Original Article

Developing and Evaluating the Effect of an Educational Multimedia on Clinical Awareness of Students in Clinical Endodontics

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Abstract

Background and Aim: E-learning can enhance dental education by providing interactive multimedia content to bridge gaps between theory and clinical practice. This study aimed to develop and evaluate an educational multimedia for endodontics and assess its impact on students' clinical awareness and satisfaction.

Materials and Methods: An instructional multimedia demonstrating root canal treatment procedures was created and validated. Fourth-year dental students (n=35) completed pre- and post-exposure tests on practical endodontic knowledge. Exam scores were compared to the previous year's class receiving traditional instruction. A satisfaction survey also evaluated the multimedia. Data were analyzed using Shapiro- wilk test, paired- samples t-test, and one-sample t-test with SPSS 26 software.

Results: Post-exposure test scores (mean 16.5) were significantly higher than pre-exposure (mean 11.2, $p<0.01$). Current students outperformed previous-year peers on the exam (mean 14.1, $p<0.01$). Students expressed high satisfaction with the multimedia, rating it 3.23 out of 4 overall.

Conclusion: The endodontic multimedia improved students' clinical knowledge and satisfaction compared to traditional lecture-based learning. E-learning can effectively supplement dental curricula, with lessons from this study guiding impactful educational technology integration.

Key Words: Educational Multimedia, Clinical Awareness, Endodontics Education, Dental Students, E-learning, Clinical Knowledge Assessment

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Received: 12 Jan 2025
Accepted: 18 April 2025

➢ **Cite this article as:** Assadian H, Rezvani G, Yusefi Holagh F, Mohammed Fakhir Z. Developing and Evaluating the Effect of an Educational Multimedia on Clinical Awareness of Students in Clinical Endodontics. J Iran Dent Assoc. 2025; 37(1-2):1-8.

Introduction

Education and learning, especially in medical sciences comprises attainment of knowledge and dexterity as well as its use in practice. Such learning should be consistent and reproducible and have sufficient flexibility (1). Since educational needs are developing alongside advancements in educational technology, novel methods are required to meet students' growing educational needs regardless of time and place. Electronic Learning (E-Learning) could meet such needs to a great extent. E-learning comprises a set of various practical software and educational methods based on information

technology (hard discs, internet, intranet, and virtual university), that enables learning for any person, in any field, at any time, and in any place (2). On the other hand, E-learning can help bridge the gap between theory and practice in dental education by providing interactive multimedia content to demonstrate complex dental procedures. For example, video demonstrations with narration can show step-by-step instructions on cavity preparations, root canal treatments, crown preparations, etc. Animations and 3D models can also enhance understanding of anatomical structures, tooth morphology, and restorative techniques. E-learning allows students to review procedures at their own pace, practice hand-eye coordination skills, and receive feedback to refine their technique before working on patients (3). The versatility and repeatability of e-learning can supplement traditional lectures and preclinical lab sessions to develop students' clinical competencies (4).

In dentistry, learning process is influenced by a variety of factors such as the student, teacher, field of education, educational methods and resources, growing trend of educational technology, and E-learning (5). Among the medical sciences, dentistry is a technique-centered and skill-dependent science requiring novel educational procedures for its multifaceted instruction. Therefore, to teach required skills, it is necessary to benefit from updated educational methods that are reproducible and widely accessible. On the other hand, as dentistry has become increasingly complex and new methods and techniques have been proposed, the use of new educational methods, especially E-learning will be effective in its continuous and repeatable learning (4). Previous studies have shown that administration of E-learning establishes a desirable learning environment and provides learners with more learning opportunities, so that their learning is not limited to a certain time and class and therefore, less time and money is spent (6). Moreover, the students have the opportunity to use unlimited educational contents and resources based on their needs and without any stress; thus having a more self-regulated and continuous learning experience (7-9).

Numerous studies have proven an increase in the awareness and positive attitude of students after applying the E-learning (10-16) and researchers have concluded that, this kind of learning is beneficial due to its unique advantages such as dynamism, flexibility, repeatability (10, 14-16), reduction of costs and time (4, 17), students ' satisfaction (8, 18) and increasing their self-confidence (19, 20) in spite of some shortcomings associated with it regarding education, learning ,and retraining.

