



# Using Edutainments in Teaching Orthodontic Lateral Cephalometric and Dental Cast Analysis

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## Abstract

**Background:** Many educators have developed an interest in an emerging new concept called entertainment education (edutainment). Edutainment is a kind of tool that, in this age of technology, can be easily incorporated into education.

**Objectives:** This study aimed to use edutainment for teaching orthodontic lateral cephalometric and dental cast analysis as well as to evaluate the dental students' attitudes towards it.

**Methods:** In this cross-sectional study, the multimedia-enhanced with edutainment was designed using Articulate Storyline version 3.5. To evaluate the students' attitudes, 52 ninth-semester dental students doing their second semester in 2019 - 2020 were included in the study. Then they were asked to complete a standard questionnaire with a 7-point Likert scale from strongly disagree to strongly agree and including 26 items in eight domains of perceived self-efficacy, perceived satisfaction, understanding usefulness, behavioral concept, e-learning system quality, interactive learning activities, e-learning effectiveness, and multimedia instructions. Data were analyzed and expressed using independent sample *t*-test, one-way ANOVA, and descriptive statistics.

**Results:** The majority of the students had positive attitudes towards the areas of perceived self-efficacy (83.3%), perceived satisfaction (90.4%), perceived usefulness (96.8%), behavioral intention (91.7%), e-learning system quality (75%), interactive learning activities (73.1%), e-learning effectiveness (88.5%), and multimedia education (85.3%).

**Conclusions:** In sum, the students' attitudes towards learning were positively and significantly influenced by the designed educational multimedia enhanced with edutainments to teach lateral cephalometric analysis in orthodontics. It was found that the application of edutainment as an educational tool together with traditional training may have been an effective method for teaching and, therefore, it was recommended that edutainment should be used as an alternative to traditional methods during crises such as the COVID-19 pandemic.

**Keywords:** Orthodontics, Education, Multimedia, Gamification

## 1. Background

Given the rapid advances in information and communication technologies, the traditional methods of training are no longer capable of fulfilling the educational needs of the new generation of students (1). Due to the recent development in information technology, newer tools and methods of education are required for transferring knowledge. In fact, the increasing availability of appropriate tools for e-learning has opened a new horizon for educational institutions. Thus, its integration into the current educational programs in universities is inevitable (2-4). Over the past few decades, e-learning for medical education and health promotion has rapidly developed due to the flexible bene-

fits of communication systems and various network flows (5). Moreover, the sudden outbreak of COVID-19 has posed many challenges to the world's healthcare systems and affected other areas, including education (6). Although the COVID-19 pandemic has created serious problems for all social indicators (e.g., public health), it has helped increase capabilities in the country by, for example, developing virtual training and providing greater access to social media and online learning resources for medical students (7, 8). Entertainment education (edutainment) is a kind of tool that, in this age of technology, can be easily incorporated into education (9). This instructional technology, which encourages active learning, might be the solution to re-

viving students' motivation, engagement, and interest (10, 11). Educational entertainment may include puzzles, video games, mime, animation, or any other activities that bring learners joy and astonishment while incorporating the information (9).

Multimedia offers educational and entertaining options based on communication and multimedia technologies. The conversion of narrative actions into visual representations is one of the most significant aspects of it (12). Multimedia refers to using a combination of different media, such as text, design, graphics, photos, audio, video, and animation, in order to convey a given message more effectively (13, 14).

According to cognitive theory, the application of multimedia with audio-visual elements (e.g., text and graphics) can facilitate active, inclusive learning (15). Moreover, it allows the student to have complete control over the content, time, and place of instruction (16). The freedom and control offered by video-based learning platforms, used in multimedia as well, makes it possible to enhance inclusive self-directed learning (15). Using educational multimedia (e.g., teaching procedures) through magnified images has been shown to improve students' learning, which is of particular importance for dental students. In addition, other multimedia features, such as the presentation of appropriate questions while presenting content and giving immediate feedback to students, can enhance student-content interaction and promote the student's learning by creating an interactive learning environment (15, 17, 18).

