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Research Article

# Medical Students' Satisfaction with a Web-based Training Module of Clinical Reasoning

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**Abstract**

**Background:** There is a paucity of literature regarding the medical students' perspectives on web-based training of clinical reasoning.

**Objectives:** This study aimed to describe the implementation of a web-based training course of clinical reasoning for medical students and to evaluate their satisfaction with the program.

**Methods:** This cross-sectional study was conducted at the Tehran University of Medical Sciences in 2018. Fifty internal medicine interns were consecutively enrolled. The study consisted of two phases. The first phase focused on the development of a web-based training module of clinical reasoning. The second focused on evaluating the trainee's satisfaction with the virtual course. The educational content of the program was prepared by an expert panel and incorporated in a web-based educational tool designed for virtual training purposes. The students' satisfaction with the virtual course was assessed using a questionnaire. Each item of the questionnaire was scored from 0 (0) to 1.5 (100). The content validity of the questionnaire determined by an expert panel, and its reliability was measured.

**Results:** The mean score of each item of the questionnaire ranged from 77.3 to 85.3 which showed that the participants agreed with the items of the questionnaire. Also, Cronbach's alpha coefficient was excellent in nine items of the questionnaire, good in four items, and acceptable in three items. The intraclass correlation coefficient was also estimated as 0.98.

**Conclusions:** The participants were satisfied with the web-based training tool for clinical reasoning, used in the present study. The developed questionnaire also showed good validity and reliability for the assessment of trainees' satisfaction with the web-based training module of clinical reasoning.

**Keywords:** Logic, Distance Education, Assessment, Medical Student

## Practical Points:

1. Considering the time constraints of face-to-face education methods in internship programs, it seems reasonable to implement electronic learning approaches to train clinical reasoning.
2. Application of multiple training media, course assessments, and feedback are among the important features of web-based programs for clinical reasoning.
3. According to the present results, the trainees were satisfied with the web-based training tool for clinical reasoning.

## Background

Independent medical practice is one of the major concerns in the early post-graduate employment of medical students (1). Some post-graduates believe that training in medical schools does not prepare them for their future role as independent clinicians (2). On the other hand, failure to solve actual clinical scenarios may have serious consequences, such as the patient's death (10). To overcome these pitfalls, training programs have been recently reassessed in medical faculties (3) to improve medical education and prepare clinicians with proper decision-making skills (4).

To improve the medical students' cognitive abilities and clinical reasoning skills, training, and assessment of medical courses have been considered (5). The diversity and complexity of clinical environments oblige instructors to improve the medical students' problem-solving

and clinical reasoning abilities (6). Generally, clinical reasoning is essential for all health professionals to make appropriate clinical decisions. Therefore, the promotion of medical skills training in medical universities has become a necessity worldwide (7, 8).

Medical education authorities emphasize the assessment of clinical reasoning in medical undergraduates (9, 10). Recently, there has been a growing interest in revising the educational content of medical courses for general practitioners by expanding clinical reasoning courses and assessments (11). Since skill training in an actual clinical environment may have multiple limitations, the importance of virtual training programs has been bolded (12). On the other hand, the rapid progress of information technologies in this era has changed the educational design and framework. To develop clinical reasoning courses, factual clinical scenarios are applied in simulation environments, using electronic learning programs (13). Today, technological evolution has resulted in the production of web-based educational programs for clinical reasoning training (14).

An internship is an engaging period for medical students, as they are involved in the patients' medical affairs during both day and night shifts. Considering the time constraints of face-to-face education in internship, it seems reasonable to implement electronic learning approaches to train clinical reasoning. Nevertheless, there is still a paucity of literature on the efficacy and significance of web-based virtual training for interns' clinical reasoning.

## Objectives

Considering the importance of clinical reasoning training and assessment, in this study, we aimed to implement a web-based training course of clinical reasoning for medical interns to increase their clinical reasoning skills and also to assess the trainees' satisfaction with the course.