The COVID-19 pandemic necessitated major changes in e-learning for dental education. With restrictions on in-person learning, many dental schools rapidly transitioned didactic courses and some preclinical activities online (21). Both synchronous (live) and asynchronous (on-demand) e-learning has been widely adopted to continue delivering core curricula (4). Virtual simulations, augmented reality, and haptics technology have enabled remote psychomotor skills training (22). Dental educators have also leveraged videoconferencing for case-based seminars, faculty-student meetings, and even remote patient consultations (23). The pandemic has accelerated e-learning innovations and expanded its role in bridging gaps between theory and supervised clinical practice (24). Lessons from this experience can inform longer-term integration of technology-enhanced dental education

In the present study, an educational multimedia was developed for clinical endodontics and its effect on clinical and theoretical awareness of the students in their clinical endodontic course as well as their satisfaction with this method of learning was assessed.

Materials and Methods

This study received approval from the Research Ethics Committee of Shahed University, under the reference number IR.SHU.Dent.Res. 13980722. The research was conducted using human extracted teeth, ensuring adherence to ethical standards and guidelines. The approval process involved a thorough review of the

study's methodology, objectives, and potential impact, ensuring that all procedures were conducted in accordance with ethical principles. The use of human extracted teeth was considered essential for the accurate preparation of the educational multimedia.

In this semi-experimental and interventional study, an educational multimedia was developed and its effect on studentś awareness was assessed. The multimedia was created to enhance learning and eliminate limitations of traditional learning. Scientific content of educational multimedia was consisted of key points and practical guidelines applicable for pre-clinical and clinical endodontic courses for senior undergraduate dental students.

Initially, extracted human teeth were obtained from the participants referred to the Department of Oral and Maxillofacial Surgery in School of Dentistry, Shahed University, Tehran, Iran. Teeth with minimal or non-carious lesions and/ or resorptive defects, and normal root anatomy were selected for educational purposes. Several types of tooth were selected based on comprehensive educational program for preclinical endodontics including a maxillary central incisor, a maxillary canine, a mandibular central incisor, a mandibular first premolar, a mandibular first molar, and a maxillary first molar and were mounted in an acrylic block. To elucidate detailed changes during root canal preparation, a transparent block containing a curved canal was used to demonstrate preparation of curved canals. Records were taken using HD camera built in a Sony Xperia Z5 device. Access cavity preparations of all aforementioned tooth types, root canal instrumentation using step-back technique, preparation of root canal sealer, and obturation of root canal space using lateral compaction of gutta- percha were demonstrated and recorded. Pre-, intra-, and post-operative radiographs were also included. Videos, radiographs, and photographs were edited using EDIUS software (Grass Valley, Canada) along with recorded studio narrations to be used in instructional package.

The instructional multimedia package was finally prepared in 3 different sections including: 1) endodontic treatment of the maxillary central incisor, maxillary canine, mandibular central incisor, and maxillary premolar, 2) root canal preparation in a transparent curved canal, and 3) endodontic treatment of the maxillary and mandibular first molar teeth.

Content of developed endodontic educational multimedia was validated by faculty members of the Department of Endodontics in School of Dentistry at Shahed University.

A total number of 35 fourth-year dental students who had passed the final theoretical and the second clinical courses of endodontics were enrolled in this study. Effectiveness of developed multimedia was evaluated using two comprehensive written examinations based on content of the film, one before and the other after watching the package. The questions included in comprehensive examinations were asked at the level of knowledge application. Then, satisfaction of the students from their E-learning experience was also assessed.

Comprehensive endodontics exam included 20 practical and effective clinical questions about endodontics based on content of the multimedia package in a true/false format. The questions were systematically arranged and included items were about cavity preparation, root canal preparation, working length measurement; finding root canal orifices in multi-canalled teeth, various file motions during preparation, and ultimately root canal obturation. The questions of the two questionnaires were parallel and homogeneous in order to reduce test-retest error. Each correct answer earned one positive score and the scores ranged from 0 to 20.

The satisfaction survey of the study consisted of 10 questions as follows: 8 questions about evaluating quality of educational product, 1 question regarding the students' attitude toward E-learning, and 1 question about the students' satisfaction with the current method (holding sessions of the traditional education). The answers were scored from 1 to 4 as weak,

moderate, good, and excellent.

Descriptive statistics were used to present the findings. After assessing and confirming the normality of the data using the Shapiro-Wilk test, the data were analyzed using the paired-samples t-test to compare mean scores of pre- and post-exposure tests. For comparing the scores of the post-exposure test and the scores of students in previous year exams, who were not subjected to any E-learning packages (as the control group), the one-sample t-test was carried out. SPSS software, version 26 was used as the statistical tool for data analysis and the significant level was set at $\alpha=0.05$.

Results

Fig. 1 shows the mean scores of the students on the first (pre-exposure) and second (post-exposure) tests. As shown in Fig.1, higher scores were obtained in the post-exposure test ($P<0.001$).

