 (38.27)	37 (22.84)
I've had the experience of taking a virtual course where the teacher starts the lesson based on an example of a "real problem"	22 (13.58)	37 (22.84)	79 (48.77)	24 (14.81)
I've had the experience of attending a simultaneous virtual class where the teacher asked a question during his speech and asked us to answer it in the chat box.	6 (3.70)	16 (9.88)	52 (32.10)	88 (54.32)
I've had the experience of attending a simultaneous virtual class where the teacher would ask a question during the lecture and ask us to raise our hands and answer	5 (3.09)	29 (17.90)	62 (38.27)	66 (40.74)
I've had the experience of participating in the simultaneous virtual classroom where the teacher shows slides while teaching	6 (3.70)	12 (7.41)	29 (17.90)	115 (70.99)
I've had the experience of participating in the "simultaneous virtual classroom" that the teacher, video or clip shows while teaching	22 (13.58)	31 (19.14)	48 (29.63)	61 (37.65)
I've had the experience of participating in the "simultaneous virtual classroom" where the teacher displays, the tables, diagrams, charts and figures while teaching.	6 (3.70)	24 (14.81)	64 (39.51)	68 (41.98)
I have had the experience of participating in a "synchronous virtual classroom" where the professor has enlisted the help of written or oral evaluation to better understand my progress	11 (6.79)	45 (27.78)	64 (39.51)	42 (25.92)
I've had the experience of attending a virtual class where the teacher shared his/her educational content with us	41 (25.31)	38 (23.46)	55 (33.95)	28 (17.28)
I've had the experience of talking to my teacher and classmates in the virtual dialogue hall	10 (6.17)	16 (9.88)	90 (55.56)	46 (28.39)
I've had the experience of doing the homework that the teacher had set online.	7 (4.32)	16 (9.88)	93 (57.40)	46 (28.40)

The challenges were categorized into four distinct domains based on the Exploratory Factor Analysis (EFA) undertaken along the validation phase of the questionnaire: i) Technical & Environmental, ii) Content and Workload, iii) Interaction and Motivation, and Practical Training. As outlined in Table 3, the domain of 'Practical Training' received the highest mean score (Mean=2.56), revealing it was perceived as the most challenging area, followed by 'Content and Workload' (Mean=2.44).

Further, the analysis delineated the primary challenges within the e-learning environment, defined as those scoring a mean of 3.0 or higher on the 5-point scale. These included difficulties pertained to the home learning environment, completion of training assignments, management of substantial volumes of educational content, participation in practical and laboratory courses, as well as adaptation to various online learning platforms. Conversely, the least significant challenge, with a mean score of 1.2, was a perceived failure to communicate effectively with instructors. The overall mean score for all

e-learning challenges was 2.4. A more granular breakdown indicated that 92 students (56.8%) reported an average challenge score below 3, while the remaining 70 students (43.2%) reported an average score of 3 or higher.

Next, to identify the interactive measures most significantly linked to students' perceptions of these challenges, a logistic regression analysis was applied. The results, detailed in Table 4, revealed that among the various interactive experiences, only two emerged as statistically significant independent predictors of greater educational exposure: i) active participation in virtual small groups and ii) engagement in peer conversations within virtual forums.

These experiences were associated with adjusted odds ratios (ORs) of 1.68 ($p < 0.01$) and 1.05 ($p = .024$), respectively. The goodness-of-fit of the final model was assessed using the Hosmer–Lemeshow test, which yielded a non-significant result ($p > 0.05$), indicating no evidence of poor model fit. Demographic variables, including gender, level of education, and faculty, were not significant predictors and were therefore not retained in the final regression model.

Table 3. The mean (Standard Deviation) of e-learning challenges, categorized by challenge domain

Challenge Domain	Specific Challenges	Mean	SD
Technical and Environmental	Technical problems in e-learning	2.1	0.79
	Difficulty using multiple online platforms	3.03	0.71
	Excessive content in a short period	2.2	0.58
	Difficulty concentrating at home	2.2	0.45
	Domain Mean	2.38	0.83
Content and Workload	Inadequate training	2.1	0.92
	Unclear teacher/assignment expectations	2.1	0.70
	Excessive content in a short period	3.02	0.89
	Incomplete assignment completion	3.02	0.78
	Failure to meet learning objectives	2.3	0.56
	Time management difficulties	2.1	0.87
	Domain Mean	2.44	0.73
Interaction and Motivation	Poor communication with instructors	1.2	0.60
	Limited access to instructors	2.4	0.79
	Difficulty concentrating at home	3.01	0.71
	Limited interaction with classmates	2.05	0.58
	Low student participation	3.1	0.45
	Reduced motivation or psychological well-being	2.3	0.83
	Domain Mean	2.34	0.92
Practical Training	Difficulty conducting practical/laboratory courses online	3.04	0.70
	Lack of practical/laboratory training	2.07	0.89
	Domain Mean	2.56	0.78

Table 4. Logistic regression for independent predictors of encountering challenges in e-learning among students

Domains of challenges	Challenges	Frequency of Participation	Adjusted OR [Exp(B)]	95% CI for OR	Wald statistic	df	P-value
Interaction & Motivation	Practical experience with other students in small virtual groups that the teacher had formed	Never/Occasionally	Ref	–	–	–	–
		Often/A lot	1.68	1.32–2.13	14.25	1	0.001
Content & Workload	Experience of doing the homework that the teacher had set online	Never/Occasionally	Ref	–	–	–	–
		Often/A lot	1.05	1.03–1.07	5.12	1	0.024

*The original four response categories were collapsed into two categories for logistic regression analysis (Never/Occasionally and Often/A lot)

Discussion

The abrupt transition from traditional face-to-face instruction to online learning during the COVID-19 pandemic has led to widespread disruptions in higher education systems globally. This study aimed to examine the e-learning challenges confronted by students at

Hormozgan University of Medical Sciences (HUMS) and identify independent predictors of these difficulties Note that this study focused on students' self-reported experiences and perceived engagement with interactive e-learning techniques, not on the evaluation or development of clinical or professional competencies. The outcome variable—"educational exposure"—reflects students' subjective sense of involvement as well as access to learning opportunities, rather than objectively validated measures of knowledge, skill, or performance. The findings offer several critical insights which are both contextually and internationally relevant.

The findings revealed that while many students reported frequent exposure to interactive teaching methods, such as the application of slides (70%), Q&A sessions (68%), and access to learning materials (62%), their overall appraisal of the e-learning experience was moderate, with an average score of 2.4 on a 5-point scale. These findings resonate with the observations of Dyrek et al. (2022), who noted that while theoretical content delivered via e-learning in Polish medical universities was rated positively, clinical education and practical sessions were poorly received (19).

Notably, while many interactive techniques were commonly applied, a quarter of students reported no experience with virtual chat interactions.

This may reflect technical or pedagogical obstacles, such as instructors' limited use of synchronous communication tools, institutional restrictions on certain platforms, or students' preference for asynchronous methods (e.g., email or forum posts) towing to connectivity issues, scheduling constraints, or privacy concerns. Since real-time interaction can augment immediacy, clarification, and social presence in online learning, the absence of chat-based communication may have limited opportunities for spontaneous dialogue and lowered the perceived interactivity of the e-learning environment—particularly for students who benefit from verbal or rapid feedback. This aligns with our regression results, which emphasize structured peer interactions (e.g., in forums or small groups) as more predictive of educational exposure than informal or ad-hoc exchanges.

The primary challenges identified by HUMS students encompassed the home learning environment, managing the volume of educational content, difficulties with practical as well as laboratory courses, and issues with online platforms. These findings mirror those of Azlan et al. (2020), who reported similar challenges in Malaysian medical institutions, particularly with internet connectivity, technical limitations, and maintaining concentration in the home setting (20). Likewise, other studies have stated that the effectiveness of e-learning is significantly hindered by infrastructural and environmental limitations, especially in developing nations (21-23).

Note that despite the frequent use of various interactive techniques in theoretical courses, practical and laboratory training remained one of the most highly rated challenges in our study. This suggests that the interactive strategies commonly utilized in online settings—such as Q&A sessions, slide presentations, and even forum discussions—are less effective or insufficient for replicating hands-on clinical and laboratory experiences. Although virtual small groups and peer forums enhanced students' perceived educational exposure, they could not fully compensate for the lack of physical practice, direct observation, as well as real-time feedback which are essential in skill-based disciplines. This aligns with the broader literature suggesting that e-learning is well-suited for knowledge transmission but faces inherent limitations in competency development for procedural and psychomotor domains (19, 20). HUMS partially addressed this gap through organizing limited in-person practical sessions in small cohorts; nevertheless, the persistently high challenge rating underscores the irreplaceable role of direct experiential learning in medical education.

The logistic regression analysis in our study exhibited that active participation in virtual small groups and peer interaction in online homework were significant predictors of students' overall educational exposure, with adjusted odds ratios of 1.68 and 1.05, respectively. These findings support the growing body of literature underscoring the role of high-touch strategies in boosting student engagement. According to Spencer (2017), such strategies, including discussion forums, synchronous sessions, and collaborative tasks, can facilitate a state of "flow," which augments focus and cognitive absorption (24).

Further, Kang and Zhang's research emphasizes that forum-based e-learning environments not only ameliorate motivation and engagement but also mitigate issues such as academic procrastination and plagiarism (25). Our findings reaffirm these observations and highlight the necessity of integrating structured peer-to-peer learning formats into online curricula. The higher regression coefficient for active participation in virtual small groups suggests that this form of interaction may have a more profound influence on students' perceived

educational exposure when compared to asynchronous forum discussions. This discrepancy could be attributed to the synchronous, dynamic, and collaborative nature of small-group sessions, which often involve real-time problem-solving, immediate feedback, as well as a sense of accountability among peers. In contrast, forum-based interactions, while valuable for reflective exchange and idea sharing, are typically asynchronous and may lack the immediacy and social presence that foster deeper engagement. This interpretation is in line with the concept of "high-touch" strategies in online education, where direct, real-time interaction tends to boost motivation and cognitive involvement more effectively than delayed communication (24).

Considering technical challenges, numerous studies have indicated that limited access to suitable digital devices and inconsistent internet connectivity significantly affect students' ability to engage with e-learning platforms (26, 27). These challenges were echoed by our participants, who identified outdated hardware and bandwidth issues as substantial barriers to learning. This is especially problematic for practical and clinical training, which requires real-time interaction and dynamic content delivery—components often inadequately replicated in virtual environments (21, 28).

While these in-person practical sessions were limited in scope and frequency owing to public health restrictions, they were generally perceived by students as essential and valuable. Notably, none of the students rated practical training as "very low" or "low" challenge. Also, the persistently high difficulty score (≥ 3) may reflect not dissatisfaction with the mitigation strategy itself, but rather the inherent irreplaceability of hands-on practice, even when partially restored. The university did not implement alternative strategies such as high-fidelity simulation or virtual labs because of infrastructural and resource constraints common in developing regions. Thus, the primary mitigation approach remained selective, small-group, in-person practical sessions, which students appeared to appreciate as a critical compromise along an unprecedented disruption.

Our study also found that students struggled with the cognitive load linked to excessive educational content. This is in accordance with the cognitive theory of multimedia learning, which suggests that the working memory has a limited capacity and can be easily overwhelmed when instructional design is not optimized (29). Instructors in developing countries, as stated by Adnan and Anwar, often lack the digital literacy required to design effective e-learning materials, resulting in inefficient knowledge transfer (28). To mitigate cognitive overload associated with excessive content, future e-learning designs could adopt evidence-based instructional strategies such as chunking information into modular units, sequencing topics from simple to complex, as well as integrating multimedia principles (e.g., reducing extraneous text, aligning visuals with narration) to optimize cognitive processing (29). Further, leveraging adaptive learning platforms that tailor content delivery based on individual student progress, or incorporating structured weekly roadmaps with clear learning objectives and prioritized resources, may help students manage workload more effectively. These approaches accord with cognitive load theory and have demonstrate promise in lowering mental effort while enhancing retention and comprehension in digital learning environments.

Interestingly, while the home environment was frequently cited as a challenge, research presents mixed findings on this topic. Whereas some scholars argue that the home setting offers flexibility and enhanced concentration for self-directed learners (30-32), others, such as Sangster et al., emphasize the distractions caused by family obligations, noise, and lack of private study space (33). Our findings support the latter view, especially in the context of students from large households or shared living environments, where study conditions are suboptimal.

In spite of these challenges, the increased use of online platforms has contributed positively to the development of students' technical competencies. As noted by multiple authors (34), the pandemic has served as a catalyst for digital transformation in education, encouraging both students and instructors to acquire new skills as well as adapt rapidly to virtual learning modalities. The experience of HUMS in organizing limited face-to-face practical sessions in small groups along the pandemic further reflects institutional resilience and adaptability.

Limitations: This study had several limitations which should be considered when interpreting the findings. Initially, a voluntary convenience sampling strategy was utilized, which may introduce selection bias, as participation depended on students' willingness to respond and may overrepresent individuals who were more engaged or motivated. Since the questionnaire link was disseminated through official faculty social media platforms, the exact number of students who viewed the

invitation could not be determined, and hence a conventional response rate was not calculated. Even though all submitted questionnaires were complete at the respondent level, this sampling approach restricts the representativeness and generalizability of the findings.

Secondly, the study was undertaken at a single medical university, which may restrict the applicability of the results to other institutions with different demographic, technological, or educational contexts. Multi-center studies across diverse institutional settings would augment external validity.

Thirdly, all data were based on self-reported perceptions, which are subject to recall bias, response bias, and subjective interpretation. The study did not include objective performance measures or observational data, which may constrain the robustness of conclusions regarding educational effectiveness.

Ultimately, even though content validity (CVI/CVR) and exploratory factor analysis (EFA) supported the internal structure of the questionnaire within the current sample, confirmatory factor analysis (CFA) was not performed owing to sample size considerations and since the instrument was adapted from previously validated tools rather than newly developed. Future studies with larger samples are encouraged to undertake CFA and report full model-fit indices to further strengthen construct validity.

In spite of these limitations, the study provides meaningful insights into students' experiences of interactive e-learning along a critical transitional period. Future research could address these limitations by applying probability-based or stratified sampling strategies, multi-institutional designs, longitudinal follow-up, and mixed-method approaches incorporating objective educational outcomes.

Conclusion

The main challenges in e-learning included the home environment, completing training assignments, managing a high volume of educational content, taking part in practical courses, and working with online learning platforms. Our regression logistic analysis indicated that actively participating in virtual small groups and engaging in conversations with peers significantly predicted the level of educational exposure students receive. This finding suggests that incorporation of these platforms into educational practices can provide opportunities for students to boost their understanding of academic subjects, exchange ideas, and gain exposure to different perspectives as well as knowledge. Thus, educators and curriculum designers in medical sciences should strategically integrate and promote the use of virtual small group discussions along with forums as a core component of e-learning modules. While this finding may not be universally applicable, it emphasizes the potential benefits of utilizing virtual small groups and forums to enhance students' educational experiences, particularly across settings facing similar challenges. Future longitudinal and multi-institutional studies are recommended to confirm these findings and explore the long-term influence of these interactive strategies.

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Original Article

Psychometric characteristics of the Persian Version of The Online Student Engagement Scale

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Abstract

Background: With the rapid growth of e-learning technology, it has become one of the most common educational approaches in educational institutions.

Objectives: This study was conducted with the aim of psychometrically evaluating the Online Student Engagement Scale (OSE) in Persian to assess the level of engagement in online courses.

Methods: In this descriptive-cross-sectional study, 125 online students completed the Persian version of the OSE. The construct validity of the OSE was examined using exploratory factor analysis (EFA) and Pearson correlations. Cronbach's alpha was calculated to determine internal consistency. Confirmatory factor analysis (CFA) was performed using Smart PLS 3 software to analyze the confirmatory factor structure of the instrument. The Larcker-Fornell criterion was used to check divergent validity.

Results: Four factors of learning engagement (social, behavioral, cognitive, and affective) were identified using factor analysis. The reliability was confirmed with a Cronbach's alpha score of 0.923. The factor structure was supported by fit indices (X^2/df = 2316.824, $p < 0.0001$, SRMR = 0.1, d_{ULS} = 29.682, RMS Theta = 0.11). The construct validity and reliability of the tool were confirmed with composite reliability (CR) validity values above 0.7.

Conclusion: The Persian version of the OSE appears to be a reliable and potentially valid instrument for use in Iranian online students. It may be favorable for evaluating e-learning engagement.

Keywords: Psychometric; Questionnaire; Engagement; Online Learning

Background

Effective e-learning can lead to deeper and higher levels of learning achievement and higher-order thinking abilities because it allows students to be actively engaged in learning anytime and anywhere (1, 2). Student engagement and participation are defined as the basic level of effort or interaction over time with learning resources that develops the learning outcomes and learning experience. The National Survey of Student Engagement and Active Engagement (NSSE) measures four factors: Academic challenges, learning with peers, interaction with school institutions, and supportive learning environments (3). The Student Engagement Instrument (SEI) measures affective and cognitive factors, and the Motivational Strategies for Learning Questionnaire (MSLQ) measures engagement based on cognitive strategies (4).

Early studies defined student participation and engagement as a single behavioral dimension. Mosher emphasized the behavioral characteristics of engagement and defined it as "an attitude toward a learning program or cooperative behavior" (5). However, these definitions lack other dimensions, such as the knowledge of learning and the psychological state of the learner (6). Currently, there are different definitions of student engagement. Lewis et al. defined engagement as "the extent to which students' thoughts, feelings, and activities are actively engaged in learning" (7). These changes in the definition of student engagement mean that student engagement expands from behavioral aspects to psychological and cognitive

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aspects, while the scope of participation ranges from in-curriculum learning activities (e.g., learning time, effort, and strategy) to extra-curricular learning activities (e.g., club activities and volunteer activities).

As shown in the definitions above, student engagement consists of both behavioral and emotional dimensions. Burch (8) designed a questionnaire to measure students' engagement using exploratory factor analysis, a tool with factors of physical engagement, motivational engagement, cognitive engagement in class, cognitive engagement outside of class, resistance, and learning. Deep engagement was the result of their activity. Among the tools for studying student engagement is the Student Engagement Questionnaire, which is part of the Australian student engagement tool. In Choi and Lee's study (9) titled "A survey to measure the perspective of students' engagement in an active learning classroom," they prepared a questionnaire with three components: Activity value, personal effort, and teacher's help.

A transcultural adaptation and psychometric study was carried out on 125 students engaged in online studies at Tehran University of Medical Sciences. These studies are limited in that many concepts specific to face-to-face environments are implemented in an e-learning environment. Therefore, the characteristics of the e-learning environment and the factors of the Online Student Engagement Scale (OSE) were developed by Lee, Hae-deok-sung, and Ah Jung-Hong in 2019 in Seoul, South Korea (10).

It should be noted that the validity and reliability of an instrument in one language do not guarantee that these characteristics will be preserved when translated into other languages due to cultural, linguistic, and geographical differences. When using a tool in a context different from where it was developed, these factors must be considered. This study aimed to adapt the Online Student Engagement Scale (OSE) into Persian and examine its psychometric properties.

Objectives

This study was conducted with the aim of psychometrically evaluating the Online Student Engagement Scale (OSE) in Persian to assess the level of engagement in online courses.

Methods

Study Design and Setting: This psychometric study was conducted at Tehran University of Medical Sciences from February 2023 to January 2024. The inclusion criteria consisted of all virtual students who had studied at least two semesters online at Tehran University of Medical Sciences and were willing to participate in this study. Participants who did not complete more than 7.4% of the questionnaire were excluded from the study.

Participants and Sampling: All participants were informed about the study objective, and it was clarified that their responses would remain anonymous. The study participants included a diverse group consisting of two bilingual translators proficient in Persian, one native English speaker with a strong grasp of Persian (during the translation phase), six experts in educational sciences and psychology familiar with psychometric procedures for assessing content validity, and 125 students selected through convenience sampling. These students were surveyed online to complete the OSE. Out of the 135 questionnaires received, 125 were eligible for use. The questionnaire was distributed to several instructors teaching online courses, who were asked to distribute the questionnaires to their students who met the inclusion criteria (students who had completed at least two semesters online and were willing to participate in the study). First-semester students were excluded due to their limited exposure to the university environment.

Tools/Instruments

Online Student Engagement: To assess learners' engagement in online courses, the OSE questionnaire was utilized, measuring four types of engagement: Social, behavioral, cognitive, and affective. Each item was rated on a 5-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = moderately agree, 4 = agree, 5 = strongly agree), with higher scores indicating increased engagement. The translation and transcultural adaptation were carried out, followed by determining the questionnaire's validity and reliability.

Translation Technique and Transcultural Adaptation: The Korean OSE questionnaire, originally developed by Lee and Hong (10), was translated into Persian using the standard forward–backward technique. To ensure a common psychological meaning between the original version and its translation, all translated versions were discussed for clarification, with minor changes made to the temporary Persian OSE.

Validity and Reliability

The validity and reliability of the Persian version of the Online Student Engagement Scale (OSE) in online courses were determined:

Validity: To determine the validity of the OSE, face validity, content validity, and construct validity were assessed.

- Content validity: The relative coefficient of content validity (CVR) was used. Experts were asked to evaluate

each item based on a three-point scale: "The item is necessary," "the item is useful but not necessary," and "the item is not necessary." Given that there were six experts, the acceptable limit for the content validity ratio (CVR = 0.91) was determined. Items with a CVR lower than this value were removed. After this process, one item was removed, 20 items were reviewed and edited, and 24 items were approved. The final questionnaire's validity and reliability were determined by experts.

- *Construct validity:* Exploratory factor analysis (EFA) was initially utilized in SPSS version 18 to determine the factor structure and assess the questionnaire's construct validity.

- *Reliability:* Cronbach's alpha was calculated to assess the questionnaire's internal consistency. The overall reliability was confirmed with a Cronbach's alpha score of 0.923. The Cronbach's alpha values for the individual factors were as follows: Social = 0.917, behavioral = 0.883, cognitive = 0.843, and affective = 0.872.

Data Collection: The study was conducted in two stages. The first stage involved translating the tool and adapting it culturally during an in-person session with translators. The second phase focused on evaluating the tool's psychometric features, including its validity (face, content, and construct validity) and reliability. After confirming content validity, the translated questionnaire was distributed to six experts for evaluation. Subsequently, the translated questionnaire, confirmed for reliability and validity, was sent electronically via email to all online students of the university who had at least two semesters of online education experience (135 students).

In the second part of the questionnaire, the level of engagement in the e-learning environment among online students was investigated with 24 items using a five-point Likert scale.

Results

Demographic Characteristics: A total of 125 participants responded to the questionnaire (92.6% response rate). The minimum age of the respondents was 23, and the maximum age was 55. The mean age was 36.99 ± 7.974. The age of the participants ranged from 23 to 54 years, with an average age of 28.31 (SD = 7.974). The group consisted of 38 males (30.4%) and 78 females (69.6%), with 67 e-learning students (53.6%), 13 medical education students (10.4%), and 45 educational technology students (36%). Other demographic characteristics are presented in Table 1.

Table 1. Demographic Characteristics of the Participants

Characteristic	Percentage	Number
Male	30.4	38
Female	69.6	87
E-learning	53.6	67
Medical education	10.4	13
Educational technology	36	45
Single	24	30
Married	76	95
Working while studying	79.2	99
Not working while studying	20.8	26
Dormitory resident	10.4	13
Not a dormitory resident	89.6	112
Faculty member	20.8	26
Not a faculty member	79.2	99
Lecturer	19.2	5
Assistant professor	53.9	14
Associate professor	26.9	7

Data Analysis: The collected data were analyzed using SPSS version 18 for exploratory factor analysis and Smart PLS version 3 for confirmatory factor analysis of the instrument. The Larcker–Fornell criterion was used to assess divergent and diagnostic validity, indicating the presence of partial correlations between the indicators of one structure and the indicators of other structures.

An EFA using the Principal Axis Factoring extraction method with Varimax rotation was performed on the 23 items of the scale in a sample (n = 125) to examine its factorial structure and construct validity. The appropriateness of performing EFA was confirmed by the Kaiser–Meyer–Olkin measure of sampling adequacy (KMO = 0.801) and Bartlett's test of sphericity ($\chi^2 = 2316.824$, $p < 0.0001$).

Descriptive Statistics: The extracted factors from the questionnaire estimated the total variance across four different areas. Questions in each field showed the highest correlation with their respective field and low to relatively weak correlation with other fields. Varimax rotation was used to justify the changes in total engagement in students' learning. The rotated components matrix was applied, and the rotation converged in four iterations. The level of students' engagement was calculated using a five-point Likert scale, determining the percentage of grades and the average of the components. The lowest and highest averages of all components were also identified.

Upon examining the Scree Plot, and considering that four factors had eigenvalues greater than 1, it was observed that these four factors could provide strong separation between the questions, forming four distinct areas of student engagement in learning.

Exploratory Factor Analysis: Initially, the Kaiser–Meyer–Olkin measure and Bartlett's Test of Sphericity were used to assess data suitability for factor analysis. The KMO index of 0.801 indicated adequate sampling, while the Bartlett's Sphericity Index was significant (2316.824, $p < 0.001$), confirming that the correlation matrix was not an identity matrix. The analysis included reviewing eigenvalues (greater than one), explained variance, and a scree plot to identify the number of factors present. According to Table 2 and Figure 1, both the principal components analysis and the scree plot supported the extraction of four factors, which explained 60.754% of the total variance, validating the structure of the scale.

Table 2. Factor Loadings of the Items of the Persian Version Online Student Engagement Scale

Item	CVR	Social	Behavioral	Cognitive	Affective
I study the contents of virtual courses with other students.	1	0.855			
I am satisfied with the virtual class that I am participating in.	1	0.726			
I try to solve difficult problems with the help of other classmates.	1	0.715			
I answer virtual projects or assignments with the help of other classmates.	1	0.680			
I manage my learning using the virtual system.	1	0.664			
I tend to apply the knowledge I have learned in virtual classes to real problems or new situations.	1	0.617			
I frequently interact with other students in my virtual classes.	1		0.831		
I often ask the professor about the lesson material	1		0.741		
I feel that I am connected with classmates in virtual classes	1		0.706		
I try to answer the questions that other students ask.	1		0.647		
I am in private contact with the professor for further guidance.	1		0.643		
I feel like I belong to the community of my virtual classmates.	1		0.577		
After passing a virtual lesson, I am waiting for the next lesson	1		0.441		
I can deeply analyze thoughts, experiences and theories related to the knowledge I have learned in my virtual classes	1			0.848	
I can gain new interpretations from the knowledge I have learned in virtual classes	1			0.753	
When participating in online classes, I remove all environmental factors that cause distraction	1			0.669	
After my virtual class, I also study related educational materials	1			0.650	
I can judge the value of information related to the knowledge learned in my virtual classes	1			0.553	
When I participate in the virtual class, I am motivated to study.	1				0.794
Virtual classes are useful for me	1				0.790
Virtual classes increase my interest in learning.	1				0.718
It is interesting to participate in virtual classes.	1				0.662

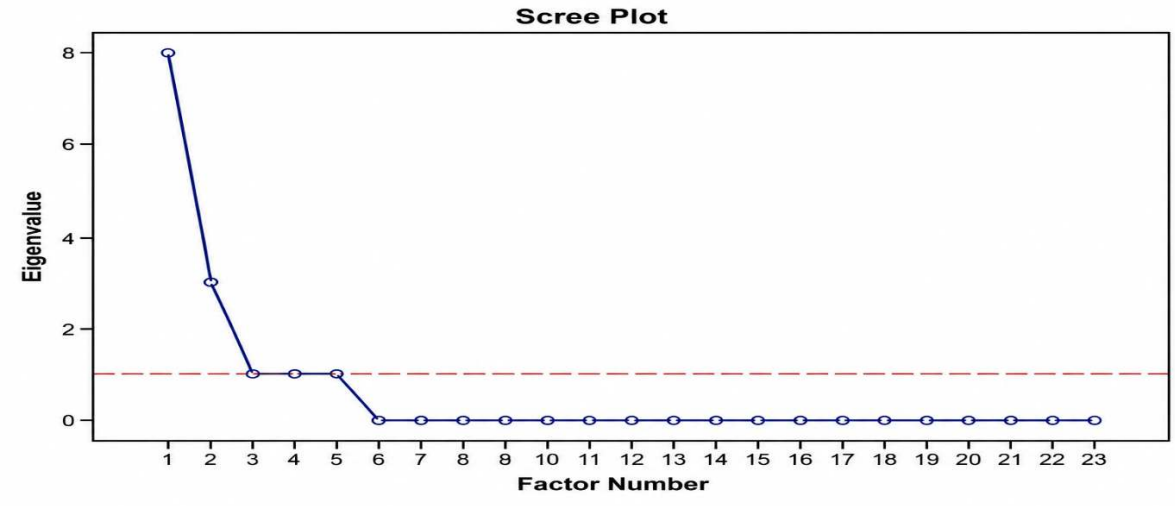

Figure 1. Scree plot

Following the rotation process, factor loadings for the 23 items are presented in Table 2. In the component matrix, four factors were extracted. In the rotated components matrix, each item aligned with only one factor, indicating a clear structure. Question 4 had a low correlation with the rest of the questions and was removed. In the initial factor analysis, five factors were identified; however, the fifth factor included only two items and was therefore removed. Ultimately, an exploratory factor analysis was conducted with four factors. These four factors had an eigenvalue greater than 1 and explained 60% of the variation in the data. Rotation converged in four iterations. After rotating the factors, the following factor structure was identified: Items (12, 13, 14, 15, 16, 22, 24) loaded on factor 1 (social); items (17, 18, 19, 20, 21, 23) loaded on factor 2 (behavioral); items (1, 2, 3, 5, 6) loaded on factor 3 (cognitive); and items (7, 8, 9, 10) loaded on factor 4 (affective).

