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The usefulness of a mixed reality haptic-based dental simulator for periodontal pocket probing learning: dental students' perceptions

Periodontal disease is one of the most prevalent oral diseases globally and strongly associated with systemic diseases.[1] Periodontal pocket probing is recognized as an essential skill to diagnose the periodontal disease by measuring probing depth, clinical attachment loss, and bleeding upon probing. However, probing is an uncomfortable dental procedure that may cause bleeding and pain to patients. The teaching of periodontal pocket probing is a difficult task in preclinical periodontal training and learning.

Recently, virtual reality (VR) and mixed reality (MR) technologies have been developed in dental simulator for skill acquisition because it allows repetitive training with standardized scoring in clinical situations.[2] MR haptic-based dental simulator Dente (SimTo-Care, Vreeland, the Netherlands) has diverse procedures including caries removal, tooth preparation, pulp chamber opening, implant placement, and periodontal pocket probing for more specialties in simulation learning.[3] The main advantage is the integration of phantom head elements with haptic feel of virtual elements that can enable the simulation of complete jaws and occlusion to allow more reality patient-centered training.[3] Based on the aforementioned improvements, School of Dentistry, Chung Shan Medical University (CSMU) has implemented MR haptic-based dental simulator Dente in 2023 to shift VR learning environments towards an advanced digital integration of clinical education and patient care in pre-clinical skills learning and training.

However, little is known about the students' perception of Dente for periodontal pocket probing learning and training. In this preliminary survey, 25 dental students (fourth year students in CSMU) have performed periodontal pocket probing in Dente with 25 g force during their periodontal examination learning course. All students were required to measure the full mouth periodontal probing depth module. Then, all of them were invited to reply the questionnaire. 5-Point Likert scale rating questions were listed in Fig. 1. About 96 %, 100 %, 100 %, 92 %, and 84 % of dental students agreed that Dente could have the benefits such as patient safety enhancement, self-directed learning, environmental sustainability, real force feedback, and visual-motor integration, respectively.

To the best of our knowledge, this is the first study about the use of MR haptic-based dental simulator for periodontal pocket probing. The user can simply look through a screen and easily switch from the virtual world to the real world. The overall satisfaction scores were highly rated. The results were in agreement with previous studies that VR haptic-based simulation technology applied for periodontal pocket probing demonstrated the effective repetitive training results and as a good tool in pre-clinical periodontal skills learning.[4,5] The reasons may be due to the force feedback system is realistic with a real-time respond and without delay. This will allow dental students to improve their motor skills immersive in the virtual oral environment and experience the tactile perception effect as in the real oral environment. In this survey, the score of visual-motor integration was relative lower as compared with other items. Compared to previous VR simulator for periodontal pocket probing task,[4] Dente can provide the clinical scenario of full arch for repetitive training that would be difficult for the novices to use the mirror for the reflection of opposite site or arch. This latest development of MR haptic-based simulator Dente still needs to collaborate with dental schools for further improvements from the feedback of customers' comments.

Taken together, the MR haptic-based dental simulator Dente could help dental students to improve their comprehensive abilities in periodontal pocket probing. This device can act as a good educational tool in preclinical periodontal simulation learning and training. Further

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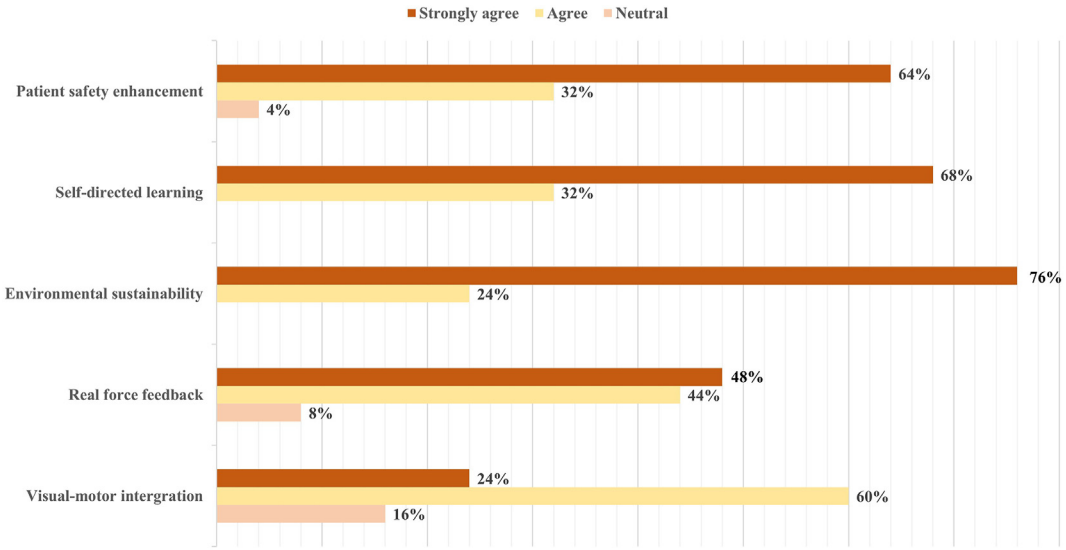

Figure 1 Dental students' perceptions of a mixed reality haptic-based dental simulator for periodontal pocket probing learning. A five-point Likert scale was used to measure the opinions of the participants.

studies with larger sample size and analytical design are required.

Declaration of competing interest

The authors have no conflicts of interest relevant to this article.

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