Fig. 2 shows the mean scores of the students in the previous year (traditional education) and the current year (E-learning using educational multimedia). As shown in Fig.2, significantly higher scores were obtained in the current year ($P<0.001$).

A significant difference was found in the awareness level of students before and after watching the educational multimedia. Moreover, the exam scores of the students in the current year were significantly better compared to those of the previous year; and the students were highly satisfied. [Fig. 3]

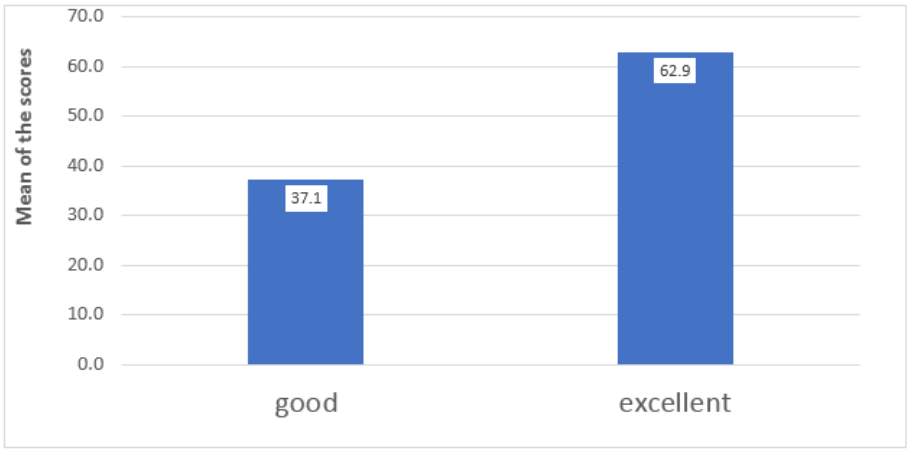

Fig. 1. Mean scores of the students on the pre- and post-exposure tests

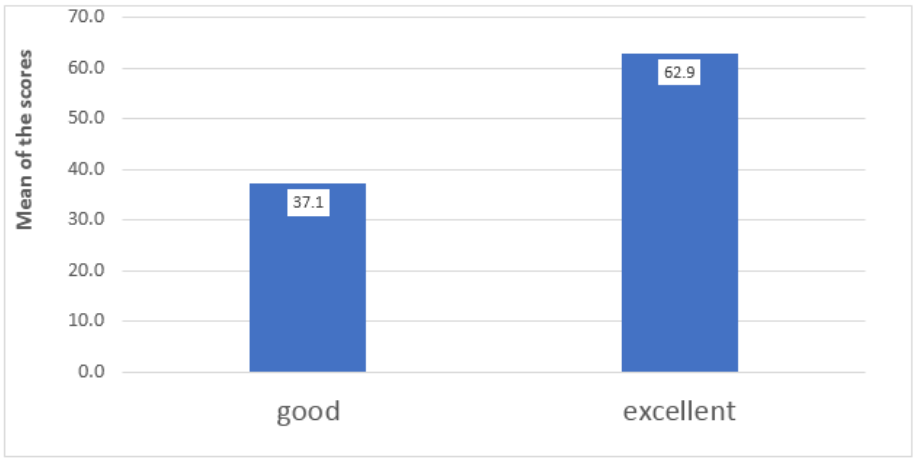

Fig. 2. Mean scores of the students on the previous and current year. The mean score of satisfaction with E-learning was equal to 3.23. The mean satisfaction survey score of 3.63 indicated that, the students were satisfied with combining both traditional and modern methods. Fig. 3 shows the frequency of answers given to related questions.

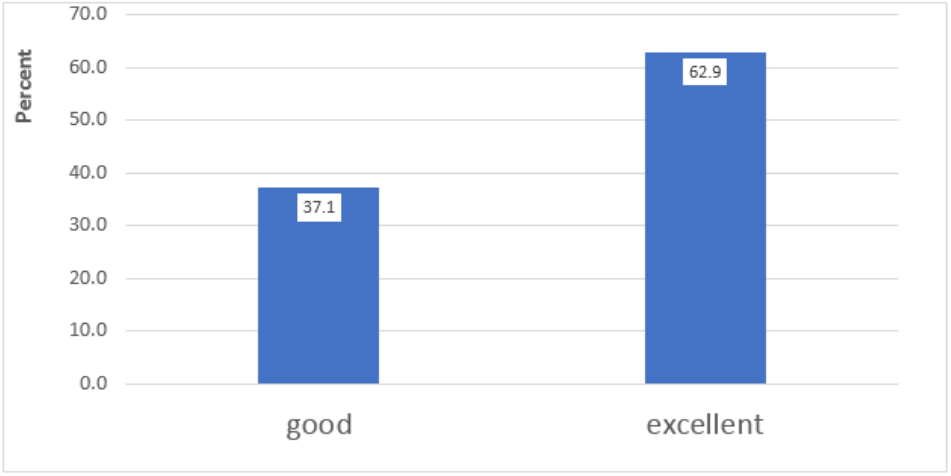

Fig. 3. Frequency of answers given to questions regarding satisfaction with two types of educational method

