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Original Article

The Applicability of Interactive Educational Applications Tailored to the Type, Nature, and Characteristics of Continuing Education Courses for General Practitioners

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Abstract

Background: Continuous education is essential for medical professionals to stay up to date. In this regard, new technologies such as appropriately designed applications tailored to the needs of the audience allow independent and high-quality learning beyond time and place restrictions for the employees. Therefore, the current study's aim was to investigate the appropriateness of interactive educational applications with the type, nature, and thematic features of the continuous education courses provided to physicians.

Objectives: The present research aimed to scrutinize the virtual CME courses held by the Shahid Beheshti University of Medical Sciences in 2018-2020. We categorized the topics of the courses based on their educational goals, content, and methods, as well as evaluation methods, and determined the applicability of using interactive educational applications for the subjects taught.

Methods: In this qualitative study, virtual continuous education courses held by the Shahid Beheshti University of Medical Sciences in 2018-2020 were examined. The data were collected by reviewing the statistics documented, scrutinizing the educational content and the characteristics of the platforms used during courses, conducting individual interviews, and holding focus group discussions with lecturers and physicians participating in these courses. Data coding, extraction, categorization, and analysis were held concomitant with each step.

Results: The educational courses were flexible in terms of accessibility and schedules. The most common subjects were related to clinical and non-specialized topics. The educational goals were mostly at low-cognitive and non-transparent levels, and the content was presented mostly in the form of audio non-interactive slides. The teaching method was mostly through lecturing, and evaluations were objective and summative. Low graphical attractiveness, poor toolbox, and poor user interactive interface were among the drawbacks of the education courses.

Conclusion: The use of interactive, appropriately designed applications tailored to the needs of the audience can resolve some of the shortcomings of conventional continuous educational courses and fulfill educational objectives at different levels. These applications provide the possibility of skillful and motivational training, as well as more proficiency, deeper learning, and higher satisfaction by creating a more attractive learning environment.

Keywords: Continuing Medical Education Courses, Educational Application, Thematic Features

Background

Regarding physicians' need for uninterrupted updating of their medical knowledge to provide better services to patients and guarantee professional achievements, it is highly important to pay attention to continuing professional education of doctors (1, 2).

According to the law of continuing education, all the members of the Iran Medical Council need to participate in continuing medical education (CME) programs since 1996 (3). However, the limitations of face-to-face training, such as physical space restrictions, shortcomings in infrastructure, transportation problems, and limitations in providing vacancies for large groups of participants, have led many doctors to decline participation in CME courses (4). The results of studies have shown that the quality and proficiency of the educational systems are among the most important developmental concerns of governments and decision-makers in every country. It is worth mentioning that holding educational courses alone cannot help organizations achieve their goals. In fact, CME can lead to the improvement of the quality of clinical care services only if appropriate teaching methods are used (5-7). A solution for this issue is to use novel technologies. The use of smart technology-based instruments and applications can facilitate doctors' access to CME courses. In this regard, interactive applications based on various educational media can perform better than text-based methods for delivering educational content (8-10). Studies have noted many advantages of e-learning educational methods, such as better access of the audience to the educational content, convenience, flexibility, reduced travel costs, saving time, adaptability to different learning styles, and the possibilities of using multimedia tools, reviewing the content, providing supplementary materials, dynamic updating of scientific content, and designing interactive case presentation scenarios (9-12).

Considering the aforementioned explanations, it is necessary to apply new and user-friendly technologies with wider accessibility to deliver educational courses, including CME programs. In order to develop interactive educational applications for delivering CME courses to doctors, we first need to identify and classify the topics for which appropriate interactive applications can be designed. For this purpose, the present research aimed to scrutinize the virtual CME courses held by the Shahid Beheshti University of Medical Sciences in 1397-1399. We categorized the topics of the courses based on their educational goals, content, and methods, as well as evaluation methods, and determined the applicability of using interactive educational applications for the subjects taught.

Objectives

The present research aimed to scrutinize the virtual CME courses held by the Shahid Beheshti University of Medical Sciences in 2018-2020. We categorized the topics of the courses based on their educational goals, content, and methods, as well as evaluation methods, and determined the applicability of using interactive educational applications for the subjects taught.

Methods

This qualitative study was conducted using a directed content analysis approach (13, 14) in 2021 at the CME site of Shahid Beheshti University of Medical Sciences. In order to design and develop interactive educational applications for the CME courses of doctors, we conducted a 3-step experiment to identify topics for which appropriate interactive applications could be designed.

