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Dental students' perceptions of two immersive reality haptic dental simulators: A pilot study

The implementation of immersive reality into dental education has significantly driven by the technological advancement. The integration of force feedback, the so-called haptic, into virtual reality (VR) and mixed reality (MR) was developed with computer-assisted learning in dentistry.^{1,2} In addition to virtual environment or combined with real world, the haptics enable trainers to develop precise motor skills, enhance hand-eye coordination, improve theoretical knowledge, and increase self-confidence. The customized patient-specific training experience could allow dental students to practice diverse clinical scenarios and ensure patient safety.^{3,4}

The School of Dentistry, Chung Shan Medical University (CSMU) has introduced VR haptic dental simulator Simodont (Nissin Dental Products Inc., Nieuw-Vennep, Netherlands) since 2018 and implemented into the current dental curriculum from the second grade dental students to the dental interns. In 2023, MR haptic dental simulator Dente (SimTo-Care, Vreeland, the Netherlands) was conducted as an improved technology for the pre-clinical skill training. The purpose of this study was to compare two haptic-based dental simulators from students' perceptions by questionnaire assessment.

After ethical approval from the institutional review board of CSMU Hospital (CS223090), a total of 73 s-year novice dental students (44 males and 29 females) were recruited. They had no prior exposure to the immersive reality or other conventional phantom head simulators. Two immersive reality haptic dental simulators Simodont (software versions V4.18.0) and Dente (software version 5891) were used for the pre-clinical skill training in this study. Prior to the experiment, a comprehensive introductory course and demonstrative video were conducted. Then, the students were assigned to operate a manual dexterity model by milling the target area following a schematic axis on both simulators, respectively. The questionnaire regarding the users' friendly, real-time

interaction, force feedback, and the expectations in the future were responded from the participants assessed by 5-point Likert scale. As shown in Table 1, the positive feedback of two immersive reality haptic dental simulators were replied from the students. There were no significant different between two dental simulators from questions 2 to 8 ($P > 0.05$). However, the hardware of Simodont was reported easily learning and used as compared with Dente from students' perceptions ($P = 0.048$).

It was not surprised that the students agreed that both VR and MR haptic dental simulators could provide a better learning scenario and enhance their eye-hand coordination with higher motivation to improve the pre-clinical skill by themselves. Many reports have shown that immersive reality simulators can improve dental training with the clinical relevance.¹⁻⁴ However, the students' responses indicate that the immersive reality haptic-based dental simulator cannot totally replace the traditional phantom head simulator. The MR, combined with the real world and virtual environments established for the dental simulator, can provide a partial immersive experience and enhance the vivid interactions.² This shift in dental education may change the traditional understanding of the clinical training. On the contrary, the students preferred the hardware design of VR Simodont than that of MR Dente in this study. The reason was not quite clear. Compared to the newly introduced Dente, the Simodont has been developed since 2003 with well documents in the dental education¹⁻⁴ and the participant schools' geographic distribution in Europe, Asia, Australia, North America, and South America.² However, little research of Dente was found in the current databank and without the sufficient evidenced support.⁵

In conclusion, the dental students are satisfied with both VR and MR haptic dental simulators. The experiences of CSMU suggested that immersive reality haptic dental simulators may not totally replace traditional simulation

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Table 1 Results of questionnaire and the comparisons of two haptic-based dental simulators.

Questions	Simodont mean $\pm$ SD	Dente mean $\pm$ SD	P-value
The hardware interface is comfortable to learn and use.	4.18 $\pm$ 0.82	3.86 $\pm$ 0.99	0.048*
The software interface is comfortable to learn and use.	4.10 $\pm$ 0.79	4.08 $\pm$ 0.83	0.922
The real-time information is easy and clear to read.	4.19 $\pm$ 0.78	4.14 $\pm$ 0.85	0.700
The images of model and instrument look true to life.	3.90 $\pm$ 0.95	4.05 $\pm$ 0.91	0.325
The tactile sensation of force feedback is realistic.	4.01 $\pm$ 0.94	4.16 $\pm$ 0.86	0.302
It can improve my visual-motor skills.	4.32 $\pm$ 0.84	4.33 $\pm$ 0.84	0.915
It can totally replace the phantom head simulator.	2.95 $\pm$ 1.08	2.97 $\pm$ 1.10	0.867
I will use it for improving preclinical skills in the future.	4.23 $\pm$ 0.88	4.25 $\pm$ 0.92	0.920

SD: standard deviation.

* represents significant difference, $P < 0.05$ by Student's t-test.

training at present. However, they are the useful tools to facilitate the patient-centered training and thus we would recommend these devices to other dental schools. Further evaluations and longitudinal follow-up are required to investigate the value of immersive reality haptic simulators implemented into the dental curriculum.

Declaration of competing interest

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

References

1. Al-Saud LM. The utility of haptic simulation in early restorative dental training: a scoping review. *J Dent Educ* 2021;85:704–21.
2. Serrano CM, Bakker DR, Zamani M, et al. Virtual reality and haptics in dental education: implementation progress and lessons learned after a decade. *Eur J Dent Educ* 2023;27:833–40.
3. Yang PY, Chang YC. The haptic 3D virtual reality dental training simulator as a good educational tool in preclinical simulation learning. *J Dent Sci* 2022;17:618–9.
4. Hsu MH, Yang HW, Liu CM, Chen CJ, Chang YC. Clinical relevant haptic simulation learning and training in tooth preparation. *J Dent Sci* 2022;17:1454–7.
5. Turkyilmaz I, Marshall LS. Preclinical prosthodontic training with mixed reality haptic-based dental simulator. *J Dent Sci* 2022;18: 905–6.

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