The analyses yielded a four-factor solution with eigenvalues greater than 1 and factor loadings of 0.30 or higher, explaining 60.754% of the variance.

Construct Validity and Reliability: Formulating hypotheses about the concepts under study, testing these hypotheses, and calculating the correlation of the obtained results with the initial measurement are key steps in assessing construct validity. A high correlation coefficient indicates high construct validity.

SmartPLS 3 output reports include Rho-A for reliability and construct validity. The matrix also provides Cronbach's alpha (CA), composite reliability (CR), and Average Variance Extracted (AVE). The Rho-A value between Cronbach's alpha and composite reliability indicates strong reliability (Table 3).

Table 3. Construct Reliability and Validity and Changes in the Total Factor Loadings from Varimax Rotation

Factor	N	Cronbach's Alpha	Rho-A	Composite Reliability	AVE	Rotation Sums of Squared Loadings		
						Total	% of Variance	% Cumulative
Social	7	0.917	0.922	0.934	0.669	4.287	18.638	18.638
Behavioral	7	0.883	0.894	0.910	0.592	4.001	17.397	36.035
Cognitive	5	0.843	0.844	0.889	0.616	2.929	12.736	48.771
Affective	4	0.872	0.888	0.912	0.722	2.756	11.983	60.754

Confirmatory Factor Analysis

All subsequent analyses were conducted to examine the confirmatory factor structure of the tool using Smart PLS 3 software. The factor structure was supported by SRMR = 0.1, d_{ULS} = 29.682, RMS Theta = 0.11, SSO = 2,875.00, SSE = 1,952.95, and Q^2 = 1 - SSE/SSO = 0.321, confirming the validity of the first-order factor model.

Construct Cross-validated Communality Factors: The covariance test results showed that the covariance validity index for the latent variables was positive, indicating that the measurement model had acceptable quality. As shown in Table 4, the Q^2 index revealed the predictive power of the model in endogenous constructs. The positive Q^2 value indicated good fit and appropriate predictive power.

Table 4. Construct Cross-validated Communality

Construct cross-validated communality	SSO	SSE	Q^2 = 1-SSE/SSO
Social	875	481.703	0.449
Behavioral	875	406.756	0.535
Cognitive	625	364.881	0.416
Learning engagement	2875.00	1952.95	0.321
Affective	500	248.752	0.502

Variance Inflation Factor (VIF): This factor indicates the degree of collinearity between latent variables. Values less than 5 are acceptable. All latent variables in the structure demonstrated acceptable values:

(Social → Learning engagement = 2.067, behavioral → Learning engagement = 1.834, cognitive → Learning engagement = 1.295, affective → Learning engagement = 1.436).

Path Coefficients: The structural model and detailed observations showed significant effects of all latent variables:

- Social → Learning engagement (O = 0.475, M = 0.475, STDEV = 0.031, T = 15.103, P < 0.001)

- Behavioral → Learning engagement (O = 0.391, M = 0.391, STDEV = 0.023, T = 16.725, P < 0.001)
- Cognitive → Learning engagement (O = 0.186, M = 0.182, STDEV = 0.026, T = 7.139, P < 0.001)
- Affective → Learning engagement (O = 0.212, M = 0.210, STDEV = 0.021, T = 10.286, P < 0.001)

Convergent Validity, Reliability, and Composite Construct Reliability: All construct reliability and composite construct reliability values for the questionnaire dimensions were above 0.7, and convergent validity values exceeded 0.5, confirming high validity and reliability. The four-factor model was validated, and items within each factor demonstrated acceptable correlations.

Construct Divergent Validity: According to the Fornell–Larcker criterion (Table 5), the square root of the AVE values on the main diagonal exceeded the correlation values in the corresponding rows and columns.

This confirmed that constructs interacted more strongly with their own indicators than with others, establishing acceptable divergent validity.

Table 5. Discriminant Validity/Fornell-Larcker Criterion

Discriminant Validity/Fornell-Larcker Criterion	Affective	Behavioral	Cognitive	Learning Engagement	Social
Affective	0.850				
Behavioral	0.518	0.770			
Cognitive	0.147	0.252	0.785		
Learning engagement	0.661	0.843	0.539	0.622	
Social	0.461	0.622	0.470	0.904	0.818

In Figure 2, the t-statistics related to the factor loadings of each item are shown under each structure. The acceptable criterion is a value greater than 1.96. All items met this threshold. The standardized values indicate the factor loadings for each question relative to the various components, demonstrating each question's contribution to explaining component variance. Figure 3 further demonstrates that the path coefficients for the four-factor model are statistically significant (T > 1.96, P < 0.001), confirming a robust fit for the OSE.

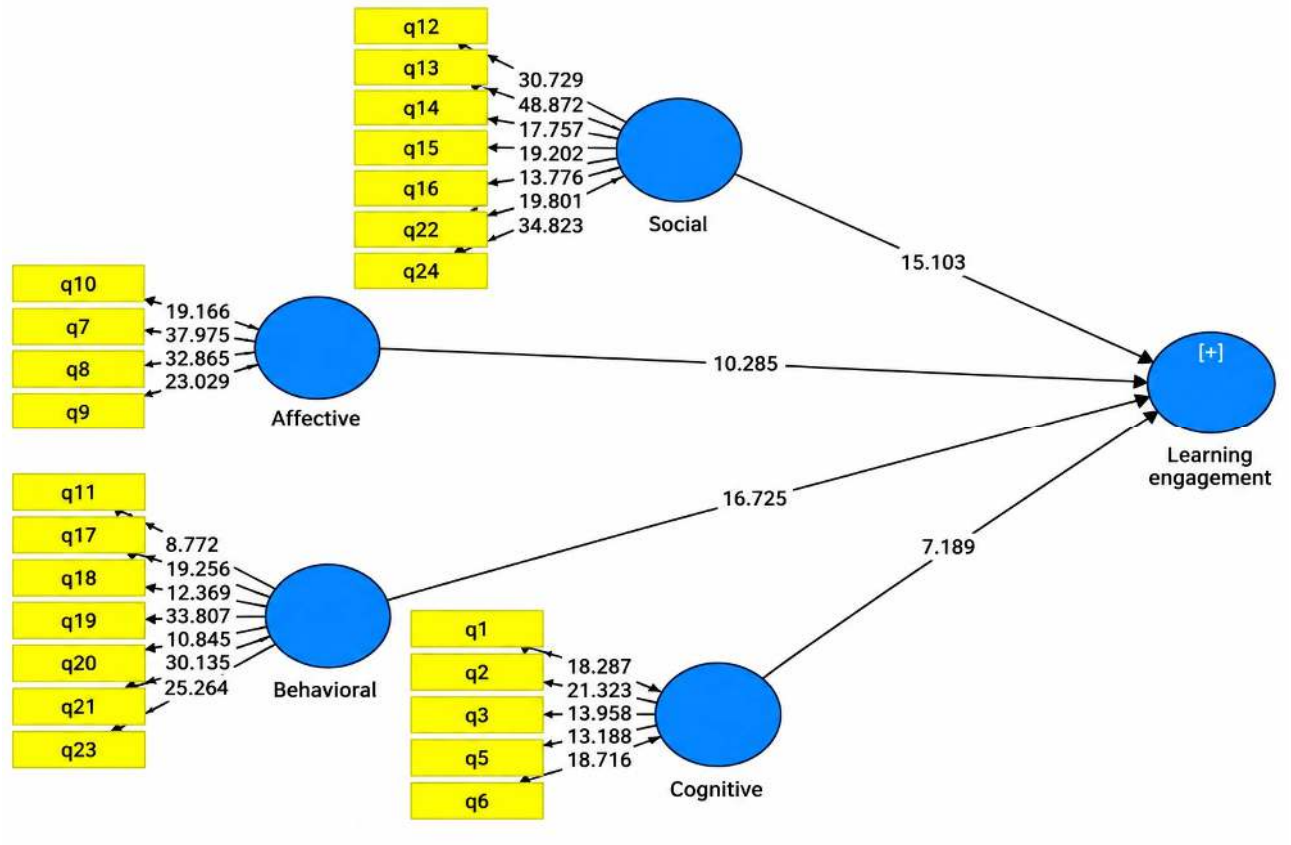

Figure 2. Display of AVE, T-values of the items on the model and confirmatory factor analysis results

Factor Loadings of the Model Sheets: Factor loadings greater than 0.7 are considered acceptable, indicating that each factor demonstrated strong loadings on its respective items.

Discussion

This study investigated the psychometric characteristics of the Persian version of the Online Student Engagement Scale (OSE). The OSE, comprising 23 self-report items across four engagement dimensions (cognitive, behavioral, social, and affective), was obtained. The psychometric analysis of the localized version of the tool showed that the tool is valid and reliable. The psychometry of this tool was done using standard procedures and using experts' analysis and review. The conducted investigations confirmed the face and content validity of the tool. The construct validity of the tool showed that this tool can adequately examine the factors of learning engagement. Comparison of the results of this study with the original version showed that one of the components (q4) was removed, but some items (11, 22, 23, 24) were moved in the Persian version, and components (social, behavioral, cognitive, and affective) were obtained from the rotation of components. In the study and analysis of students' engagement in the e-learning environment, four factors were found (social, behavioral, cognitive, and affective).

The first factor in the present study was social (original sample = 0.391, sample Mean (M) = 0.388, STDEV = 0.024, T-statistics = 16.156, P-values = 0.000, AVE = 0.669, Cronbach's Alpha = 0.917, SSO = 875, SSE = 481.703, Q^2 = 0.449) and is related to collaborative learning activities with other students and refers to activities in which students discuss knowledge and issues with participation. Since cooperative learning and interaction are becoming increasingly important in the e-learning environment, it is important that cooperative learning appears as a separate factor in this study.

The second factor was behavioral (original sample = 0.475, sample mean (M) = 0.476, STDEV = 0.029, T-statistics = 16.343, P-values = 0.000, AVE = 0.592, Cronbach's Alpha = 0.883, SSO = 625, SSE = 364.881, Q^2 = 0.416), which engages students in learning and refers to psychological factors, such as perceived bonds and connection with other students. Fredericks (Figure 2 - 3) emphasized that the sense of belonging helps students to participate in classes. According to Fredericks, in the light of this perspective, the Behavioral factor is obtained from this study in the sense that it is directly related and significant to the measures of the student's psychological status.

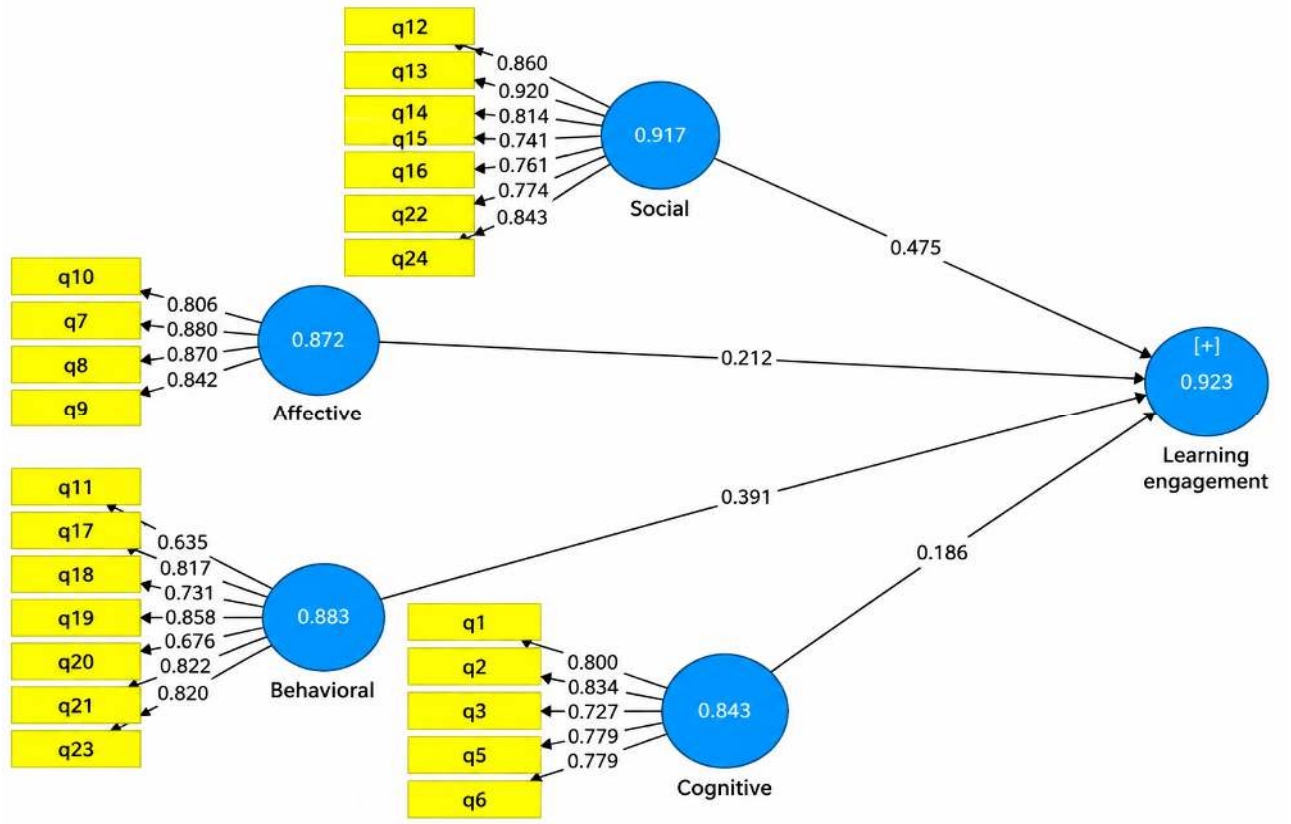

Figure 3. Effects (path coefficients) and factor loadings of the items on the model

The third factor, cognitive (original sample = 0.186, sample mean (M) = 0.183, STDEV = 0.026, T-statistics = 7.136, P-values = 0.000, AVE = 0.616, Cronbach's Alpha = 0.843, SSO = 500, SSE = 248.752, Q^2 = 0.502), was proposed as the influencing factor of learning engagement among students, which is related to the internalization of tasks. It is cognitive, which shows the importance of the process of acquiring, understanding, and using knowledge in learning. These are important factors because they affect learning progress. Fredericks (Figure 2-3) emphasized that it is important to strengthen this skill, especially in students who have chosen distance learning methods (based on hybrid methods), due to the independence they have in receiving training and curriculum. Horton (11) explained that the measurement of engagement in face-to-face settings has mainly focused on behavioral or emotional types of engagement. Researchers have recently begun to pay attention to the cognitive process of learning.

The fourth factor was affective (original sample = 0.212, sample mean (M) = 0.21, STDEV = 0.021, T-statistics = 10.324, P-values = 0.000, AVE = 0.722, Cronbach's Alpha = 0.872, SSO = 500, SSE = 248.752, Q^2 = 0.502) among students, which is related to the psychological aspect of learning. This factor represents the thoughts or feelings of learners, such as interest, expectations, and motivation associated with e-learning. The Online Student Engagement Scale (OSE) developed by Dixson (12) comprises 19 items on a 5-point Likert scale that assesses the extent to which individuals perceive their thoughts, behaviors, and feelings as representative of themselves or their conduct. Learning motivation and learning expectations are necessary for a higher level of learning activities in the e-learning environment. Jung (13) stated that the level of interaction and engagement is higher when students feel the educational presence in the field of real learning with the professor.

This study shows that students want to actively participate in learning and learn actively in virtual courses. Garrison (14) stated that teaching presence is facilitated when students regularly interact with professors. Joo and Lim (15) emphasized that students learn successfully when they feel a high level of teaching presence through interaction and continuous engagement with the professor in online courses. Parkes (16) believed that the criteria for measuring engagement in learning tend to focus on the quantity and quality of students' engagement in activities and situations related to their studies. It seems that e-learning environments are of special importance by creating cognitive and intellectual interaction and strong scientific content to create changes in students' understanding, perspective, or cognitive structures. Parks (16) stated that this factor is related to active and self-directed learning activities for students in an independent learning environment.

All paths have significant coefficients, which indicate that the paths and relationships between latent variables have been chosen correctly. The matrix of correlation coefficients of latent variables was calculated and showed that learning engagement has the highest correlation with endogenous cognitive variables, then with behavioral variables. Also, the cognitive, behavioral, and cognitive endogenous variables have the highest correlation with the exogenous latent variables of their domain. This confirms that the endogenous variables and their associated factors are properly selected. Based on the obtained results, a positive and significant statistical relationship between learning engagement and the mentioned components was shown. Considering that learning engagement includes behavioral, cognitive, and emotional engagement, the findings of the present research are consistent with the findings of Fredericks (3) regarding the main factors of student engagement. The factor of Social is related to cognitive engagement, and the factors of Affective and Social are related to emotional engagement. Professors' supportive behaviors also motivate students and increase their engagement in the learning environment (16), showing that interaction with professors, which refers to communicative actions such as asking for additional help from the professor or asking questions about course content, can be considered an important predictor of student engagement in e-learning.

The Larcker-Fornell criterion was used to check the divergent validity and diagnostic validity of the model, which indicates the existence of partial correlations between the indicators of one structure and the indicators of other structures. The Larcker-Fornell criterion refers to the fact that the square root of the explained variance (AVE) of each construct is greater than the correlation values of that construct with other constructs. The values on the main diagonal of the following matrix must be greater than all the values in the corresponding column, which is the case. Therefore, the divergent validity of the following construct was confirmed. AVE is the value of extracted variance related to the constructs, and the acceptable value for this criterion is greater than 0.5, which shows that our constructs have good validity.

Assessing student engagement can pinpoint both students who are thriving and those who require

additional support to excel (17). Tools designed to gauge engagement in traditional university settings may not effectively reflect the unique engagement behaviors seen in e-learning environments, where learner competencies, motivations, and navigation methods often differ significantly (18). Studies have underscored the critical role of engagement in predicting academic success in online settings (19, 20).

The results of face validity, simplicity feedback, and fluency showed that this study is consistent with previous research using similar instruments to assess face validity across different contexts and demographics (21). In conclusion, this finding suggests that participants found the questionnaire items relevant and appropriate for measuring their online engagement, indicating a comprehensive understanding of the concept being measured.

The findings showed that the CVR value for each questionnaire item and the average CVR (0.91) exceeded the minimum acceptable level. Thus, these outcomes affirm the questionnaire's content validity. These findings indicate that the questionnaire has satisfactory content validity for assessing online student engagement. These findings suggest that the questionnaire adequately captures the domain of online student engagement, which encompasses Social, Behavioral, Cognitive, and Affective engagement. This implies that the questionnaire is characterized by high relevance, clarity, and simplicity for assessing this construct. These results are aligned with prior studies that have utilized or adapted the questionnaire in different settings and among different populations (22).

In the process of performing EFA, four distinct factors were revealed: Behavioral, affective, cognitive, and social engagement. These factors collectively explained 60.754% of the total variance. Furthermore, CFA supported a first-order factor structure with robust fit indices, confirming that the questionnaire is valid for assessing various dimensions of online student engagement. This indicates that items of the questionnaire measure the four distinct dimensions of online student engagement, including social engagement, cognitive engagement, affective engagement, and behavioral engagement, as described by the theoretical framework of engagement, thereby affirming the construct validity of its Persian adaptation, as it yielded a similar factor structure to the original instrument. Such consistency aligns with previous studies that utilized the same questionnaire to gauge online student engagement across diverse settings and demographics (23). For instance, Hoi and Hang (24) used the questionnaire on 363 undergraduate students enrolled in an online English as a foreign language program at a large multidisciplinary university in Ho Chi Minh City, Vietnam. Their findings revealed that the questionnaire exhibited a four-factor structure with strong reliability and validity.

The complete scale and each of the four subscales (cognitive, behavioral, social, and affective engagements) had Cronbach's alpha 0.923. This demonstrated acceptable internal consistency and further supported its psychometric robustness. High Cronbach's alpha coefficients (above 0.7) indicated that the items on a scale consistently measured the intended construct, thereby enhancing the validity of research findings. This result aligns with prior studies that utilized the same questionnaire to assess online student engagement across various contexts and populations (25, 26). The current study findings suggest that the questionnaire consistently produces reliable scores when measuring online student engagement, indicating that its items are clear, straightforward, and pertinent.

This research gives professors and university officials the possibility to measure the level of students' engagement in research activities to provide the basis for recognizing and educating active and capable students in the field of practice and to be used as an efficient tool in universities and higher education institutions.

Due to the constrained sample size (N=125) and strict inclusion criteria, data splitting for independent EFA and CFA was not feasible, as reducing the sample would have compromised statistical power. We prioritized using the full cohort to ensure stable parameter estimation via PLS-SEM, which is robust for smaller samples. We acknowledge this as a methodological limitation and recommend that future studies cross-validate this 23-item scale across larger, independent, and multi-center cohorts.

Conclusion

This study provides strong evidence for the psychometric properties of the OSE based on a study conducted at Tehran University of Medical Sciences. Analysis of the 4-factor structure (social, behavioral, cognitive, and affective) with satisfactory fit indices and reliability scores was identified. The findings significantly increase the existing knowledge about online engagement measures by confirming the reliability and validity of the OSE instrument for use in online learning contexts.

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Brief Report

What Is Your Name and Where Are You Going? The Distribution of Non-Common Names Among 2024 United States Residency Match Specialties

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Abstract

Background: First names have been studied as an indicator of an individual's background, and have been shown to have associations with socioeconomic status and discriminatory practices. There are many studies in the literature that demonstrate discrimination against traditionally black names and studies have shown some names can be predictive of socioeconomic status independent of race.

Objectives: To determine the prevalence of non-common names among Matched applicants of different specialties.

Methods: In this observational study 2024 United States Residency Match lists (from 18 institutions from 14 different states) were obtained through convenience sampling, and a total of 2378 Matched applicants were identified. Match participant names were compared with the 200 most common names (according to the Social Security website) of three consecutive decades from the 1980s through the 2000s to cover the expected birth years of the applicants in the 2024 residency Match cycle, and designated as common or non-common. The frequency of non-common names was reported by specialty.

Results: Of the 2378 Matched applicants, 1023 (43.0%) of which had non-common names. Non-common names were significantly over-represented in internal medicine (47.8% non-common, p=0.023), general surgery (51.8% non-common, p=0.032), and dermatology (56.5% non-common, p=0.062). They were a trend toward over-representation in pediatrics (35.9% non-common, p=0.041) and orthopedic surgery (34.1% non-common, p=0.079) They were a trend toward under-representation.

Conclusion: This study establishes a novel, easily replicable metric that may serve as a baseline for suggesting variations in the distribution of non-common names across specialties over time.

Keywords: Cultural Diversity; Internship and Residency; Workforce Diversity

Background

When I was applying for residency in the United States as an international medical graduate, I was told to apply wide- even to apply for all of the programs if I could afford it. But if I could not, I should skip the programs that would not take me. Those programs were not necessarily the best programs though. So how could I identify them? *Open the website, look at the residents' names. You will know which ones will not take you. You can skip those.*

Surely, I can't have been the only one who had this experience. I made a game of it. I took great institutions, one subjectively diverse, one subjectively not very diverse. I would have people read me the first names of the residents from random years and disciplines: the PGY 2 psychiatry residents, the PGY 3 urology residents, the internal medicine interns, the graduating class pathology residents: take your pick. Reading the first names only, I would tell you with perfect accuracy which program was from which institution. The first names seemed to be some indicator of diversity.

We know from the literature that names carry information (1). A well-studied phenomenon is how traditionally black names are discriminated against, usually done by submitting identical applications or CVs with different names and measuring the impact of the names themselves (2-6). Figlio (6) described factors associated with low socioeconomic status independent

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of race in traditionally Black names. Could names also be an indication of cultural diversity?

This study aims to determine if the frequency of non-common names among matched applicants varies significantly across US residency specialties.

Objectives

To determine the prevalence of non-common names among Matched applicants of different specialties.

Methods

The Social Security website provides a database of the 200 most common names from each decade (7). The most common names for boys and girls from the 1980s, 1990s, and 2000s were collected from the website and the redundancies were removed resulting in a list of 499 discrete names from the three decades. Names that appeared in the resulting database were designated as "common". These decades were selected to cover the expected birth years of the applicants in the 2024 residency Match cycle.

All available US medical school Match lists that were posted online in a format from which data could be extracted were included in the study. Many of these Match lists from various institutions were found on the Student Doctor forum (8) in addition to Google search results of the term "match list". Since the data were extracted from US medical school Match lists, no international medical graduates were included. Despite the fact that all Match lists that were found were used in the study, the convenience sampling was a major limitation which may have skewed the data.

The first names of the Match applicants were subsequently compared to the database of common names and each name was designated as common or non-common, based on whether it appeared on the list exactly. This comparison was case sensitive. The gender of the names was not included in analysis, so as long as the name of the applicant matched the name on the common name list, it was considered common, even if the gender was mismatched.

Findings were reported by residency specialty and a Chi-square test [using the Social Science Statistics Online Chi-Square calculator (9)] was used to determine significantly different levels for each category (individually compared to all others) that had at least 40 samples, between the frequency of common and non-common names within that category. Essentially, each specialty was divided by those who matched into it versus those who did not and was stratified based on whether their name was common or non-common. Significance was set at $p<0.05$. The expected frequency for each Chi-square test was the proportion of non-common names among the Matched applicants in all other specialties. The Chi-square test results are, however, exploratory and uncorrected, and should be interpreted with caution. When both a preliminary position and a categorical position was reported, the categorical position was considered only.

To evaluate the association between applicant name categories and medical specialties, unadjusted chi-square tests of independence were initially performed. Given the multiple comparisons across various specialties, unadjusted P-values are presented alongside effect sizes—namely Odds Ratios (OR) with 95% confidence intervals (CI) for individual specialties versus all others, and Cramér's V for overall associations—to provide a more robust measure of practical significance beyond mere statistical significance. Due to the exploratory nature of this study and the risk of over-correction obscuring meaningful variations, uncorrected thresholds are reported with appropriate caveats, acknowledging the limitations of family-wise error rate inflation.

Results

2024 Match lists from 18 institutions from 14 different states were analyzed, accounting for 9.2% of all Matched MD and DO senior medical students based on the NRMP results and data report (10). These institutions include a variety of institutions including high tier academic centers, as well as lower tier programs. A total of 2378 Matched applicants were identified, 1023 (43.0%) of which had non-common names.