As required by directional content analysis, we initially performed a review of overseas and domestic literature using the keywords and phrases of continuing education courses, educational applications, continuing education topics, etc. Relevant articles authored by Iranian or foreign researchers were extracted from validated databases, according to which a number of questions were raised to be asked during semi-structured interviews. These questions covered areas such as educational goals, educational content, teaching and learning methods, evaluation methods, and type of interaction, as well as the strengths and weaknesses of the virtual CME courses (Appendix 1) (5, 15-23).

In the second step, information such as the frequency and area of the CME topics provided to general practitioners between 2018 and 2020 were extracted from the university's CME website, and relevant educational documents and media were categorized. Then, the necessity and appropriateness of the subjects in terms of educational goals, educational content, teaching methods, and user environment were analyzed. For this purpose, 42 courses out of a total of 420 courses were chosen using the 10% sampling strategy. The researcher registered for these courses and completed them in order to be able to fill out the checklist of the research objectives. According to the study's objectives, this checklist included the type of disease, course name, educational goals, educational content, teaching-learning methods, evaluation methods, and the user environment (interactive tools) of the applications designed.

In the third step, individual interviews were conducted with CME specialists. In addition, two focused group discussion sessions were held with the participation of ten physicians selected by purposeful and snowball sampling methods. The interviews continued until they reached data saturation. The duration of individual interviews ranged between 40 and 50 minutes, and the focus group sessions lasted 90 minutes. The criteria for selecting an interviewee included having at least two years of experience in managing or preparing and teaching a training course.

For conducting the individual interviews, the time and place were arranged with the interviewee. Written informed consent was obtained to audio-record the interview, and after each interview, the recorded file was transcribed verbatim. Next, the recorded file was matched with the transcribed text. Every interview (either individual or focus group) was then summarized, coded, and finally categorized with regard to the objectives of the interview. Duplicated categories were identified in subsequent interviews. Finally, themes, categories, and their frequencies of mentioning were extracted and organized in seven dimensions (Table 1).

The data gathered during the literature review, reviewing documents and checklists related to courses, individual interviews, and focus group sessions were analyzed using MAXQDA software version 2010 (VERBI Software GmbH, Germany).

In order to ensure the reliability and accuracy of the qualitative data, the criteria of Lincoln and Guba, including reliability, verifiability, and transferability (15), were utilized. Credibility was achieved by long-term communication with the participants and prolonged engagement with the data through conducting in-depth interviews, as well as by reviewing the interview texts by the participants. Reliability was achieved via peer-reviewing by external reviewers. For this purpose, the texts of some of the interviews, along with the codes, categories, and themes extracted, were provided to three experts in the field of qualitative research (who were not members of this study's research team) to be verified.

Table 1. Themes Derived from Individual Interviews and Focus-group Sessions

Categories	Themes	Number of mentioning
Educational goals	Cognitive, such as education of diseases, therapeutic courses, patient care, pharmaceutical treatment, prescription writing	6
	Attitudinal, such as education on ethics and professionalism	4
	High-level cognitive goals (creative thinking and problem-solving), differential diagnoses of diseases, and clinical reasoning	4
Educational content	Educational videos are so attractive that they can establish an interaction between the content and learners.	3
	The platform allows the easy access of the content to learners.	5
	At the present time, most of the educational content is in the form of PowerPoint slides and podcasts.	6
	Educational content that consists of textbooks or long texts is inappropriate.	4
	Textual content and articles are better to be derived from reliable databases so that learners can be assured of their reliability.	3
	Educational games can be more attractive to learners.	1
	The educational content should be diverse to support different learning styles of learners.	1
	The educational content should provide feedback to learners so that an effective interaction can be established between the content and the learners.	2
Teaching-learning methods	Flipped classroom + online session is an excellent choice.	5
	Question and answer + online session is a key choice.	4
	Gamification should be used as an educational method.	1
	The educational content should initially be presented to the learners in the platform's environment, followed by concomitant webinar meetings and questions and answers to monitor the learning process.	4
Evaluation	The entrance exam and pre-exam should be considered.	3
	The discussion and case analysis methods should be used for evaluation.	3
	Attention should be paid to formative evaluation during the course based on measurable educational activities, such as doing homework and participating in non-simultaneous scientific discussions in the platform's environment.	4
	Online exams should be held to grant the certificate.	2
	In-person exams should be held to grant the certificate.	2

Type of interaction	Effective interactions should be established between learners and professors.	3
	Effective interactions should be established between the content and learners.	1
	Effective learner-learner interactions should be established.	2
	Constructive, immediate, and effective feedback should be provided by the instructor to learners' learning activities	2
Strengths	Flexibility of the courses, allowing the participation of a wide range of professionals	2
	The possibility of free access to educational content and self-regulated studying	5
	The possibility of asking questions at any time and receiving immediate feedback.	2
Weakness	The lack of effective professor-learner and learner-learner interactions during the course	4

For transferability, a complete description was provided for the background of the research, the process of participant selection, and the procedures used for data collection and analysis. Verifiability was confirmed through an audit trail for the research process and decisions.