A systematic review investigating the most effective method of dental education for dental students compared to film-based education has indicated that using additional assistance tools (e.g., video-based education and computer-assisted learning (CAL)) improves students' performance. However, a limited number of studies have explored this area, and there is still a need for further studies to investigate the application of new technologies in education (19). One of the most important aspects of teaching medical students -dental students, in particular- is teaching them practical skills. Given the complexity of the required skills (e.g., manual, psychosocial, and practical clinical skills), it is extremely important to provide competence-oriented training in academic education (20, 21). A review study conducted by Patano et al. has found that e-learning is as effective as traditional education in the current conditions of the COVID-19 pandemic; however, the study has also highlighted the need for conducting further studies on the integration of e-learning into dental college teaching methods by, especially, giving most of the attention to teaching practical skills and clinical decisions (22).

## 2. Objectives

Given the growing need to use technology in the educational system, the present study aimed to use edutainments for teaching orthodontic lateral cephalometric and dental cast analysis as well as to evaluate the dental students' attitudes towards it.

## 3. Methods

In this descriptive and cross-sectional study, 52 ninth-semester students from Zanjan Dental School doing their second-grade practical orthodontic course during the second semester of the 2019 - 2020 academic year were included. The students were allowed to participate in the study only if they were willing to; all 52 students participated in the study on a voluntary basis and signed a written informed consent form. This study was approved by the ethics committee of Zanjan University of Medical Sciences with the code IR.ZUMS.REC.1398.468. Students withdrawing from the second-grade practical orthodontic course during the study, students from the previous semester already taking the second-grade practical orthodontic course but failing the course, and students unwilling to participate were excluded from this study.

To produce the required content, the topics for teaching were initially categorized by an orthodontist according to the curriculum of orthodontic practical courses and based on reliable and up-to-date orthodontic resources. The multimedia content included three sections: educational videos, questions, and educational games. Cephalometric analysis training videos were prepared and classified into five subsets of video films (i.e., vertical skeletal dimension analysis, posterior-anterior skeletal dimension analysis, dental analysis, soft tissue analysis, and tracing); then the dental cast analyses were prepared and classified into three subsets of video films (i.e., tooth size and arch length analysis, Bolton analysis, and orthometer use). In the questions section, four-choice questions with interactive feedback were designed and accompanied by a creative graphic environment and a two-dimensional animation; in the educational game section, the landmarks of lateral cephalometric image and dental cast analysis were designed and determined as two-dimensional simulation and graphic animation design. Articulate Storyline version 3.5 was used to design this educational content. Images of the animation and the game's graphic elements are shown in Figure 1.

The designed multimedia was presented to all 52 ninth-semester students doing their second-grade practical orthodontic course as convenient samples voluntarily



**Figure 1.** Images of the animation and game's graphic elements

participating in the present study. Since the students' education was only delivered virtually during the COVID-19 period, the content was presented virtually in the form of uploads on the university website for about three months.

A standard questionnaire developed by Liaw was used by the researchers to determine the students' attitudes (23). This questionnaire is graded based on a 7-point Likert scale ranging from strongly disagree to strongly agree and includes 26 items in eight domains: perceived self-efficacy (3 questions), perceived satisfaction (4 questions), understanding usefulness (3 questions), behavioral concept (3 questions), e-learning system quality (4 questions), interactive learning activities (3 questions), e-learning effectiveness (3 questions), and multimedia instructions (3 questions). Cronbach's alpha (0.97) indicated that its in-

ternal consistency of reliability was well-accepted (23). Demographic information in the questionnaire included age, gender, marital status, place of residence, and total grade point average. The questionnaire is based on the 3-TUM (three-tier Technology Use Model), which integrates multidisciplinary opinions such as motivation, social cognitive theory (SCT), theory of planned behavior (TPB), and technology acceptance model (TAM). It is also useful for determining students' perceived satisfaction, behavioral intentions, and the effectiveness of e-learning (23).

First, the translated questionnaire was given to five medical education specialists, and its content validity was approved by the experts; no question was eliminated (CVR 0.99). To measure the reliability of the questionnaire, Cronbach's alpha index of 0.88 was obtained. Statistical

analysis was performed using IBM SPSS Statistics, version 26 (IBM Corp, Chicago, IL, USA). Data analysis methods included the independent sample *t*-test, one-way ANOVA, and descriptive statistics.

#### 4. Results

A total of 52 ninth-semester students doing their second-grade practical orthodontic course were included in this study. The mean  $\pm$  SD age of the students volunteered for the study was  $23.92 \pm 2.27$ . Demographic data are shown in Table 1. The data distribution was examined using the Kolmogorov-Smirnov test; given the significance of the test result, it was concluded that the data distribution followed the normal distribution curve.