The most common names among medical students were Matthew (28), Sarah (24), and Emily (24). Among non-common names, Madeleine (8) was the most frequently occurring, followed by Saad (4) and Harrison (4).

The frequency of common and non-common names of the Matched applicants by state of their medical school is shown in Table 1.

The frequency of common and non-common names of the Matched applicants by the specialty they matched into is shown in Table 2.

Uncorrected p-values suggested an over-representation of non-common names in internal medicine, general surgery, and dermatology and under-representation in pediatrics and orthopedic surgery. Preliminary positions (medicine, surgery, and transitional) were all among the categories that had a smaller number of Matched applicants ($N<40$). A number of categories had less than 5 Matched

applicants, which are shown in aggregate as "other" in Table 2. These positions included Internal Medicine-Psychiatry, Oral and Maxillofacial Surgery, Child Psychiatry, Neurodevelopmental Disabilities, Psychiatry-Family Medicine, and Triple Board.

Three of the names in our study (0.1%) met the criteria described by Figlio (6) that denoted names associated with low socioeconomic status. They matched into internal medicine, pathology, and radiology.

Table 1. The frequency of common and non-common names among the Matched applicants by state of the medical school

State	Common	Non-common	Total	Percentage of Non-common Names
New York	154	237	391	60.6
California	162	143	305	46.9
Alabama	149	94	243	38.7
Minnesota	144	84	228	36.8
Nebraska	107	56	163	34.4
Iowa	102	48	150	32.0
Virginia	79	55	134	41.0
Pennsylvania	76	57	133	42.9
Oklahoma	86	46	132	34.8
Ohio	73	53	126	42.1
Rhode Island	75	47	122	38.5
Florida	57	48	105	45.7
Illinois	49	29	78	37.2
North Dakota	43	26	69	37.7
Total	1356	1023	2379	43.0

Table 2. The frequency of common and non-common names among the Matched applicants by residency specialty

Specialty	Common	Non-common	Total	Percentage of Non-common Names	p-value*	Odds Ratio (95% CI)**
Internal Medicine	246	224	470	47.8	0.023	1.26 (1.03 – 1.54)
Family Medicine	128	90	218	41.3	0.587	0.92 (0.69 – 1.22)
Emergency Medicine	117	81	198	40.9	0.531	0.91 (0.68 – 1.22)
Pediatrics	118	66	184	35.9	0.041	0.71 (0.52 – 0.98)
Anesthesiology	85	69	154	44.8	0.644	1.08 (0.78 – 1.50)
Psychiatry	81	63	144	43.8	0.856	1.03 (0.74 – 1.45)
General Surgery	66	71	137	51.8	0.032	1.46 (1.03 – 2.06)
Gynecology and Obstetrics	85	49	134	36.6	0.121	0.74 (0.51 – 1.07)
Diagnostic Radiology	58	45	103	43.7	0.890	1.03 (0.69 – 1.54)
Orthopedic Surgery	60	31	91	34.1	0.079	0.66 (0.42 – 1.03)
Neurology	42	23	65	35.4	0.207	0.71 (0.42 – 1.19)
Ophthalmology	36	26	62	41.9	0.863	0.95 (0.57 – 1.60)
Internal Medicine-Pediatrics	29	18	47	38.3	0.509	0.81 (0.44 – 1.48)
Dermatology	20	26	46	56.5	0.062	1.76 (0.97 – 3.20)
Urology	26	18	44	40.9	0.775	0.91 (0.49 – 1.68)
Otorhinolaryngology	29	14	43	32.6	0.162	0.62 (0.32 – 1.18)
Preliminary, Surgery	17	21	38	55.3	—	—
Physical Medicine and Rehabilitation	15	13	28	46.4	—	1.66 (0.86 – 3.19)
Pathology	18	10	28	35.7	—	1.15 (0.54 – 2.45)
Preliminary, Medicine	16	11	27	40.7	—	0.73 (0.33 – 1.60)
Preliminary, Transitional	14	10	24	41.7	—	0.91 (0.41 – 2.01)
Plastic Surgery	10	11	21	52.4	—	0.94 (0.41 – 2.16)
Neurosurgery	7	7	14	50.0	—	1.47 (0.61 – 3.52)

Specialty	Common	Non-common	Total	Percentage of Non-common Names	p-value*	Odds Ratio (95% CI)**
Child Neurology	8	5	13	38.5	—	1.33 (0.46 – 3.82)
Radiation Oncology	3	8	11	72.7	—	0.82 (0.27 – 2.55)
Interventional Radiology	7	4	11	36.4	—	3.57 (0.94 – 13.5)
Vascular Surgery	3	4	7	57.1	—	0.75 (0.22 – 2.61)
Thoracic Surgery	5	2	7	28.6	—	1.78 (0.40 – 8.00)
Other**	6	3	9		—	0.52 (0.10 – 2.73)
Total	1355	1023	2378	43.0	—	0.66 (0.16 – 2.66)

Note: *Chi-square; **Including Internal Medicine- Psychiatry, Oral and Maxillofacial Surgery, Child Psychiatry, Neurodevelopmental Disabilities, Psychiatry-Family Medicine, and Triple Board
Odds Ratio (OR) with 95% Confidence Interval
(CI) compares the odds of having a non-common name in the designated specialty versus all other specialties combined.
Unadjusted Chi-square test (calculated only for specialties with N≥40, consistent with original methods).
Other includes combined programs with low representation

Discussion

The frequency of names may represent something about a person and their culture. It is unclear exactly what though. Names have been used many times in lieu of ethnicity when needed, in many cases with success (11). Non-common names are a heterogeneous group, including people from ethnic minorities, but also names of celebrity children such as Apple, North, and X Æ A-12. Of course, the most prevalent non-common names would actually be those that rank just above 200 for each decade- most would be names that would not be associated with non-white ethnic minorities. For example, in 2024, the 201st through 210th most common names for girls were Haven, Scottie, Gemma, Ana, Tatum, Arabella, Lila, Molly, Stevie, and Blake and for boys were Bentley, Zayden, Messiah, Abraham, Alex, Adonis, Kaiden, Timothy, Knox, and Tate (7). This is the limitation of looking at names as measure of diversity. This limitation may of course be addressed to some extent by further subcategorizing the names into ethnic groups. Just as we have done with traditionally Black names, we could also look into how Arabic names, East Asian names, South Asian names, and Latin names perform differently. The strength is that it cannot be easily manipulated, so if it is an indicator of something, it can be easily compared between groups and time points. Names are not easily changed and they are relatively objective and less subject to misreporting.

Using the same methodology, it was previously shown that non-common names constituted 32.2% of radiology residents that were US graduates and were PGY 2 (R1) in 2013, 31.8% in 2014, 31.7% in 2015, and 32.0% in 2016. (12) In our study 43.7% of those Matched in radiology in 2024 had non-common names. If this figure is representative, that is the proportion expected to be PGY 2 in 2025. In isolation, not much can be said, maybe non-common names are trending toward popularity, but between groups and throughout time, maybe it does.

There are many limitations to this brief study. The data was heterogeneous and coming from different sources. Not all programs had the names of their Matched students, and others had limited information. It is after all possible that school with lower Match rates or Match lists that may be less impressive than their prestige from brand name alone may avoid publishing their Match lists, and this in turn may skew the data. While the institutions included high tier academic centers as well as lower tier programs, the access sampling cannot ensure that the sample represents the entire pool of applicants in the residency Match. My hope is that for future years, this information can be obtained from the NRMP directly to provide a complete unbiased dataset. In addition, non-common names may be associated with other things such as city-dwelling, as the medical schools from New York had a much higher rate of non-common names than other states, followed by a distant second California, and non-common names were least frequent in Iowa, Nebraska, and Oklahoma. It is also recognized that the states with larger cities are inherently more diverse with higher immigration rates. These states also demonstrate a larger variety in the types of medical education institutions available. Another direction that may help is subcategorizing the names by ethnicity or geographic origin to differentiate the underlying reasons for non-common names.

A statistical limitation is also present. When accounting for the number of analyses performed, if a Bonferroni correction or False Discovery Rate is used, none of the categories fall into statistically significant territory. This is important in that possibly there are not as many differences among specialties as there may seem and thus, the most important finding may be establishing a benchmark to compare with other years.

Furthermore, a critical methodological limitation of this study is the construct validity of using 'non-common names' as a proxy for racial, ethnic, or cultural diversity. Name rarity is a heterogeneous construct and does not serve as a direct or validated measure of minority status or background. Many non-common names stem from mainstream cultural trends, unique parental naming preferences, or regional variations within majority populations (e.g., modern or unconventional names among native white populations), whereas many individuals from diverse racial or ethnic minority backgrounds possess culturally integrated or common Western names. Therefore, our findings should be interpreted strictly as reflecting patterns of name rarity rather than direct evidence of demographic, racial, or ethnic diversity, and caution should be exercised against over-interpreting these results in the context of systemic diversity, equity, and inclusion (DEI).

Conclusion

No real conclusions can be drawn at the time from this report, although it provides a baseline from which further research can be performed as to whether the frequency of non-common names can be any indicator of diversity. The numerous limitations of the current study are noted in the discussions section, but it is not difficult to imagine future studies that could easily include entire databases and thus remove some of the sampling bias. In addition, comparisons through time could provide interesting information about how trends form and change.

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Brief Report

Let's "PREPARE": A Foundational Module to Guide Undergraduate Medical Students toward Their Future Practice of Entrustable Professional Activities

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Abstract

Background: Entrustable professional activities (EPAs) are core clinical tasks that medical graduates must perform independently to demonstrate competency. Introducing EPA-based training in the early years of medical education provides a solid foundation for workplace-based assessment (WBA), and emphasizes essential skills such as history taking, clinical reasoning, and decision making.

Objectives: This study aimed to evaluate the "PREPARE" (PRomote Entrustable Professional Activities via Responsible Engagement) module, which was designed to integrate EPAs early in medical training using a self-directed learning approach.

Methods: The module was validated by experts for face and content validity using the Item Content Validity Index (I-CVI) and Scale Content Validity Index for Universal Agreement (S-CVI/UA). Reliability was assessed using the Intraclass Correlation Coefficient (ICC). Following validation, the module was piloted among first-to-final-year medical students. Knowledge improvement was assessed using pretest and posttest, and the scores were analyzed for their statistical significance.

Results: The results showed adequate face and content validity (I-CVI, 0.978; S-CVI/UA, 0.96) and excellent reliability (ICC, 0.998). During the pilot testing phase, students demonstrated significant knowledge improvement, with posttest scores averaging 85% compared to pretest scores of 25% ($p < 0.0001$). Participants reported increased confidence and readiness to perform EPAs, highlighting the role of the module in fostering clinical preparedness.

Conclusion: "PREPARE" module introduces EPA-based training in the early stages of undergraduate medical education. With evidence of validity and reliability, and observed improvements in student knowledge and self-reported confidence, this module contributes to building clinical readiness. It offers a structured framework for developing core professional activities and supports students in preparing for future clinical responsibilities within the existing educational context.

Keywords: Entrustable Professional Activities; Medical Education; Clinical Competence; Undergraduate Medical Training; Workplace-Based Assessment; Self-Directed Learning

Background

Entrustable Professional Activities (EPAs) are a core set of tasks or responsibilities that medical graduates are entrusted to perform without supervision once they have attained a reliable level of mastery in the related competencies (1). These EPAs are independently executable and measurable in terms of process and outcome, and hence serve as reliable workplace-based assessments (WBA) to evaluate the essential skills of a medical practitioner (2). The American Association of Medical Colleges (AAMC) has drafted a set of 13 core EPAs for professionals entering medical residency. These skills, ranging from history taking to decision-making, offer a holistic evaluation modality (3). However, many may perceive EPAs to be at a higher level on the educational pyramid. Although entrustment of these tasks usually occurs at a higher or qualified level

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in the medical profession, preparation begins much earlier.

The concept of the EPA is introduced only at a later stage, and learners are expected to have mastered the relevant skills. As EPAs are WBA requiring the interaction and execution of clinical tasks on real patients under no supervision, practice or training is generally not performed at the undergraduate level (4). Even during clerkships and internships, students are under supervision for clinical duties performed directly on patients. Supervision is an integral part of the internship/clerkship experience, ensuring that interns are guided, supported, and evaluated as they apply their medical knowledge and skills in clinical settings (5). Supervision levels may vary depending on the task, intern's competence, and specific clinical environment; however, supervisors are always present to ensure patient safety and promote professional development.

Some studies on the EPA have focused on its development and implementation in postgraduate training programs, such as for psychiatry residents in China and family medicine trainees in South Africa. These studies emphasize the need to create specialty-specific modular EPA frameworks to address advanced clinical competencies (6, 7). The Chinese study used the Delphi method to establish 17 EPAs tailored to standardize psychiatric training (6), whereas the South African study developed 19 EPAs through national collaboration, addressing challenges such as limited resources and heavy clinical workload (7). However, incorporation of the foundations of the EPAs at the undergraduate level remains underexplored, with limited studies focusing on early integration to bring in awareness and prepare the undergraduate students for clinical practice.

Medical education, at its best, should inform and transform the way students learn. EPAs are essential units of practice, and perfection occurs through repeated exposure. In light of this, it is essential to incorporate the foundations of the EPA, beginning with undergraduate medical education to guide learners on the path to practice. Taking this a step further, “PREPARE” (PRomote Entrustable Professional Activities via Responsible Engagement), a foundational module on EPAs, was developed, validated, and pilot tested among first to third professional part 2 (final professional year) medical students.

Objectives

This study aimed to evaluate the "PREPARE" (PRomote Entrustable Professional Activities via Responsible Engagement) module, which was designed to integrate EPAs early in medical training using a self-directed learning approach.

Methods

Development of the Module: The "PREPARE" module was developed to align with key learning objectives that prepare students for clinical practice through EPAs [8]. This module educates students about the role of EPAs in bridging the gap between medical schools and internships by enhancing practical skills and clinical readiness. Core EPAs were introduced, along with detailed guidance on integrating them into learning experiences. The module includes hands-on practice, assessments via direct observation, simulations and multisource feedback mechanisms. Strategies to address common challenges, such as time management and performance under pressure, were embedded to encourage self-assessment and proactive learning. The conceptual framework for the development of this module is shown in Figure 1.

Validation of the Module: Validation was conducted through an 18-item online questionnaire using a four-point Likert scale ranging from 0–3 (3-To great extent, 2-To moderate extent, 1-To some extent, and 0-To no extent). The questionnaire assessed the clarity, coherence, and content. A panel of 10 medical education experts was invited via email to participate, with a follow-up reminder sent after 1 week. Experts were selected through purposive sampling based on their qualifications, institutional roles, prior experience in curriculum development, competency-based medical education (CBME), and workplace-based assessments. All panelists had a minimum of 5 years of academic experience in undergraduate or postgraduate medical education and held advanced degrees (MD or equivalent), with several having additional credentials such as MMedEd, MHPE, or PhD in health education. Each had demonstrable engagement in the development or implementation of EPAs, either through CBME initiatives, national medical curriculum reforms, scholarly engagement, or EPA-aligned assessment courses. SurveyMonkey was used as the data collection platform. The validity of the module was assessed using Face Validity, Item Content Validity Index (I-CVI), and Scale Content Validity Index for Universal Agreement (S-CVI/UA). Reliability was measured using the Intraclass Correlation Coefficient (ICC). Face validity was included to ensure that the module was appropriate and relevant. As the goal was to introduce EPAs at an earlier stage than usual, expert impressions of the content clarity and alignment were essential.

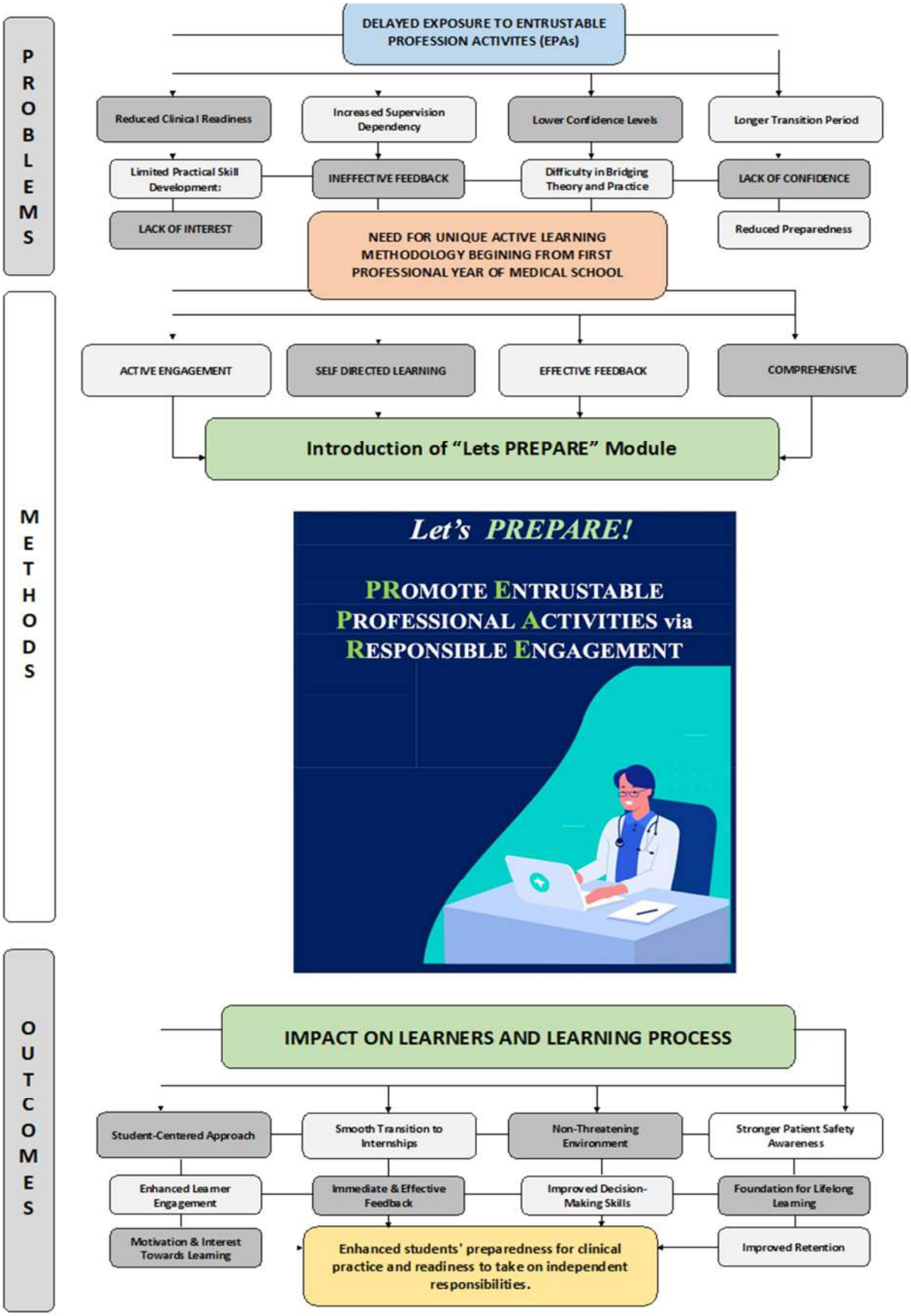

Figure 1. Conceptual framework

The I-CVI was used to further assess how well each item reflected the intended learning objectives. This measure is helpful when working with smaller expert panels, as it quantifies the proportion of agreement on the relevance of each individual item. To understand how well the module worked as a whole, the S-CVI/UA was applied, offering a more stringent examination of the overall consistency across items. For reliability, the ICC was selected because it reflects the degree of agreement among multiple raters, especially when they scored responses on a Likert scale, to ensure that different experts interpreted and rated the items consistently.

Pilot Testing of the Module: The module was piloted with first-to-final-year medical students (24 from each year) who were selected through random sampling. This number was selected based on methodological recommendations for pilot studies, which suggest that a minimum of 20–30 participants is sufficient to evaluate the feasibility, clarity of procedures, and preliminary effects of an educational intervention. A pretest with 30 multiple-choice questions was conducted to assess the participants' baseline knowledge of EPA principles, benefits, and applications. Following module implementation, pedagogy included self-directed learning activities. A posttest was conducted to evaluate knowledge improvement. Additionally, students completed a 9-item online questionnaire on a 10-point rating scale to evaluate the effectiveness of the module in achieving its educational objectives.

Data Variables: The variables used in this study were classified based on their functions during the evaluation. The primary outcome variables included the pretest and posttest scores, both treated as continuous variables, representing students' knowledge levels before and after engaging with the "PREPARE" module. Additionally, the students' perceived effectiveness of the module, measured using a 9-item questionnaire on a 10-point rating scale, was treated as a continuous variable to assess learner satisfaction and perceived educational value.

The exposure variable was participation in the module, which was a categorical variable with two levels: before (pretest phase) and after the module implementation (posttest phase). This structure enables the assessment of changes in knowledge and perceptions associated with the module.

Statistical Analysis: To evaluate the pretest and posttest knowledge scores, paired t-tests were performed after confirming the normality of difference scores using the Shapiro-Wilk test (p>0.05). For first-year students, a statistically significant improvement was observed from pretest to posttest (t (23) =18.45, p<0.0001, 95% CI [17.5, 19.7], Cohen's d=3.76). Similar significant gains were observed across other academic years. All calculations were conducted using Stata BE/18.5 with a significance threshold of α= 0.05

Results

Validation Results: The validation of the "PREPARE" module demonstrated strong agreement among experts regarding its clarity, coherence, and content. The module achieved a perfect Face Validity score of 1.00, indicating unanimous agreement that its content was appropriate, relevant, and reflective of its intended objectives.

The Item Content Validity Index (I-CVI) ranged from 0.90 to 1.00 across all 18 items, yielding a mean S-CVI/Ave (average I-CVI) of 0.978. Furthermore, the Scale Content Validity Index for Universal Agreement (S-CVI/UA) was calculated as 0.96, reflecting robust expert consensus (Table 1). The reliability analysis further validated the module, with an ICC of 0.998, underscoring its consistency across expert evaluations. Collectively, these results affirm the validity and reliability of this module as an educational tool for preparing students for EPAs.

Pilot Testing Results: Pilot testing of the module with first-to-final-year medical students (24 from each year) revealed a significant improvement in their knowledge and understanding of EPAs. The pretest results showed an average score of 25%, with most students indicating limited awareness of the principles, benefits, and applications of EPA. After the module implementation, the posttest scores averaged 85%, demonstrating a substantial and statistically significant improvement ($p < 0.0001$) (Table 2).

Students provided highly positive evaluations of the module through a 9-item online questionnaire on a 10-point rating scale. They highlighted the relevance, clarity, and impact of the module on preparedness for clinical responsibility (Figure 2). Many participants reported increased confidence in applying EPAs and acknowledged the role of the module in bridging the gap between theoretical learning and practical application.

Table 1. Module validation results

Item Description	No. of Experts Selecting "3" (To great extent)	No. of Experts Selecting "2" (To moderate extent)	No. of Experts Selecting "1" (To some extent)	No. of Experts Selecting "0" (No extent)	I-CVI
Clarity of learning objectives	9	1	0	0	1.00
Relevance to EPA competencies	10	0	0	0	1.00
Logical flow of content	8	1	1	0	0.90
Depth and adequacy of content	10	0	0	0	1.00
Coherence between sections	9	0	1	0	0.90
Appropriateness of visuals and media	8	2	0	0	1.00
Alignment with learning outcomes	10	0	0	0	1.00
Clarity of language used	10	0	0	0	1.00
Effectiveness of interactive elements	9	1	0	0	1.00
Appropriateness of assessment methods	10	0	0	0	1.00
Ease of navigation	8	1	1	0	0.90
Support for self-directed learning	10	0	0	0	1.00
Relevance of real-life examples	10	0	0	0	1.00
Integration of reflective components	9	0	1	0	0.90
Practical applicability to clinical settings	10	0	0	0	1.00
Overall coherence of the module	10	0	0	0	1.00
Ease of understanding instructions	9	1	0	0	1.00
Suitability for medical students	10	0	0	0	1.00
S-CVI/UA (Universal Agreement)					0.96
Mean I-CVI (Average across all items)					0.992

S-CVI/UA: Scale-level Content Validity Index / Universal Agreement; Mean I-CVI: Mean Item-level Content Validity Index

Table 2. Pretest and Posttest Score Comparison of Medical Students

Academic Year	Pretest Mean (out of 30)	Pretest SD	Pretest Mean (%)	Posttest Mean (out of 30)	Posttest SD	Posttest Mean (%)	Mean Difference	p-value (paired t-test)
First Year	6.6	2.25	22	25.2	2.04	84	18.6	< 0.0001
Second Year	7.2	2.46	24	25.5	2.13	85	18.3	< 0.0001
Third Year	7.8	2.70	26	25.8	2.22	86	18.0	< 0.0001
Final Year	8.4	2.61	28	26.1	2.10	87	17.7	< 0.0001

SD: Standard deviation

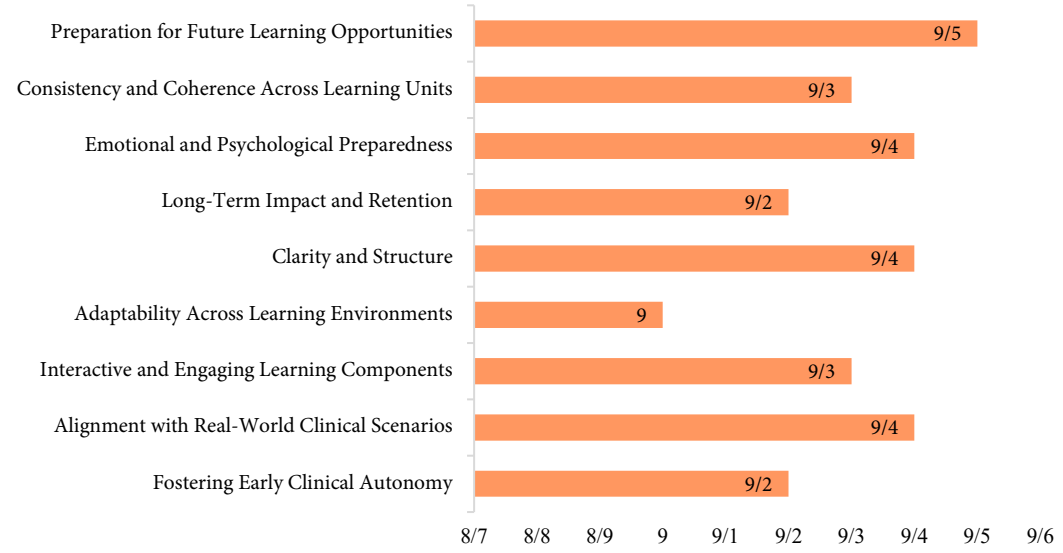

Figure 2. Evaluation of "PREPARE" (PPromote Entrustable Professional Activities via Responsible Engagement) Module on EPA

Mean indicates the average score, SD denotes standard deviation, pretest refers to the assessment conducted before the intervention, posttest refers to the assessment conducted after the intervention, mean (%) represents the mean score expressed as a percentage of the maximum possible score, mean difference denotes the difference between posttest and pretest mean scores, and p-value indicates the level of statistical significance obtained using a paired t-test.

Discussion

The findings of this study underscore the effectiveness of integrating the EPA into undergraduate medical education. Unlike traditional models, in which EPAs are introduced at a later stage, this module offers a structured, self-directed learning approach starting from the first year of medical training. This aligns with the growing emphasis on early clinical exposure and progressive autonomy in medical education. Previous studies have highlighted the benefits of EPAs in fostering clinical competence. However, most implementations have focused on graduate students (9, 10). In contrast, the results of this study demonstrated significant knowledge gains among undergraduate students, with posttest scores showing an average improvement of 25–85%. These findings align with those of studies advocating scaffolded learning approaches to bridge the gap between medical schools and internship readiness.