## Methods

This cross-sectional study was conducted at Tehran University of Medical Sciences, Tehran, Iran, in 2018. Fifty internal medicine interns, with rotating shifts at a teaching hospital, were consecutively enrolled in the study. They participated in the program for one month and had access to the training course online anytime on any device.This study consisted of two phases. The first phase focused on developing a web-based training module for clinical reasoning, while the second phase focused on evaluating the trainees' satisfaction with the virtual course. The educational content of the course was prepared by an expert panel, consisting of two faculty members of the internal medicine department and two faculty members of the medical education department. The clinical reasoning scenarios presented factual clinical cases, with appropriate complexity for an undergraduate medical student.

The educational content included five scenarios related to internal medicine diseases, cardiology, rheumatology, nephrology, hematology, and gastroenterology. Three scenarios were designed, based on the Key Feature and Clinical Reasoning Problem approaches, and the other two scenarios were designed, based on the Puzzle format. The educational content also included the trainees' feedback and false choices in quizzes. The expert panel prepared the educational content in the form of slides and podcasts to introduce the clinical reasoning concept. The content was presented in a virtual course, which was accessible to the trainees prior to encountering the scenarios. The constructed content was uploaded on the Moodle website ("https://...moodlecloud.com").

The educational content was presented in a free web-based program with multiple educational properties. Educational media, including short clips, photos, podcasts, and slides could be uploaded to the program. The web-based program consisted of five quizzes, with scores ranging from 0 to 100. A 15-minute time limit was considered for each quiz, and the trainees could access the quizzes only once. A pilot study was also conducted among 20 trainees to define possible limitations, including web-based system bugs. To facilitate the program and complete the learning cycle, some of the educational content was revised, based on the trainee's primary feedback in the pilot study.

In the second phase, the trainees' satisfaction with the clinical reasoning course and method of learning (including the web-based software) was assessed. For this purpose, a questionnaire was designed by an expert panel in the following steps. In the first step, the expert panel reviewed the literature to determine the main domains for assessing satisfaction with a training module, including web-based training courses. In the second step, the content of the reviewed articles was extracted and analyzed to determine the key factors to be incorporated into the questionnaire. The panel also determined the format (e.g., simplicity and lack of redundancy), order (e.g., prioritizing important items at the beginning of the questionnaire), and a number of questions. An explanation of the aims of the questionnaire was added to the beginning of the survey. In the third step, the expert panel interviewed ten trainees, who participated in the pilot study to determine their demands when using the web-based program.

The questionnaire items were refined, based on the feedback from the pilot study. Finally, an initial draft of the questionnaire, containing 16 items rated on a four-point Likert scale, was prepared. The score of each item ranged from 0 (0%) to 1.5 (100%) in both surveys. If the participant strongly disagreed with the item, the score would be zero; if he/she disagreed with the item, the score would be 0.5 (33%); if he/she agreed with the item, the score would be 1 (66%); and if he/she strongly agreed with the item, the score would be 1.5 (100%).

Moreover, another expert panel evaluated the content validity of the questionnaire by reviewing the content. This panel consisted of three experts in medical education and two experts in informatics, who assessed the content quality regarding ambiguity, duplication, phrasing, and grading of items. The content validity ratio was estimated at 100%. The final version of the questionnaire was uploaded to the

program, and then, a web-based assessment of trainees' satisfaction with the educational program was performed twice during one week after the course.

Data were analyzed in SPSS Version 20 (Chicago, IL, USA). Quantitative variables are expressed as mean and standard deviation (SD). The test-retest reliability of the questionnaire was evaluated by measuring the internal consistency of the questionnaire, using Cronbach's alpha at 95% confidence interval (CI). The intraclass correlation coefficient was also calculated.

## Results

Fifty medical interns (21 males and 29 females) participated in this study. The age range of the interns was 24 to 27 years, and the response rate was 100%. In this survey, the range of quiz scores from one to five was 33-92, 31-97, 40-100, 42-94, and 7-100, respectively. Also, the mean (SD) of quiz scores from one to five was 68.15 (0.11), 73.42 (0.13), 74.74 (0.12), 74.07 (0.11), and 47.12 (0.17), respectively. The quiz scores in the virtual course are presented in Table 1.