**Table 1.** Demographic and Baseline Data

Variables	No. (%)
<b>Gender</b>	
Male	20 (38.5)
Female	32 (61.5)
<b>Marital status</b>	
Single	45 (86.5)
Married	7 (13.5)
<b>Place of residence</b>	
Dormitory	19 (36.5)
Personal home	33 (63.5)
<b>Total grade point average</b>	
< 12	0 (0)
12 - 14	4 (7.7)
14 - 17	36 (69.2)
17 - 20	12 (23.1)

The students' positive attitudes about the domains of perceived self-efficacy, perceived satisfaction, perceived usefulness, behavioral intention, e-learning systems quality, interactive learning activities, e-learning effectiveness, and multimedia education were 83.3%, 90.4%, 96.8%, 91.7%, 75%, 73.1%, 88.5%, and 85.3%, respectively. The mean and standard deviation of different domains of the questionnaire are presented in Table 2.

The frequency (percent) reports for the items of the questionnaire are presented in Table 3.

The findings revealed that the student attitudes were not significantly associated with gender ( $P = 0.351$ ), marital status ( $P = 0.408$ ), place of residence ( $P = 0.837$ ), and total grade point average ( $P = 0.912$ ) in any of the aforementioned domains.

#### 5. Discussion

According to the results of the *t*-test and one-way ANOVA test, the attitudes of students were not significantly associated with gender, marital status, place of residence, and total grade point average ( $P$ -value  $> 0.05$ ) in all domains inquired by the questionnaire. The percentage of students with general positive attitudes was 85.3%.

Patano et al. reviewed 25 articles on the application of educational technology for teaching orthodontics and pediatric dentistry and assessed the students' admission in the results (22). They found that only seven articles used the Likert scale in the questionnaire, whereas the rest failed to use it. They also reported that all students responded positively to the application of online education, and only students investigated by six articles recommended using it as an aid to education rather than an alternative to the traditional method; this result was in line with our study result, suggesting a greater acceptance of e-learning (22).

In a study conducted by Liaw, the students' attitudes were evaluated using the reference tool also employed by the present study, and the results indicated that students had a moderate level of positive attitudes toward e-learning (23). The results also showed that although the students considered e-learning as a useful teaching aid, they were more concerned about the quality of the system, especially its interactive features (23). In the present study, unlike Liaw's study, a higher level of positive attitude was recorded for all 8 domains; however, a similar result was achieved by two studies regarding the domain of system quality, where the least satisfaction was observed, suggesting concerns about the interactive features and internet speed (23).

Institutions have been obliged by COVID-19 pandemic to immediately implement new teaching methods. Gamification is one of the newest approaches to education, whereby the participants in the learning process are encouraged to learn by creating a joyful and vibrant environment (24).

The benefits of gamification for medical education include the promotion of students' engagement during the instruction and the facilitation of the application of what is learned in the real world (25, 26). In this regard, the present study attempted to use the features of two-dimensional graphics and animation in an amazing and creative environment.

According to our study results, the students' opinions were not significantly associated with age and gender. According to studies similar to ours, moreover, there was no significant relationship between age and students' attitudes (27). However, a number of studies reported a sig-



**Table 2.** The Minimum, Maximum, Mean, and Standard Deviation for Each Questionnaire's Domains

Questionnaire's Domains	Minimum	Maximum	Mean $\pm$ Standard Deviation
Perceived self-efficacy	6.00	21.00	15.96 $\pm$ 3.35
Perceived satisfaction	14.00	28.00	22.02 $\pm$ 3.53
Perceived usefulness	13.00	21.00	17.29 $\pm$ 2.29
Behavioral intention	3.00	21.00	16.40 $\pm$ 3.00
E-learning system quality	4.00	28.00	19.67 $\pm$ 4.47
Interactive learning activities	8.00	21.00	15.40 $\pm$ 3.42
E-learning effectiveness	12.00	21.00	16.81 $\pm$ 2.75
Multimedia instruction	9.00	21.00	16.38 $\pm$ 2.46

nificant relationship in this regard (28, 29).

According to Khajeali et al., the learners become adequately prepared for a high-risk exam if a low-risk and user-friendly examination causing a moderate degree of stress is designed (30). Therefore, a low-risk test was developed in the current study by employing edutainments.