Results

Four professors in the field of medical education participated in individual interviews, two of whom (50%) were full professors; one was an associate professor (25%), and the other was an assistant professor (25%). Two of the professors were male (50%), and the mean age of the participants was 49 ± 8 years.

In focus group sessions, 20 general practitioners participated, 55% (n=11) of whom were male and 45% (n=9) were female, and the means of age and work experience were (mean ± SD) 38 ± 5 and (mean ± SD) 7 ± 2 years, respectively.

The analysis and recapitulation of nine domestic articles and eight foreign articles revealed that online CME programs delivered via e-learning platforms were largely effective. The topics chosen for the courses were largely suited to the interests of the audience. The physicians preferred the afternoon and before dinner as the best time for participation in these courses, and most of them used mobile phones, and fewer used iPads to participate in the courses. Most of the doctors had a sincere commitment to accomplish the courses. Also, the quality of voice and the style of presentation were directly associated with the enthusiasm of doctors to attend the courses.

The review of the documents showed that a total of 546 face-to-face and virtual CME courses, some of which are still ongoing, were held by the Shahid Beheshti University of Medical Sciences over the two years under investigation. Out of these, 420 courses were completely virtual; 362 courses were held by clinical departments, and 58 courses were held by basic science departments (Tables 2 and 3).

In this study, 42 courses were selected by statistical sampling to investigate the trends and goals of the virtual CME courses held at the Shahid Beheshti University of Medical Sciences. Among the 420 virtual courses, according to statistical calculations, we projected three scenarios of 10% sampling for different situations, which led to the suggestion of sample sizes of 42, 80, and 59. According to our analyses, we selected the first scenario (i.e., the 10% sampling method that required a sample size of 42) (Appendix 2).

The reviewing of the documents showed that the educational goals of the courses had been defined at lower Bloom cognitive levels (i.e., knowledge, perception, and application). Only a few courses defined educational goals at the analytic level, and there were no courses focusing on higher-level objectives such as evaluation and synthesis. Objectives either were not mentioned or were verbally explained for some courses, indicating a low focus on educational goals (Table 4).

Reviewing the educational content of the CME courses revealed that most of them employed non-interactive lecture-based teaching using slides, and in most of them, the images and diagrams were fixed and inactive. Some of the courses included videos, but interactive tools such as Storyline had been employed uncommonly (Table 4).

Investigating the teaching and learning methods demonstrated that they were not diverse, and the most common methods included non-interactive lecturing, case studies, and questioning without the instructor's feedback. Some of the courses used problem-oriented methods by presenting a scenario, and at the end of some courses, a summary or conclusion was provided. In addition, some courses employed samples, key concepts, and content organization methods (Table 4).

Regarding the type of evaluation in the CME courses examined, all courses used the same evaluation method, which was based on the final exam.

Table 2. The Titles and Frequencies of Virtual Learning Courses Held in the Context of the Continuing Clinical Medical Education Program for General Practitioners at Shahid Beheshti University of Medical Sciences from 2018 to 2020

Department	The course's title	Frequency	Fields
Clinical departments (362 courses)	Internal	171	Internal (47), gastroenterology and endocrinology (17), rheumatology (7), neurology (14), lung (6), infectious diseases (33), allergy-immunology (6), pediatrics (33), pediatric infectious diseases (10), dermatology (5), psychiatry (11), psychology (7)
	Surgery	23	Surgery (8), orthopedics (7), neurology (8)
	Internal surgery	90	Nephrology (5), urology (7), otolaryngology (6), ophthalmology (5), obstetrics and gynecology (15), dentistry (4), cardiology (5), emergency medicine (43)
	Other	66	Radiology (4), anesthesiology (17), forensic medicine (35), sports medicine (3), physical medicine and rehabilitation (7)

Table 3. The Titles and Frequencies of Virtual Learning Courses Held in the Context of the Continuing Non-clinical Medical Education Program for General Practitioners at Shahid Beheshti University of Medical Sciences from 2018 to 2020

	The course's title	Frequency
Non-clinical departments (basic sciences, 58 courses)	Pharmacy	13
	Nutritional sciences	12
	Medical education	1
	Community health	12
	Health service management	5
	Occupational Medicine	5
	Health and disasters	5
	Medical ethics	5

The questions were answered on multiple random choice scales, requiring a minimum score of 70 out of 100 to pass the exam. The duration of the test was 30 minutes, and the maximum number of retesting was three times for each participant (Table 4).