**Table 1.** The distribution indices of the participants' scores in the virtual course quizzes

| Quiz (score range) | Minimum | Maximum | Mean | Standard deviation |
|---|---|---|---|---|
| Quiz 1 (0-100) | 33 | 92 | 68.15 | 0.11 |
| Quiz 2 (0-100) | 31 | 97 | 73.42 | 0.13 |
| Quiz 3 (0-100) | 40 | 100 | 74.74 | 0.12 |
| Quiz 4 (0-100) | 42 | 94 | 74.07 | 0.11 |
| Quiz 5 (0-100) | 7 | 100 | 47.12 | 0.17 |

The participants' lowest and highest mean (SD) scores of the questionnaire items were 1.16±0.49 (32, 77.3%) and 1.28±0.56 (37, 85.3%), respectively. The Cronbach's alpha coefficient of the items ranged from 0.69 to 0.98 The mean (SD) scores of the trainees in the first and second surveys are presented in Table 2. The reliability and Cronbach's alpha coefficient (95% CI) for each item of the questionnaire are shown in Table 2. The intraclass correlation coefficient was estimated at 0.98.

**Table 2.** The mean (standard deviation) scores of the participants in the first and second surveys and reliability assessment of the newly developed questionnaire

| Questionnaire items | First survey | | Second survey | | Cronbach's alpha (95% CI) |
|---|---|---|---|---|---|
| Application of the program is straightforward. | 1.16 | (0.7) | 1.16 | (0.7) | 96.80 (94.70-98.10) |
| I feel confused while using the program. | 1.18 | (0.75) | 1.21 | (0.77) | 97.10 (95.10-98.30) |
| I receive the necessary educational points by using the program. | 1.28 | (0.56) | 1.18 | (0.68) | 78.60 (66.20-86.80) |
| The examples presented in the program guide help me learn how to use the program. | 1.19 | (0.52) | 1.23 | (0.42) | 76.20 (62.70-85.30) |
| I easily find the data in the program. | 1.16 | (0.49) | 1.19 | (0.51) | 86.20 (77.60-91.60) |
| The data demonstrated in each page gives me enough information. | 1.16 | (0.49) | 1.16 | (0.49) | 98.40 (97.30-99.10) |
| The content of each page is packed and confusing for me. | 1.16 | (0.75) | 1.16 | (0.75) | 96.80 (94.70-98.10) |
| I clearly understand all the words used in the program. | 1.18 | (0.76) | 1.21 | (0.77) | 98.50 (97.50-99.10) |
| I am confused with the program. | 1.28 | (0.56) | 1.18 | (0.68) | 88.00 (79.6-92.90) |
| The program informs me about each activity and shows my location. | 1.19 | (0.52) | 1.23 | (0.42) | 86.50 (77.10-92.00) |
| The exit message is shown when terminating activity. | 1.16 | (0.49) | 1.19 | (0.51) | 92.60 (87.40-95.60) |
| I can easily find my requested information in the help section. | 1.16 | (0.49) | 1.19 | (0.39) | 84.80 (74.20-91.00) |
| I have access to the support section in every page. | 1.16 | (0.75) | 1.21 | (0.70) | 95.70 (92.70-97.50) |
| The program improves student-teacher interactions. | 1.19 | (0.52) | 1.21 | (0.52) | 94.80 (91.20-97.00) |
| The security of users is well preserved in the privacy section. | 1.16 | (0.49) | 1.21 | (0.41) | 69.30 (47.80-81.90) |
| I am generally satisfied with the virtual course. | 1.18 | (0.76) | 1.19 | (0.69) | 93.70 (89.30-96.30) |

If the participant strongly disagrees with the item, the score will be zero; if he/she disagrees with the item, the score will be 0.5; if he/she agrees with the item, the score will be 1; and if he/she strongly agrees with the item, the score will be 1.5.

## Discussion

The results of the present study showed that the majority of the participants were significantly satisfied with the virtual course of clinical reasoning. Our results regarding the trainees' satisfaction with the virtual clinical reasoning course are comparable with previous research. In line with our findings, a previous study showed that the application of virtual patient simulation improved the clinical reasoning skills of medical students compared to the traditional learning environment. Also, the students

showed a positive attitude toward the virtual method (15).