In a study by Bovermann et al., 32 individuals were included in an online survey, and eight students were interviewed (31). In the given study, a significant positive association was detected between the self-reported attitudes toward gaming and the dimension of coping with study-satisfaction. Furthermore, a great acceptance of the implemented gamification concept was found using badges and progress bars, and the students were determined to be motivated and satisfied by the gamified learning environment (31). These results were consistent with our study results, suggesting a 96.8% satisfaction rate for students' perceived usefulness.

Lin demonstrated that the students' learning attitudes were positively influenced by the perceived learning ease, enjoyment, and practical knowledge and that the curriculums incorporating gaming may have improved students' attitude toward learning (32), which were consistent with our study results.

Similar to our study, the study by Alizadeh et al. found that students showed positive reactions to the instruction and course (33). Chen and Tat Yao revealed that only the design dimension was a critical factor influencing e-learner satisfaction (34). Our study concluded that the design dimension, according to the younger generation, was the most important factor contributing to the given generation's study satisfaction. Thus, it may have been more strategic for institutions to pay careful attention to the design domain when implementing e-learning, especially young learners (34).

One of the limitations of this study was imposed by its type since it was impossible to conduct face-to-face training and compare it with virtual training due to the COVID-

19 pandemic. Another limitation of the present study was imposed by its small sample size; therefore, it was suggested that future studies with a larger statistical population should be carried out to investigate face-to-face training and compare it with virtual training. It was also recommended that the application of three-dimensional animation and graphics should be included in future studies.

### 5.1. Conclusions

It was concluded that the students' attitudes towards learning were positively and significantly influenced by the designed educational multimedia enhanced with edutainments to teach lateral cephalometric analysis in orthodontics. It was found that the application of edutainment as an educational tool together with traditional training may have been an effective method for teaching; therefore, it was recommended that edutainment should be used as an alternative to traditional methods during crises such as the COVID-19 pandemic.

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### Footnotes

**Authors' Contribution:** Study concept and design: A. N.; acquisition of data: N. R., and F. D.; analysis and interpretation of data: N. R., F. D., and F. K.; drafting of the manuscript: A. N.; critical revision of the manuscript for important intellectual content: A. N., R. N., and F. K.; statistical analysis: F. K.