Regarding the utilization of tools and software in the courses, most of the educational content had been presented in the form of videos and audio slides in the software environment, equipped with adequate and appropriate tools for changing the size of the window, moving forward, and backward, pausing, as well as tools such as eraser, lighter, outline, search, adjusting the volume and timeline, and note-making (Table 4). Table 4 summarizes five examples of the courses, but all 42 courses can be analyzed based on the criteria provided in this table.

The results of the third step of the study (a recapitulation of focus group sessions) showed that 40% of the content was about diseases such as COVID-19, cancers, eye diseases, and diabetes, and 30% of the courses were held virtually, enabling access to the course at any time and in any location. One advantage of virtual courses is their flexibility, allowing the participation of different professional groups, but a noteworthy drawback can be the lack of adequate interaction between the instructor and learners (Appendix 3).

The data from the interviews were organized into seven dimensions, including objectives, content, teaching methods, evaluation, type of interaction, strengths, and weaknesses. The views and concerns of the interviewees about the topics covered in CME courses were also outlined, and the themes intertwined with their needs and concerns were extracted to obtain more comprehensive findings (Appendix 4).

According to the main objective of the study, the CME courses were categorized based on their subjects to assess the applicability of interactive educational applications, the results of which have been shown schematically in Appendix 4.

Table 4. The Results of Analysis of 42 Virtual Clinical/Basic Science Continuing Medical Education Courses Provided to General Practitioners

Group	Title	Educational goals	Educational content	Teaching-learning methods	Evaluation	Tools
Ethics	Research ethics	Cognitive goals/knowledge ranking (verbal expression of goals)	Slide with audio files/non-interactive/no charts or tables/fixed images	Lecture/non-interactive, case presentation, questions and answers	A minimum score of 70/ time of 30 minutes/random and multiple-choice questions/test repetition for 3 times	Full screen/ stop button, forward and backward moving of slides/ marker tools (eraser, lighter, outline, search, volume, and timeline adjustment)
Cardiovascular diseases	Herbal medicines' effectiveness in the treatment of cardiovascular disorders	Cognitive goals/knowledge ranking (verbal expression of goals)	Slide with audio files/non-interactive/no charts or tables/fixed images	Lecture/non-interactive	A minimum score of 70/ time of 30 minutes/random and multiple-choice questions/test repetition for 3 times	Full screen/ stop button, forward and backward moving of slides/ marker tools (eraser, lighter, outline, search, and volume and timeline adjustment)
Urology	Etiology/symptoms and prevention of kidney stones in traditional medicine	Cognitive goals/knowledge ranking (verbal expression of goals)	Slide with audio files/non-interactive/ fixed images	Lecture/non-interactive	A minimum score of 70/ time of 30 minutes/random and multiple-choice questions/test repetition for 3 times	Full screen/ stop button, forward and backward moving of slides/ marker tools (eraser, lighter, outline, search, and volume and timeline adjustment)
Psychology	Active listening and empathy	Cognitive goals/knowledge ranking (verbal expression of goals)	Slide with audio files/non-interactive	Lecture/non-interactive, case presentation, questions and answers	A minimum score of 70/ time of 30 minutes/random and multiple-choice questions/test repetition for 3 times	Full screen/ stop button, forward and backward moving of slides/ marker tools (eraser, lighter, outline, search, and volume and timeline adjustment)
Dermatology	The basics of laser therapy for dermatologic disorders	Cognitive goals/knowledge ranking (verbal expression of goals)	Slide with audio files/non-interactive/ charts /fixed images	Lecture/non-interactive	No testing	Full screen/ stop button, forward and backward moving of slides/ marker tools (eraser, lighter, outline, search, and volume and timeline adjustment)

Discussion

Based on the results of the present study, CME courses had good accessibility, but their educational goals were mostly at low Bloom cognitive levels, and they mostly contained non-interactive content. In most cases, the teaching method chosen was through lecturing, while it was expected to use more interactive methods. Evaluations were objective and summative, while formative evaluation should be considered more frequently. In addition, educational platforms lacked appropriate graphical efficiency and user-friendly tools, which need to be improved.