Discussion

The present study was conducted to assess the effect of novel educational technology on quality of 2 practical courses of endodontics for dentistry students. It was found that, the studentś awareness increased with respect to practical clinical points. Taking two parallel tests enabled the students to raise the questions in their minds while taking the first test. Since the questions were designed systematically, the studentś attention was drawn to useful and practical points while watching the film. Previous studies showed that, in traditional educational methods, memorized content has little permanence and they should be repeated for memorization (25). Moreover, teaching content in the form of lecture by the teacher does not necessarily mean that it has been learnt by the student. In fact, learning a skill and practicing it should last for a long time (20). E-learning meets the needs of students with various learning styles through different modes such as print, sound, image, film, and animation; in other words, in this method, the focus is on the learner (26). In the recent years, various studies have proven effectiveness of multimedia educational methods over traditional ones (27, 28), which is consistent with our findings.

Mean exam scores of the students in the current year increased compared to previous-year students. It seemed that, novelty of E-learning and its ability to cover studentś problems, had a positive effect on studentś knowledge. On the other hand, since students were not limited to certain time and class, they experience less stress and could learn in a more flexible environment (10). Clear summarization of content and the possibility to review could also be other factors that would have increased studentś knowledge in the E-learning program (28).

It was found that, the studentś satisfaction increased in the E-learning program. The studentś motivation positively increased after watching the film. This was in accordance with previous studies in which satisfaction was more obtained in E-learning approaches. (29-31) More than 62% of the students answered, “as excellent “to the question regarding the use of educational multimedia, an no one stated” weak “or “moderate responses. Novelty, attraction, and innovativeness of this method could have increased the studentś satisfaction with the E-learning approach. Factors such as flexibility, no limitations on time and place, sufficient visual field, reproducibility, freedom of action, and lower stress were also influential in increased knowledge gain of the students (30).

The COVID-19 pandemic necessitated rapid adaptation in dental education, with widespread transition to online learning modalities. Dental schools implemented virtual lectures, case discussions, preclinical skill training, and even remote patient consultations

via videoconferencing (3, 4). While this emergency remote teaching resolved immediate challenges, longer-term integration of technology-enhanced education can further bridge gaps between theory and clinical practice. The pandemic experience revealed the versatility of e-learning for delivering core content, developing psychomotor skills, and fostering clinical reasoning abilities (24). Lessons learned can guide dental schools in blending online and in-person instruction and expanding the role of simulations, virtual reality, and haptics technology. With thoughtful implementation, innovations emerging from the pandemic can enhance dental curricula and better prepare students for supervised patient care.

Production of an educational multimedia to demonstrate different stages of root canal treatment in the form of a CD handed to all the students, as a comprehensive educational package was the strength of the present study. However, the present study had several limitations. It focused on only two practical courses of endodontics for dentistry students, which may not be representative of the entire curriculum or other educational settings. Additionally, the study did not assess the long-term retention of knowledge and skills acquired through the e-learning program. Student satisfaction and motivation were measured through self-reported surveys, which could be subjective. The study did not address potential disparities in access to digital technology among students, which could affect the generalizability of the findings.

Expanding the study to include a broader range of courses and involving multiple educational institutions can enhance the generalizability of the findings. Conducting long-term follow-up studies to evaluate the retention of knowledge and skills acquired through e-learning programs will provide valuable insights into their effectiveness. Incorporating objective assessments, such as practical exams and clinical performance evaluations, will complement self-reported surveys and offer a more comprehensive understanding of learning outcomes. Exploring the integration of advanced technologies such as virtual reality (VR), augmented reality (AR), and haptics can further enhance the learning experience and simulate clinical scenarios. Addressing potential disparities in access to digital learning resources for all students, regardless of their socioeconomic background or technological proficiency, is crucial. Developing and evaluating blended learning models that combine online and in-person instruction can bridge the gap between theoretical knowledge and practical skills.

Conclusion

Findings of the present study revealed that, E-learning through educational multimedia could increase knowledge and satisfaction of the endodontics students in clinical endodontics compared to traditional lecture-based educational methods.

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