**Table 3.** Attitudes of Students Toward the Designed E-Learning Content <sup>a</sup>

Items	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
<b>Perceived Self-efficacy</b>							
1. I feel confident using the e-learning system	0 (0.0)	2 (3.8)	3 (5.8)	1 (1.9)	22 (42.3)	13 (25)	11 (21.2)
2. I feel confident operating e-learning functions	0 (0.0)	1 (1.9)	3 (5.8)	4 (7.7)	21 (40.4)	13 (25)	10 (19.2)
3. I feel confident using online learning contents	0 (0.0)	1 (1.9)	5 (9.6)	6 (11.5)	21 (40.4)	11 (21.2)	8 (15.4)
<b>Perceived Satisfaction</b>							
4. I am satisfied with using e-learning as a learning assisted tool	0 (0.0)	0 (0.0)	3 (5.8)	1 (1.9)	22 (42.3)	13 (25)	13 (25)
5. I am satisfied with using e-learning functions	0 (0.0)	0 (0.0)	2 (3.8)	4 (7.7)	23 (44.2)	13 (25)	10 (19.2)
6. I am satisfied with learning contents	0 (0.0)	1 (1.9)	4 (7.7)	3 (5.8)	24 (46.2)	12 (23.1)	8 (15.4)
7. I am satisfied with multimedia instruction	0 (0.0)	0 (0.0)	1 (1.9)	1 (1.9)	25 (48.1)	13 (25)	12 (23.1)
<b>Perceived Usefulness</b>							
8. I believe e-learning contents are informative	0 (0.0)	0 (0.0)	0 (0.0)	2 (3.8)	21 (40.4)	18 (34.6)	11 (21.2)
9. I believe e-learning is a useful learning tool	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.9)	23 (44.2)	17 (32.7)	11 (21.2)
10. I believe e-learning contents are useful	0 (0.0)	0 (0.0)	0 (0.0)	2 (3.8)	18 (34.6)	19 (36.5)	13 (25)
<b>Behavioral Intention</b>							
11. I intend to use e-learning to assist my learning	1 (1.9)	0 (0.0)	1 (1.9)	0 (0.0)	22 (42.3)	16 (30.8)	12 (23.1)
12. I intend to use e-learning content to assist my learning	1 (1.9)	0 (0.0)	0 (0.0)	0 (0.0)	20 (38.5)	21 (40.4)	10 (19.2)
13. I intend to use e-learning as an autonomous learning tool	3 (5.8)	4 (7.7)	1 (1.9)	2 (3.8)	21 (40.4)	12 (23.1)	9 (17.3)
<b>E-learning System Quality</b>							
14. I am satisfied with e-learning functions	1 (1.9)	0 (0.0)	2 (3.8)	2 (3.8)	26 (50)	12 (23.1)	9 (17.3)
15. I am satisfied the Internet speed	6 (11.5)	10 (19.2)	14 (26.9)	0 (0.0)	8 (15.4)	9 (17.3)	5 (9.6)
16. I am satisfied with e-learning content	1 (1.9)	0 (0.0)	3 (5.8)	2 (3.8)	25 (48.1)	11 (21.2)	10 (19.2)
17. I am satisfied with e-learning interaction	2 (3.8)	2 (3.8)	2 (3.8)	5 (9.6)	18 (34.6)	16 (30.8)	7 (13.5)
<b>Interactive Learning Activities</b>							
18. I would like to share my e-learning experience	1 (1.9)	0 (0.0)	1 (1.9)	11 (21.2)	18 (34.6)	12 (23.1)	9 (17.3)
19. I believe e-learning can assist teacher-learner interaction	1 (1.9)	1 (1.9)	4 (7.7)	8 (15.4)	15 (28.8)	15 (28.8)	8 (15.4)
20. I believe e-learning can assist learner-learner interaction	1 (1.9)	1 (1.9)	7 (13.5)	6 (11.5)	17 (32.7)	13 (25)	7 (13.5)
<b>E-learning Effectiveness</b>							
21. I believe e-learning can assist learning efficiency	0 (0.0)	0 (0.0)	2 (3.8)	4 (7.7)	18 (34.6)	15 (28.8)	13 (25)
22. I believe e-learning can assist learning performance	0 (0.0)	0 (0.0)	0 (0.0)	2 (3.8)	23 (44.2)	15 (28.8)	12 (23.1)
23. I believe e-learning can assist learning motivation	0 (0.0)	1 (1.9)	0 (0.0)	9 (17.3)	18 (34.6)	12 (23.1)	12 (23.1)
<b>Multimedia Instruction</b>							
24. I like to use voice media instruction	0 (0.0)	0 (0.0)	3 (5.8)	10 (19.2)	18 (34.6)	16 (30.8)	5 (9.6)
25. I like to use video media instruction	0 (0.0)	0 (0.0)	1 (1.9)	3 (5.8)	20 (38.5)	19 (36.5)	9 (17.3)
26. I like to use multimedia instruction	0 (0.0)	0 (0.0)	1 (1.9)	5 (9.6)	18 (34.6)	19 (36.5)	9 (17.3)

<sup>a</sup> Values are expressed as No. (%).

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**Ethical Approval:** This study was approved by the ethics committee of Zanjan University of Medical Sciences with the code [IR.ZUMS.REC.1398.468](#).

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**Informed Consent:** Students participated in the study on a voluntary basis and signed a written informed consent form.