The results of studies have confirmed that continuing education programs held online and via e-learning instruments are somehow more effective than traditional programs; nevertheless, the transformation of Iran's education system in parallel with technological advances takes place slowly due to the lack of the infrastructure required, as well as due to cultural barriers. The preferences of the audience, including duration, type of presentation, and evaluation methods, are deterministic in choosing the topics and features of CME courses, encouraging participants to favor virtual courses. This finding was in line with the report of Atai and Siamian, who investigated the role of virtual learning in holding CME courses during the COVID-19 pandemic (16). However, our observation was opposed to the results of a study by Wang *et al.*, who investigated the effectiveness of e-learning in CME among healthcare workers in China (17) and asserted that virtual learning was effective among healthcare staff but not for general practitioners, which could be due to the poor quality of educational content or choosing topics unmatched with the needs of the audience.

According to the results obtained, the educational content presented in virtual courses is longer available compared to that presented in face-to-face training courses, so physicians can register and complete these courses when they need to. This flexibility causes doctors to be more enthusiastic about virtual rather than in-person CME courses. This finding was consistent with the results of Sadeghi-Tabar *et al.*, who investigated various dimensions and components of CME based on blended learning (18).

The results of the present research showed that in most CME courses, general topics were offered to medical professionals, while specialized and challenging topics were avoided.

This can be probably due to the lack of appropriate software and hardware infrastructure and the unavailability of a user-friendly management platform allowing for constructive communication with the audience. This finding was in line with the results of Atai *et al.* (19), who studied the effectiveness of conventional CME methods.

In a study by Fani *et al.*, the challenges of virtual medical education were investigated, and the results suggested that virtual training methods might not be applicable to specialized and practical topics (20). This finding opposed the results of the present study, and this difference could be related to the type of educational content. On the other side, simulation and gamification can provide a safe and stress-free environment to facilitate learning and reinforce traditional education (21).

In most CME courses analyzed, there was no clear mention of the objectives, which is an important part of the courses. These courses mostly focus on low-level cognitive objectives. Experts, however, presume such goals to be the best for virtual CME courses if these courses address diseases and their treatments. Consistently, the results of Ammenwerth *et al.* approved this observation (22).

Our analysis showed that the educational content in the CME courses was mostly presented through audio slides and podcasts. This is while educational videos seem to be more effective for learners. In addition, the use of diverse content, such as simulators and educational games, can help exert deeper learning effects. Micro-educational content, despite having narrower objectives, can also help the audience learn more deeply. The results of studies by De Gagne *et al.* (23, 24), Gawlik *et al.* (25), Sozmen *et al.* (26), and Thillainadesan *et al.* (27) were also in line with our findings.

Overall, conventional teaching-learning methods more commonly use non-interactive techniques such as lectures. Although methods such as presenting clinical cases and scenarios and problem-solving techniques are also used, these methods use less interactive content. Experts suggested the use of not only non-simultaneous teaching methods but also simultaneous techniques such as reverse classes, which was consistent with the results of studies by Hradetzky *et al.* (3), Atai *et al.* (19), and Xiberta *et al.* (28).

In terms of interactions, the CME courses analyzed had low levels of interactions. This interaction was more focused on the engagement of the learner with the educational content through the tools offered by the

applications used to present the course. However, less attention was paid to other types of interactions, including the interaction of learners with the professors and their peers, as well as providing constructive feedback. Consistently, Momtazmanesh *et al.* (5), Longhini *et al.* (10), and Yeh *et al.* (29) reported similar findings; however, our observation opposed the results of Tehrani *et al.*, who assessed the perception of university professors from virtual learning and highlighted the low levels of interactions, inadequate motivations, and inefficient support in virtual learning (30), which can be due to the fact that the audience of virtual learning in the recent study were students.

Regarding evaluation, most CME courses were focused on multiple-choice final exams. Experts suggest using formative evaluation methods, such as taking a pre-test and using case-oriented methods, as well as paying attention to cheating prevention strategies. This observation agreed with the results of Cheong and Hsu (31), Ebrahimi *et al.* (32), and Eskanderzadeh *et al.* (33).

The strengths of the CME course held included the diversity of courses and their wide accessibility to learners. The most prominent limitation of these courses included the lack of effective interactions between learners and instructors.

