Investigating the Application of New Technologies in Dental Education: A Systematic Review

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Abstract- Technology provides many opportunities in distance education in the field of dentistry, while the need to use the most appropriate educational methods is well defined. The purpose of this study was to investigate the application of new technologies in dental education. This study was a review study by undertaking PRISMA guidelines that were performed by reviewing relevant texts by searching the databases of PubMed, Springer link, ProQuest, Wiley Scopus, Science Direct, and Web of Science. Inclusion criteria included original and non-original articles related to the technology in dental education from 2016 to 2020. Finally, 23 studies were presented as the final sample of review, analysis, and results in the form of tables. Analysis of 23 studies showed that technologies such as digital simulation and Virtual Reality/Augmented Reality (VR/AR) combined with haptic technology could be very useful for teaching skills. Based on these studies, distance education 34.7% (n=8), dental technology 30.4% (n=7), VR & AR 17.3% (n=4), mobile learning8% (n=2), serious games 4% (n=1), and blended learning 4% (n=1) have been evaluated useful and effective in dental education. Technology offers many opportunities for teaching and learning solutions. Therefore, dental schools should use technology to support clinical and theoretical education. Digital assessment gadgets in restorative dentistry and dentures allow students to evaluate their performance in real time without direct surveillance.

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Introduction

Dental education plays an essential role in educating future generations of oral health professionals; with the emergence of new educational approaches and shaping its presentation, dental education will evolve and evolve over time (1). The history of dental education is marked by change and continuity. With the advancement of dental science and technology, education in dental practice has become more complex both in nature and method (2). Unprecedented innovations in this area have been made possible by reforms in information and communication technology and the increasing popularity of e-learning or online learning platforms (3). Planning and delivering dental education will also be influenced by numerous other factors, including demographic changes such as the age of the population. Critical thinking and problem-solving skills are essential skills that are developed through dental education. However, technology can be a useful and powerful tool and act as a lever for the development of education and learning in dentistry (1,2).

Use of Information Technology (IT) has a wide range in dentistry, in order to produce a working document for dental professors, IT could train and develop competencies to help dentists and dental students. IT offers added value to traditional teaching methods (4). Dental education is trying to use the methods of traditional teaching with technology advance technology balanced to meet the needs of an expanding curriculum.

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Creating distance learning technologies is one of the specific goals of dental education Students who are technologically savvy tend to have meaningful and efficient distance learning. Most preclinical training is devoted to the acquisition of psychomotor skills and methods of providing patient care, and simulation is an educational training tool used to acquire preclinical skills (5).

In response, dental schools and faculty members have launched many promising and useful research initiatives and projects (6). In today's world, education uses emerging technology to reach its goals. For example, a lot of training in dentistry, the visual nature of the images, and the guidelines are provided by the film in areas such as geriatric oral health, orthodontic, and quitting tobacco (7). Other technologies include laboratory simulation of preclinical and simulation of clinical cases. Probably the most well-known of these technologies is a Virtual Reality (VR) system for training in restorative dentistry (8). Studies show that students evaluate the technology faster than teach them, the same stage of performance, you arrive, practice, and practice more hours in the day and request evaluation more in any method or hours in the laboratory in the traditional (9). Three-dimensional (3D) Software is mainly used for teaching the anatomy of teeth for dental and dental hygiene predoctoral and is designed to help students. 3D Software uses an innovative approach, including stereoscopic 3D models of teeth, to help students understand 3D structures and their relationships (10). E-textbooks were another pioneering application in dental education. However, the move to e-books in general, and e-textbooks in particular, seems inevitable as an increasing amount of content is being transferred to digital format (11). In addition, the fan-tech mobile is also increasingly for use by researchers in the health sciences, including dentists, to educate students as well as advice and access to communication for the purposes of scientific research in support of patient treatment preferred you are (12). Also, Virtual PC technology for patients has several advantages such as flexibility of the space and speed for learning and teaching as well as a high degree of repeatability as it is cost-effective, standard, and a group of people could use it (13).

Conceptually, however, the use of IT in dental schools is only in its childhood Challenges and opportunities for IT for improving clinical care support training and research are very high (6). This research aimed to investigate the application of new technologies in dental education.

