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Derleme

Dental Education In The Time of Covid-19: Impact, Emerging Technologies and Trends

Covid-19 Sürecinde Diş Hekimliği Eğitimi: Etkisi, Gelişen Teknolojiler ve Eğilimler

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ABSTRACT

Dental education requires students to acquire a certain skill set in addition to academic-based theoretical education. Changes in the education method, during the Covid-19 pandemic, have had different effects on dentistry students. The e-learning method offers advantages such as removing physical limits and supporting self-learning and creativity. However, clinical learning of dental education and the psychological state of the students affected negatively all around the world. Digital Simulation Technologies (DSTs) including augmented reality (AR), virtual reality (VR), and haptic simulation, have been a valuable resource coping with adverse situations in dental education due to the impact of the Covid-19 pandemic. DSTs need to be developed in the future on finger support, tactile sensation, force feedback, high screen resolution, depth perception in stereoscopic images, accurate deformation simulation, different training difficulty levels, big data technology in dental skills training.

Keywords: Augmented reality; Covid-19, Dental education; Haptic simulation; Virtual reality

ÖZET

Diş hekimliği eğitimi, öğrencilerin akademik temelli teorik eğitime ek olarak belirli bir beceri seti kazanmasını gerektirir. Covid-19 pandemisi sürecinde eğitim yönteminde yapılan değişiklikler diş hekimliği öğrencileri üzerinde farklı etkilere neden olmuştur. E-öğrenme yöntemi, fiziksel sınırların kaldırılması, kendi kendine öğrenme ve yaratıcılığı destekleme konusunda avantajlar sunmuştur. Ancak diş hekimliği eğitimi klinik öğrenimi ve öğrencilerin psikolojik durumu dünya çapında olumsuz etkilenmiştir. Covid-19 pandemisinin etkisi nedeniyle diş hekimliği eğitiminde ortaya çıkan olumsuz durumlarla başa çıkmada artırılmış gerçeklik (AR), sanal gerçeklik (VR) ve haptik simülasyonu içeren Dijital Simülasyon Teknolojileri (DST) değerli bir kaynak olmuştur. DST'lerinin parmak desteği, dokunma duyusu, kuvvet geri beslemesi, yüksek ekran çözünürlüğü, stereoskopik görüntülerde derinliği tespit edebilme, doğru deformasyon simülasyonu, farklı eğitim zorluk seviyeleri, dental beceri eğitiminde büyük veri teknolojisi alanları gelecekte geliştirilmesine ihtiyaç bulunmaktadır.

Anahtar kelimeler: Arttırılmış Gerçeklik; Covid-19; Diş hekimliği eğitimi; Haptik simülasyon; Sanal gerçeklik

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INTRODUCTION

Humanity, which has faced many pandemics in history, has finally had to struggle with Covid 19, which was declared a pandemic disease by WHO on March 11, 2020. Almost every aspect of social life has been affected on a global scale. One of the areas that have been suffered the most was education, which is very important for societies. Traditional education practices have been significantly affected after the Covid 19 pandemic. While campuses were closed in March 2020 in the vast majority of universities, more than 185 million students worldwide were affected, and 22 million students living below the poverty threshold in Europe and Central Asia experienced learning loss.[1] In March 2020, the Higher Education Council of Turkey (YOK) decided to continue higher education remotely in the spring semester.[2] Universities have faced a loss of income, problems of registration and starting education of foreign nationals and candidate students, and problems of gaining experience for students studying health sciences.[3] The change experienced in higher education has been reflected in the form of distance from classroom teaching and clinical education to students studying in health sciences due to restrictions on social distance. The change experienced limited students from being active members of clinical teams.[4]

Dental education requires students to acquire a certain skill set in addition to academic-based theoretical education. Changes in the education method have had different effects on dentistry students. This article, it is aimed to reveal the effect of Covid 19 on dental education, the technologies used, and the future perspective.