Nowadays, most CME courses are held virtually, and clinical courses generally outnumber courses related to basic sciences. There is a need to revise the design of educational plans and reinforce technical infrastructure. The objectives of the courses were mainly at low and middle cognitive levels, with less attention being paid to higher cognitive levels, such as criticism, evaluation, or synthesis.

The use of e-learning tools can augment the active role of the learner, leading to more comprehensive learning. Therefore, it is suggested to renew technical infrastructure and empower instructors by familiarizing them with the fundamentals of designing virtual courses and technological infrastructures so that they can develop motivational, educational content.

One of the limitations we faced during conducting interviews and focus-group sessions was the poor cooperation of doctors due to their busy schedules. Also, parts of the research coincided with the COVID-19 outbreak that made accessibility to the audience difficult, requiring extensive efforts and prolonged time for making arrangements.

Conclusion

According to the results of the present study, the design and development of interactive applications can help deliver effective CME courses only if these applications are designed based on learners' requirements and possess suitable pedagogical features. These applications can obviate the drawbacks of the conventional methods used to deliver CME courses (e.g., low to medium cognitive levels) and allow for holding higher-level courses. On the other hand, the smart platforms of these applications enable effective education at skill-based and motivational levels. Moreover, because learners are offered numerous complex and multifaceted choices, they are expected to master problem-solving and decision-making skills through receiving feedback. Finally, these applications provide accessibility to educational courses anywhere and anytime, making them applicable for learners who cannot attend them. Moreover, the attractive learning environment encourages learners to actively participate in the course and experience more satisfaction and deeper and more meaningful learning.

Supplementary Material(s): is available here [To read supplementary materials, please refer to the journal website and open PDF/HTML].

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Appendix

Appendix 1. Themes Derived from Individual Interviews and Focus-group Sessions

	Interview questions
1	Can you recall the courses you conducted and the topics you covered in the last two years?
2	How many of these courses were conducted face-to-face, and how many were virtual?
3	In your opinion, what were the strengths of conducting virtual courses?
4	In your opinion, what were the weaknesses of conducting virtual courses?
5	Were you satisfied with the platform used for virtual education?
6	What additional features do you think the current virtual education platform needs to enhance the learning experience?
7	What types of educational subjects do you believe can be effectively presented in a virtual format?
8	What educational goals can be achieved in the virtual education space? (Note: Educational goals refer to cognitive, skill, and attitude objectives. For instance, can high-level cognitive goals like diagnosing and examining a specific disease be effectively presented virtually? Provide an example of virtual learning objectives.)
9	What types of content, such as educational videos, animations, podcasts, PowerPoint presentations, etc., did you use in virtual training programs?
10	How was this content delivered to the learners?
11	In your opinion, what other types of content could be employed to make virtual education more engaging for learners and facilitate their learning process?
12	Regarding content organization, do you believe all course material should be made available for learners to study at their own pace after the course starts? Alternatively, should content be arranged from simple to complex? Or, should no content be included, with references provided to encourage independent study?
13	How can the content be designed to enhance interaction between the learners and the course materials, promoting independent learning and communication with the content?
14	What teaching and learning methods did you employ in virtual training courses?
15	In your opinion, what are the most effective educational methods for designing applications? Should we focus on question-and-answer formats, problem-solving, pre-organizers, group discussions, flipped classrooms, presenting educational scenarios, clinical cases, summarization techniques, procedural demonstrations, using object generators, games, augmented and virtual reality, or other approaches?
16	Did the platform you used for virtual education facilitate interaction between students and between students and teachers?
17	What, in your view, are the key characteristics of an interactive application that can accommodate various types of interactions effectively?
18	What evaluation methods did you employ in your virtual continuing education program? Did you include formative evaluations such as self-evaluation, peer evaluation, procedural demonstrations, projects, individual and group assignments, and critiques of media, in addition to final evaluations like tests, with considerations for online formats such as multiple-choice, true/false, diagram completion, activities, projects, etc.?
19	What features should interactive software possess to facilitate effective learner evaluation?
20	In your field of expertise, [insert the field], what subjects do you believe are best presented through virtual training and application?
21	Considering all these factors, can you prioritize the most important topics in your training course based on the needs of the target group, particularly general practitioners?