Materials and Methods

This study was a systematic review using library studies and literature review. The search strategy in this study is described in table 1. To extract and collect appropriate articles in the first step using keywords dental education and educational technology and dentistry and technology, In the database PubMed، springer link، Scopus، science direct، web of science، ProQuest as well as the search engine google scholar searched. Inclusion criteria include genuine and non-genuine articles related to dental education; articles published in the period 2016 to 2021. Articles that are in full text and in English. Criteria for exclusion of articles unrelated to the topic and articles that have been in the field of non-technology and dental. Then, the titles and abstracts of the articles were reviewed based on the inclusion criteria. The full texts of published articles were also reviewed. The two reviewers independently reviewed the articles and summarized the article information. At the end of the total of 200 retrieved studies, 23 studies were reviewed and analyzed. Diagram 1 shows the steps for selecting studies.

Table 1. Search Strategy

#1	Dentistry
#2	Technology
#3	Education, Dental OR Dental Education
#4	Technology, Educational OR Educational Technologies OR Technologies, Educational OR Instructional Technology OR Technology, Instructional OR Instructional Technologies OR Technologies, Instructional
#5	# 1 AND # 2 AND # 3 AND # 4

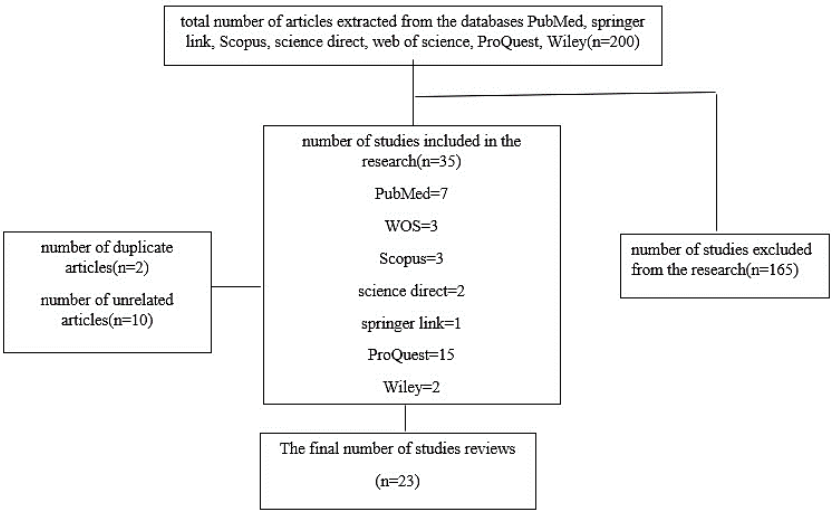

Diagram 1. Steps for selecting studies

Results

The review of 23 studies showed that studies of dental education had different purposes. Table 2 describes the objectives of the studies conducted in the field of dental education.

Based on these studies, distance education 34.7% (n=8), dental technology 30.4% (n=7), VR & AR 17.3% (n=4), mobile learning 8% (n=2), serious games 4% (n=1) and blended learning 4% (n=1) were useful and effective in dental education.