However, these results contrast with earlier reports that documented limited success in implementing EPAs at the undergraduate level, often citing barriers such as lack of clinical autonomy, insufficient patient interaction, and unclear assessment frameworks (11, 12). A key methodological difference that may explain this contrast is the use of a focused, standalone module rather than embedding EPA training within broader curricular reforms. This allowed for targeted instruction without overhauling existing structures, making it easier for students to understand the core EPA principles.

Additionally, the design minimizes dependence on real-time clinical exposure to gain knowledge of the EPA, which is often cited as a limiting factor in undergraduate settings.

Contextual factors may have contributed to the positive outcomes observed. This study was conducted in an institution where CBME reforms were newly introduced, and students may have been receptive to structured, competency-oriented interventions. Faculty familiarity with newer assessment methods and institutional emphasis on early clinical readiness may have created a supportive environment for module implementation. These conditions differ from those in earlier studies conducted in regions or institutions where either EPA integration was attempted without sufficient faculty preparation or where logistical challenges limited hands-on exposure (13).

To implement these lessons in EPAs in medical schools, it is essential to create modules that integrate emotional readiness and real-world applications from the beginning of medical education. EPAs should be introduced early, using structured, scaffolded approaches that progressively build student autonomy. In physiology education, EPAs can be used to understand physiological processes in clinical contexts, such as linking cardiovascular physiology to patient assessment skills. Incorporating interactive, case-based learning will help students practice EPAs in a simulated, yet realistic environment, thereby enhancing the practical application of theoretical knowledge. Adapting these modules across various learning environments ensures broader accessibility and effectiveness for diverse student groups.

While students demonstrated a statistically significant improvement in posttest scores, these preliminary findings should be interpreted with caution. Due to the single-group pretest-posttest design without a control group, the observed knowledge gains cannot be exclusively attributed to the module, as potential confounding factors such as testing effects or concurrent academic coursework may have contributed.

This study has several limitations that should be acknowledged. First, the single-group pretest-posttest design lacks a control or comparison group, limiting our ability to establish definitive causality between the module and student performance. Second, the evaluation was conducted at a single institution with a relatively small sample size per academic year, which may constrain the generalizability of the findings to other medical schools. Third, the study assessed immediate posttest knowledge acquisition and self-reported confidence, without evaluating long-term retention of knowledge or transfer to actual clinical settings. Future multi-center studies employing controlled experimental designs and longitudinal follow-up are warranted to robustly validate the long-term impact of this educational intervention.

Conclusion

The study findings indicated that the “PREPARE” module was effective in enhancing undergraduate medical students’ understanding of the term EPA.

Validation by medical education experts confirmed that the module content was clear, coherent, and aligned with the intended learning objectives. Reliability analysis showed adequate consistency in the expert evaluations.

Following the pilot testing, students demonstrated a significant improvement in their knowledge of EPAs and reported greater confidence in their ability to apply these concepts in clinical contexts. These results support the usefulness of the module as a structured approach for introducing EPA-based learning into undergraduate medical education.

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Conflict of interests: There is no conflict of interest.

Ethical approval: This study was approved by the Institutional Human Ethics Committee of Panimalar Medical College Hospital & Research Institute (IHEC/PMCH&RI/2024/126; dated 16/04/2024).

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Strides Dev Med Educ. 2026; 23(1):e1528. doi 10.22062/sdme.2025.200941.1528

Brief Report

An Assessment of the Effectiveness of an in-House Designed Low-Cost Trainer for Teaching Cardiovascular Examination in Comparison to Traditional Teaching Among Novice Undergraduate Medical Students

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Abstract

Background: Teaching cardiovascular examination skills to large groups of undergraduate medical students poses critical challenges due to the limited availability of patients and peer practice limitations.

Objectives: This study aimed to evaluate the effectiveness of an indigenous designed low-cost trainer for teaching cardiovascular examination compared to the traditional training.

Methods: A half-body CPR mannequin was upgraded to teach cardiovascular physical examination by the addition of inflatable bladders for pulsations, and a Bluetooth speaker for heart sounds. Undergraduate medical students, divided into experimental and control groups, were trained by demonstration and practice on a simulator/volunteer. A quasi-experimental study with a non-equivalent control group design was conducted to compare the outcomes of the two teaching models. Performance was assessed by Objective Structured Practical Examination (OSPE) and compared. Feedback on confidence and satisfaction was gathered. *A* value <0.05 was considered statistically significant.

Results: The total OSPE scores showed no significant difference between the experimental and control groups (p=0.184) [P value <0.05 was considered statistically significant]. However, the control group performed significantly better in in-patient interaction skills (p=0.008). Student feedback indicated a preference for a combination of both traditional and simulator-based teaching methods, with 43% favoring this approach. Additionally, 33% preferred traditional methods alone, while 24% chose simulator-based teaching exclusively.

Conclusion: The indigenous designed low-cost cardiovascular examination trainer demonstrated comparable effectiveness to traditional teaching methods in skill acquisition. It offers a cost-effective alternative for large-scale medical education, though additional emphasis on patient interaction skills is placed while simulators are used. Student preferences suggest that a blended approach, combining both traditional and simulator-based methods, may be optimal for teaching cardiovascular examination skills

Keywords: Cardiovascular Physical Examination; Simulation; Low-Cost; Medical Education

Background

The National Medical Council of India revised the undergraduate medical program to a competency-based curriculum, mapping the skills to be learned and mastered by a medical graduate. Clinical examination of the cardiovascular system is one of the skills listed as a core competency to be acquired by first-year undergraduate students, and the recommended mode of teaching is DOAP [Demonstrate by student Observe Assist Perform] in a normal volunteer or in a simulated environment (1). The facilitator traditionally

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demonstrates the skill on the healthy subjects, and students are instructed to practice the skills on their peers. Most of the facilitators encounter challenges in this form of teaching. Firstly, a large number of students ranging anywhere between 150-250 in number in most of the medical colleges across India, secondly, there exists a paucity of subjects or patients for the students to learn the skill concerned (2). Thirdly, practice on peers poses a few limitations, like a lack of standardization due to varied body types and body mass index, obesity, hesitancy among these millennial students to expose the precordium in front of their peers; this challenge is observed more among female students (3, 4). All these challenges are a few of the obstacles faced by the facilitators in this traditional mode of teaching. The alternative approach is by adopting various simulation-based skill teaching, which have their own pros and cons. High-fidelity mannequins are expensive, and simulated patients pose huge financial burdens on the institutes due to the large number of students (5). A systematic review on simulation-based cardiovascular physiology teaching states the shortcomings of existing models, especially the cost that makes the high-technology simulators unreachable in low-resource settings (6).

Objectives

To develop a cost-effective simulator with indigenous available material that would depict the basic features of cardiovascular examination, and to study the effectiveness of the heart simulator in skills teaching to medical graduates.

Methods

Study design and participants: "A quasi-experimental study with a non-equivalent group design was conducted by the Department of Physiology and the Medical Simulation Centre of a medical university in South India to evaluate the effectiveness of both teaching models."

Inclusion criteria: All the years I graduated; medical students of the current year were recruited since the intervention is a part of routine teaching (N = 250). Participants were informed that the assessment would be more of a formative type and not be included in their summative assessment, and consent was obtained from them.

Exclusion criteria: Students who missed any of the sessions or assessments were excluded (n=12). Therefore, the final sample size was 238 students (out of 250).

Design and functioning of the simulator

Assembling the heart simulator

Materials utilized: Half-body mannequin, Inflatable bladders connected to bulbs, Bluetooth speaker, as shown in Figure 1.

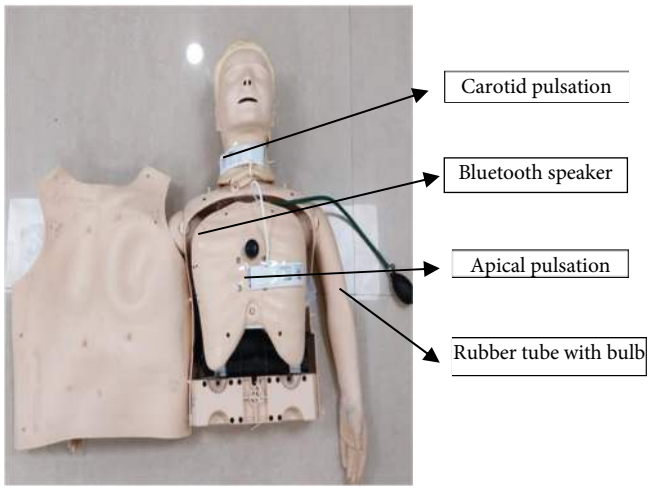

Figure 1. Half-body mannequin, Inflatable bladders connected to bulbs, Bluetooth speaker

Apical and carotid pulsations: Two inflatable bladders with tubes are attached to the bulb via a two-way valve. Placed underneath the skin of a half-body CPR mannequin, one at the location of the apex and another at the carotid triangle. Pumping of the bulb, the bladder gets inflated and deflated, which produces a palpable rise over the skin mimicking a normal apical and carotid pulsation. The bulb is pressed manually at the required rate by the facilitator. The rate is synchronized with the heart sounds with the aid of the metronome app. Expansion of the cuff due to bulb compression creates a palpable pulsation over the chest wall and neck. It is felt by the student by placing the palm over the chest and then localizing with the ulnar aspect of the hand, and finally with the tip of one finger. The manual compression of the bulb leads to palpable pulsations at the neck due to inflation and deflation of the bladder. The student locates and feels the pulsation at the carotid triangle with the standard examination protocol.

Carotid pulsation: A Bluetooth speaker is placed under the precordium equidistant from all four cardiac areas. Normal heart sounds and murmurs are played on a digital device [mobile phone, iPad] connected to the Bluetooth speaker. The student auscultates the sounds by placing the stethoscope over 4 cardiac areas while simultaneously palpating the carotid pulsations on the right side of the neck. The heart sound that coincides

with the carotid pulsations is identified as the first heart sound. The sound that follows the pulsation is the second heart sound. The bulb is pressed manually at the required rate by the facilitator. The rate is synchronized with the heart sounds with the aid of the metronome app. The process of development of the product is published as a short report under innovations (7).

Data collection and measurement

All 250 first-year medical students were included in the study. Since twelve students missed either one of the sessions, the remaining 238 (N=250-12) who underwent training by both models were recruited for the study. Students were grouped by sequential allocation into the experimental and control groups. They were grouped by placing roll number in alternating order by the clerical staff, who were blinded to the study to overcome the selection bias. Still, the limitation of non-randomization, such as confounders and risk of bias, exists. Students were exposed to two forms of teaching. Group A was taught using a simulator a few key components of the cardiovascular system, like examination of apex beat and auscultation of cardiac areas (mitral, tricuspid, aortic, and pulmonary) in groups of 10 with the help of the facilitator. Group B was taught by the traditional learning method, the same components of cardiovascular system examination, which is an initial demonstration by the facilitator, followed by peer examination among students.

Skill assessment: The students were assessed regarding the skill attainment component for apex beat examination using an OSCE/ OSPE checklist (Table 1). Table 1 contains the OSCE/ OSPE steps for the location of the apex beat.

Table 1. Model OSPE Checklist

Questions: Locate the apex beat of the given subject and report the finding				
Step	**Expected performance**	**Score**		
		Satisfactory performance	**Need improvement**	**Not done**
1	Introduces him/herself, asks the subject to relax, explains the procedure, and obtains informed consent	1.0	0.5	NIL
2	Exposes the chest and inspects the chest wall for apical impulse	1.0	0.5	NIL
3	Places the palm over the precordium and feels for the apex beat. Locate with the ulnar border and then point the apex beat with a finger	1.0	0.5	NIL
4	Counts the intercostal space to identify the exact location of the apex beat	1.0	0.5	NIL
5	Reports the findings	1.0	0.5	NIL

The checklist was prepared by the investigator and validated by two senior faculty members and experts from the medical education department. Assessment was done by double-blinded faculty, and it was ensured that they were not a part of the teaching session.

Validation of Assessment Tool: The OSCE/OSPE checklist used to assess skill attainment was developed by the investigators based on standard clinical examination guidelines. To ensure its content validity, the checklist was reviewed by a panel of experts, including faculty members from the departments of Physiology and Medicine, as well as clinical skills educators with experience in undergraduate medical education. These experts evaluated the checklist items for their relevance, clarity, and comprehensiveness in covering key components of cardiovascular examination skills. Face validity was established through iterative discussions with the panel to confirm that the checklist appeared to adequately measure the intended competencies. Minor modifications were made based on their feedback to improve item clarity and alignment with learning objectives.

A pilot test of the checklist was conducted with a small group of students (not part of the final study sample) to ensure usability, timing, and inter-rater consistency. Feedback from this pilot was used to further refine the checklist before final implementation. Inter-rater reliability was discussed and calibrated among assessors to ensure consistent scoring.

Reliability testing of the assessment tool: "Inter-rater reliability was evaluated by three assessors independently scoring the same set of students, followed by a statistical analysis of the agreement between scores. Test-retest reliability was considered by re-evaluating a subset of students later to ensure Consistent performance assessment over time. Internal consistency of the checklist was also analyzed using Cronbach's alpha to confirm coherent item responses.

Data analysis

Data were entered into a Microsoft Excel spreadsheet and saved as a comma-separated value (CSV) file.

A frequency distribution of the teaching modality was calculated. Scores obtained were tested for normality using normal probability plots and the

Shapiro-Wilk normality tests. The independent t-test was conducted to compare the mean test scores of students post the educational intervention among the control and intervention groups, and a P value <0.05 was considered statistically significant.

Feedback was obtained by an anonymized online Google form with Likert response closed-ended questions and an open-ended question to gather learners' perception of the simulator and their preference. The questionnaire was vetted by two experts for face and content validity. Question one was on the preferred method of learning, with one open-ended question explaining the reason for the preferred method and two questions about the realism of the simulator and confidence level among students. The open-ended questions were thematically analyzed individually by two investigators, who were then authenticated by the expert to identify emerging themes. The themes identified for the reasons to prefer the simulator were user-friendly, repeated practice possible, and a realistic experience. The limitation expressed was a lack of human interaction and opportunity to learn doctor-patient communication.

Statistical analysis: An Independent sample t-test was performed to compare the OSPE score of the two groups. It was ensured that assumptions of normality and equal variance were met before the test was applied. Feedback on the Likert responses was compiled, and the open-ended responses were analysed quantitatively.

Results

Out of the total 250 students, 12 students were excluded since they missed one of the teachings sessions, hence the sample size was 238.

The total score of both groups was almost equal (p=0.184). The control group performed significantly better in-patient interaction skills (Step I: 0.84 vs 0.70, p=0.008). The total score of both groups was almost equal (p=0.184). The control group performed significantly better in-patient interaction skills (Step I: 0.84 vs 0.70, p=0.008). It refers to the mean score of the two groups for step 1 of the OSPE checklist, "Explain the procedure to the subject and obtain consent," which were 0.84 versus 0.70, respectively. No significant differences were found in the other technical skills, indicating both the methods were equal with respect to the knowledge acquired, but traditional methods showed an advantage in patient interaction skills, which should be considered in curriculum design, as students found it difficult to explain the procedure and obtain informed consent from the mannequin (Table 2).

Table 2. OSPE score

Step	Group A (mean (SD))	Group B (mean(SD))	t	df	p (two-tailed)
I	0.70 (0.41)	0.85 (0.36)	-3.037	238.0	0.008*
II	0.74 (0.41)	0.86 (0.34)	-2.488	234.0	0.21
III	0.57 (0.47)	0.61 (0.34)	-0.762	220.4	0.447
IV	0.36 (0.41)	0.38 (0.46)	-0.359	238.9	0.720
V	0.33 (0.44)	0.37 (0.47)	-0.686	241.0	0.493
TOTAL	2.78 (1.70)	3.09 (1.50)	-1.510	238.3	0.184

*Steps I show statistically significant differences between groups, p=0.008, **Steps III–V and TOTAL are not statistically significant (p > 0.05).

It refers to the mean score of the two groups for step 1 of the OSPE checklist, "Explain the procedure to the subject and obtain consent," which were 0.84 versus 0.70, respectively. No significant differences were found in the other technical skills, indicating both the methods were equal with respect to the knowledge acquired, but traditional methods showed an advantage in patient interaction skills, which should be considered in curriculum design, as students found it difficult to explain the procedure and obtain informed consent from the mannequin.

Student feedback: A total of 112 students chose to respond to the questionnaire, and student feedback indicated a preference for a combination of both traditional and simulator-based teaching methods, with 43% favoring this approach. Additionally, 33% preferred traditional methods alone, while 24% chose simulator-based teaching exclusively. Indicating a combination has a better preference among the students. Student preferences for learning cardiovascular examination were clearly defined as 65% preferred demonstration and practice on the heart simulator (manikin), whereas 35% favored faculty demonstration followed by practice on peers.

This indicates a strong acceptance and perceived value of simulator-based learning among students. A substantial minority (35%) still prefer the traditional method of faculty demonstration followed by practice on peers. This suggests that while simulator-based learning is more popular, traditional methods still have a place in medical education (Figure 2a).

"Student feedback on the realism of the heart simulator was generally positive, with approximately 70% of students agreeing that the simulator was realistic, 23% remaining neutral, and 7% disagreeing with its realism (Figure 2b).

The strong preference for simulator-based learning among students supports the use of these tools in medical education. However, the significant minority preferring traditional methods suggests a blended approach might be beneficial.

Ninety percent of students feel confident in performing CVS examinations on real patients/subjects after learning with the heart simulator. This suggests that the simulator is highly effective in preparing students for real-world clinical scenarios. Only 10% of students did not feel confident after using the simulator (Figure 2c). This could indicate areas for potential improvement in the simulator or the need for additional support for a small subset of students.

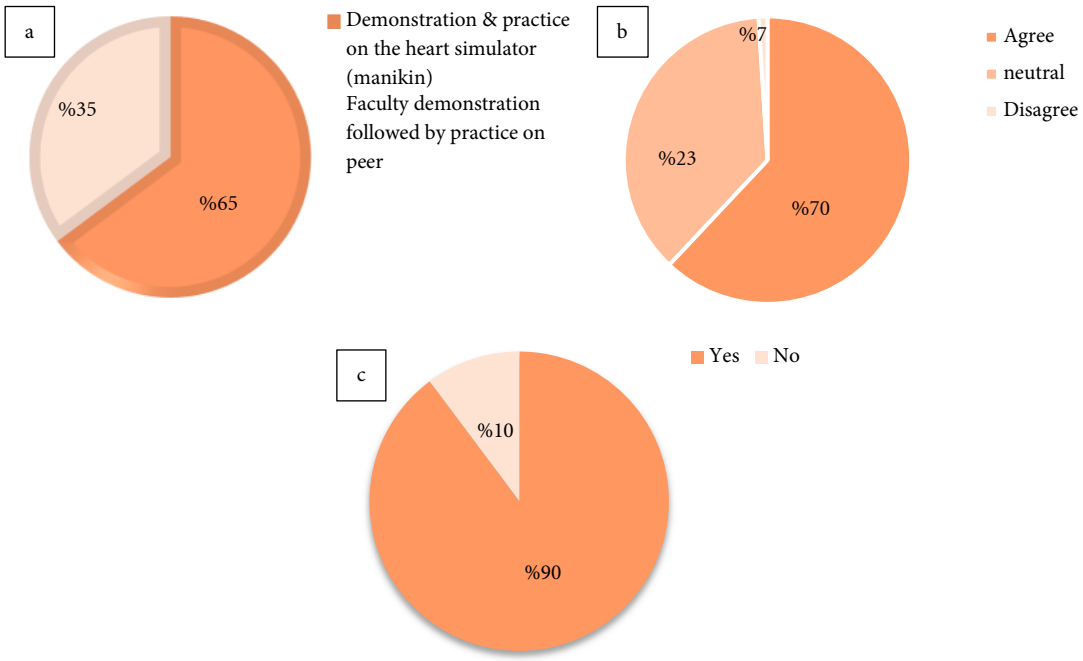

Figure 2. a) Preferred method for skills practice, b) Simulator realism, c) Confidence in performing on a patient

Discussion

This study evaluated the effectiveness of an in-house designed low-cost trainer for teaching cardiovascular examination skills to undergraduate medical students compared to traditional teaching methods. The results provide valuable insights into the potential of simulation-based learning in medical education, particularly in resource-constrained settings like ours.

Cost analysis of the simulator

- The cost of the materials used is 13000 INR
- The cost of a high-tech mannequin is 1800000 INR

Our study result showed no significant difference in overall OSPE scores between the simulator group and the traditional teaching group (p=0.184). This suggests that the low-cost simulator is as effective as traditional methods in teaching cardiovascular examination skills. This finding aligns with previous studies that have demonstrated the efficacy of simulation-based learning in medical education (8, 9).

However, it's noteworthy that the control group performed significantly better in in-patient interaction skills, highlighting the potential limitation of simulator-based training and emphasizing the importance of incorporating patient interaction elements in simulation-based curricula in the current setting. Previous studies on students' perception report that they rated standardized patients (SPs) more highly than mannequins to learn interviewing (10).

Yet another qualitative study found that students felt that low-technology mannequins could not adequately

simulate verbal/non-verbal cues and human interaction. Students believed this deficit impacted their performance when interacting in real clinical settings (11).

Most students agreed that the heart simulator was realistic, with only a small minority (less than 5%) disagreeing. This high level of perceived realism likely contributes to the simulator's effectiveness as a learning tool. Moreover, an overwhelming 90% of students reported feeling confident in performing CVS examinations on real patients after using the simulator. This high confidence level suggests that the simulator effectively bridges the gap between theoretical knowledge and practical application, a crucial aspect of medical education (12). Interestingly, our study results demonstrated a greater percentage of students preferred learning with the simulator; there was also a strong preference (43%) for a combined approach using both traditional and simulator-based methods. This aligns with the concept of blended learning, which is effective in medical education (13). The preference for a combined approach may reflect students' recognition of the need for both technical skills and patient interaction skills in clinical practice.

A significant advantage of the developed simulator is its cost-effectiveness. At 13,000 INR, it is substantially cheaper than high-fidelity mannequins (1800000 INR). This makes it a viable option for medical schools in resource-limited settings, potentially democratizing access to high-quality simulation-based learning (14). Recent research has also studied the benefits of such low-cost alternatives and suggests they are beneficial (15-17). The factors that determine the effectiveness of the simulators are the extent to which they are integrated into the regular curriculum and the acceptance of the educators involved in teaching (18, 19).

Implications for Medical Education

The findings of this study have several implications for medical education:

1. *Incorporation of Low-Cost Simulators:* The comparable effectiveness and high student acceptance of the low-cost simulator support its integration into medical curricula, especially in resource-constrained settings.
2. *Blended Learning Approach:* The student preference for a combined approach suggests that a blended curriculum, incorporating both simulator-based and traditional teaching methods, might be optimal.
3. *Focus on Patient Interaction Skills:* The better performance of the traditional group in patient interaction skills highlights the need to supplement simulator-based training with exercises focused on patient communication and interaction.

Confidence Building: The high confidence levels reported by students after using the simulator suggest that such tools can play a crucial role in preparing students for clinical practice, potentially reducing anxiety and improving performance in real patients.

Limitations: While this study provides valuable insights, there are some limitations. As the study was conducted at a single institution, this may limit its generalizability. No subgroup comparisons, such as between age or gender groups, were conducted. Future multi-center studies could provide more robust evidence. Additionally, long-term follow-up studies in the future could assess the retention of skills and confidence levels over time.

Future Directions: Future research could also focus on developing and evaluating methods to incorporate patient interaction skills more effectively into simulator-based training. This could involve the use of standardized patients in conjunction with the simulator or the development of virtual reality applications that simulate patient interactions. Evaluation of long-term retention of skills learnt by low-cost simulation must be done so that their utilization is justified.

Conclusion

In conclusion, this study demonstrates the potential of low-cost, indigenous designed simulators in teaching cardiovascular examination skills. The low cost and equivalent efficacy of such simulators compared to the high-technology mannequins make their utility feasible in low-resource settings.

While such simulators can effectively teach technical skills and build student confidence, a blended approach that also emphasizes patient interaction skills may provide the most comprehensive preparation for clinical practice.

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Conflict of interests: There is no conflict of interest.

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Brief Report

Evaluating the Effect of Hospital Information System Simulation-Based Training on Informatics Skills of Operating Room Students: A Semi-Experimental Study

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Abstract

Background: The use of technology-based learning methods, such as computer simulation-based learning, is increasing in medical education. Applying these methods can empower and improve the practical skills and readiness of this group of students.

Objectives: This study aimed to determine the effect of training based on a hospital information system (HIS) simulator on the informatics skills of operating room students.

Methods: This quasi-experimental before-and-after study was conducted in the first semester of 2022-2024 on 3rd-semester undergraduate operating room students at Ferdows University of Medical Sciences. The educational content in this study was the simulated operating room module in the HIS simulation training system. Students were tested before and after the intervention. Data were analyzed using SPSS 26 and the Wilcoxon test to compare students' scores before and after the intervention.

Results: A total of 12 students participated in this study, with 8 (67%) being female. Before starting the training with the educational simulator, the mean test score was 20.25±6.86 (out of 28). The mean score after the intervention was 24.67±3.45. Data analysis revealed a significant difference in mean test scores before and after the intervention ($P = 0.028$). Additionally, there was no significant relationship between gender, age, and student GPA and the pre- and post-test mean scores ($P > 0.05$).

Conclusion: The results of this study showed the effectiveness of simulation-based training in improving the informatics skills of operating room students. It is suggested that the application of this teaching method be investigated in other skill areas of medical students as well.

Keywords: E-Learning; Simulator System; Hospital Information System; Skill; Operating Room Students

Background

Due to the COVID-19 outbreak, many educational activities in educational institutions, universities, and medical centers faced limitations or stopped altogether. To reduce the spread of COVID-19 infection, in-person education activities were transitioned to online education methods in most developed and developing countries. On the other hand, in many cases and for some medical science educational groups, due to various limitations such as data and information security

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concerns, patient safety issues, a lack of specialist instructors, and crowded hospital environments, there is no opportunity for training and working with health information systems. Thus, the students cannot acquire sufficient and correct practical skills to work with these information systems (1).

Considering all the mentioned issues and the limitations that exist in the field of education, especially traditional education (2), there are new, complementary, and technology-based methods that can help reduce the gap in scientific knowledge and practical skills of students. In various fields of medical sciences, including medicine, dentistry, pharmacy, nursing, and paramedical sciences, different types of clinical and non-clinical e-learning tools have been used. The results of most studies conducted indicate success in using this method and relative satisfaction among students in using it (3-10). The results of two systematic review studies (11, 12) showed that these methods can increase the skills, knowledge, and satisfaction of users and also serve as a complementary method to in-person education by providing multiple capabilities.

Various technologies, such as virtual education, virtual reality, augmented reality, educational simulator software, and applications, are among the complementary educational methods (1, 3, 4, 11, 12). Using these methods, students can learn in suitable conditions that closely resemble the real work environment, applying real data, practice each process several times, experiment, and gain experience in a real environment. Using these methods, without disrupting hospital processes or compromising information security or patient safety, education is carried out with appropriate quality (1, 13). Additionally, e-learning methods can increase students' motivation, participation, and satisfaction in the field of education (14).

Operating room students require various types of clinical training, including familiarity with different surgical methods and the acquisition of skills in performing them. Additionally, they need non-clinical training, such as acquiring basic knowledge in their theoretical courses based on their curriculum. The use of simulator systems is one of the new methods in e-learning. Several simulators have been created for the clinical education of operating room students (15). These simulators include McGill for teaching and evaluating laparoscopic skills (16), Sim Man 3G for teaching simulation-based surgical methods on computer mannequins (17), and the spinal fusion surgery training simulator (18). The results of these studies showed that the use of clinical education simulators has had a significant impact on the basic knowledge and practical skills of operating room students (15).