Appendix 2. The Number of Examples of Specialized Courses in the Continuing Education Program Based on Different Scenarios

Row	Expertise	Program number	Scenario 1	Scenario 2	Scenario 3
			10% sample	10%sample with at least two programs from each specialty	10%sample with at least two programs from each specialty with 10 or more programs and one program from specialties with less than 10 programs
1	Internal	47	5	5	5
2	Emergency Medicine	43	4	4	4
3	Forensic Medicine	35	4	4	4
4	Children	30	3	4	4
5	Internal/Infectious	23	2	2	2
6	Anesthesia	17	2	2	2
7	Internal / Digestion and Glands	17	2	2	2
8	Obstetrics and Gynecology	15	2	2	2
9	Internal / Brain and Nerves	14	1	2	2
10	Medicine	13	1	2	2
11	Nutrition	12	1	2	2
12	Community Health	12	1	2	2
13	Psychiatry _	11	1	2	2
14	Pediatric Infectious	10	1	2	2
15	Neurosurgery	8	1	2	1
16	Surgery	8	1	2	1
17	Internal/Rheumatology	7	1	2	1
18	Psychology _	7	1	2	1
19	Physical Medicine and Rehabilitation	7	1	2	1
20	Orthopedics	7	1	2	1
21	Urology	7	1	2	1
22	Internal/Lung	٦	1	2	1
23	Allergy and Clinical Immunology	٦	1	2	1
24	Ear Nose and Throat	6	1	2	1
25	Internal Nephrology	5	1	2	1
26	Eye	5	1	2	1
27	Medical Ethics	5	1	2	1
28	Cardiovascular	5	1	2	1
29	Occupational Medicine	5	1	2	1
30	Skin	5	1	2	1
31	Services Management	5	1	2	1
32	Health in Disasters	5	1	2	1
33	Dental	4	0	2	1
34	Radiology	4	0	2	1
35	Sports Medicine	3	0	2	1
36	Medical Education	1	0	1	1
Total		420	42	80	59

Appendix 3. Summary of Focus Group Meetings

Questions	Summary of group interviews
Topics in the courses held in the last two years	Forty percent of the mentioned titles include diseases such as Covid19, cancer, influenza, eye diseases, diabetes, hypertension. - 10% of the topics on occupational medicine - 20%of the courses on ethics and professionalism training - 30%of the course in the form of practical workshops and skills training
The number of virtual courses	Thirty percent of all courses are virtual and most of the topics include cancer and viral diseases
Strengths of the courses held	Access to the course at any place and time, the flexibility of the course for the participation of a wide range of participants, the possibility of accessing the course content and studying with a self-regulation method (as a prominent feature that 4. people mentioned) depended on it
Weaknesses of virtual courses	The lack of effective interaction between professors and learners and learners with each other during the course, the possibility of holding a meeting at the same time and online interaction was low, and many meetings were satisfied only with content being placed in the system.
The level of satisfaction with the virtual platform	The level of satisfaction with the virtual continuing education system was average and there was a balance between the stated advantages and limitations.
Good features of a virtual platform	Having effective interaction between professors and learners and learners with each other, providing content in different formats, having space for group participation of learners, having homework modules or self-tests for formative evaluation.
Subjects that can be taught virtually	Theoretical topics in practical courses and workshops also include part of the content that can be presented in virtual form.
Objectives that can be taught virtually	Courses that have cognitive and attitudinal goals, for example, teaching diseases and how to treat or diagnose them. For attitudinal purposes, if it is possible to create meetings and discussion rooms, a more effective understanding of the subject will be obtained.
The type of content you use	Thirty percent of the content was PowerPoint with a text file, 20% of the content was a text file with an audio file, 30% of the content was a video file with a text file, 20% of the content was an animation with a text file.
How learners access content	The content was placed in the continuous education system of the university and the learners had access to the content through this way.
What other content can increase the appeal?	The content includes animation or content that has interaction between the learner and the content, for example, a story line file that determines the learning path for learners with different scenarios and feedback questions. Content including educational games can be more attractive for learners.
How is the content organized?	In order to organize more content, according to the goals of the course, the pre-considered content is placed in the system according to the sequence of educational goals, and the learners study it according to a specific schedule.
The feature of interactive content is inclusive content	Providing feedback to the learners, matching the content with the goals of the course, matching the content with the level of the learners, the content should have diverse learning styles.
Your virtual training method	The content should first be presented to the learners in the system environment and then the sessions should be held in the form of a webinar, and in the same way, questions and answers were done after the content was presented to follow up the learning.
What is the optimal virtual training method in an application?	Using the gamification method, using self-centered learning methods such as the flipped class, using the wiki as a collective wisdom.
Types of interaction in the course	The interaction between learners and professors of the course has been done through the system, but there was no effective interaction between learners and learners with the content.
Features of an interactive software	An interactive software should have three types of effective interaction including interaction between professors and learners, interaction between learners and interaction between learners and content.
Evaluation method used	60%face-to-face exam, 20% online exam, 20% formative evaluation
Desirable features of a software to help in evaluation	It has an entrance exam, presentation of goals and outcomes of the course, a clear evaluation path, self-examination during the course, immediate assignments, automatic feedback by the system.
What courses can be made virtual?	Courses that do not have practical goals and consequences, such as familiarity with diseases such as cancer, infectious diseases, etc.