## References

- Eckleberry-Hunt J, Tucciarone J. The challenges and opportunities of teaching "generation y". *J Grad Med Educ*. 2011;3(4):458-61. [PubMed ID: [23205190](#)]. [PubMed Central ID: [PMC3244307](#)]. <https://doi.org/10.4300/JGME-03-04-15>.
- Hendricson WD. Changes in educational methodologies in predoctoral dental education: finding the perfect intersection. *J Dent Educ*. 2012;76(1):118-41. [PubMed ID: [22262556](#)].
- Rao GKL, Iskandar YHP, Mokhtar N. Understanding the nuances of E-learning in orthodontic education. *Educ Inf Technol*. 2019;25(1):307-28. <https://doi.org/10.1007/s10639-019-09976-2>.
- Silva CC, Toledo SL, Silveira PS, Carvalho CR. Evaluation of a multimedia online tool for teaching bronchial hygiene to physical therapy students. *Rev Bras Fisioter*. 2012;16(1):68-73. [PubMed ID: [22441231](#)]. <https://doi.org/10.1590/s1413-35552012000100012>.
- O'Doherty D, Dromey M, Loughheed J, Hannigan A, Last J, McGrath D. Barriers and solutions to online learning in medical education - an integrative review. *BMC Med Educ*. 2018;18(1):130. [PubMed ID: [29880045](#)]. [PubMed Central ID: [PMC5992716](#)]. <https://doi.org/10.1186/s12909-018-1240-0>.
- Mian A, Khan S. Medical education during pandemics: a UK perspective. *BMC Med*. 2020;18(1):100. [PubMed ID: [32268900](#)]. [PubMed Central ID: [PMC714929](#)]. <https://doi.org/10.1186/s12916-020-01577-y>.
- Ahmady S, Kallestrup P, Sadoughi MM, Katibeh M, Kalantarion M, Amini M, et al. Distance learning strategies in medical education during COVID-19: A systematic review. *J Educ Health Promot*. 2021;10:421. [PubMed ID: [35071627](#)]. [PubMed Central ID: [PMC8719547](#)]. [https://doi.org/10.4103/jehp.jehp\\_318\\_21](https://doi.org/10.4103/jehp.jehp_318_21).
- Ahmed H, Allaf M, Elghazaly H. COVID-19 and medical education. *Lancet Infect Dis*. 2020;20(7):777-8. [PubMed ID: [32213335](#)]. [PubMed Central ID: [PMC7270510](#)]. [https://doi.org/10.1016/S1473-3099\(20\)30226-7](https://doi.org/10.1016/S1473-3099(20)30226-7).
- Mehrotra P. Edutainment in dental curriculum-A systematic review. *J Oral Biol Craniofac Res*. 2020;10(4):417-21. [PubMed ID: [32775185](#)]. [PubMed Central ID: [PMC7403770](#)]. <https://doi.org/10.1016/j.jobcr.2020.07.016>.
- Luchi KC, Montrezor LH, Marcondes FK. Effect of an educational game on university students' learning about action potentials. *Adv Physiol Educ*. 2017;41(2):222-30. [PubMed ID: [28377436](#)]. <https://doi.org/10.1152/advan.00146.2016>.
- Cortright RN, Lujan HL, Blumberg AJ, Cox JH, DiCarlo SE. Higher levels of intrinsic motivation are related to higher levels of class performance for male but not female students. *Adv Physiol Educ*. 2013;37(3):227-32. [PubMed ID: [24022768](#)]. <https://doi.org/10.1152/advan.00018.2013>.
- Karime A, Hossain MA, El Saddik A, Gueaieb W. A multimedia-driven ambient edutainment system for the young children. *MM08: ACM Multimedia Conference 2008*. Vancouver, Canada. 2008. p. 57-64.
- Savage TM, Vogel KE. *An introduction to digital multimedia*. 2nd ed. Burlington, USA: Jones & Bartlett Publishers; 2013.
- Ilhan GO, Oruc S. Effect of the Use of Multimedia on Students' Performance: A Case Study of Social Studies Class. *Educ Res Rev*. 2016;11(8):877-82.
- Yuen M, Koo A, Woods PC. Online Video for Self-Directed Learning in Digital Animation. *Turkish Online J Educ Technol*. 2018;17(3):91-103.
- Aly M, Willems G, Carels C, Elen J. Instructional multimedia programs for self-directed learning in undergraduate and postgraduate training in orthodontics. *Eur J Dent Educ*. 2003;7(1):20-6. [PubMed ID: [12542685](#)]. <https://doi.org/10.1034/j.1600-0579.2003.00263.x>.
- Fakhry A, Cooper S, Slach N, Krenz S. Video-assisted clinical instruction in dentistry. Overview and applications. *Eur J Dent Educ*. 2007;11(4):230-7. [PubMed ID: [17935563](#)]. <https://doi.org/10.1111/j.1600-0579.2007.00461.x>.
- Fakhry A, Dehkordi-Vakil FH. Video-Assisted Clinical Instruction in Dentistry (VACID) enhances real-time visualisation of clinical procedures. *Eur J Dent Educ*. 2007;11(4):238-44. [PubMed ID: [17935564](#)]. <https://doi.org/10.1111/j.1600-0579.2007.00465.x>.
- Gopinath V, Nallaswamy D. A systematic review on the most effective method teaching dentistry to dental students compared to video based learning. *Am J Educ Res*. 2017;5(1):63-8.
- Goodwin J. The importance of clinical skills. *Bmj*. 1995;310(6990):1281-2. [PubMed ID: [7773033](#)]. [PubMed Central ID: [PMC2549673](#)]. <https://doi.org/10.1136/bmj.310.6990.1281>.
- Hoefler SH, Sterz J, Bender B, Stefanescu MC, Theis M, Walcher F, et al. Conveying practical clinical skills with the help of teaching associates-a randomised trial with focus on the long term learning retention. *BMC Med Educ*. 2017;17(1):65. [PubMed ID: [28351359](#)]. [PubMed Central ID: [PMC5371235](#)]. <https://doi.org/10.1186/s12909-017-0892-5>.
- Patano A, Cirulli N, Beretta M, Plantamura P, Inchingolo AD, Inchingolo AM, et al. Education Technology in Orthodontics and Paediatric Dentistry during the COVID-19 Pandemic: A Systematic Review. *Int J Environ Res Public Health*. 2021;18(11). [PubMed ID: [34199882](#)]. [PubMed Central ID: [PMC8200064](#)]. <https://doi.org/10.3390/ijerph18116056>.
- Liaw S. Investigating students' perceived satisfaction, behavioral intention, and effectiveness of e-learning: A case study of the Blackboard system. *Comput Educ*. 2008;51(2):864-73. <https://doi.org/10.1016/j.compedu.2007.09.005>.
- Zarzycka-Piskorz E. Kahoot it or not? Can games be motivating in learning grammar? *Teach Engl Technol*. 2016;16(3):17-36.
- Lee JJ, Hammer J. Gamification in education: What, how, why bother? *Academic exchange quarterly*. 2011;15(2):146.
- Bigdeli S, Kaufman D. Digital games in health professions education: Advantages, disadvantages, and game engagement factors. *Med J Islam Repub Iran*. 2017;31:117. [PubMed ID: [29951418](#)]. [PubMed Central ID: [PMC6014762](#)]. <https://doi.org/10.14196/mjiri.31.117>.
- Chu R. How family support and Internet self-efficacy influence the effects of e-learning among higher aged adults - Analyses of gender and age differences. *Comput Educ*. 2010;55(1):255-64. <https://doi.org/10.1016/j.compedu.2010.01.011>.
- Venkatesh VV, Morris MG, Ackerman PL. A Longitudinal Field Investigation of Gender Differences in Individual Technology Adoption Decision-Making Processes. *Organ Behav Hum Decis Process*. 2000;83(1):33-60. [PubMed ID: [10973782](#)]. <https://doi.org/10.1006/obhd.2000.2896>.
- Wang Y, Wu M, Wang HY. Investigating the determinants and age and gender differences in the acceptance of mobile learning. *Br J Educ Technol*. 2009;40(1):92-118. <https://doi.org/10.1111/j.1467-8535.2007.00809.x>.