The surgical information system (SIS) is a key subsystem of the hospital information system (HIS), with surgeons and operating room specialists being the primary end-users of this system. The SIS has various capabilities, such as recording patient information and status, entering information on services/surgeries performed for patients, transferring patients from the waiting list to the clinical department, and requesting blood and other services from other departments (19). Based on our knowledge, operating room students do not receive training on the use of health information systems (HISs) during their studies, and their education is often limited to clinical training. Therefore, there is a need to learn how to use these systems before entering the real work environment and hospital. Thus, this study was conducted to evaluate the impact of HIS simulation-based training on the informatics skills of operating room students before entering the internship course in the hospital.

Recent advancements in healthcare simulation technologies have expanded educational opportunities for medical students across specialties. The results of some studies have demonstrated that students who received simulation-based EHR training showed improvements in documentation quality and efficiency compared to those trained through traditional methods (12, 20). Similarly, other studies have found that perioperative nurses and surgical technologists who participated in HIS simulation training reported higher confidence levels and made fewer errors during their initial clinical rotations (21-23). Despite these promising findings, some studies (24, 25) identified a critical gap in specialized informatics training for operating room personnel, noting that most existing simulators focus on clinical skills rather than health information management competencies. This gap is particularly concerning as Abbasi et al. observed that the participants mentioned their need for training to use the surgical information system. Inadequate HIS training may be associated with increased documentation errors and workflow inefficiencies in surgical settings.

The pandemic-era shift to digital education has accelerated innovation in simulation-based training approaches. Some studies have found that virtual HIS simulators not only maintain educational continuity during clinical placement disruptions but also enhance students' digital literacy skills compared to pre-pandemic cohorts (26, 27). Building on this momentum, Kinnunen et al. (28) evaluated the informatics competencies among healthcare providers and

emphasized the need for specialization in HIS training. Our study addresses these identified gaps by implementing a tailored simulation system specifically designed for operating room students, focusing on the unique documentation and information management challenges they face in surgical settings. Unlike previous approaches that adapted general healthcare informatics curricula, our intervention targets the specialized needs of the operating room environment.

Objectives

This study aimed to determine the effect of training based on a hospital information system (HIS) simulator on the informatics skills of operating room students.

Methods

Study Setting and Population: This quasi-experimental study was conducted as a before-and-after design in the first semester of the academic year (2023-2024). A total of twelve third-semester undergraduate operating room students at Ferdows Faculty of Medical Sciences were eligible to participate in this study during the first semester of the 2023–2024 academic year. All twelve students were invited to participate through an announcement made during their regular curriculum activities. A census sampling method was used, and all eligible students were included in the study without any sampling. Our inclusion criteria required participants to be actively enrolled in the Operating Room program with no previous formal training or experience with hospital information systems. Students with prior HIS usage experience or those who were unable to attend the orientation session were excluded. All 12 students who met all criteria provided written informed consent and were enrolled in the study. No sampling method was applied as we included the entire eligible population of third-semester students.

In this regard, an orientation session was held for all students, introducing the scenario-based computer simulator and providing explanations about the training method, practice, and testing procedures, as well as the purpose and necessity of using the simulator. Sufficient time was also allocated to address ambiguities and answer questions about its implementation. After providing necessary explanations about the study procedure, their demographic characteristics (i.e., gender, age, grade point average, informatics skill, and HIS usage experience) were recorded in a checklist.

HIS Simulator System: The web-based simulator for teaching HISs offers important functional capabilities, including interactive training courses, multimedia content, practical exercises, tests, and user feedback. In addition, the administration, communication, and content management capabilities considered in this system can extend the learning process beyond other educational simulators. Other features, such as an information dashboard, reporting, question bank design, and messaging, have also been implemented to create an integrated educational system.

One of the simulated educational contents in this system is the training module for the operating room, available in the HIS, which was provided to the students. After students registered in the educational simulator system, they were given access to the "test" section related to the operating room module. After taking the test and obtaining and recording the score for this section (maximum 28), the educational content was made available to them for further review. Subsequently, the practice content for this module was provided to students so they could practice at any time, from anywhere, and on any device (mobile phone, tablet, laptop, or personal computer) for two weeks. Training and practice with the simulator system provided students with access to the test section of this module. Finally, the test scores were recorded in the post-training stage with the simulator system. The developed exam was based on the content of the educational process and completed practices, and was designed as a scenario.

To assign scores to each process, the weighted importance analysis (WIA) approach was employed. This scoring method is based on the principles of weighted importance analysis, a method applicable to evaluating the performance of complex processes. WIA is a scientific method for evaluation and decision-making in which the relative importance of each element or stage in a process is determined, and based on that, a weight or coefficient is assigned to each element. Then, the performance of each element is combined with its weight, and the overall impact is calculated. Accordingly, the key steps related to each scenario were determined by health information management (HIM) experts, medical informatics (MI) experts, and a hospital information system (HIS) analyst. The scoring was completed. The simulator system also automatically calculates students' scores for each scenario in the exam section based on their performance. Each scenario was designed based on a real case and, after scoring, underwent testing and evaluation. The validity and reliability of the exam were reviewed and confirmed by HIM and MI experts. As well, all students have provided informed consent to participate in the study.

Data Analysis: After completing the checklist and students' test scores through the simulator system, the

data were entered into SPSS.26 for analysis. First, using descriptive statistics indices such as central and dispersion indices (i.e. frequency, percentage, mean, and SD), the data were described. Then, using the Wilcoxon test, a comparison of students' scores was made in two stages before and after the intervention. Additionally, the Mann-Whitney test was employed to assess the relationship between gender and pre-test and post-test scores, while the Kruskal-Wallis test was used to examine the relationship between age and pre-test and post-test scores. Spearman's correlation coefficient test was also used to examine the correlation between GPA and pre-test and post-test scores. A p-value of less than 0.05 was considered significant.

Results

As shown in Table 1, 8 (67%) students out of 12 were female. Seven of them (25%) were 22 years old, and the mean of total GPA was 15.70 ± 1.13.

Before starting the training with the educational simulator, the highest and lowest scores obtained by students were 28 and 11, respectively, and their mean score was calculated as 20.25 ± 4.86. Following the intervention, the highest and lowest scores obtained by students were 28 and 16, respectively, with a mean score of 24.67 ± 3.45. Considering that the test score did not follow a normal distribution (p = 0.011), the non-parametric Wilcoxon test was used to compare the pre-test and post-test scores.

Table 1. Demographic information of participants

Demographic Information		Frequency (%)
Gender	Female	8 (67)
	Male	4 (33)
Age	22	3 (25)
	21	7 (58)
	20	2 (17)
Informatics Skill (self-declaration)	Low	8 (67)
	Medium	3(25)
	High	1 (8)
HIS Usage Experience	No	12 (100)
GPA	Mean ± SD	15.7±1.13

GPA: Grade Point Average; SD: Standard deviation

Data analysis revealed that the difference in test scores obtained before and after training was statistically significant (p = 0.028) (Table 2).

Table 2. Comparison of students' score before and after the intervention

Variable	Mean(SD)	Median	Min	Max	P-value
Pre-test score	20.28(6.86)	22	11	28	0.028
Post-test score	24.67(3.45)	26	16		

SD: Standard deviation

Additionally, no statistically significant relationship was found between any of the variables, including gender and age (Table 3). Furthermore, based on the Spearman correlation test, there was no statistically significant correlation between students' GPA and their pre-test scores (r = -0.51, P = 0.088). Similarly, no statistically significant correlation was found between their GPA and post-test scores (r = 0.51, P = 0.092). Figures 1-3 show the students' scores before and after the intervention, broken down by gender and age groups.

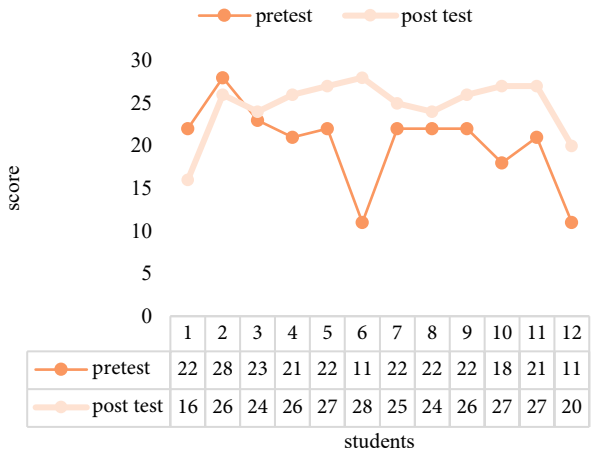

Figure 1. The students' score before and after the intervention

Table 3. Effect of gender and year of birth on pre-test and post-test scores

Variable		Pre test		Post test	
		Mean	SD	Mean	SD
Gender	Female	19.88	5.89	24.00	4.04
	Male	21.00	2.16	26.00	1.41
Test Result		U**=15.5, P=0.933		U**=11.5, P=0.461	
Year of Birth	2001	23.67	3.79	26.33	0.58
	2002	18.14	5.08	23.71	4.27
	2003	22.50	0.71	25.50	2.12
Test Result		H***=3.64, P=0.162		H***=0.83, P=0.66	

SD: Standard Deviation

Mann-Whitney U test, * Kruskal-Wallis H test

Discussion

This study was conducted to evaluate the impact of a web-based HIS simulation system on the informatics skills of undergraduate operating room students. The results indicated a significant effect of training using the simulator system on the skill level of students in this field in using the HIS. Based on the results of this study, students' demographic information, including age and gender, as well as their GPA, did not significantly affect the scores obtained in the test.

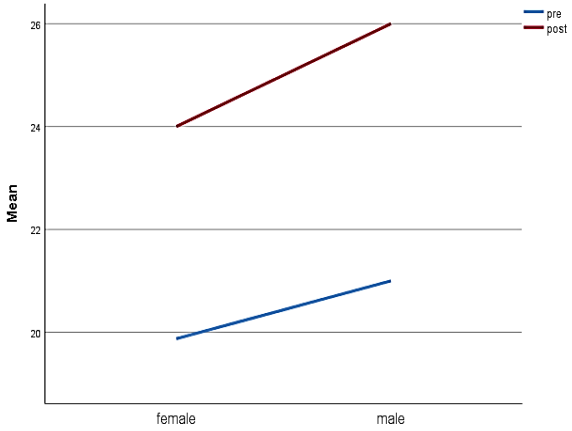

Figure 2. The students' score by gender before and after the intervention

To our knowledge, all studies conducted in this field on operating room students have focused on the clinical education using simulators. In this study, non-clinical education for students was implemented to improve their informatics skills, which demonstrated a positive impact of this type of education. In line with these findings, the results of Ghaffari et al.'s study showed that applying an interactive software to teach the HIS to undergraduate students of health information technology (HIT) could increase students' scores after training with the software compared to before the intervention. The results of the present study indicated an increase in students' informatics skills in using the HIS, which is confirmed by Ghaffari et al.'s study (1).

In line with the findings of the present study, two studies also used an electronic health record (EHR) simulator to train pharmacy students. The results of their study indicated that these students were appropriately prepared to use the EHR and had increased their skills. Vuk et al. (10) also examined the impact of EHR training through simulation on physicians and nurses in their study. Their study also demonstrated that training through simulation can enhance the efficiency of physicians and nurses in delivering healthcare services. They also suggested that the use of simulators should be an important educational method before implementing and using health information systems.

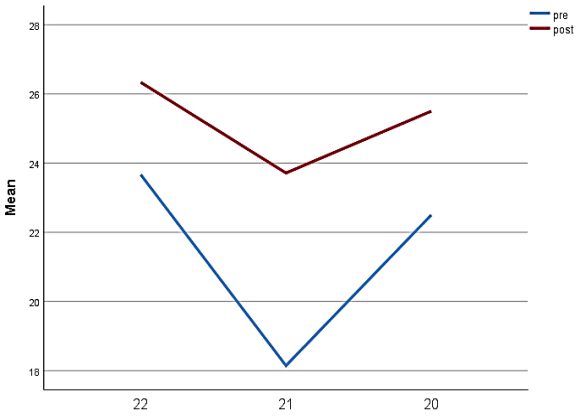

Figure 3. The students' score by age before and after the intervention

Insufficient user training is a major barrier to the successful use of HITs (29, 30). Upgrading the skills of the healthcare workforce requires creating opportunities for extensive, accessible, and cost-effective learning (31). As healthcare institutions increasingly rely on the use of health information systems, the demand for personnel with strong informatics competencies increases (32). The results of this study and, as well a those of Shachak et al. (9) showed that simulator systems are useful tools for education. Positive evaluations of the hospital information system education through using a simulator system showed that simulator-based learning can effectively complement the traditional learning approach for teaching students' practical skills. Therefore, it is suggested that the use of simulator-based tools be included in the syllabi and curriculum of other medical science groups as well. Future research should address these limitations through multi-center randomized controlled trials with longer follow-up periods and performance assessment in actual clinical settings.

The significant improvement in students' informatics skills following simulation-based training has substantial implications for curriculum development in medical informatics education, particularly for operating room professionals (33). Our findings suggest that formally integrating HIS simulation modules into operating room technology curricula could address a critical educational gap that currently exists between theoretical classroom instruction and practical clinical applications. Curriculum developers should consider creating a

progressive informatics competency framework that spans the entire program, beginning with foundational digital literacy in early semesters and culminating in advanced, system-specific training using simulators prior to clinical rotations. This approach would enable students to develop familiarity with healthcare information systems concurrently with their clinical skill development, rather than treating informatics as an isolated or ancillary competency. Additionally, our results support the development of interprofessional informatics education modules, where operating room students can interact with nursing, medical, and health information management students in simulated documentation scenarios, thereby better reflecting the collaborative nature of healthcare information management. As healthcare delivery becomes increasingly technology-dependent, curriculum committees should consider establishing dedicated informatics competency assessments as graduation requirements, potentially through objective structured clinical examinations (OSCEs) that incorporate HIS simulation scenarios alongside traditional clinical skills evaluation.

Strengths and Limitations: This study is the first study in the field of non-clinical education of operating room students to enhance their informatics skills in using the HIS with a simulator system. One limitation of this study is the small number of participating students. Furthermore, there are several additional limitations that warrant consideration. First, the single-institution design at Ferdows Faculty of Medical Sciences limits the generalizability of the findings to other educational settings with different curricula, technological infrastructure, or student demographics. Second, the absence of a control group introduces potential confounding factors, as improvements might partially reflect the natural learning progression of students or exposure to related content in other courses. Third, our assessment focused on immediate post-intervention skills, without follow-up evaluation to determine long-term retention or transfer of these skills to authentic clinical environments. Fourth, potential self-selection bias may exist, as students with a higher affinity for technology might have engaged more thoroughly with the simulator. Fifth, the simulator itself, while designed to replicate real HIS functionality, cannot fully reproduce the complexity and contextual challenges of actual hospital environments, including time pressures, interruptions, and system integration issues commonly encountered in practice. Finally, the Hawthorne effect may have influenced the outcomes, as participants were aware of being evaluated, which could have potentially altered their performance. Future research should address these limitations through multi-center randomized controlled trials with longer follow-up periods and performance assessment in actual clinical settings.

Implication of the Study: For educators in operating room and surgical technology programs, our results suggest that integrating HIS simulation-based training into standard curricula offers a viable strategy to develop essential informatics competencies before clinical placements. This approach may reduce the technical onboarding burden for clinical sites while potentially decreasing documentation errors during students' initial clinical experiences. For department chairs and curriculum developers, our findings support allocating resources to develop and maintain simulation environments that mirror contemporary hospital information systems, potentially through partnerships with HIT vendors or teaching hospitals. Medical education policymakers should consider updating accreditation standards to explicitly include informatics competencies for operating room professionals, recognizing these skills as core requirements rather than ancillary knowledge. Furthermore, healthcare administrators may benefit from incorporating similar simulation-based approaches into their onboarding processes for new surgical staff. Given the continuous evolution of health information systems, our study demonstrates the value of establishing educational frameworks that can adapt to technological advancements while providing consistent skills development, thereby creating a more prepared and technologically adept surgical workforce.

Conclusion

The results of this study showed the effectiveness of simulation-based education in improving the informatics skills of operating room students. These positive evaluations showed that the HIS education by the simulator system could be useful in enriching traditional HITs education. It is suggested that the application of this educational method in other areas of medical science, such as skills, should also be investigated. Additionally, the use of these platforms during crises, such as the COVID-19 pandemic, can help maintain learning continuity during the stoppage and disruption of in-person educational activities.

Additionally, we recommend future research involving multiple institutions and cohorts across different medical universities to increase the sample size

and enhance the generalizability of the findings. A multi-center approach would not only strengthen statistical power but also allow for comparative analyses across different educational contexts and student populations. Additionally, a longitudinal study design that tracks students' performance throughout their clinical rotations could provide valuable insights into the long-term retention of acquired informatics skills and their practical application in real clinical settings.

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Conflict of interests: There is no conflict of interest.

Ethical approval: This study was approved by the ethics committee of Birjand University of Medical Sciences (IR.BUMS.REC.1402.445).

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Brief Report

Horizontal Education in Medical Sciences in Iran: A Certificate-Based Strategy for Skill Enhancement

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Abstract

Education plays a crucial role in sustainable development and is a significant investment in building a skilled workforce that fosters enduring societal growth. In medical sciences, horizontal education is a novel and effective method to continuously improve the knowledge and skills of healthcare professionals. Recent advancements in technology and the significant influence of artificial intelligence are driving the need for updated skills in healthcare. Short-term, need-based courses in horizontal education allow healthcare professionals to refresh their specialized skills quickly, without the obligation of lengthy academic programs. This approach is aligned with national health policies and the country's seventh development plan. It holds the promise of enhancing both public and specialized healthcare services, empower graduates from medical and allied health disciplines, reduce skill gaps, and modernize the nation's health system. This concise report offers a practical framework for implementing horizontal education in Iran's health and medical education sectors. It underscores the significance of establishing clear policy guidelines, developing robust infrastructure, and creating comprehensive quality assurance mechanisms to ameliorate health outcomes and elevate Iran's standing in the global health arena.

Keywords: Horizontal Education; Iranian Health Education; Professional Skills; Certificate-Based Training; Continuing Education

Background

The Imperative for Educational Innovation in Iranian Healthcare

Education transcends the mere acquisition of knowledge—it serves as a powerful tool for sustainable progress. Traditional medical training in Iran, typically provided through long-term programs and fellowships, struggles to keep pace with rapidly evolving healthcare landscape (1). Horizontal education (HE) responds to this challenge by offering short-term, targeted training courses that allow professionals to update their skills effectively without requiring prolonged academic commitments (2). This educational model represents a paradigm shift from traditional vertical specialization toward cross-disciplinary, competency-based approach to skill enhancement integrating various domains of knowledge at the same educational level (3-5). This educational model underscores the dissolution of traditional departmental barriers to establish connections between different medical specialties and disciplines, facilitating knowledge transfer and skill integration across conventional academic boundaries (4, 6).

Further, the rapid integration of digital and virtual learning modalities—propelled by technological advancements and artificial intelligence—further facilitates the transition toward more agile educational methods (7).

Horizontal education fundamentally contrasts with conventional continuing medical education (CME) in

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various key aspects that merit thorough analysis (3). The distinctions between horizontal education and traditional CME are multifaceted and fundamental. Traditional CME generally centers on single-specialty knowledge updates provided through rigid, scheduled programs that utilize time-based credit systems. These create isolated learning experiences characterized by fixed time requirements and participation-based assessment structures. Conversely, horizontal education prioritizes multi-disciplinary integration through flexible, need-responsive training programs. It applies outcome-based assessment methods and competency-based evaluation systems, promoting cross-specialty collaboration with variable duration based on mastery achievement (3, 6, 8, 9).

The conceptual framework of horizontal education is founded on five fundamental principles. First, cross-disciplinary integration ensures that knowledge and skills are acquired across traditional specialty boundaries instead of being confined to isolated disciplines (6, 10). Second, competency-based progression indicates that advancement hinges on demonstrated competencies rather than the duration of training (9). Third, flexible learning pathways enable educational trajectories to adjust to individual learning needs and professional demands (8). Fourth, real-world application contextualizes learning within genuine clinical scenarios that necessitate multi-disciplinary expertise (11). Lastly, collaborative learning environments enable learners from various specialties to learn together, fostering interprofessional collaboration (6).

Methods

This concise report was developed utilizing a two-stage methodology. Initially, a narrative literature review was performed to examine the conceptual evolution, operational models, and effectiveness of horizontal as well as certificate-based education in health sciences. Databases including PubMed, Scopus and Google Scholar were searched using keywords such as "horizontal education", "modular training", "competency-based medical education" and "micro-credentials" concentrating on studies published between 2010 and 2024. Pertinent global policy documents and implementation frameworks were also included.

Secondly, insights were obtained from national expert panels comprising senior faculty, curriculum designers, and healthcare policy advisors affiliated with Iranian medical universities and the Ministry of Health, Treatment, and Medical Education (MoHME). These panels were organized to pinpoint national implementation deficiencies, prioritize strategic initiatives, and confirm the proposed policy recommendations. The synthesized findings derived from literature and expert consultation serve as the foundation for the proposed operational framework and policy recommendations presented in this report.

This comprehensive analysis indicates that while horizontal education offers substantial promise for Iranian medical education, several interconnected challenges currently hinder its effective implementation.

Systemic Barriers to Educational Modernization

The current educational framework in Iran primarily relies on structured, long-term programs such as fellowships and formal continuing education initiatives, which have established a robust foundation for professional development. Nevertheless, several challenges have arisen with this traditional approach (Table 1).

Table 1. System-level Challenges in Implementation of Horizontal Education in Iranian Medical Sciences

Challenge Category	Identified Issues
Current System	Vertical specialization emphasis Limited adaptability to emerging needs Resource allocation inefficiencies
Infrastructure	Insufficient technological integration Limited digital learning platforms Inadequate virtual education tools
Regulatory Framework	Lack of standardized certification process Unclear quality assurance mechanisms Undefined assessment criteria

Numerous courses prioritize prolonged specialization, leaving minimal opportunity for rapid skill updates (12). In addition, there exists a mismatch in resources, as health professionals require a broad range of skills that current programs often fail to address (13). Further, current offerings often focus too narrowly on specialized content, neglecting the wider competencies required for general practice and local needs. This leads to a shortage of courses designed for non-specialist audiences, ultimately impeding overall workforce development (5). Traditional curricula frequently find it difficult to keep pace with rapid technological and scientific advancements, leading to a lack of flexibility (7). Moreover, lack of clear guidelines creates uncertainty regarding the value and recognition of certificate-based short courses (14). Inconsistent oversight and the absence of standardized evaluation methods further compromise the quality of these training programs (15). The distinction between horizontal education and conventional continuing

medical education remains ambiguous, leading to confusion among stakeholders. Meanwhile, ongoing resource limitations make the allocation of essential financial, human, and infrastructural support uncertain (13, 16).

A Strategic Framework for Implementation

In recent years, Iran has made significant progress in implementing horizontal, certificate-based education within the medical and health sciences sector through various pilot programs showcasing practical feasibility and positive effect on learner competence and service delivery. The National Center for Skills and Vocational Training of Medical Sciences (NACEHVET), operating under the Ministry of Health, Treatment, and Medical Education (MoHME) has taken the lead in creating short, competency-based educational modules that are distinct from traditional curricula (17). These modules result in recognized certificates while placing a strong emphasis on interdisciplinary professional skills and responding dynamically to evolving health system requirements.

The Iran Advanced Clinical Training (iACT) Center, in partnership with NACEHVET and Tehran University of Medical Sciences, offers modular programs in clinical procedures, medical technologies, and professional competencies. These programs are delivered through theoretical instruction, simulation exercises and supervised clinical experiences. Current programs include certificates in professional communication, workshops on practical clinical skills in emergency medicine and clinical reasoning, as well as medical technology literacy in digital health and telemedicine (18).

International Precedents and Validation: Global experiences further substantiate the horizontal education approach through systematic applications across diverse healthcare systems. The Royal College of Physicians and Surgeons of Canada has pioneered comprehensive competency-based medical education based on its "Competence by Design" framework, revolutionizing specialty training across 67 specialties and serving over 13,000 trainees through time-variable, competency-focused pathways that underscore individualized progression (19). The European Union has officially endorsed horizontal education through its 2022 Council Recommendation on micro credentials, advocating for short-term, modular learning experiences that offer flexible skill development across healthcare disciplines (20). The World Health Organization's Global Competency Framework sets forth international benchmarks for competency-based health worker education, organizing competencies within six domains that directly parallel Iran's horizontal education principles: people-centeredness, decision-making, communication, collaboration, evidence-informed practice, and personal conduct (21). WHO's execution of the EQUIP-Foundational Helping Skills program across Nepal, Peru, and Uganda illustrates successful scaling of horizontal education via modular, culturally-adapted curricula, with assessments indicating significant improvements in healthcare worker competencies and enhanced helping knowledge following completion (22). International evaluations consistently reveal positive outcomes from horizontal, certificate-based medical education, including improved trainee preparation for practice, enhanced assessment quality, greater alignment with patient care needs and boosted workforce resilience during public health emergencies (23). These global implementations affirm Iran's systematic approach to horizontal education and highlight the growing international trend toward competency-based, modular medical training that adapts dynamically to evolving healthcare needs.

To incorporate horizontal education effectively into Iran's medical training system, the following framework is proposed (Figure 1, Table 2):

Table 2. Core Components of the Horizontal Education Implementation Framework

Component	Key Elements
Policy Structure	Dedicated ministerial unit National digital platform Standardized guidelines
Quality Control	Expert committee oversight Accreditation system Performance monitoring framework
Stakeholder Integration	Medical universities integration Professional association participation Healthcare organization involvement

Establishing Governance Infrastructure: For defining the role of horizontal education, a detailed policy document should be created which outlines its purpose, scope and operational requirements, while also establishing a dedicated unit within the MoHME to manage and monitor these programs effectively. This unit will elucidate how short-term courses integrate within the broader health service delivery system while ensuring regular evaluations to update course content and pedagogical methods based on scientific advances and local needs.

It is essential to align horizontal education with existing continuing medical education policies for systematic integration. This necessitates revising current policies to incorporate horizontal education principles, harmonizing credit systems and incentives for both traditional and modular courses, as well as developing unified management systems for delivering diverse training modalities.

Such integration establishes a cohesive educational landscape which addresses the evolving needs of health professionals while maintaining quality standards and professional recognition across all pathways.

Building Digital and Physical Learning Ecosystems: Establishing a robust infrastructure starts with the creation of a national digital platform that allows educators and learners to access, manage and oversee course activities seamlessly. This necessitates amelioration of domestic internet infrastructure to support remote and blended learning environments, while also investing in simulation technologies that provide realistic virtual training environments.

Effective execution necessitates the establishment of multidisciplinary simulation centers that cater to various specialties at the same time, as opposed to isolated department-specific facilities. Physical co-location allows for cross-specialty equipment sharing, with advanced technologies including surgical navigation systems, robotic surgery platforms and high-fidelity simulators accessible to learners from different disciplines simultaneously. Digital platforms should support integrated scheduling systems enabling learners from multiple disciplines to engage in shared training sessions, incorporating enterprise-wide standardization protocols that enhance resource utilization and knowledge transfer.

Technology integration needs to support collaborative assessment methodologies ascertaining interprofessional skills alongside discipline-specific competencies. The execution requires phased development starting with shared technology platforms serving multiple specialties. It is then followed by integrated digital assessment systems, concluding with comprehensive collaborative learning management systems that reflect the interdisciplinarity of modern healthcare delivery.

Ensuring Excellence through Collaborative Oversight: Establishing explicit standards for needs-based education requires formation of expert committees tasked with developing content and operational standards. This process involves creating frameworks for course duration, curriculum design and evaluation methods. It encompasses defining qualifications for instructors and training institutions alongside the establishment of systematic processes for regularly ascertaining and prioritizing training needs to ensure course relevance as well as effectiveness.

Quality assurance necessitates establishing independent oversight units or integrating with current quality commissions to manage accreditation processes. It is imperative to establish clear accreditation guidelines and performance indicators in conjunction with continuous monitoring and evaluation systems to ascertain course effectiveness. Further, procedures for issuing and renewing certificates based on quality standards are crucial for maintaining program credibility.

