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Virtual Haptic Reality: A Teaching Strategy to Achieve Significant Learning in Dentistry

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Abstract

Objectives: To evaluate the students' perception towards the similarity between working with extracted human teeth, plastic teeth (MESH, Medical Shapes), and a haptic virtual reality simulator (HVRS, Simodont, Moog and ACTA). Methods: 273 undergraduate dental students followed the three training methods to perform tooth preparations. 67% of the students answered an anonymous questionnaire to evaluate the experience. Results: 67% of them stated that the sensation produced by the simulator Simodont was similar to working on extracted human teeth or plastic teeth. 80% considered that Simodont simulated a real handpiece. 50% assured that the experience using Simodont was good and 16% classified it as very good. Conclusions: The sensation produced by HVRS was very similar to that perceived when working on extracted human teeth and plastic teeth, so this technology can be implemented in preclinical training as a complementary strategy.

Keywords**:** Dental Education, Simulation, Haptic Technology, Virtual Reality

Introduction

Before starting clinical practice, dental students need to acquire competences and psychomotor skills to ensure safe practice (Farag & Hashem, 2021). In the traditional teaching-learning method, the teacher performs the demonstration and the students train using extracted human teeth and/or plastic teeth that are placed on phantom head simulator (De Boer, Wesselink, & Vervoorn, 2013; Farag & Hashem, 2021). Unfortunately, it is difficult to collect sufficient extracted teeth for pre-clinical training and sometimes extracted teeth must be sterilized, negatively affecting their structure (De Boer et al., 2013). On the other hand, plastic teeth are cheaper and easier to obtain but they do not reflect the

anatomy and hardness of human teeth. Usually, plastic teeth have no simulated pathology, so it is hard to simulate realistic clinical situations (De Boer et al., 2013; Farag & Hashem, 2021).

Previous studies have shown that traditional training methods do not predict the clinical performance of dental students, as they do not allow to manage complex patient cases and do not provide sensory feedback (Farag & Hashem, 2021; San Diego et al., 2022). Other technological advances are required to enhance dental skills and facilitate transition from laboratory work to clinical practice (Farag & Hashem, 2021; San Diego et al., 2022).

The current trend points towards the use of technology in dental education (Suebnukarn et al., 2009). Technological advances such as computer-assisted learning, augmented reality, and virtual reality simulators allow for the transmission of knowledge in an interactive and efficient way (Suebnukarn et al., 2009). Among them, haptic virtual reality simulators stand out due to their high degree of realism (Suebnukarn et al., 2009). Haptic technology recreates the sense of touch through the application of forces, vibrations, and movements, and can be combined with other sensory mechanisms to offer a more realistic experience (Suebnukarn et al., 2009). This technology enables the development of more precise clinical skills than the traditional learning methods, which according to De Boer et al. (2019), leads to greater satisfaction to the students.

Simodont, is a new dental training simulator developed by Moog (Nieuw-Vennep, Netherlands) and the Academic Centre for Dentistry Amsterdam (ACTA), which combines haptic technology with virtual reality (Farag & Hashem, 2021). Through visual, sensory, and audio experiences, it simulates realistic clinical situations, from the simplest cases to the most challenging (Farag & Hashem, 2021). This technology overcomes the limitations of the conventional dental education, and offers a realistic, practical, and efficient approach for preclinical training without compromising the patient's safety and the environment (San Diego et al., 2022).

Some higher education institutions have already implemented the use of virtual reality simulators in their programs, with favorable results (Genaro & Capote, 2021). However, there are still few studies evaluating the use of these simulators, so more research work needs to be done (Genaro & Capote, 2021). The present study aimed to evaluate the students' perception towards the similarity between working with extracted human teeth, plastic teeth, and the Simodont Dental Trainer.

Materials and Methods

The haptic virtual reality simulator Simodont (HVRS, Moog, Nieuw-Vennep, Netherlands) was implemented at a dental school in Lima, Peru (Fig. 1). A total of 273 undergraduate dental students followed three preclinical training methods during their tooth preparation practice: Simodont, extracted human teeth and plastic teeth (MESH,

Medical Shapes, Medellin, Colombia).

Figure 1: Haptic virtual reality simulator Simodont (Moog, Nieuw-Vennep, Netherlands)

The students were trained in the use of the HVRS before the experience, and a teacher was always available in the simulation center to provide necessary support. The teacher demonstrated a cavity preparation, a pulp chamber opening, and a dental crown preparation, and then, the students performed the training using each of the learning methods described above. After the activity, the students' perception of the experience using these training methods was evaluated through an online questionnaire created with Google Forms. Participation in the research was voluntary and anonymous. Data was collected and analyzed.

Results

Out of a total of 273 students, 183 (67 %) answered to the questionnaire. 85.2 % of the participants were aged between 20 and 25 years old, 8.2 % of them were under 20 years old and 6.6 % were older than 25 years old. Most of the participating students were woman (74.86 %) and there were few men (25.14 %). The results of the questionnaire are shown in Fig 2. Half of the participants rated the similarity between working with the simulator and the extracted human teeth as good. The similarity was moderate for 26 % of them and very good for 17 % of the students. The rest considered the similarity between

these learning methods to be poor (2 %) or very poor (5 %).