Moreover, the application of an immersive patient simulator caused a significant improvement in identifying the proper treatment after using a simulator by third-year medical students. The students described a high level of motivation while using the simulator (16). In this regard, Weiner et al. showed that Web-based Simulation of Patients (Web-SP) is a valuable tool for teaching clinical reasoning to undergraduate oral surgery trainees, as it improves the learning outcomes in comparison with traditional teaching alone. Besides, the students had a positive attitude toward the teaching method (17). In contrast to our study, which indicated the trainees' satisfaction with the virtual course, a previous study showed that virtual collaborative learning (VCL) was as effective as traditional problem-based learning (PBL) in improving the clinical reasoning skills; however, the trainees accepted VCL less than PBL (18). The differences in the results might be partly due to the nature of virtual programs.

To the best of our knowledge, this study presented the first web-based training program for clinical reasoning training at Tehran University of Medical Sciences. A similar web-based program was designed at Tabriz University of Medical Sciences, Tabriz, Iran. Nonetheless, the program used in the present study had some advantages over the mentioned program. First, we were able to upload media, including short clips and images of patients' examinations. Therefore, the trainees could conduct an actual patient assessment rather than merely using books and manuscripts, which undermines the importance of physical examination findings in a clinical setting. Second, the program used in the present study provided feedback for false choices and offered the trainees an opportunity to learn from their mistakes, which had significant educational impacts. In other words, while it was traditionally presumed that assessments only rate the trainees, the current perspective is that providing scientific feedback would increase the training effects (19).

In a previous study, the Lasater Clinical Judgment Rubric (LCJR) model was used to evaluate the nursing students' clinical reasoning skills during simulated patient care scenarios. It was concluded that students need feedback from faculty members throughout the training process to improve their self-appraisal (20). Therefore, the application of media related to clinical reasoning quizzes and appropriate feedback at the end of exams would be an effective approach to improve the training experience.

The web-based design of our program facilitated training and education, since the target population (interns) had on-call shifts, and therefore, had limitations for participation in the classes. In line with our study, the literature suggests the successful application of virtual methods for training clinical skills. In this regard, a web-based unfolding case strategy was used as an electronic learning tool to enhance and evaluate the clinical reasoning skills of medical students (21). Similarly, in a previous study, a research team developed a web-based tutorial environment to improve critical thinking (22).

Another group of researchers introduced a web-based multimedia platform to enhance intraoperative learning and develop clinical reasoning (23). They concluded that the operative video platform, implemented during a surgical clerkship, was independently associated with the improvement of clinical reasoning skills, clinical funds of knowledge, and overall assessment. Parallel to these findings, Badiyepeymaie et al. compared the WebQuest and team-based learning approaches in a mental health course and observed that the students' final scores were higher in the former approach than the latter (24). Meanwhile, a systematic review concluded that virtual reality used for laparoscopic surgery training improved learning in 74% of the included studies and was associated with a higher level of competence in medical practice in 87% of the reviewed articles (25).

In contrast to our study and the literature, a systematic review indicated the paucity of information on the effectiveness of high-fidelity human patient simulation manikins for teaching clinical reasoning skills to undergraduate nursing students (26). Generally, the prospects of virtual education are growing. There are some major factors that influence the success of virtual education. First, the trainers' familiarity with the optimal use of virtual learning facilities and their ability to apply technologies properly should be considered. Also, learner-related factors, including motivation, must be emphasized. Finally, the virtual tool characteristics need to be addressed. It is important to consider these points when comparing the effectiveness of virtual education with conventional methods.

In this study, we constructed and validated a web-based questionnaire for assessing the satisfaction of participants with the virtual educational program. According to our results, the newly developed questionnaire showed good validity and reliability. The calculated Cronbach's alpha was excellent in nine items of the questionnaire, good in four items, and acceptable in three items.

One limitation of this study was the lack of a control group; therefore, no comparisons could be made. We recommend further matched studies to compare the trainers' satisfaction with virtual training and conventional training methods of clinical reasoning skills. It is also recommended to revise the developed questionnaire, based on the feedback of upcoming studies, and assess its reliability in larger cohorts.

## Conclusion

The participants were satisfied with the web-based training tool for clinical reasoning. The newly developed questionnaire showed good validity and reliability for the assessment of trainee's satisfaction.

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