Engaging stakeholders involves professional associations, healthcare organizations and non-governmental groups in course design and delivery, establishing partnerships with medical universities for co-hosting programs, promoting private sector contributions and collaborating with the Medical Council as well as regulatory bodies for proper oversight and accreditation.

Comprehensive evaluation requires systematic evaluation across various outcome domains. Essential indicators include knowledge retention rates ascertained through longitudinal evaluation, competency scores based on validated frameworks such as CanMEDS or ACGME domains, employment rates within six months post-certification and program quality metrics including completion rates as well as participant satisfaction. Health system impact measures should evaluate patient outcomes, effectiveness of team collaboration, and graduates' contributions to healthcare innovation. All of these indicators incorporate specific measurement methodologies and benchmark targets based on international best practices (9, 24).

Whereas these quality assurance and stakeholder engagement mechanisms provide the foundation for successful horizontal education, the practical implementation of this framework confronts significant operational and cultural obstacles that warrant strategic intervention.

Navigating Implementation Barriers and Solutions: Faculty resistance represents a significant challenge, often arising from institutional cultures and professional identities. Medical educators frequently experience "change fatigue" caused by continuous reforms, resulting in skepticism toward new approaches (25, 26). This resistance is further compounded by traditional disciplinary boundaries that delineate

professional expertise and status within academic medical centers.

Implementation necessitates considerable initial investment in technology infrastructure, faculty development, and curriculum redesign. Traditional funding models seldom support innovative cross-disciplinary initiatives, especially in resource-limited settings. The current regulatory frameworks designed around specialty-based training models may face resistance from accrediting bodies unfamiliar with cross-disciplinary competency-based assessment methods.

Addressing faculty resistance necessitates structured change management programs dealing with underlying psychological and professional concerns. Early adopter networks have the capacity to identify and support faculty champions who exhibit success and influence colleagues through peer validation. Incentive alignment achieved through restructured reward systems should recognize cross-disciplinary teaching contributions and educational innovation. Professional development opportunities should aim to improve faculty cross-disciplinary competencies, thereby alleviating anxiety about teaching outside traditional expertise areas.

Addressing funding limitations requires the creation of public-private partnership models that involve healthcare systems, technology companies, and government agencies as educational innovation stakeholders. Phased implementation approaches allows for gradual expansion based on proven success and available resources. Cost-effectiveness demonstrations through pilot initiatives can provide evidence of enhanced learning outcomes and cost savings compared to traditional approaches.

Strategic Priorities for National Implementation

Given the challenges identified in Iran's current educational framework and the proposed operational framework for horizontal education, several key recommendations emerge to guarantee its effective implementation:

1. *Develop a Clear Policy:* Generate a detailed document that outlines the goals and requirements for horizontal education.
2. *Establish dedicated Structures:* Develop a specific organizational unit to manage these programs within the Ministry of Health and Medical Education.
3. *Set National Standards:* Form expert committees to establish and monitor content as well as operational standards.
4. *Implement a Robust Accreditation System:* Ensure that all courses fulfil quality standards through a thorough evaluation process.
5. *Invest in IT Infrastructure:* Build a comprehensive digital platform to manage course delivery along with monitoring.
6. *Foster Stakeholder Collaboration:* Leverage the expertise of academic institutions, professional organizations and private companies.
7. *Integrate with Existing Programs:* Align horizontal education with current continuing education systems in order to maximize efficiency.

Limitations: This report had limitations that should be acknowledged. The proposed framework has not yet undergone pilot testing or validation, where resource requirements for full implementation were not quantitatively ascertained. Nevertheless, the expert panel consultations drew from the prestigious Academy of Medical Sciences of Iran, comprising healthcare elites from the ministry, universities and clinical practice, strengthening the validity of our policy recommendations. Future research should deal with remaining limitations through pilot implementations and comprehensive cost-benefit analyses.

Conclusion

Horizontal education offers a practical and dynamic solution to the evolving needs of medical professionals in Iran. By offering flexible, certificate-based training, this approach effectively addresses skill gaps, improves service quality, and keeps pace with technological advancements. With a solid policy framework, strong infrastructure, and active stakeholder involvement, horizontal education has the capacity to revolutionize medical training and elevate Iran's standing within the global healthcare community.

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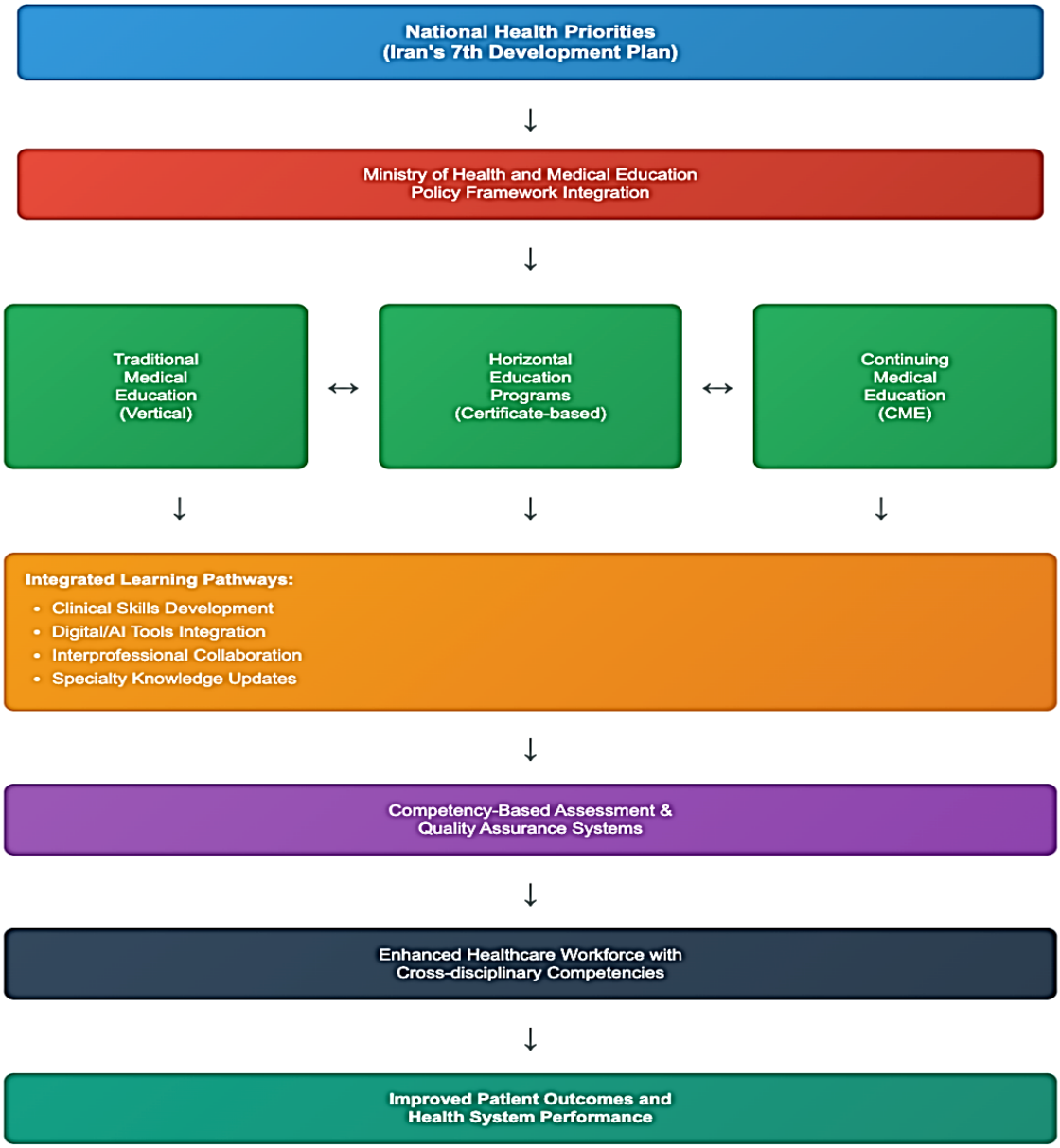

Figure 1. Integrated Horizontal Education Model and Its Relationship to Existing Iranian Medical Education Systems. The model indicates how horizontal education programs complement rather than replace traditional vertical education and continuing medical education pathways. National health priorities drive policy formation at the ministerial level, establishing an integrated framework where certificate-based horizontal modules work synergistically with existing educational structures. Learners can access cross-disciplinary competencies based on clinical skills, digital/AI technology, interprofessional collaboration, and specialty update modules. The framework highlights competency-based assessment and quality assurance mechanisms that eventually contribute to enhanced healthcare workforce capabilities and enhanced patient outcomes. The bidirectional arrows reveal the interconnected nature of these educational pathways, allowing for flexible movement and integration between various learning modalities based on individual professional development needs and healthcare system requirements.

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Brief Report

Evaluating the Effectiveness of a Three-phase Clinical Education Model for Midwifery Students: A Quasi-Experimental Study

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Abstract

Background: Clinical education represents the cornerstone of midwifery training. Professional competency acquisition underpins effective practice, with adequate learning opportunities fundamental to the clinical education process.

Objectives: This study aimed to examine the effectiveness of clinical education using a three-phase clinical education model among midwifery students.

Methods: This quasi-experimental study employed a pre-test-post-test design with a control group, comprising 26 students and 3 clinical instructors selected through census sampling. The study was conducted in the labor ward of Ali ibn Abi Talib Hospital (Zahedan University) from September to December 2023. Students were randomly assigned into two groups (n=13 each). The control group received traditional education, while the intervention group followed a three-phase clinical education model. Training effectiveness was evaluated using pre/post-intervention questionnaires. Data were analyzed using paired t-tests for within-group comparisons and independent t-tests for between-group analyses. Open-ended responses underwent summative content analysis.

Results: The intervention group showed a significant improvement in perception scores from 50.30±8.58 at pre-test to 64.40±9.06 at post-test (P<0.001), whereas the control group showed no significant change (P=0.900). Between-group comparisons confirmed a significant post-test difference, and the mean score change was significantly greater in the intervention group (14.07±11.78 vs. −0.33±10.04, P=0.001). Qualitative findings identified three subcategories of advantages and three subcategories of disadvantages regarding the educational method.

Conclusion: The new educational method improved learning, structure, and clinical competency acquisition among midwifery students, potentially contributing to higher quality clinical practice and patient care readiness.

Keywords: Educational Model; Clinical Education; Midwifery; Quasi-Experimental Study

Background

Clinical education forms the core of midwifery training, translating theoretical knowledge into practical competencies and serving as the crucial link between classroom instruction and clinical environments (1, 2). By developing essential cognitive, emotional, and psychomotor skills for client care, midwifery students- who spend over 50% of their training in direct patient care settings- build the clinical proficiency fundamental to their professional practice (3, 4). This is particularly critical in midwifery, as evidence shows that effective midwifery significantly reduces maternal and neonatal mortality, with trained midwives capable of delivering essential maternal and newborn care services (5). Globally, such evidence underscores the transformative potential of skilled midwifery; in the Iranian context, this is exemplified by the substantial decline in the maternal mortality ratio from 48 per 100,000 live births in 2000 to 16 in 2017, largely due to enhanced midwifery services under multidisciplinary supervision (6).

Despite the central role of clinical education's importance in midwifery, studies reveal a significant gap between theoretical instruction and students' clinical performance (7). Research shows that current clinical

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training programs inadequately develop required competencies, with most midwifery students focusing on lower cognitive domain levels (e.g., knowledge recall and basic comprehension) rather than higher-order skills- such as analysis, evaluation, and clinical decision-making- contrary to curriculum objectives (8, 9).

Midwifery education in Iran primarily follows a traditional instructor-led approach where instructors explain patient conditions before joint examinations and diagnostic decisions (10). This method may limit students' clinical competency development. In spite of exploring various educational frameworks, midwifery training lacks a comprehensive model addressing all clinical skill dimensions, particularly the integrated development of higher cognitive skills (e.g., critical thinking), affective domains (e.g., emotional resilience), and advanced psychomotor abilities through structured, progressive training (11). Implementing more effective teaching approaches could enhance midwifery care quality and potentially further reduce maternal and infant mortality rates.

Objectives

This study was conducted to evaluate the effectiveness of the clinical education model (a three-phase model of clinical skills training) at Zahedan University of Medical Sciences.

Methods

Study design: This study employed a quasi-experimental design with a pre-test–post-test structure and a control group.

Study setting and participants: The research was conducted over a 120-day period, from September 1 to December 30, 2023, in the maternity ward of Ali ibn Abi Talib Teaching Hospital, affiliated with Zahedan University of Medical Sciences. The study included all 26 fifth-semester undergraduate midwifery students and their instructors, using census sampling due to the small and accessible population.

Sample size calculation: According to the study conducted by Mohammadi Rizi et al. (2015) and considering students' perceptions of clinical education quality as the main outcome, the sample size was calculated (95% confidence interval and 80% power) according to the relevant formula for comparing means between two independent groups:

Where:

n: the required sample size per group,

$Z_{1-\alpha/2}$: The Z-value corresponding to the two-tailed confidence level (1.96 for $\alpha = 0.05$, or 95% confidence),

$$(n = \frac{\left(z_1 - \frac{\alpha}{2} + z_1 - \beta\right)^2 (\delta_1^2 + \delta_2^2)}{(\mu_1 - \mu_2)^2})$$

$Z_{1-\beta}$: The Z-value corresponding to the desired power (0.84 for $\beta = 0.20$, or 80% power),

σ_1 and σ_2: The standard deviations of the outcome variable in the control and intervention groups, respectively,

$\mu_1 - \mu_2$: The anticipated difference in means between the two groups**.**

A sample size of 13 individuals was obtained for each group (12). Thus, regarding normality assumptions with our small sample size (n=13 per group), we conducted the Shapiro-Wilk test to formally assess whether our data met the assumptions for parametric testing. Results of the Shapiro-Wilk test indicated that all variables (pre-test and post-test scores in both control and intervention groups) demonstrated normal distribution (all P>0.05, ranging from 0.933 to 0.970).

Inclusion and exclusion criteria: Eligible participants included fifth-semester midwifery students at Zahedan University enrolled in childbirth internship who attended regularly and completed all assessments. These 26 students were included via census and then randomly assigned into intervention/control groups. Students missing multiple sessions or unavailable were excluded.

Inclusion criteria for clinical instructors required: 1) at least 3 years of responsibility for teaching midwifery students; 2) possession of a master's or doctoral degree in midwifery or a related field; and 3) willingness to participate in the study and implement the clinical education model, assessed via formal consent and a pre-study orientation workshop. Three such willing clinical instructors who applied the clinical education model were selected and included via census among eligible candidates.

Research approach: This study evaluated a three-phase clinical education model in midwifery training. After explaining objectives and obtaining informed consent, 26 fifth-semester midwifery students enrolled in 'Normal and Abnormal Delivery Internship' were included via census and then randomly divided into control and experimental groups (13 each). The control group received conventional training (a teacher-centered approach standard in Iranian midwifery programs, involving instructor explanation after student history-taking, joint examination, and diagnostic decision-making (10), while the experimental group followed a novel model developed by the research team through a literature review and expert consultations. This three-phase clinical education model was implemented across ten sessions (each

lasting approximately 6-8 hours), aligned with typical clinical shift durations in Iranian midwifery internships to balance practical training and student well-being (13). This model focused on preparation, interpersonal interaction, active learning, critical thinking, and clinical reasoning, supported by proactive instructor guidance and constructive feedback. Two weeks post-intervention, identical post-test questionnaires were administered to both groups to evaluate short-term retention and skill consolidation, minimizing immediate recall bias and longer-term confounding. Additionally, the experimental group provided qualitative feedback on their learning experience.

Pre-implementation measures for the educational intervention: Prior to implementation, a clinical education model was developed based on comprehensive literature review, research team expertise, and input from medical education experts, and documented in a training booklet. Various clinical education models (14, 15) and their applications were examined, leading to finalization of the model through expert feedback. The booklet outlined the model's features, content, and procedures, and included a schematic framework (Figure 1). Midwifery instructors participated in a six-hour workshop on effective implementation, including questions and challenges addressed through interactive discussions, as well as intervention planning, duration, and assessment timeline.

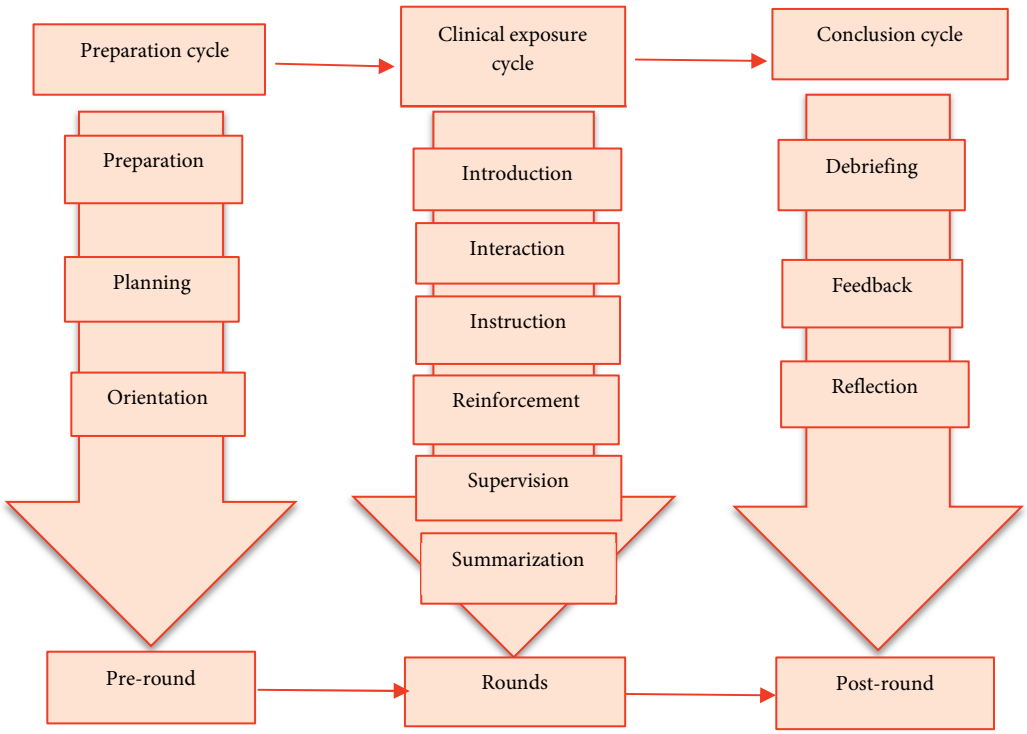

Figure 1. Schematic framework of the Clinical Education Model

Educational intervention: The newly implemented clinical education model was structured in three distinct phases, as summarized in Table 1.

Data Collection Instrument: Students' perspectives on the quality of midwifery education were evaluated using a validated questionnaire designed by researchers. This questionnaire was administered before the intervention and two weeks after. It included demographic data, 16 items rated on a five-point Likert scale (1=strongly disagree to 5=strongly agree), and open-ended questions regarding the new educational approach. Questionnaire items, developed from literature review (16, 17) and research team insights, covered four domains: motivation for clinical education (2 items: 1 and 2), participation in learning (4 items: 3, 4, 5, 6), educational structure (4 items: 7, 10, 12, 15), and clinical readiness (6 items: 8, 9, 11, 13, 14, 16). For clarity and fidelity to the actual instrument, one authentic item from each domain is provided in Table 2. Content validity was evaluated using the Content Validity Index (CVI) and Content Validity Ratio (CVR) by ten experts. CVI was calculated as the proportion of experts rating items 3 or 4 (relevance, clarity, simplicity); scores>0.79 were acceptable, 0.70–0.79 required revision, and <0.70 led to elimination. CVR was computed using Lawshe's formula.

Table 1. Structure of the Clinical Education Model for Midwifery students

Cycle	Step	Description
Preparation Cycle	Preparation	Instructors demonstrate full mastery of educational content and clinical skills.
	Planning	Determining student numbers, clinical round objectives, patient selection, student role allocation, and scheduling.
	Orientation	Assessing students' baseline knowledge through question and answer to tailor instruction and communicate educational objectives and policies.
Clinical Encounter Cycle	Introduction	Students meet patients and obtain informed consent in accordance with hospital procedures and ethical guidelines, ensuring patient privacy and confidentiality.
	Interaction	Patient engagement in the educational process with student questioning encouraged.
	Instruction	Structured teaching focused on critical thinking and clinical reasoning skills.
	Reinforcement	Enhancing clinical skills through feedback and error correction.
	Supervision	Close monitoring of student activities.
	Summarization	Reviewing and consolidating session content.
Conclusion Cycle	Debriefing	Comprehensive explanation of discussed subject matter.
	Feedback	Examining student strengths and weaknesses.
	Reflection	Planning targeted strategies to address weaknesses and enhance future performance.

Table 2. Authentic questionnaire items by domain (one example per domain)

Domain	Item No.	Description
Motivation for clinical education	Item 2	"I have motivation, enthusiasm, and interest in attending the clinical training sessions."
Participation in learning	Item 3	"I play an active role in my own learning process."
Educational structure	Item 12	"The objectives and teaching plan are clearly defined."
Clinical readiness	Item 13	"The clinical training sessions increase my readiness and mastery in performing clinical skills."

Results confirmed adequate content validity. Cronbach's alpha was 0.921, indicating high reliability (>0.70). Content validity was established through review by medical education experts with suggested revisions incorporated. Reliability was confirmed using test-retest method with Cronbach's alpha coefficient of α=0.92.

Data Analysis: Data analysis employed descriptive statistics, paired t-tests for within-group comparisons, and independent t-tests for between-group comparisons using SPSS v26 (significance level 0.05, 80% power). Open-ended responses underwent summative content analysis with independent coding by two authors, involving keyword extraction, code organization into categories, and credibility review. Discrepancies in coding were resolved through discussion and consensus between the two coders, with a third author consulted if agreement could not be reached. This method was chosen due to response brevity, allowing systematic pattern identification and comprehensive understanding of participants' experiences (18).

In this study, 26 undergraduate midwifery students and 3 clinical instructors participated. The mean age ± standard deviation of students in the control group was 21.30±1.31 years, while in the intervention group, it was 21.84±2.08 years. The mean age of the clinical instructors was 43.60±2.08 years. Additional demographic information of the study participants is presented in Table 3. Independent t-tests and chi-square tests were performed to compare demographic characteristics between the intervention and control student groups. No significant differences were found (p>0.05 for gender, age and marital status).

Comparison of clinical education evaluation scores between traditional and new method: To assess intervention effectiveness, total questionnaire scores were analyzed using paired t-tests for within-group comparisons. In the control group, mean perception scores of clinical education quality showed a slight decrease from 48.90±8.77 at baseline to 48.60±4.94 post-intervention (P=0.900). In contrast, the intervention group demonstrated a substantial improvement, with mean scores rising from 50.30±8.58 to 64.40±9.06 (P<0.001) (Table 4).

Due to the constraints of the paper's work limit, supplementary results from this study are included in the Appendices 1-3.

Table 3. Demographic characteristics of the study participants

Variable	Clinical Instructors	Control Group	Intervention Group
Gender (n) (%)			
Female	3 (100.0)	13 (50.0)	13 (50.0)
Male	0 (0)	0 (0)	0 (0)
Age (year)	43.60 ± 2.08	21.30 ± 1.31	21.84 ± 2.08
Marital Status (n) (%)			
Single	1 (33.3)	12 (92.3)	10 (76.9)
Married	2 (66.7)	1 (7.7)	3 (23.1)
Field of Study (n) (%)			
Reproductive Health	2 (66.7)	0 (0)	0 (0)
Midwifery	1 (33.3)	13 (50.0)	13 (50.0)
Educational Level (n) (%)			
PhD	2 (66.7)	0 (0)	0 (0)
Master's Degree	1 (33.3)	0 (0)	0 (0)
Bachelor's Degree	0 (0)	13 (50.0)	13 (50.0)
Teaching Experience (n) (%)			
1–5	0 (0)	0 (0)	0 (0)
6–10	2 (66.7)	0 (0)	0 (0)
11–15	1 (33.3)	0 (0)	0 (0)

Table 4. Comparison of students' perceptions between traditional and new clinical Teaching Method

Group	Before (Mean(SD))	After (Mean(SD))	t-statistic*	P-value
Control	48.90(8.77)	48.60(4.94)	0.129	0.900
Intervention	50.30(8.58)	64.40(9.06)	-4.62	<0.001

SD: Standard Deviation

*Paired t-test

Discussion

This study assessed the effectiveness of a three-phase clinical education model on instruction quality for midwifery students at Zahedan University of Medical Sciences, finding that the intervention enhanced students' perceived quality of instruction.

Clinical Education Model: This study's educational model provided structured clinical instruction through a systematic approach. It aligns with established frameworks like SNAPPS (formerly SNNAP) (19) and the four-step method (12), but uniquely integrates a three-stage structure—preparation cycle (pre-round), clinical encounter cycle (round), and conclusion cycle (post-round)—tailored to midwifery contexts in resource-limited settings. Research confirms that such structured approaches standardize instruction, enable objective evaluation, and bridge the theory-practice gap (20). While similar to models by Mohammadi Neyrizi et al. (12, 21), and Cohen et al. (22)—as well as Cox (23), Meeting-to-Meeting (15), and Engage (24)—our model advances these by emphasizing patient involvement as educational partners. This fosters ethical balance between student learning and patient dignity, an aspect underexplored in prior midwifery-focused studies (25). By starting with preparation and clear objectives, progressing through other steps to develop diverse competencies, and ending with feedback for deep learning, our approach addresses gaps in traditional models, such as inconsistent patient-centered integration.

Quantitative findings indicate the intervention's effectiveness, with students' perceptions of clinical education quality significantly improving (intervention group scores increased from 50.30 to 64.40). This enhancement is likely due to the incorporation of active, participatory learning methods that foster direct engagement and hands-on experience, promoting deeper understanding and improved competencies (26). Our results align with but extend previous research. For instance, Mohammadi Neyrizi et al. (12) reported 77% improvement in delivery management skills, while Parchebafieh et al. (27) noted enhancements in clinical skills and satisfaction. However, unlike these smaller or qualitative studies, our quasi-experimental design provides robust evidence of perceptual improvements in instruction quality, complementing skill-focused outcomes in competency-based models (28). Additional studies confirm that innovative methods during clinical rounds enhance learning (29), but our work contributes novel insights into midwifery-specific applications in Iran, where structured models are less evaluated (25).

Advantages of the New Educational Approach: Clinical education is vital for developing midwifery students' professional competencies.

Student perspectives indicate that effective teaching methods enhance learning and qualification acquisition through two key dimensions: enhanced learning and targeted instruction (14), aspects our model uniquely operationalizes via its phased structure. Students reported appropriate strategies led to deeper understanding and better theoretical knowledge consolidation. They also noted improved ability in physiological childbirth (30). Targeted instruction with clear objectives (31), continuous supervision, and in-depth content (32) increased student confidence with patients and enhanced clinical skills. Literature supports the value of targeted education and effective knowledge transfer (33).

Our study adds to this by demonstrating how integrating these elements in a midwifery-tailored model yields measurable perceptual gains, beyond the self-efficacy and skill development reported in placement-focused research (34).

Disadvantages of the New Educational Approach: Despite its advantages, our model faces challenges common to clinical education in midwifery. These include time constraints due to high student numbers (35, 36) and inadequate infrastructure, such as insufficient spaces and equipment (37). Such factors can lead to incomplete content coverage, hindered skill acquisition, and diminished student confidence (25, 38). While our intervention mitigated some issues through standardized protocols, broader environmental limitations persist, as highlighted in recent surveys of nursing and midwifery education (25).

Study limitations included a small sample size, single-center implementation, varying clinical case complexity, and differences in instructor implementation. While these were partially addressed through uniform case selection and standardized protocols, they still pose potential impacts on validity and generalizability. The small sample may introduce selection bias and reduce statistical power, limiting the detection of subtle effects beyond Zahedan University. The single-center design restricts external validity, potentially overestimating effectiveness in better-resourced environments. Varying case complexity could confound results, while instructor differences may threaten internal validity through inconsistent model delivery. Future research should utilize semi-structured interviews for deeper insights, adopt multi-center designs for broader applicability, and employ larger samples to enhance power and reduce bias.