The similarity between the simulator and the plastic teeth was rated as good by over half of the students (51 %), moderate by 29 % of them, and very good by 16 %. 4 % of participants found the similarity to be poor and none of them rated it as very poor.

Over half of the students (55 %) believed that the similarity between the sensation produced by the simulator's handpiece and a real high-speed handpiece was good, 25 % perceived the similarity as very good, 17 % as moderate, and 3% of them expressed that the similarity was very poor.

Half of the students (50 %) assured that the experience using Simodont was good and 16% classified it as very good. 31 % of them rated it as poor, and 4 % as very poor.

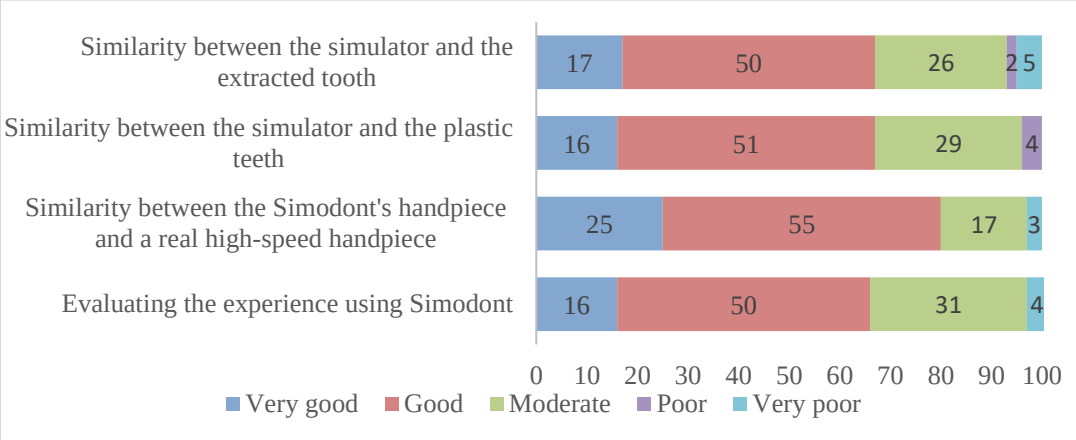

Figure 2: Student's perception towards the use of the haptic virtual reality simulator Simodont

Text in Figure 2 was altered "Similarity between the simulator and the extracted tooth" instead of "Simiarity between the simulator…"

Discussion

The present study aimed to evaluate the students' perception towards the similarity between working with extracted human teeth, plastic teeth, and the Simodont Dental Trainer. The results of this study (Fig 2) demonstrated that Simodont could complement traditional preclinical training methods since most of the participating undergraduate students (67 %) believed that the sensation produced by the simulator was similar to working on extracted or plastic teeth. In addition, most of them (80 %) considered that Simodont simulated a real handpiece. According to the manufacturer, Simodont provides highly realistic force feedback to give an exact feeling of the objects (Farag & Hashem, 2021). Moreover, half of the students assured that the experience using Simodont was good and 16 % classified it as very good.

Current dental education focuses on the use of innovative strategies to teach the necessary skills and knowledge to begin the clinical practice (Saravia-Rojas, 2022). There is a growing interest in the use of HVRS during preclinical training, as this technology offers significant advantages (Genaro & Capote, 2021).

HVRS increases fine motor skills and hand-eye coordination (Murbay et al., 2020; Roy, Bakr, & George, 2017). Training can be programmed according to each student's skill level, and they can repeat the task indefinitely while receiving real-time objective feedback (Murbay et al., 2020; Roy et al., 2017). This technology allows dental students to be in the best conditions for their clinical activities (Murbay et al., 2020; Roy et al., 2017). Previous studies have shown that Simodont significantly improved the performance of undergraduate dental students (Murbay et al., 2020; Roy et al., 2017).

The results found in the present study are in partial agreement with those obtained in a previous study by De Boer et al. (2015), in which the participants considered the virtual teeth generated by Simodont to be very similar to extracted human teeth but not very similar to plastic teeth. The participants in that study claimed that the shape, color, and overall appearance of the virtual teeth were very similar to extracted human teeth, and that the latter could be replaced by simulation (De Boer et al., 2015). In that study, in addition to the participation of undergraduate dental students, there was collaboration from teachers, dentists, and postgraduate students with greater clinical experience, making it easier for them to differentiate between a human tooth and a plastic one (De Boer et al., 2015). HVRS should be part of modern education, not only for undergraduate students but also for graduate ones (Murbay et al., 2020; Roy et al., 2017). Simulation centers should be accessible to everyone to overcome economic and intellectual obstacles (Murbay et al., 2020; Roy et al., 2017).

The sensation produced by HVRS was very similar to that perceived when working on extracted human teeth and plastic teeth, so this learning method can be implemented in the preclinical training as a complementary strategy. Before HVRS replaces traditional training methods, further studies must be conducted to assess the faculty and students' perception of this technology, the clinical performance after its use and the cost-benefit of this strategy. Research must be continuous due to rapid advances in hardware and software technology that allow better virtual reality experience (Roy et al., 2017).

Conclusion

The sensation produced by the haptic virtual reality simulator Simodont was very similar to that perceived when working on extracted human teeth and plastic teeth, so this technology can be implemented in preclinical training as a complementary strategy.

Acknowledgments

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