CHALLENGES IN DENTAL EDUCATION

European University Association (EUA) "digital learning and teaching research" found that 95% of universities have turned to remote education as of March 2020.[4] The American Association for Dental Education (ADEA) has made recommendations on teaching modalities including online education and creative teaching methods.[5] This education method provided an opportunity for education beyond physical limitations due to the high availability of the internet. In addition, students are encouraged to learn by themselves, use online learning resources, and discover the latest academic developments and innovations. [6] The ability of students to interact with lecturers by asking questions through online platforms has been identified as one of the most positive aspects of e-learning. [7,8]

In order to manage the impact of the pandemic, online pedagogical software tools, live videos, and offline videos have been used in dentistry schools, and virtual meetings and webinars have begun to be organized.[4,5,9,10] Small-scale working groups, social media groups, journal clubs, online case discussions, more online materials on different online platforms, including applications such as podcast, twitter, facebook, are included in the training processes.[11-14] However, within the scope of country policies, treatment restrictions in clinics and pre-clinics in dentistry services, inability to treat patients in faculty clinics, and limited access to clinical learning opportunities for students have caused challenges in dentistry education all around the World.[9] Challenges experienced in dentistry education caused students to experience anxiety about the education they received. It has been determined that the students experience anxiety about issues such as lack of education, lack of educational materials and not getting enough feedback due to the e-learning method. In addition, they are worried about the decrease in the desire to study, how the educational results will be evaluated, and the decrease in their grades.[12,13,15]

Although both clinical and preclinical students are afraid of infecting themselves and their environment with Covid 19[16], the majority of students feel the lack of clinical practice and want to return to the clinical environment.[11,15,17] According to the common results of the publications in which students' interest in the e-learning method was investigated after the Covid 19 pandemic, students prefer the hybrid learning method, which combines classical learning and e-learning[7,9,14] and demand that multimedia elements be increased.[15] Students who think that clinical skills training has been negatively affected during the pandemic have self-confidence problems in starting an independent practice after graduation, so they want to take postgraduate courses in the future.[11,13,18]

The Covid 19 pandemic and the concerns experienced also affected the psychological state of the students. It has been confirmed that college students are at increased risk of experiencing depression and

anxiety, and suicidal tendencies associated with the Covid 19 outbreak, and an increase in depression symptoms in those with longer school years.[19-21]

FUTURE PERSPECTIVE

Dentistry faculties need to find reliable and robust, yet inexpensive solutions to ensure the continuity of practical skills training in dentistry education.[22] Digital simulation technologies (DST), including augmented reality (AR), virtual reality (VR), and haptic simulation, are considered key technologies in the education for the 21st century. DSTs have been a valuable resource and frequency of use increased as an effective tool for coping with adverse situations in dental education due to the impact of the COVID-19 pandemic.[5,23,24] VR is a computer-generated medical simulation of a three-dimensional (3D) image or environment. AR differentiates itself from VR by combining computer-generated graphics with real-life and incorporating natural conditions into the environment. Haptic is a newer simulation technology and provides haptic feedback by combining interaction with the external environment through tactual sensation.[25] Research results show that DST-based educational tools are capable of developing psychomotor skills before actual experience in healthcare implementations.[26] Since dentistry practices and education require taction with tissue, haptic applications are of particular importance. Before the Covid 19 pandemic, the use of these technologies in dental education has been the subject of research. The advantages of DST, such as the motivating effect of learning, the opportunity to repeat dental procedures, improving effect on clinical skill education, and the high user satisfaction, caused a positive attitude towards the inclusion of these technologies in the curriculum.[27,28] In the Covid 9 pandemic, DSTs have offered an alternative and safe way to ensure compliance with dentistry schools, to provide general education at a lower cost, to enable students to acquire clinical skills without direct contact with patients and to reduce anxiety when implementing a treatment plan.[25,29-33]

Considering the contributions of DSTs to dental education during the Covid 19 pandemic, it has been proven that students improve their hand-eye coordination, preclinical fine motor skills and perform dental procedures, especially in the early stages of skill acquisition. A comparable effect was seen in performance evaluation results compared to the phantom head practice in performing dental skills.[5,34-36] DSTs can be applied in different dental disciplines and a variety of clinical procedures, improving the quality of dental education outcomes. Students performed better in removing caries, preserving healthy tissue, cavity preparation, dental anesthesia, implant accuracy using DSTs. Dentistry students had faster mean manipulation time and higher mean knowledge scores after DSTs.[25,28,35,37-42] The ability of DSTs to give kinematic data and force feedback, and to mimic real-life situations such as coughing, head movement, tongue thrusting, gag reflex, and salivation, provided basic skill acquisition in dental education and ensure the retention of learned skills.[5,31,35,36]

4. Aspects of DSTs that need improvement in terms of dental education

Some areas need improvement to overcome some of the challenges brought by DSTs in dental education. The areas that need improvement are given below