Conclusion

The findings of this quasi-experimental study indicate that innovative, active teaching methods in midwifery education enhance student learning, build professional competencies, and improve the quality of clinical education and training outcomes. Successful implementation necessitates faculty mentorship, sufficient clinical instruction time, appropriate infrastructure, and adequate equipment. Additionally, developing flexible programs that can adapt to emergencies further strengthens educational outcomes.

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Appendix 1. Between-group comparison of students' perception scores before and after the intervention

Group		t-statistic*	P-value
Pre-test	Control	-0.442	0.642
	Intervention		
Post-test	Control	-5.929	<0.001
	Intervention		

*Independent t-test

Appendix 2. Comparison of mean score differences between groups pre- and post-intervention

Group	Mean	SD	Difference in mean change	Test Statistic	P-value	Effect Size	95% CI
Control	-0.33	10.04	14.4	-3.60	0.001	1.28	0.50-2.04
Intervention	14.07	11.78					

SD: Standard Deviation

Appendix 3. Students' perspectives of the new teaching method

Main Category	Subcategory	Codes	Example quotes
Strengths	Enhanced Learning	Deepened understanding Improved retention of theoretical concepts Adequate preparation and practical experience for future work Enhanced performance in physiological childbirth Effective integration of theory and practice	"This method helped me understand the material much deeper than before." "Theoretical lessons are more firmly fixed in mind. We gain readiness and experience for future work."
	Goal-oriented teaching	Clear learning objectives at session start Defined tasks reducing confusion Continuous instructor supervision Detailed coverage of educational topics	"The clear objectives and feedback made me more confident in handling patients."
	Development of Professional Competencies	Improved history-taking skills More effective physical examinations Instructor modeling of professional patient interaction Increased confidence in patient care	"I felt more prepared for real clinical decisions after the structured phases."
Weaknesses	Time Constraints	Limited time per student due to high volume and emergencies Prolonged sessions without sufficient breaks Scheduling conflicts with residents	"With so many students, we sometimes ran out of time to cover everything." "Prolonged sessions with no sufficient downtime made it hard to retain information or stay engaged with patients."
	Inadequate Educational Infrastructure	Lack of dedicated space for educational rounds Insufficient facilities in physical environment Shortage of equipment for clinical skill practice	"Lack of equipment in the ward made some practices difficult."
	Communication and Support	Poor coordination among staff, instructors, and students Insufficient instructor support and excessive criticism Disrespect from personnel reducing student confidence	"There was no clear communication about who was responsible for what during rounds, leading to confusion and missed learning opportunities for us." "The disrespect from personnel, like ignoring our input or belittling our efforts, made me doubt my abilities and hesitate in clinical situations."

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View point

Augmenting the Effectiveness of the Jigsaw Method in Medical Education by Overcoming Potential Challenges

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Abstract

Background: The jigsaw method is a teaching-learning approach to promote collaborative learning among medical students. In this method, students are encouraged to take responsibility for their education and contribute to the group's collective knowledge.

Objectives: The objectives of the article are to propose a step-wise plan for the implementation of the jigsaw method in medical education, identify challenges that could hinder successful implementation, and propose targeted solutions to overcome the difficulties identified.

Methods: This viewpoint was developed by searching published literature on the implementation of jigsaw methods in medical education. In addition, best practices and solutions were recommended to overcome the identified challenges.

Results: In addition to problem-solving and critical thinking skills, this method also helps in improving communication skills, teamwork, and leadership skills. The jigsaw method has been linked with a wide range of benefits for medical students, especially with regard to improving their comprehension, problem-solving abilities, and critical thinking. The success of the jigsaw method in the attainment of educational outcomes depends on identifying the potential challenges and measures employed to overcome them. All these identified challenges can be handled by training teachers to conduct such sessions, informing students well in advance, and promoting better group dynamics.

Conclusion: The Jigsaw method has been linked with a wide range of benefits for medical students. However, to optimise the benefits for medical students, there is an indispensable need to invest in training teachers and improving group dynamics.

Keywords: Jigsaw Method; Group Dynamics; Teaching; Learning; Problem-Solving; Teamwork; Medical Education

Background

The jigsaw method is a teaching-learning approach to promote collaborative learning among medical students, wherein, through group work, teachers foster active engagement, peer teaching, and critical thinking (1, 2). As students work together towards the attainment of shared learning goals, they interact with peers, exchange knowledge, apply knowledge in clinical practice for problem-solving, and subsequently even reflect on their experiences (1, 3, 4). In this method, students are encouraged to take responsibility for their learning and contribute to the group's collective knowledge (1). Apart from problem-solving and critical thinking skills, this method is also helpful in improving communication skills, teamwork, and leadership skills, all of which are crucial to being a successful healthcare professional (1, 3, 5). The objectives of the article are to propose a step-wise plan for the implementation of the jigsaw method in medical education, identify challenges that could hinder successful implementation, and propose targeted solutions to overcome the difficulties identified.

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Methods

A targeted literature search was conducted across international electronic databases, including PubMed, Scopus, and ERIC, for English-language peer-reviewed articles published up to November 2024. The search strategy utilized combinations of relevant keywords and MeSH terms: "jigsaw method", "cooperative/collaborative learning", "group dynamics", and "medical education". Studies and reports evaluating the implementation, challenges, assessment strategies, and educational outcomes of the jigsaw technique among health professions students were identified and synthesized to formulate the proposed recommendations.

Implementation of the jigsaw method

In this method, students are divided into small groups of 4-6 members each, with each member assigned a different part of the topic to study (6). This is followed by the creation of an expert group, wherein students assigned the same sub-topic come together, share their insights, clarify doubts, and enhance their understanding for a fixed period of time (6, 7). After this, students return to their original group, and each one of them teaches their sub-topic to the group so that everyone can completely understand the whole topic (6). The teacher monitors group dynamics throughout and ensures equal participation and intervenes to guide discussion or clarify confusion (6, 8). At the end of the activity, groups present their findings to the complete class, followed by discussions to reinforce key learning points (6, 7).

Teachers are also expected to provide feedback to students individually as well as in groups regarding their participation and performances (6). Further, even assessments can be carried out to measure the extent of learning, and measures should also be taken to ascertain the attainment of learning outcomes (6-8). In a quasi-experimental crossover study, the jigsaw method was employed to teach physiology to medical undergraduates in India (3). In another study done to facilitate cooperative learning, 53 participants were involved in the jigsaw method to teach abdominal anatomy in Australia (4). Further, the jigsaw method was employed in a randomized controlled trial done to assess the effectiveness in teaching principles of diagnostic reasoning, and it was concluded that the jigsaw method can promote collaborative learning and student engagement (8).

The jigsaw method encourages students to become experts in specific sub-topics and promotes active learning through student engagement and deep understanding via peer teaching (1). It also promotes teamwork and the development of interpersonal skills by creating a sense of shared ownership. In the process, it reduces unnecessary competition in classrooms by cultivating a supportive environment wherein students help each other succeed (1, 2). Finally, as students teach others, it reinforces their own knowledge, resulting in better long-term retention (1-3). However, we must not ignore the inherent limitations of this method, like the involvement of a small number of students, which restricts the prospects of generalizability of learning outcomes (5). Moreover, because these sessions are conducted for small durations, they do not provide insights into long-term effectiveness and sustained skill development (2, 3). In addition, the success of the method precisely depends on individual preparation by students, and any lack of effort interferes with the learning acquisition among others (4, 5). Moreover, the process of assessment in a collaborative setting can be complex when compared to the evaluation of a single student (3).

Identified challenges and Potential solutions

Even though challenges in implementing the jigsaw method might appear separate, they are usually linked under the broader themes like the need for structured facilitation, student adaptability, and readiness of the institution (9, 10). For instance, unequal participation or poor group dynamics justify the importance of providing an inclusive learning environment. The findings obtained from a study that used peer rating and self-reported data from study participants concluded that successful cooperative learning depends on the willingness to work with their peers (9). Further, with the increase in use of blended learning, multiple digital tools (like Google Docs) can be used to stimulate group collaboration (2, 8). The success of the jigsaw method in the attainment of educational outcomes depends on identifying the potential challenges and measures employed to overcome them (Table 1).

One of the primary concerns is about the suitability of the method in all subjects or topics, and we must realize that not all topics can be divided into sub-topics (in other words, suitable for jigsaw learning) (7). This calls for the need for the curriculum committee and subject experts to meet and finalize those topics that are suitable for cooperative learning. From the students' perspective, the concerns include unequal participation (with a few students dominating while others contribute less to the discussion), and varying levels of preparedness, which can be either due to the quality of the students as a whole or

their familiarity with the learning resource materials shared (4, 6). At the same time, this form of teaching can prove to be either time-consuming (if time limits for expert discussion and group discussion are not defined) or resource-intensive (if teachers fail to use the existing resource materials within the curriculum) (7, 8).

Table 1. Identified challenges and potential solutions

Identified challenges	Potential solutions
Unequal participation	The roles assigned to each member of the group should be changed in every jigsaw session.
	Explain to all students what is expected of them and that every member must participate.
	Teachers can monitor the discussion and subsequently provide feedback to students for both individual and group participation.
	Introduce peer assessments to hold each student accountable for their involvement.
Time consuming	Share learning resources in advance to expedite the process
	Pre-define time limits for each phase of the process (viz., expert group discussions, group teaching, etc.)
	Use technology (like Google Docs for collaborative working) to expedite the discussion.
Difficulties in assessment	Employ individual assessments (like a quiz) to measure the extent of understanding.
	Formulate rubrics to measure both individual contributions and overall group performance.
	A combination of peer and self-assessment will be used to make the assessment process comprehensive.
Varying levels of student preparedness	Share learning resources in advance to ensure everyone has a basic understanding.
	Create groups with students of different abilities so that stronger students can help less-prepared ones.
	Teachers can monitor discussions and extend support to students who struggle with the learning resources.
Poor group dynamics	Start with team-building activities to improve bonding before the jigsaw session.
	Designate roles like "mediator" or "timekeeper" to manage group dynamics effectively.
	Teachers can observe group interactions and intervene early to resolve any conflicts.
Poor effectiveness of the expert group	Share structured templates for expert groups to ensure deep engagement with the material.
	Teachers can monitor and guide students to ensure key aspects are covered
Concerns with facilitator role	Organise training sessions to empower teachers to conduct jigsaw sessions effectively.
	Frame rubrics to help teachers assess group dynamics and performance
Resource intensive	Encourage use of digital resources (viz., online articles, videos) to reduce the need for physical materials.
	Incorporate content from textbooks or already available curriculum resources to save time and effort.
Relevance in all subjects	Curriculum committee and Subject experts should carefully select the topics that require collaborative learning.
	Combine jigsaw with other learning techniques, like problem-based learning, when topics are too complex for simple division.

From the teachers' side, their competence levels in conducting and facilitating such sessions play a crucial role in the success of the method (6). The effectiveness of the session depends a lot on the group dynamics, as any conflict or lack of cooperation between group members can significantly impact the learning process (9, 11). On a similar note, if the students in the expert group fail to engage with the learning resources, it will result in a direct impact on the quality of information that is subsequently shared with the original group (4, 7, 8).

This calls for the need to encourage students to engage actively, and there also lies the importance of the role of the teacher in addressing any potential concerns in the group (10). All these identified challenges can be handled by training teachers in conducting such sessions, informing students well in advance, and promoting better group dynamics, as detailed in Table 1 (4, 5, 7-11).

Several limitations should be acknowledged. First, as a viewpoint article rather than an empirical or systematic review, this commentary relies on selected literature and qualitative insights, which may introduce selection bias. Second, the proposed implementation strategies lack quantitative validation through prospective, multi-center trials across diverse medical curricula, limiting their generalizability. Finally, factors such as student motivation, group dynamics, and faculty readiness—which significantly influence the success of the jigsaw method—were not empirically controlled, highlighting the need for future longitudinal research.

Conclusion

In conclusion, the jigsaw method has been linked with a wide range of benefits for medical students, especially with regard to improving their comprehension, problem-solving abilities, and critical thinking. However, to optimise the benefits for medical students, there is an indispensable need to invest in training teachers and improving group dynamics.

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Policy Brief

The Willingness to Migrate Specialized Residents: Policy Brief

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Abstract

This study, conducted in 2022, aimed to explore the reasons behind and the willingness to migrate among physicians, as perceived by specialized residents within the medical communities of Kerman, Tehran, Shahid Beheshti, and Iran University of Medical Sciences. Notably, around 80% of clinical residents indicated that, with their current insights, they would opt for migration over pursuing a residency in their future careers. To mitigate physician migration, significant measures can be undertaken to enhance the conditions of specialized residency programs and to implement strategies that focus on retaining human resources, such as expanding educational and job opportunities.

Keywords: Migration; Physicians; Clinical Residents

Background

The migration trend is a significant concern for policymakers globally, both in origin and destination countries. Particularly, the migration of physicians and healthcare workers leads to a shortage of health personnel in low-income countries, despite the high costs incurred for their training and education (1, 2). The migration of elites inflicts numerous damages on the country; besides creating a void and a lack of specialized, skilled workforce and disrupting the meritocracy system in the country's management, it provides host countries with the opportunity to benefit from and reap the fruits of training these elites (3). The departure of skilled professionals such as physicians, nurses, and engineers during low supply and high demand can have destructive economic and social consequences. The departure of such health professionals has negatively impacted the capacity of medical and social services to meet basic health and social needs in the countries of origin. Consequently, the reduction in the number of physicians, besides its detrimental economic and social effects, leads to reduced access to health services and a decline in the health status of individuals (4, 5).

Domestic evidence regarding the causes and willingness of Iranian physicians to migrate is limited. Specialized and subspecialty medical training is of key importance in the country's higher education system due to the special role of residents from various specialties in the educational-treatment system of universities (6, 7), as well as the significant role of these graduates as specialists and subspecialists in the community's health system. Now, considering the importance of specialized residents' position in the country's health system, who can play a significant role in expressing the reasons for the migration of Iranian physicians, and also considering the educational conditions of the specialized residency period which can influence this matter, this study aims to investigate the opinions of specialized medical residents regarding the causes and extent of physicians' willingness to migrate. Utilizing the results of this study, in addition to achieving the aforementioned objectives, will provide practical information to health system policymakers and

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officials so that, through effective planning, they can identify the obstacles to the activity of medical science elites within the country and take steps to resolve them in order to prevent the increasing migration of physicians in the form of brain drain.

This policy brief synthesizes the core empirical findings of our multicenter study previously published in BMC Medical Education to provide actionable recommendations for healthcare policymakers (1).

Key Findings and Suggestions

Willingness and Planning for Migration: The results of this study showed that 81.5% of the clinical specialized residents who participated in the research were willing to migrate (N=254). Also, the average score for willingness to migrate overall was 4.03 ± 1.53, which is a significant figure. However, the results showed that residents' planning for migration is low. Only 28% of individuals had some degree of planning for migration, and the most significant number of residents (26.4%) had no planning. 58.9% of those willing to migrate had not planned for it.

Generally, migration studies focusing on clinical specialized residents and evidence related to them are scarce, and studies have usually examined the willingness to migrate and its reasons from the perspective of students and physicians. It seems that different conditions lead to the willingness to migrate among specialized residents, but planning for migration is low among physicians and residents due to the difficulty of the migration path, high migration costs, uncertainty of a positive outcome, as well as the busyness of the residency period, medical practice, and living expenses.

Examining the relationship between demographic characteristics, year of entry, and willingness and planning for migration showed that gender had a significant relationship with residents' willingness to migrate, such that 27.4% of men were very willing to migrate. In comparison, this figure was 15.3% for women. However, this relationship was not significant when planning to migrate. Younger individuals and newer entrants to this period, because less time has passed since the start of their residency, and they have more awareness about the migration path and indeed more courage, are more willing to migrate and have plans for it.

Examining the relationship between field of study and willingness and planning for migration revealed that this factor was related to willingness to migrate but not to planning for it. A notable point is that although it was assumed that fields with fewer shifts, better financial prospects in the future, and more comfortable work conditions would have less willingness to migrate, the results were different. Zero percent of the minor non-surgical field group selected "not at all" and "very little" for willingness to migrate, while this figure was 13.9% for the surgical field group. These fields' job and educational conditions are no longer as ideal as before. Furthermore, results showed no significant relationship between marital status and university of study with willingness to migrate and planning for it. The conditions of the residency period and residents in these universities are similar, and marital status does not affect the willingness to migrate. The influence of marriage in reducing the willingness to migrate and attachment to the country has diminished, and the willingness of young people to migrate is greater.

The Impact of Residency Conditions on Willingness to Migrate and the Suitable Time from the Perspective of Clinical Residents

The conditions of clinical specialized residency influence their willingness to migrate. Results show that 56.7% of residents stated that if they had their current insight into the residency conditions before entering the residency period, they would have chosen migration over studying in the residency program as their main future path to a great or very great extent. A notable point is that investigations show that 50.4% of residents who had little willingness to migrate, if they had their current awareness of the residency conditions, their willingness towards the path of migration instead of residency would have been high. Therefore, the willingness to migrate was significantly related to the conditions of the specialized residency period (willingness to migrate instead of the residency path given current insight into its conditions). Also, most residents (44.5%) stated that the best time for migration is after the general medicine period, before residency. These results also attest to the fact that residency conditions likely influence migration, and also that there is not much hope regarding financial and work conditions as a specialist, and these residency conditions or work conditions could also indicate that migration as a specialist has more difficult conditions and a more extended acceptance period in the healthcare systems of destination countries. Also, the impact of residency conditions on willingness to migrate was only significantly related to the age of the participants, and individuals with a higher average age stated that if they had the current insight, their willingness to choose the path of migration over residency would have been low.

Factors Influencing the Willingness to Migrate Among Physicians and Clinical Specialized Residents

The most influential causes for the willingness to migrate among physicians and clinical specialized residents, in order, were: "Income inappropriate for medical professions compared to inflation, workload, and cost of living," "Better relative welfare in the destination country," "Existence of weak and unfair laws in the work and income system of the healthcare sector," "Lack of economic stability in society and better relative welfare in destination countries," "Unfavorable future outlook," and "Lack of facilities, income, and sufficient security during compulsory service periods." Also, the items "Encouragement from family and acquaintances to continue education or work abroad," "Religious constraints, laws, and lifestyle (including behaviors, values, attitudes, and beliefs) governing Iranian society," "Difficulty of entry, high competition, and inappropriate method of selection and admission for specialized fields and better conditions in destination countries," "Dissatisfaction with social status and public perception as a physician in society," and "Need for progress in the academic and professional field" were, in order, considered by residents as having the least impact on migration. Furthermore, 85.5% of residents selected economic and occupational factors as the most important causes of brain drain and the migration of specialists. After that were socio-cultural causes, educational-academic causes, and personal causes. However, overall socio-cultural causes had the highest average score across all items, with an average score of 37.42 and a very slight difference compared to economic and occupational causes, with an average of 36.52. After these two categories came educational-academic causes and personal causes. Reasons related to economic, financial, payment, occupational, and prospects of physicians held the most importance for residents as the leading causes of willingness to migrate. Also, given that the items with the highest scores were in the economic and occupational group, and from the residents' perspective, this category was more effective than the others, economic and occupational causes are the most influential and important causes of physician migration and the willingness of clinical residents to migrate. However, socio-cultural causes are slightly higher than economic and occupational ones, which indicates the importance of this issue in the subconscious of residents regarding physician migration and their willingness to do so.

Physicians are generally elite and capable individuals in any society and play an effective role in enhancing the community's public health level, which significantly impacts human development indices. Also, medical education is costly. Therefore, retaining and maintaining a specialized medical workforce is particularly essential. According to various reviews and research, the statistics of physician migration, as one of the country's most important groups of elites and specialists, have been increasing in recent years, especially since the beginning of the COVID-19 pandemic. This is while, according to supply and demand forecasts, Iran will face a shortage of physicians in the coming years.

On the other hand, in recent years, the inclination towards taking the entry exam for specialized residency has decreased, and for the first time in the 2021-2022 academic year, failure to fill capacity occurred extensively in many specialized fields. These cases indicate that physicians are concerned about the future and sometimes think about migration. One of the compelling reasons for physicians' willingness to migrate is the conditions of the residency period in various dimensions and the conditions after graduation as a specialist. On the other hand, evidence providing a comprehensive overview of the willingness and reasons for physician migration from the perspective of clinical specialized residents, who have a special role in the educational-treatment system of universities, and also a significant role after graduation as specialists and subspecialists in the community's health system, is minimal. The willingness to migrate within the medical community has increased in recent years. The present study shows that this willingness is also very significant among clinical specialized residents studying at the best medical universities in the country. Furthermore, the current educational, payment, and work conditions during clinical specialized residency influence physicians' willingness to migrate. Many physicians and residents are dissatisfied with the job, economic, and financial conditions, and the support that should be provided to them, and these reasons themselves are the most important reasons for their willingness to migrate.

Conclusion

Physicians are among the most important specialized forces in society, and considering the cost spent on their education and the country's need for them due to the anticipated future shortage of physicians, efforts must be made through macro strategies to improve their conditions. Improving the educational and work conditions during residency, such as

standardizing their weekly working hours and number of shifts, appropriately distributing the treatment load according to the number of attendings present in hospitals, providing payment commensurate with their four years of work and activity, and ensuring they have suitable conditions and payment as specialists after graduation, coupled with improving the economic and occupational conditions of physicians in proportion to increasing costs and inflation at the macro level, enacting fair laws instead of strict occupational regulations, providing necessary support during their compulsory service period, and creating appropriate payment commensurate with the education and work level of specialists, can encourage the medical community to work in their own country, create hope regarding the residency period and specialist conditions, subsequently encourage entry into residency, and deter physician migration.

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Policy Brief

Factors Influencing Students' Choice of Universities in the 8th Macro Region: Policy Brief

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Abstract

Countries around the world are increasingly recognizing the critical role of universities in fostering national development and advancing knowledge and technology. As a result, development policies are inherently connected to universities, research institutes, and industrial centers. This research explores the factors influencing currently enrolled students' choices of universities in the eighth macro region, employing a sequential exploratory method that integrates both qualitative and quantitative approaches.

Keywords: Career Choice; Higher Education; Regional Health Planning; Universities; Students; Health Occupations

Background

Every year, many high school graduates choose which university to attend. Research has been conducted on the decision-making of high school graduates when selecting a university. In Iran, factors identified in previous studies as influencing students' choice of university include: family, friends, availability of the desired program, university reputation, distance from home, and future career prospects. Researchers have also identified university entrance exam scores and tuition costs as factors in decision-making (1-3). In fact, university managers and educational policymakers can transform the university into an attractive environment for students' education by investing in utilizing positive factors or opportunities and reducing the negative impact of challenging factors. The 8th Health Higher Education Macro Region includes the Universities of Medical Sciences in Kerman, Zahedan, Rafsanjan, Jiroft, Zabol, Bam, and the faculties of medical sciences in Sirjan, Iranshahr, and Chabahar located in the region. The National Spatial Planning Document emphasizes utilizing the social, cultural, and scientific capacities of the country's provinces and regions, and laying the necessary groundwork for maximizing the use of capacities and capabilities of small and dispersed population centers in preserving and maintaining the population, establishing balance in the population distribution pattern by diversifying activities, creating employment, and increasing the role of educational, research, industrial, and service activities that can be established in these centers. This is achieved by limiting the quantitative development of lower levels of higher education in favor of higher levels and enhancing the quality of higher education institutions and their research and technology centers for developing scientific collaborations, including international ones. All countries are certainly striving to emphasize the role of universities in national development and the advancement of knowledge and technology. Therefore, development policies are fundamentally linked to universities, research, and industrial centers (4-6). This research investigated the reasons for choosing universities in the eighth macro region by currently

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enrolled students, using a sequential exploratory (qualitative and quantitative) method.

The findings of this research identified five factors as the most important reasons for choosing universities in the macro region, prioritized as follows by students: being a resident and ease of commuting from their hometown to the current university; admission based on their entrance exam rank to the current university; relatives and close family members living in the city where the current university is located; the admission capacity for the specific major at the current university; and the allocation of suitable dormitory facilities from the first semester. These factors accounted for the highest percentages. Notably, reasons such as the university's national ranking, high acceptance rates of graduates into higher degrees at the current university, international ranking of the university, and the role and importance of prominent graduates from the current university received the lowest percentages.

Suggestions

Considering the results of this study, the Universities/Faculties of Medical Sciences in the 8th Macro Region, with their nine educational university centers, should take steps towards creating a competitive advantage to attract students with top ranks in various academic entrance exams. Based on the opinions of students studying in this macro region, these steps should include:

Educational Advantages: Promoting the scientific reputation of university faculty members, implementing modern student-centered educational strategies, utilizing international faculty members, maintaining proper connections with alumni, attracting international collaboration in educational programs, and implementing "brain circulation" among universities in the eighth macro region.

Advantages Related to Infrastructure and Facilities: Having equipped dormitories within the university campuses and providing dormitories from the first semester until the end of studies; providing transportation facilities on various land and air routes for student travel and signing memoranda of understanding for student discounts; implementing "University Day" programs for high schools and creating virtual tours to introduce universities; establishing equipped recreational halls and rest areas on university campuses; developing modern educational infrastructure; and providing students with strong internet and information technology access.

Conclusion

Every higher education institution's goal is to meet its students' needs, fulfill their expectations, and provide high-quality educational services that enable students to gain a competitive advantage in the job market. However, with today's intense competitive pressure, educational institutions must be able to build their brand and choose marketing tools that convince all stakeholders of their quality. Only by understanding the needs, preferences, motivations, desires, and other characteristics of students can a higher education institution respond to these differences, gain a sustainable competitive advantage among educational institutions, and create practical concepts and strategies for attracting and retaining students, while continuously improving the quality of its services. Higher education institutions can then use this knowledge to formulate policies and target specific groups of students to ensure a favorable learning environment and enhance their image.

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Policy Brief

Optimizing Medical Workforce Distribution for a Sustainable Healthcare System in Iran

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Abstract

Public health is one of the most valuable assets of any country, and the level of development of societies largely is contingent upon the quality and equity of their healthcare systems. This policy brief analyzes recent trends in medical education in Iran, examines the current physician-to-population ratio in a regional context, and highlights structural challenges in physician distribution as well as referral systems. Official reports from the Ministry of Health and the Iranian Medical Council demonstrate that while Iran's physician-to-population ratio (1.7–1.9 per 1,000) remains below the WHO recommended level (2–3 per 1,000), the main issue lies in unequal geographic distribution, lack of incentives for medical specialization, and insufficient educational infrastructure. According to evidence, merely elevating the number of medical graduates, without addressing structural and economic factors, may fail to improve health outcomes. It could even contribute to unintended consequences such as physician unemployment and increased migration of skilled professionals. Thus, effective policy-making in this domain requires a clear understanding of verified data sources, robust distribution policies, as well as realistic strategies to align medical workforce expansion with national healthcare needs and development plans.

Keywords: Medical Education; Physician-To-Population Ratio; Physician Distribution; Physician Migration; Health Policy

Background

Public health is widely recognized as one of the key indicators of sustainable development and social resilience. Throughout history, inadequate healthcare infrastructure and poor disease control have subjected societies to severe public health crises, as observed during recent global pandemics. In Iran, the formal training of local physicians dates back to the establishment of *Dar ul-Funun* and the country's first modern hospitals in the 19th century, which significantly diminished dependence on foreign medical practitioners.

Nowadays, despite significant growth in medical education, Iran's healthcare system is facing emerging challenges such as regional physician shortages, unequal distribution of medical personnel, limited economic incentives for specialization, and growing trends of physician migration. Official data from the Ministry of Health and the Iranian Medical Council reveal disparities in the availability of healthcare services across provinces, with some underserved areas reporting fewer than 10 physicians per 10,000 people, compared to over 55 per 10,000 in major urban centers such as Tehran.