Appendix 4. Thematic Classification and Features of Continuing Medical Education Courses Applicable to Be Presented Using E-Learning Applications

<table>
<tr><td>Courses</td><td colspan="2"></td></tr>
<tr><td>Specialized clinical courses</td><td colspan="2">Specialized non-clinical courses (basic sciences)</td></tr>
<tr><td colspan="3">Courses' topics</td></tr>
<tr><td colspan="3">Theoretical topics: All general and specialized theoretical topics in clinical and non-clinical fields can be presented through e-learning courses.</td></tr>
<tr><td colspan="3">Skill-based and process topics:
- Process and skill-based courses in which the desired processes or skills are not too complicated, and the trainee can learn them through educational games, puzzles, simulators, or augmented virtual reality technologies.
- Courses that require multistep and complex procedures or acquisition of more advanced skills require smart and complex technologies, so if these technologies are not available, such courses are not suggested to be held.
- Courses that require internships, especially at the patient's bedside, presence in the real environment, and communicating with the patient cannot be presented through virtual learning courses.</td></tr>
<tr><td colspan="3">Courses' objectives</td></tr>
<tr><td>All-level cognitive goals:
- Knowledge
- Perception
- Application
- Analysis
- Evaluation
- Synthesis</td><td>Psychomotor goals:
• Processes and skills with minimal complexity
• Processes and skills with fewer steps and dimensions
If advanced instruments and technologies are available, psychomotor goals with moderate complexity can also be considered.</td><td>Emotional-motivational goals:
Emotional-motivational goals are suitable for e-learning courses only when a variety of interactions and interactive tools are used and timely, constructive, and motivational feedback is provided.</td></tr>
<tr><td colspan="3">Courses' content features</td></tr>
<tr><td colspan="3">- Content with small components (i.e., microlearning) can cover a limited number of educational objectives.
- Content should be updated and obtained from new and valid sources.
- Single or multimedia and mixed content.
- Interactive and non-interactive content.
- Content obtained from various sources.
- Content generated by content management software
- Content with appropriate hierarchy and coherence
- UI & UX: content with a user-friendly interface, user guide, icons and indicators, adequate blank space, and suitable graphics and colors.
- Content with hyper-text and hyper-media
- The presence of highlight, note-taking, copy, cut, paste, timeline, etc. tools in the virtual environment is necessary for interactive content.</td></tr>
<tr><td colspan="3">Teaching-learning methods' features in courses</td></tr>
<tr><td colspan="3">- Active methods that can engage the learner with the teaching-learning process:
- Problem-solving
- Collaborative
- Questions and answers
- Using familiar cases and examples
- Inductive and deductive methods (considering the audience and the topic)
- Explorative methods
- Investigational and search-based methods
- Discussion and dialogue
- Focusing on projects occupying the minds of the learners
- Providing timely and constructive feedback
- Gamification of the learning process
- Guiding enthusiastic learners toward studying more resources through the facilitation process
- Team working with rotational leadership
- The presence of interactive and discussion tools such as forums, chat rooms, online classes, etc., simultaneously and non-simultaneously, can be largely helpful.</td></tr>
<tr><td colspan="3">Evaluation methods</td></tr>
<tr><td colspan="3">- Formative evaluation, including:
- Self-assessment
- Peer-assessment
- Assigning individual and group homework and projects
- Self-evaluation
- Multiple-choice final exam</td></tr>
<tr><td colspan="3">The features of tools and technologies used in courses</td></tr>
<tr><td colspan="3">- The list of titles</td></tr>
</table>

- Interactive tools:
- Interaction with the content
- Interaction with peers
- Interaction with the instructor
- Interaction with resources
- Marking and note-making tools
- Tools for controlling the speed, size of the page, marker, eraser/lighter, search box, outline
- Interactive and guiding tabs
- Reminders and alarms for important dates
- Advanced tools allowing performing procedures and skills, such as simulators and augmented virtual reality
- Smart platforms
- Interactive educational applications