30. Khajeali N, Amini M, Kalantarion M. Practical Solutions for designing gamification during COVID-19: Medical faculty member experience. *J Educ Health Promot.* 2022;**11**:282. [PubMed ID: 36325212]. [PubMed Central ID: PMC9621384]. [https://doi.org/10.4103/jehp.jehp\\_212\\_22](https://doi.org/10.4103/jehp.jehp_212_22).
31. Bovermann K, Weidlich J, Bastiaens T. Online learning readiness and attitudes towards gaming in gamified online learning – a mixed methods case study. *Int J Educ Technol High Educ.* 2018;**15**(1). <https://doi.org/10.1186/s41239-018-0107-0>.
32. Lin J. The Effects of Gamification Instruction on the Roles of Perceived Ease of Learning, Enjoyment, and Useful Knowledge toward Learning Attitude. *Turkish Online J Educ Technol.* 2022;**21**(2):81–91.
33. Alizadeh A, Sheikhi M, Vakili MM, Nourian A. Live demonstration versus multimedia: A comparison of two educational methods of orthodontic dental cast trimming. *J Adv Med Educ Prof.* 2022;**10**(2):120–5. [PubMed ID: 35434149]. [PubMed Central ID: PMC9005755]. <https://doi.org/10.30476/JAMP.2021.91561.1450>.
34. Chen WS, Tat Yao AY. An Empirical Evaluation of Critical Factors Influencing Learner Satisfaction in Blended Learning: A Pilot Study. *Univers J Educ Res.* 2016;**4**(7):1667–71. <https://doi.org/10.13189/ujer.2016.040719>.