Table 2. Describes the objectives of the studies

Row	Targets
1	Investigate the impact of the use of blended learning on the achievement of Dentistry College students on a physics course (14)
2	Investigate the perceptions of postgraduate dental learners and instructors about the transition to distance learning, including the changes to learning and teaching and its efficaciousness (15).
3	Specific digital tools supporting collaborative learning (16).
4	Evaluate the effectiveness of evaluating crown preparations among 360 predoctoral dental students for self-assessment (17).
5	Adapt the ultimatum game to classroom application for instructional purposes (18).
6	Evaluate the classification consistency of features in oral lesion images by experts and students for use in the learning tool (19).
7	Evaluate the efficacy of an educational module on evidence-based medicine (EBM) assisted with electronic medical databases (20)
8	Construct a conceptual framework of serious games (21).
9	Explore the effectiveness of the Phone-Based Audience Response System (PB-ARS) as an adjunctive pedagogy tool to enhance the retention of orthodontic information by dental students (22).
10	Investigation of alternative and auxiliary methods of dental education during the Covid-19 pandemic (23).
11	To investigate the effectiveness of technology-enhanced teaching and assessment methods of undergraduate preclinical skills in comparison to conventional methods (24).
12	To describe and compare how three dental schools from different countries (Australia, Brazil, and the USA) have managed experiences in dental education during the COVID-19 crisis (25).
13	Identify topics (knowledge and skills) from the dental curricula that would benefit from having a 3D learning resource using an exploratory sequential design method (26).
14	Evaluate the awareness and knowledge of dental students concerning oral-health care for persons with SHCN, and assess the effectiveness of an educational intervention in improving their knowledge (27).
15	Investigates VP as an alternative to lecturer-led small-group teaching in a curricular, randomized, and controlled setting (28).
16	Investigate Digitally Augmented Learning in Implant Dentistry (29).
17	Investigate the validity of the AR virtual tooth identification test and evaluate the users' experience with the virtual testing method (30).
18	Determine if integrating iPad technology as a visual learning tool would enhance the exchange of assessment information and improve academic performance in Indiana University School of Dentistry's preclinical curriculum (31).
19	Determine the mobile technology usage habits of undergraduate dental students and their attitudes and opinions towards m-learning in terms of various variables (32).
20	Assessment of computer and Internet use and its application in dental education among dental students (33).
21	Establish best practices for incorporating the impact of new research findings and technological advances into the education of our dental students (34).
22	Assess knowledge, attitudes, and behavior regarding occupational blood exposure accidents (OBEA) among dental students at the end of the whole dental education program (35).
23	Confirm the applicability of YouTube as a delivery platform of micro-lecture videos to provide a flexible learning environment for the flipped classroom (36).

Table 3. The characteristics and conclusions of the studies

Row	Writers	Year and area	Study results
1	Alsalhi et al. (14)	2021 Effect of Blended Learning on the Achievement	✓ Blended learning with technology leads to students' academic achievement
2	Amir Rad et al. (15)	2021 Distance learning	✓ Creating significant opportunities through tele-education that is worth investing in learning and training health professionals ✓ Share experiences through telelearning ✓ Use telelearning to overcome sudden pandemic challenges
3	J. Mehta et al. (16)	2021 Interactive web-based platform	✓ Padlet to be beneficial to their learning and easy to use ✓ Padlet proved to be a promising tool for collaborative learning in this content-specific context, and the approach promises participatory and distributed practices to achieve active learning through collaboration
4	Kang et al. (17)	2021 utilizing digital dental technology in crown preparation	✓ Digital dentistry proves to be more impactful to learning without creating confusion from biased evaluations ✓ Dental schools need to stay current and incorporate methods of improving teaching and learning ✓ Dental technology can be utilized upon graduating from dental school ✓ in private practice, may also use the CEREC software 5.1.3 to refine tooth preparations post-color metric analysis to avoid lab limitations when fabricating the crowns
5	N. Bertolami et al. (18)	2021 ultimatum bargaining game in teaching ethics	✓ Successful outcome could offer students an in-class, real-time, concrete appraisal of their own fairness and generosity as well as insights into their peer's preferences relative to their own
6	Shen et al. (19)	2021 the web-based image classification tool	✓ Learning tools like DiLearn have the potential to facilitate an independent learning process
7	Sheng-Kai Ma et al. (20)	2021 EMB through electronic databases	✓ Improvements in awareness, behavior, confidence, and performance in mastering EBM
8	Sipiyaruk et al. (21)	2021 evidence-based medicine with electronic databases	✓ Serious games include positive educational outcomes, enhanced engagement and motivation, interactive asynchronous distance learning, a safe learning environment, and the advantage of stealth assessment ✓ Very promising future for serious games, particularly in dental education
9	Alharbi et al. (22)	2020 Phone-based audience response system as an adjunct in orthodontic teaching	✓ PB-ARS was the preferred adjunct tool to conventional classroom teaching in orthodontic courses.
10	G. Saeed et al. (23)	2020 silver linings for dental education	✓ Use of teledentistry technology as a way to reduce the destructive effects of Covid 19 on dental education ✓ Videoconferencing opens up an opportunity to have substantially higher participation in these meetings, making the generated new knowledge available to more people.
11	Khalaf et al. (24)	2020 Technology-enhanced teaching tool	✓ Technology-enhanced teaching and assessment tools used in preclinical skills training of undergraduate dental students have the potential to improve student's performance
12	Peres et al. (25)	2020 challenges in dental education and technology	✓ For the return to teaching activities, the use of information and communications technology resources for distance learning was recommended
13	Poblete et al. (26)	2020 3D Technology Development	✓ Key topics that would benefit from 3D digital learning resources: anatomy of temporomandibular joints, detailed anatomy of head and neck, dental anesthesiology, dental clinical skills techniques, dental occlusion, and mandibular functioning.
14	S.Salama et al. (27)	2020 Effectiveness of educational intervention of oral health	✓ Introducing the educational intervention in the form of PowerPoint and video to participating dental students of all years was effective in communicating and teaching them basic information on persons with special health care needs
15	B. Seifert et al. (28)	2019 Computerized virtual patients	✓ VP cases are an effective alternative to lecture-led SGT in terms of learning efficacy in the short and long-term as well as self-assessed competence growth and student satisfaction ✓ VP cases feasible and leads to substantial growth of clinical competence in undergraduate dental students