In clinical operations, dentists decide whether to continue the operation by perceiving different force feedbacks of different oral tissues and continuously evaluating the process. In some dental implementations, tactile feedback is considered more important than patient symptoms. DSTs offer dentists the opportunity to have tactile perception along with vision. The tactile sensation provided by DSTs has proven to be one of the factors influencing students' performance. DSTs using haptic devices, especially in surgery, allow to detect texture of surrounding soft tissues or the bone-handling drill, and as a result, prepare students for real-case scenarios. Although DSTs are considered as good training tools in dental applications and dental surgery, it has been determined that, the force feedback field should be strengthened to eliminate inconsistencies due to inappropriate feedback, high contact speed, and the need for a rigid environment setup in wired teleoperation systems[33,43-47] Furthermore, The benefits of haptic devices are still not well documented. Implementation of haptic devices is a subject of controversy until now and the absence of limited haptic feedback is one of the reasons inhibiting the growth of these devices. More research on the technical aspect of haptic devices is required.

To investigate the technical aspect, our future work will focus on clarifying the haptic devices in terms of their linkage configuration, the actuation and sensor system used, and their mechanism and solutions to adress kinematic challanges such as redundancy.[44]

One of the areas that needs to be developed in the future is finger support, which may be related to tactile feedback. Stable finger support is of great importance in sensitive dental and intraoral operations. In cases where finger support is not provided, an accidental injury may occur in the surrounding soft and hard tissues. Finger supports should be provided for optimal simulation during dental skills training.[33]

Another area that needs improvement in the future is high screen resolution. The low-resolution image quality of the simulation makes it difficult to identify changes in the color of the oral tissues and subtle differences between tissue types. Images with poor resolution can cause adverse effects such as dizziness and nausea in users. High-resolution images will allow users to observe finer tooth details, which can greatly increase the realism and immersion of the experience for users. Hence, further studies are needed to obtain high resolution in simulations.[33,45]

Some people are insensitive to binocular retinal disparity resulting in defective stereopsis. For this reason, individual differences arise in the ability to perceive depth in stereoscopic images in virtual reality. The fact that it is more difficult to grasp the depth in the haptic simulator and the difference in the depth perception ability of stereoscopic images may affect the performance of the students. There is a possibility that turning the depth direction to width or height direction on the screen plane compensates for the difficulty of detecting depth in haptics. More research is needed to clarify the relationship between item kinds and individual stereoscopic ability.[48]

Simulation of the oral environment should include the simulation of tongue and facial tissue deformation. Deformation simulation is based on physical properties of soft tissues such as density and elasticity. A physical model that can better represent the physical properties of oral tissues, with higher computational efficiency and more accurate simulation, needs to be created.[33]

In cases where DST is used as a training tool, it has been determined that the training content prepared at different levels will have a more observable effect on the success rate of the experience and the success rate of the training, and there are significant improvements in the success rates of the participants in the difficult training scenarios.[26] There is a need for different difficulty levels in DSTs in dentistry education too. Comprehensive and systematic educational content should be developed so that students can learn skills gradually in the education process, skill acquisition can be evaluated at each stage, and performance feedback can be given.[33]

It is necessary to combine DSTs with 5G and cloud computing technology and create a dental implementation database to facilitate dental students to independently practice various clinical procedures, analyze online training, predict learning activity, and use big data technology in dental skills training.[33,43]

The lack of validation needs to be remedied since research on DSTs is often done in small samples. Prospective randomized future studies with adequate cohorts are needed to evaluate the tangible benefits, long-term effects, and training outcomes of systems in training using simulation.[33,48,49]

CONCLUSION

The Covid 19 pandemic has caused challenges in dentistry education as well as in health science education, and dentistry schools have quickly adapted to these conditions. It is thought that the adoption of the hybrid education method in which traditional education approaches are given together with DSTs to respond to possible conditions that may be experienced in the future, as in the Covid 19 pandemic, to provide skill training as well as theoretical education, and to reduce dependence on real-time patient-based education, will carry dentistry education into the future.

In conclusion, there is a need to carry out educational diversification studies in dentistry schools, and to conduct research on screen resolution, large databases, finger support, performance evaluation in large sample groups to increase the contribution of DSTs to education. Furthermore, since dentistry education requires direct tissue tactile sensation, it is recommended to increase the research to strengthen haptic feedback in DSTs. Additively, practicing of

non-technical studies with the technical skills studies including problems integrating the technology in dental curricula, student or faculty feedback mechanism, new scoring system of dental education is a very important subject to improve in dental education.

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