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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 regression coefficients of 1.324 ($p<0.01$) and 1.047 ($p<0.05$), 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 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 α = 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%, n=113), "question and answer sessions" (68%, n=110), and "sharing teaching materials" (62%, n=100). Meanwhile, 25% 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 46%, respectively).

Table 2. The status of students' participation in the experience of interactive techniques in E-learning

Experiences	Frequency (Percent)			
	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)	90 (28)	46 (55)

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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