Cont. table 1

16	Durham et al. (29)	2019 Digitally Augmented Learning in Implant Dentistry	✓ Virtual reality, combined with online learning, will allow dental schools to lower educational costs. ✓ Virtual reality and online learning were used to explore the value of innovative solutions to the high costs in dental education.
17	Kim-Berman et al. (30)	2019 Validity and User Experience in an Augmented Virtual Reality	✓ Virtual Dental Library and the virtual tooth identification test may become more effective, efficient, user-friendly, and valid tools for use in dental education
18	L. Kirkup et al. (31)	2019 Effectiveness of iPad Technology in Preclinical Dental Laboratory Courses	✓ Academic performance may also be improved with the addition of iPad image feedback, particularly for novice dental students who are in the earliest stages of motor skill development ✓ iPad image feedback in conjunction with verbal feedback resulted in an enhanced exchange of assessment information compared to verbal feedback alone
19	Suner et al. (32)	2019 Mobile learning	✓ Dental students generally have positive attitudes towards m-learning ✓ The students raise awareness towards the promises of m-learning in order to utilize their individual technology usage and learning behaviors. ✓ Designing learning materials and applications for mobile devices may increase students' overall performance in dental courses
20	Agrawal et al. (33)	2018 application of computers and the internet in dental education	✓ Majority of dental students use computers and the internet for their studies ✓ Students should take the computer and internet as a supplement and not as the replacement
21	F. Dragan et al (34)	2018 Impact of scientific and technological advances	✓ Augmented reality, haptic technology, virtual reality, Japanese robot patient simulator, integrated TEL system, hyperlinked 2D / 3D, 3D printing, faculty evaluation, video and audio with analysis for self and external evaluation, e-portfolio, VR complements mannequins, 3D printing simulates tissues, collaborative learning technologies and video for teaching communications ✓ "In the classroom" learning: podcasts and webinars, software for curriculum management/mapping, assessment, delivery strategies, virtual reality, interactive e-learning, case-based, social media as advising and motivation tool, gaming, cloud LMS, student evaluation of faculty teaching, cross country and institution teaching, flexibility in lecture, flipped classroom, daily quizzes and online learning with embedded quizzes ✓ Telehealth can be beneficial in professional versus students, variety of techniques, most untested, behavioral approaches and skills, data used for decision support, access, cost, follow-up care, second opinion, specialty care, faculty evaluation of teaching, team teaching (horizontal & vertical), interdisciplinary experiences including geographical, record consultations and add to cloud electron health records (EHR), smartwatch for notifications, consultations, diagnosis, triage, combine with mobile clinics, cloud EHR and advanced data collection ✓ Videos of treatment and analysis to provide feedback to student, artificial intelligence that learns about student (analytics), complex scenarios, 3D printing, CBCT, genetic sequencing, personalized medicine, big data for decision support, imaging, scanning, e-assisted surgical tools , faculty evaluation, team (horizontal and vertical), patient perspective, e-portfolio, community-based education, voice-operated EHRs, integrated EHRs, CAD / CAM and interprofessional collaborations in patient care
22	Hbibi et al. (35)	2018 current educational technology	✓ Virtual reality could help the dental student improve his / her dexterity to perform appropriate tasks in a safe environment ✓ Surgical procedures could even be learned with secure tools and give more confidence to the student in the high-risk situations ✓ infection control education may have a large perspective since the primary feedback seems to be satisfactory
23	Wan Seo et al. (36)	2018 YouTube as a lecture video hosting platform	✓ Students considered the YouTube platform to be an efficient platform for distributing the lecture videos ✓ Students thought that the video lectures were better than face-to-face lectures for understanding the content ✓ Functions of the micro-lecture videos provided on the YouTube platform, such as pause, replay, speed adjustment, and comments, promoted students' understanding by enabling iterative learning and two-way feedback ✓ YouTube's functions of sharing and exposing students to related videos helped students grow as subjects of learning by enabling students to experience more meaningful and personalized learning ✓ YouTube platform could support the self-directed learning of students by providing high accessibility and serving as a tool that is fit for their needs