Moreover, factors such as limited investment in rural healthcare infrastructure, inadequate residency support, and external pull factors such as international recruitment contribute to the ongoing brain drain. These challenges necessitate careful, evidence-based policy-making to ensure that any expansion of medical school admissions is matched by sustainable workforce planning, equitable distribution, and robust support systems (1, 2).

Current Status of Medical Workforce

According to the *Annual Statistical Report* of the Ministry of Health (2023) along with the data published

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by the Iranian Medical Council (*IMC Report on Medical Licenses*, 2022):

- Approximately 200,000 students are currently enrolled in different medical sciences programs in Iran, of whom about 55,000 are studying general medicine (*MOHME, 2023*).
- As of 2023, an estimated 176,000 physicians hold valid practice licenses nationwide. Each year, between 5,000 and 6,000 new general practitioners graduate and enter the workforce (*IMC, 2022*).
- Of the total medical graduates, 46,000 have completed specialist or subspecialist training, and approximately 16,000 are enrolled in residency programs (*MOHME Graduate Tracking Report, 2022*).
- It is estimated that more than 20,000 general practitioners have left the medical field in recent years owing to factors such as international migration (~12,000), transition to non-medical careers (~5,000), or non-renewal of licenses because of early retirement or career changes (~3,000) (*IMC Migration and Workforce Report, 2022*).

According to these figures, Iran's physician-to-population ratio ranges between 1.7 and 1.9 per 1,000 people. This variance reflects differences in data reporting and regional fluctuations (*MOHME Workforce Dashboard, 2023*). Although this ratio remains slightly below the World Health Organization (WHO) recommended standard of 2–3 per 1,000, Iran's ranking is comparable to the lower-middle range among countries in the Middle East and North Africa (MENA) region (*WHO Global Health Observatory, 2022*).

Nevertheless, a closer look indicates that the main issue is not the absolute number of physicians; rather it is inequitable geographic distribution. For example, in Tehran and major urban centers, the ratio exceeds 5.5 physicians per 1,000 (55 per 10,000), while in at least six provinces—including Sistan and Baluchestan, Kohgiluyeh and Boyer-Ahmad, Ilam, South Khorasan, Hormozgan, and Lorestan.

These gaps, coupled with insufficient rural healthcare infrastructure and limited incentives for specialization, have significant implications for national health equity and access (3-7).

Challenges in Physician Distribution and Medical Student Admission

1. Inequitable Distribution of Physicians

Although Iran's overall physician-to-population ratio is close to regional averages, there persists significant internal disparities. For instance, while Tehran enjoys over 5.5 physicians per 1,000 people, provinces such as Sistan and Baluchestan, Hormozgan, and Lorestan report ratios under 1 per 1,000 (*MOHME Regional Report, 2023*). According to studies, more than 35% of new graduates prefer to practice in major urban centers due to better healthcare infrastructure, higher pay, and lifestyle advantages (*IMC Physician Location Survey, 2022*). This urban concentration exacerbates service gaps in rural and underserved areas.

2. Limited Economic Incentives for Specialization

In spite of the rise in medical residency capacity from 3,600 to 4,300 positions in 2021, many specialties remain unpopular given unattractive salaries—often below $150 per month—long working hours, and insufficient legal protections (*MOHME Residency Enrollment Report, 2021*). For instance, fields such as family medicine, emergency medicine, and rural general practice confront chronic recruitment shortfalls.

3. Limited Impact of Increased Physician Supply on Health Outcomes

Evidence suggests that boosting graduate numbers alone does not automatically translate to better health indicators. For example, from 2010 to 2020, although Iran doubled the number of dental graduates, national oral health surveys revealed only marginal improvements in oral hygiene and caries indices (*National Oral Health Report, 2021*). A similar pattern could emerge in general medicine if structural issues such as referral system weaknesses and lack of preventive care models remain unresolved.

4. Insufficient Educational Infrastructure

While admission quotas have grown in response to physician shortages, some universities lack sufficient teaching hospitals, clinical laboratories, and qualified faculty. As of 2022, 27% of Iran's medical schools report faculty-to-student ratios lower than WHO's recommended standard of 1:7 for clinical training (*MOHME Medical Education Capacity Report, 2022*). Without substantial investment, further expansion may jeopardize the quality of medical education and clinical competency (8-12).

Policy Recommendations

1. Implement Targeted Incentive Packages for Underserved Areas

International experience indicates that competitive salaries and non-financial incentives are essential for attracting physicians to underserved regions. For instance, Turkey's rural physician program enhanced coverage by offering 30–50% higher salaries, subsidized housing, and fast-track promotion schemes (*OECD Health Workforce Report, 2021*). Iran could adopt a similar approach by allocating special budget lines to offer financial incentives, housing benefits, and career

advancement opportunities for doctors who commit to working at least 5 years in low-coverage provinces.

2. Reform the Referral and Family Medicine System

A robust referral system lowers unnecessary specialist visits and helps distribute healthcare demand more evenly. Strengthening Iran's family medicine program—by augmenting family medicine residency slots, raising salaries to match specialist levels, and integrating family doctors into urban clinics—can diminish overcrowding in tertiary hospitals. A 2020 pilot in Fars Province revealed that a 20% reduction in unnecessary specialist referrals is achievable with an active family physician network (*MOHME Pilot Evaluation, 2020*).

3. Align Admissions with Verified Infrastructure Capacity

Medical school admissions should be explicitly linked to capacity of teaching hospitals, availability of clinical placement slots, and faculty numbers. A transparent national capacity map—updated annually—can prevent over-enrollment. For example, South Korea's Ministry of Health ties university admission quotas to annual hospital accreditation reviews (*Korean Health Workforce Policy Review, 2019*). Iran can adopt a similar dynamic quota system.

4. Mandatory Service with Clear Enforcement Mechanisms

Evidence from Thailand and Malaysia suggests that requiring graduates to serve in designated regions is only effective if backed by clear penalties and benefits. For Iran, a 3–5-year compulsory service period for students admitted under expanded quotas can be enforced by tying license renewal and board certification to completion of this service. Graduates who fail to comply would face license suspension or fines equal to the cost of their subsidized education (*Thailand Rural Doctor Program Evaluation, 2018*).

5. Enhance Residency Program Support

To address specialist shortages, residency stipends have to be elevated to at least cover basic living expenses. Further, offering loan forgiveness, subsidized housing, and guaranteed job placement after graduation can attract more applicants. Studies from Eastern European countries demonstrate that residency retention improved by 40% when financial and legal protections were introduced (*European Medical Training Trends, 2020*).

6. Promote Alternative Career Pathways and Public Awareness

Ultimately, to alleviate excessive pressure on medical school admissions, it is essential for policymakers to advocate for the social and economic significance of allied health professions, nursing, and non-medical careers. Media campaigns, high-school counseling, and financial incentives for high-demand non-medical fields can gradually balance student interest across disciplines.

Conclusion

In conclusion, while raising the number of physicians in Iran is a necessary step toward ameliorating healthcare access, it is not sufficient by itself. The key challenges lie in the uneven geographic distribution of medical personnel, insufficient educational infrastructure, weak referral systems, and inadequate incentives for specialists, all collectively limiting the influence of increased physician numbers on public health outcomes.

Without coordinated reforms that address these structural and systemic challenges—including targeted financial incentives, compulsory service programs with clear enforcement, and alignment of medical school admissions with actual capacity—the risks of physician unemployment, quality decline in medical education, and increased brain drain will persist.

Accordingly, evidence-based policy-making that integrates comprehensive workforce planning, educational capacity building, and social incentives is essential to enhance the quality, equity, and sustainability of Iran's healthcare system. Only through such multifaceted approaches can the country ensure that medical education expansions translate into tangible improvements in population health.

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Policy Brief

Social Accountability in Medical Education: A Policy Brief

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Abstract

Background: Social accountability in medical education refers to the ability of the medical education system to fulfil the health needs of people in society. Justice, quality, relevancy, effectiveness, professionalism, and community participation are known as six principles of social accountability. Even though medical schools have made efforts to educate physicians capable of addressing population health needs, shifts in population size and demographics, evolving patterns of disease distribution and prevalence, as well as the growing scope of specialized care have all progressively transformed those needs over time. In response to these needs, the concept of responsive doctors' and 'accountable medical schools' has recently emerged in medical education. Within our setting, the theoretical aspects of social accountability are well integrated into medical curricula and feature prominently in many seminars, a focus that is further reflected in a substantial body of published literature. Unfortunately, in practice, medical students still receive training that is not compatible with the needs of society, and they do not have sufficient ability to solve basic problems of the people. Thus, it seems we need a local model to educate and train the medical students to address the public's health problems while focusing on social accountability. We undertook a study to determine the social accountability of medical schools. Design of the study was cross-sectional, and we employed a structured questionnaire including three assessment parts of structure, process, and outcome. The current report is a policy brief based on the findings of the study.

Keywords: Social Accountability; Education; Medicine

Background

The medical profession has a long-standing tradition of addressing social issues that affect public health—a mission that can be traced as far back as the time of Hippocrates. Indeed, this commitment is deeply embedded in the core of the profession and is actively underscored across all medical schools.

The World Health Organization (WHO) defines social accountability in the field of medical education as the responsibility to focus education, research, and service provisions based on the health needs of the communities, regions, and countries where doctors are supposed to serve (1). The WHO has also introduced social accountability with four criteria of justice, quality, effectiveness, and relevancy in service delivery (2, 3). Hence, social accountability should emphasize compliance with professional standards and meeting society's expectations by providing equal opportunities for health care for all, addressing problems related to society, as well as ensuring the cost-effectiveness of health care services (4-6).

In parallel with global changes and developments, Iran's medical education system underwent major transformations. The turning point of these changes—specifically the shift toward addressing societal needs—dates to 1986, when the Ministry of Health and Medical Education was established.

The introduction of community and preventive medicine rotations along the clerkship and internship phases marked another significant step toward

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accountable medical education. Subsequently, the fourth phase of the "Health System Evolution Program" in 2013 served as a foundational initiative which brought substantial effects to the broader effort of aligning the medical education system with societal needs.

At present, addressing the issue of social accountability in medical education appears to be unavoidable. Based on the findings of our study on social accountability of medical schools in Iran, we suggest the following steps to run a socially accountable program of medical education:

Policy recommendation

Steps to provide social accountability in medical education

- Addressing the health needs of society through producing science that is responsive to those needs, training skilled human resources, and delivering effective services.
- Focusing on the framework in which the educational system leads the health system, encompassing education, research, and service delivery. With a curriculum focused to societal needs, graduates are anticipated to be proactive in delivering services, while research is developed to address community requirements alongside education. As a macro-level step, policymaking should be centrally aligned with the needs of society, reflecting the country's centralized education system. This involves performing continuous and dynamic needs assessments to account for changes over time. Based on these assessments, stakeholders should be trained in accordance with the necessary needs. Ultimately, comprehensive planning should be undertaken to address the identified needs, ensuring that all aspects and subsets of the organization are included to enhance accountability in education and ultimately ameliorate the health system.
- Achieving social accountability in education requires involvement of all organizational components. To this end, the system needs to ensure the presence of knowledgeable, expert, and capable managers, as well as competent trainers—including academic faculty members with the requisite skills and qualifications—alongside the necessary resources. Adequate resources of departments can provide the facilities and equipment required to support accountable education. Further, faculty members should be familiar with societal needs and actively engaged with them in some capacity. Equally important is an institutional attitude that prioritizes responsiveness to community needs, which serves as a key driver of educational accountability. This step can be regarded as a meso-level initiative, implemented within medical schools.
- Once the foundations are in place, training can be planned in alignment with community needs. In this respect, after identifying the health needs of society, these priorities are incorporated into the curriculum—which is itself designed around expected competencies and qualifications—with courses and training programs subsequently developed based on those identified topics.
- Thereafter, the conditions for education in community settings—such as the provision of authentic environments—need to be established. The training environment should reflect real-world conditions, including health comprehensive service centers, outpatient clinics, and other settings relevant to public health. Ultimately, the philosophy underlying curriculum development should be outcome-oriented, with a focus on addressing people's health needs, to accomplish social accountability. These steps can be considered as the meso-level and macro-level respectively.
- The educational system should be appraised through evaluating the accreditation of the organization and the responsive training program. In the standards of institutional accreditation and program accreditation, social accountability should be addressed and placed among the most essential criteria. The inclusion of standards related to responsive education in institutional and program accreditation can guide and motivate organizations to develop educational goals aimed at social accountability—particularly when accreditation outcomes are linked to incentive allocation. It should be demonstrated that education, research, and responsive service delivery have been able to generate a measurable impact on community health. To ensure this effectiveness, the data of the health system should be continuously reviewed and analyzed (7-10).

Obstacles to the implementation of education with social accountability

Barriers to implementing social accountability in medical education include limited awareness among stakeholders and faculty members regarding its concept as well as significance, insufficient infrastructure for

implementation, resistance to change and adherence to traditional educational methods, excessive responsibilities assigned to faculty members, inadequate motivation, along with a shortage of suitable training settings—such as rural field placements.

Conclusion

As a first step toward implementing socially accountable medical education, we should address weaknesses that can be resolved through simple, cost-effective interventions. These include establishing committees or working groups for accountable education within medical schools, organizing regular workshops for various beneficiary and stakeholder groups, as well as supporting the design of programs that promote social accountability—such as early community exposure.

It is also essential to train suitable human resources, identify and prioritize the health needs of the community, and gather the necessary evidence to deliver effective services. Curriculum should be designed around competencies and outcomes, with university courses developed in accordance with these frameworks and the health needs of society. All elements of the medical schools should participate in the development of the educational program so that the implementation of the program is possible. For the program to be feasible, all organizational managers should be involved in formulating the faculty's mission, to secure their support along the implementation phase.

Eventually, the program should undergo evaluation and accreditation. Its effectiveness in enhancing service delivery to fulfil the health needs of the population should be assessed, and the resulting feedback should be continuously integrated into the curriculum as well as course plans.

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Letter to editor

Military Crises and Pediatric Medical Curricula

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Keywords: Pediatric Education; Medical Curriculum; Psychosomatic Symptoms

Dear Editor,

This letter points out an overlooked educational deficit in pediatric training during a state of societal distress. During an evening in a pediatric emergency department during a period of military unrest in my area, an educational point began to become obvious in our clinical learning environment. Despite our prior expectations for a crisis setting, the pediatric emergency department was less populated with critically ill and critically injured children than we would have expected to be. Instead, we had a large number of children presenting to the pediatrics emergency department for symptoms of abdominal pain, difficulty breathing, palpitations, headaches, inability to sleep, nausea and behavioral irritability without explanation. Upon work up of the children in many of the listed presentations, we were largely able to document absent serious organic pathology and a clear temporal correlation with increased family and societal stress levels. These are qualitative observations. However, these experiences suggested a largely unrecognized gap in conventional pediatric medical curricula. Medical and pediatric students were skilled and were trained extensively to recognize and manage acute organic illness and emergency, but many were poorly equipped to deal with psychosomatic symptoms and anxiety-based physical symptoms in children. Bedside teachings often included discussion of ruling out organic illness, e.g. Differentiation of acute appendicitis from anxious functional abdominal pain, while comparatively little emphasis was placed on psychosocial history taking, communication with upset families and caregivers, identifying clusters of functional symptoms, or dealing with pediatric crisis anxiety. There is increasing attention in the public health literature (1, 2) that Children exposed to social unrest and military pressure frequently exhibited psychological distress through somatic symptoms, often showing a higher prevalence of these manifestations compared to explicitly expressed fear or pain (3). Thus, it is conceivable that periods of crisis could potentially impact significantly on the spectrum of clinical presentations in children's emergency services, and medical schools' educational curricula. Inexperienced clinician faces a diagnostic problem, and is unable to allay the worries of the caregivers, and are insecure on when to initiate further diagnostic workups. Lack of training in the use of those skill set may also result in needless testing, subsequent re- consultations or loss of confidence in what may constitute valid clinical explorations. While aspects such as trauma response and disaster readiness have grown in focus in disaster medicine curricula, the psychosocial aspects of pediatric crises have been under-addressed in many pediatric training programs relative to their physical trauma and readiness components. Multiple previous studies have shown the extensive negative psychological and behavioral impact on children from war and disasters, such as symptoms of anxiety, sleep disruption, and somatic symptom disorders (3).

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Discussions concerning health in the context of emergencies over the last several months have also raised questions about the indirect effects of crises on underlying chronic pediatric disease processes, and on children's access to and utilization of care (2). This evidence suggests that the pediatric competence model of disaster preparedness must necessarily include the integration of skills and training in psychosomatic examination and communication. From a training curriculum standpoint, formal integration into the pediatric residency curricula will, even via current residency teaching methods, help prepare them for such experiences. By utilizing bedside teaching, simulation opportunities, dedicated communication education sessions, and interdisciplinary teaching with child psychiatry, clinical psychology, and medical social work, training might enhance confidence and clinical judgment when residents manage these instances (4, 5). Furthermore, education about psychological first aid, family-centered communication skills, and recognizing the functional nature of such symptoms within the Pediatric curriculum may result in better overall pediatric care during periods of communal unrest. Note that those societal and pedagogical impacts are not confined to conflict or disasters as such and can be seen during conditions characterized by long periods of internal instability and widespread concern for individuals, even without any evidence of societal physical collapse. Crisis pediatric training based on psychosocial aspects therefore needs to be an integral aspect of any standard pediatric training. A potentially less observed outcome of crises is likely that in many contexts affected children come to the clinic not necessarily with physical evidence of harm, but rather with the manifestations of distress and alarm. These children have issues as to how they can cope and adapt and what their parents should be aware of, revealing as well a clear void in the medical school curriculum, preparing them for these issues.

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Letter to editor

Personalized Medical Education: An Innovative Approach for Training Future Physicians

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Keywords: Education; Medical; Physicians; Students

Dear Editor,

The "one-size-fits-all" approach to medical education is becoming increasingly inadequate for the modern learner. There are still considerable challenges to overcome, especially the volume of theoretical knowledge, the vital integration of theory and practice, and the considerable individual differences in attitudes, cultural factors, and the cognitive make-up of contemporary students, which have greatly undermined the efficacy of standardized teaching. Just as clinical medicine has progressively embraced personalization in diagnosis and therapy in recent decades, medical education must also accelerate its transition from time-based traditional models toward competency-based and personalized frameworks (1, 2). This letter outlines conceptual personalized medical education, its key elements, the influence of new technologies, challenges in its adoption, and its anticipated consequences on the education of physicians.

Personalized education stems from the works of John Dewey and other 20th-century educational theorists (3).

The essential components of personalized medical education include:

1) Assessing the student's needs and learning style: Systematic identification of strengths, weaknesses, learning styles, and learning patterns.

2) Flexible learning methods: Personalizing educational trajectories to align teaching objectives and individual competencies.

3) Intelligent Educational Technologies: Incorporating artificial intelligence (AI) and adaptive learning systems that modify content and adjust instructional sequences based on several performance indicators in real-time.

4) Continuous Formative Evaluation: Over time, monitoring student advancement with successive modifications to ensure acquisition (1).

The most recent advancements in AI are geared toward personalizing learning in medical education. OSCEai shows how adaptive learning technology personalizes clinical assessments and exercises offered to learners at different levels (4, 5).

The immediacy of performance feedback, the constant availability of learning materials, and the adaptive learning paths are pivotal to educational advancement. Recent studies show that higher knowledge retention and improved learning outcomes respond to adaptive educational systems (6).

Implementation Challenges

There are pronounced barriers to personalized learning systems:

- Data privacy and security concerns.
- The digital divide and unequal access to technology.
- Risks of AI-generated inaccurate content.
- Lack of long-term outcome evaluations.
- The need for standardization of approaches and assessment methods (1, 7)

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Regional Implementation and Context:

In the Middle East, since 2025, Dubai Medical College for Girls has introduced an educational competency model integrating portfolios and individual mentoring from the first year to provide continuous feedback and reflection, thereby engaging in self-reflection, fostering critical thinking, and overall professional growth (8).

Iran's medical education system experiences specific obstacles and challenges. Since the with the recent substantial increase in medical student admissions have been increased by 50%, and without appropriate increments in the admissions infrastructure, the overworked clinical faculty has been stretched too thin, which has resulted in an overwhelming lack of clinical training opportunities. Coupled with the digital resource disparity between the capital's universities and peripheral educational centers, this presents a systemic problem (9-11). These problems point to the necessity for an educational value shift to innovation. A change to competency-based education in Iran can lead to paradigm shifts whereby clinicians can achieve competency within a variable-duration training program. To this end, we recommend that Iranian medical universities develop pilot programs to implement this approach. This would allow for evaluating its outcomes while accelerating the development of necessary infrastructure.

To develop flexible, critical, and competent clinicians who can respond to the clinical challenges of tomorrow, we prepare personalized medical education.

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Letter to editor

How Artificial Intelligence is Reshaping the Dominant Discourse in Evidence-Based Medicine?

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Keywords: Artificial Intelligence; Evidence-Based Medicine; Clinical Gaze; Biopower; Subjectivity

Dear Editor,

The current integration of artificial intelligence (AI) into evidence-based medicine (EBM) marks not only a technological innovation but also a profound reconfiguration of power, knowledge, and subjectivity within clinical practice (1). From a Foucauldian critical discourse perspective, this transformation is best understood as a shift in the regimes of truth and the modalities of governance that structure medical discourse and practice (2).

AI and the Extension of the Clinical Gaze

Foucault's concept of the clinical gaze describes how medical knowledge objectifies patients, reducing them to a set of observable signs and symptoms (3). AI amplifies this gaze by transforming the patient into a data subject—an assemblage of biomarkers, risk scores, and algorithmic predictions. The acceleration of evidence synthesis through AI-driven "living systematic reviews" is not merely an efficiency gain; it is a mechanism by which the medical field extends its surveillance and standardization of bodies, further entrenching the authority of biomedical discourse (4).

Biopower and the Regulation of Populations

AI's capacity to aggregate and analyse vast datasets enables new forms of biopolitical governance. By continuously updating clinical guidelines and stratifying risk at the population level, AI operationalizes Foucault's notion of Biopower—the management of life through statistical norms and regulatory interventions (5). This process, while promising more equitable and timely care, also risks marginalizing those whose data are underrepresented, reinforcing existing health disparities under the guise of objectivity and neutrality (6).

Discursive Shifts in Clinical Decision-Making

The promise of personalized medicine and shared decision-making, as mediated by AI-powered clinical decision support systems, must be critically examined. While these systems claim to incorporate patient preferences, they do so within the constraints of algorithmic logic and pre-defined categories (7). The subjectivity of both clinician and patient is thus reconfigured: clinicians become operators of decision-support technologies, and patients are interpellated as data points within evidence hierarchies. This shift reflects a broader transformation in the subject positions available within medical discourse, as agency is distributed between human and non-human actors (8).

Ethical Tensions and the Production of Truth

The Foucauldian lens draws attention to the ethical and epistemological tensions inherent in AI-driven EBM. The authority of evidence is increasingly tied to the outputs of opaque algorithms, raising questions about transparency, accountability, and the very definition of "best evidence" (4). The discourse of AI as a barrier-breaker risks obscuring how new forms of surveillance, normalization, and exclusion are being enacted in the name of progress (6).

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AI's integration into EBM is not a neutral or inevitable evolution; it is a discursive event that reshapes the production of medical knowledge, the exercise of clinical power, and the constitution of patient subjectivities. A Foucauldian analysis urges us to remain vigilant to how these technologies may reinforce or challenge existing hierarchies, and to interrogate the regimes of truth they produce critically.

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Letter to editor

Academic Dishonesty Among Dental Students in Southeast Iran

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Keywords: Academic Dishonesty; Dental Students; Attitude

Dear Editor,

Academic integrity is an essential component of professional formation in health sciences education. In dentistry, academic dishonesty is of particular concern as students' progress from classroom learning to patient-based clinical responsibilities, where records, signatures, attendance, and treatment notes are linked to competence and patient care. The fundamental values of academic integrity—honesty, trust, fairness, respect, responsibility, and courage—are directly relevant to dental professionalism (1).

We wish to highlight findings from an analytical cross-sectional survey conducted in May 2023 among third- to sixth-year dental students at Zahedan Faculty of Dentistry, Zahedan University of Medical Sciences, Iran. A census approach was planned, and all eligible students were invited; 291 complete, anonymous, self-administered questionnaires were analyzed, corresponding to an 88% response rate. Only complete returned questionnaires were analyzed; because the survey was anonymous, respondents could not be compared with nonrespondents. The questionnaire was adapted from previously published dental education studies of cheating behaviors; during this process, its face and content relevance were evaluated in relation to examination, assignment, attendance, and clinical documentation contexts. It covered demographic characteristics, 13 item-level perceptions of wrongdoing, and self-reported misconduct, methods, motivations, and responses to peer cheating. Because the items represented heterogeneous behaviors rather than a single latent construct, no total score or internal consistency coefficient was calculated. Data were analyzed using descriptive statistics and Pearson's chi-square test, with $P < 0.05$ considered statistically significant; sparse subgroup findings were interpreted cautiously and were not regarded as stable subgroup estimates. The study was approved by the Ethics Committee of Zahedan University of Medical Sciences (IR.ZAUMS.REC.1402.092), and written informed consent was obtained.

Students' judgments of dishonest behaviors varied. Intentional falsification of treatment notes was most often rated as "very wrong" (61.8%), followed by taking an examination on behalf of a friend (49.5%) and forging an instructor's signature in a patient chart (43.3%). In contrast, asking students who had already taken an examination about its questions was rated as "not wrong" by 86.3% of participants. Unauthorized homework help was also frequently normalized: 70.0% considered giving such help "not wrong," and 72.0% considered receiving it "not wrong." Among students who responded to the cheating item (n = 291), 191 (65.6%) reported cheating at least once, whereas 100 (34.4%) did not. Self-reported cheating differed by academic year (P = 0.001): 28/60 third-year, 52/81 fourth-year, 51/78 fifth-year, and 60/72 sixth-year

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respondents reported cheating. The most frequently reported method involved asking other students. The main reasons were fear of failure and the desire to obtain better grades; these reasons differed by academic year (P = 0.003), with fear of failure becoming more prominent in the higher academic years. Reporting peer cheating was also associated with academic year (P = 0.001). No perception item was significantly associated with sex.

These findings are educationally important because they reveal a gap between students' recognition of severe clinical falsification and their tolerance of peer-assisted or assessment-related misconduct. Similar patterns have been reported in dental and health professions education, where students may perceive the sharing of examination information or unauthorized collaboration as socially acceptable rather than dishonest (2-5). Consistent with previous dental studies, our findings reinforce the observation that students often distinguish between serious clinical dishonesty and behaviors perceived as common, low-risk, or peer-supportive. This distinction may reflect assessment pressure, a low risk of detection, unclear collaboration rules, and a hidden curriculum in which repeated minor violations are normalized through peer norms or inconsistent enforcement.

Potential COVID-19-related educational disruptions should also be considered. Although this survey was conducted after the main pandemic restrictions, recent experiences with remote learning, altered assessment formats, and increased digital communication may have blurred the boundaries between legitimate collaboration and unauthorized assistance. Future studies should examine digital and post-pandemic forms of misconduct rather than focusing solely on traditional examination cheating.

Dental schools should address academic integrity as a longitudinal educational competency rather than relying solely on punitive rules. These efforts should include defining acceptable collaboration, discussing the integrity of clinical documentation before students begin patient care, designing assessments that reduce opportunities for misconduct, and establishing confidential and fair reporting and remediation pathways. Future intervention studies should evaluate structured integrity modules, honor-code or professionalism workshops, feedback based on clinical record audits, assessment redesign, and confidential reporting systems using outcomes such as perceived seriousness, self-reported cheating, reporting behavior, and documentation accuracy.

This study was limited by its single-center, cross-sectional design, reliance on self-reported data, inability to compare respondents with nonrespondents, absence of formal psychometric indices for the adapted item-level questionnaire, and potentially sparse cells in subgroup analyses. Nevertheless, the findings support targeted integrity education in dental curricula, particularly regarding peer-assisted misconduct, the sharing of examination information, and clinical documentation.

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