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CONGRESS PROCEEDING

Dental Education Digitization: Virtual Reality (Vr) And Augmented Reality (Ar)

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Abstract

In dental education, the role of practical training is crucial. Dental students undergo numerous practical training sessions during the first three years to enhance their manual and visual skills. Technological advancements have found their place in the field of dentistry, as in every other area. Three-dimensional (3D) imaging and printing, computer-aided design and computer-aided manufacturing (CAD/CAM), artificial intelligence (AI), virtual reality (VR), and augmented reality (AR) based applications are building a significant presence in both dental education and practice.
Objective and Method: Our aim in this review is to investigate the impact and significance of VR and AR in dental education. Therefore, a comprehensive literature review was conducted on the subject, and the results were evaluated and summarized.
Results and Conclusions: One of the most significant advantages of AR and VR systems is their ability to facilitate manual skill acquisition and minimize errors with instant feedback. The major distinguishing feature of AR systems from VR systems in education is the absence of disconnection from reality in the former case. AR gives students the feeling of being in a real environment and guides them during dental treatment. Although AR and VR applications seem easily integrable into dental education, further research is needed for these emerging digital technologies.

Key words: AR; Dentistry; Dentistry education; Digitalization; Digitalization in dentistry; VR

Introduction

In dental education, practical training plays a crucial role. Dental students participate in numerous practical trainings during their first three years to improve their manual and visual skills. The aim of these practical trainings is to prepare students for patient care by equipping them to perform endodontic, restorative, and prosthetic procedures through simulation-based training in laboratory settings.[1–3]

Technological advancements have made their mark in the field of dentistry, as they have in many other areas. Three-dimensional (3D) imaging and printing, computer-aided design and computer-aided manufacturing (CAD/CAM), artificial intelligence (AI), virtual reality (VR), and augmented reality (AR) applications are increasingly prominent in both dental education and practice. VR is a technology that immerses individuals in a simulated 3D environment that mimics real-world properties through head-mounted displays, engaging their senses of sight, hearing, and motion. AR, on the other hand, enables users to overlay virtual objects onto physical objects, allowing interaction with both simultaneously.[2,4]

Methods

Our aim in this review is to investigate the impact and significance of VR and AR in dental education. Additionally, it aims to explore in which areas of dental education the current practical training using VR and AR can be applied, and whether these innovative training methods can replace traditional practical treatments. Therefore the results were evaluated and summarized.

Results

One of the key advantages of AR and VR systems is their ability to facilitate the acquisition of manual skills while minimizing errors through instant feedback. A major distinguishing feature of AR systems, compared to VR systems in education, is that AR does not disconnect users from reality. AR provides students with the sensation of being in a real environment and offers guidance during dental procedures.[5–10]

Discussion

Studies have been conducted on many subjects in VR and AR supported education. The main ones included anatomy and radiology training, tooth preparation techniques, practical motor skills training, surgical training, and 3D vision training.[5–11]

In a study by Al-Saud et al. evaluating students' motor skill acquisition using a haptic dental simulator with 63 participants, the students were divided into three groups. Group 1 received only device feedback during the training phase, meaning they used the simulator's visual display. Group 2 received verbal feedback from a qualified dental instructor. Group 3 benefited from both instructor and device feedback. The comparisons showed that Group 3 was the most successful. This highlighted that combined training, which includes both instructor guidance and simulator feedback, is the most effective type of training.[5] In a study by Suebnukarn et al. evaluating the validation of a VR dental simulator for motor skills training, the findings revealed that the VR simulator was capable of distinguishing between the performances of experts and non-experts.[10] De Boer et al. examined the differences in students' performance and appreciation in a virtual learning environment. The study found that 3D vision in a virtual learning scenario had a significantly positive effect on both students' performance and their overall appreciation of the environment, compared to 2D vision.[7] Correa et al. examined the accuracy of a dental anesthesia training simulator for the inferior alveolar nerve block. The simulation was tested to be highly suitable in terms of the proper localization of the needle, insertion depth, and the sensitivity of the virtual tissue resistance.[6] Similarly, in comparable studies conducted by Samuel et al. and Lamira et al., it was highlighted that dental students who used virtual environments for practicing inferior alveolar nerve block were more confident when performing their first clinical injections compared to those exposed only to traditional supplementary materials. These students required fewer syringe readjustments and were more successful in anesthetizing patients. This indicates that virtual environment training can be beneficial in surgical practical education and can be integrated into training programs.[12,13]

In a study by Eve et al., which compared the caries removal performance of dental students and experienced prosthodontics specialty students using a haptic simulator, it was found that the average performance of novice and experienced participants differed significantly in terms of the percentage of carious lesion removed and the volume of sound tooth structure removed during the caries removal exercise. Experienced dentists were found to be more successful in the virtual environment. This result suggests that a hybrid training approach, which includes both traditional practical training and VR/AR-supported education, may lead to higher success rates in dental education, rather than relying solely on VR/AR-based training.[9]

As highlighted in the articles mentioned, this review focuses on the latest research in VR/AR technologies, which represent current advancements in dental education. It has been observed that AR/VR systems offer valuable educational opportunities for both undergraduate and dental specialty students. Given that clinical dental education relies heavily on serious and continuous practice for motor skill acquisition, AR/VR is generally seen as having a positive impact on the quality of the learning process.[5–11] However, several uncertainties currently limit the widespread application of AR/VR technologies in clinical practice. Effective management of existing data, data anonymization, proper security protocols, and the development of new algorithms for the statistical analysis and interpretation of generated data are essential measures to address these limitations.[3,6,8,11]

Conclusion

AR and VR systems are ideal for dental education due to they facilitate manual skill acquisition and minimize errors through real-time feedback. Although AR and VR applications seem easily integrable into dental education, further research is needed for these emerging digital technologies. Additionally, some changes in the curriculum are needed to integrate current dental practical training with VR/AR-supported education.[6,8,11,14] In light of these studies, it is believed that in the future, VR and AR training and courses could be expanded to all branches of dentistry. Through VR/AR-based education, students could become more successful and confident in areas such as surgery, radiology, restorative dentistry, and prosthetics. However, further research is needed.

Author Contributions

Detailed literature review and compilation : M.O.
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Conflict of Interest

There is no conflict of interest.

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