Discussion

Teaching dental students is a complicated process because, in addition to acquiring knowledge, it requires the attainment of fine motor skills and the coordination of limbs and eyes to perform clinical tasks. Awareness of the limitations of conventional simulators used for preclinical training has paved the way for digital dentistry as a new training model that offers several advantages over conventional dental training methods (37,38). In general, based on the results of the study of new technologies, they are widely used in dental education. However, the evolution of education and technological advancement has been the main catalysts for change in the clinical landscape (39). Dental students must achieve an acceptable level of eligibility because most of the teeth are inalterable, so learning these skills is simply not accepting patients (40). Also, since dentistry is a skilled profession, the dentist's tactile skills play an obvious role in providing dental services to patients. One of the current trends in dental education is the empowerment of dental students in a global context using advanced technology (41). Additive technology, for example, is a key pillar of new specialized digital skills to enhance dental education (42). In accordance with the advancement of technology, dental support for proficient psychomotor is necessary before actual clinical applications are under development (40). Touch technology is known as a unique tactile or motion experience for the user. A Force feedback system in a touch device can be a "doctor in training " to help to work on real patients" , texture and " during preclinical sense (41). In addition, virtual reality and simulation of digital interaction in education, dental, and medical training dental students Medical interact with real patients used to have. Scientific evidence has provided the usage of virtual technology in dental education, and some recent publications show that virtual and tactile technologies have positive effects on the results of dental education (43). One of the problems of dental education is uncooperative children, whose studies show that special software such as Simodont ®can be used as a supplement in training dental students to practice clinical restorative dentistry used (37). Simulation involves computer-aided learning, augmented reality, and virtual reality, which are largely devoted to preclinical training. Augmented reality is generally used in maxillofacial training, restorations, dental morphology, and mastery of techniques for performing local anesthesia in dentistry. Virtual reality is especially used in implant planning before treatment and dental education for students. The usage of tactile technology, such as robotics, is also increasing and facilitates two-way communication between the user and the setting to better simulate the clinical environment for learning aims (44).

As a result, with the advent of technology in dentistry, preclinical education has now used simulation. The chance for knowledge school provides the skills psychomotor to practice with competence learning pre- clinical and standardized before being involved in patient management, develop (44). In other words, the fan-modern tech education of students in the process of dental medicine is the tool that makes connections between theory and practices acts that continue to impact the development of the skills of professionals (45). Subsequently, technology has revolutionized the field of dentistry, and digital workflows have become commonplace in everyday dental work (46). Continuous adaptation to technology and investment in education maintains different specialties at the forefront of dentistry (39).

Objectives such as promoting distance education, securing clinical and preclinical education for predicting, diagnosing, treating, managing, and promoting dental education for students, extracting and retrieving information in evidence-based medicine, data sharing, and greater safety for Patients and students in different situations such as pandemics and effective use of data between different centers . Therefore, using this approach and its various goals can be an effective step in using health information technology to optimize dental education, which in itself leads to improving the quality of patient care, dental education, and in the future, the expertise we will benefit from the expert.

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