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Perspective

Perspectives on the implementation of haptic virtual reality simulator into dental curriculum

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Simulation learning and training is an important part of clinical competency-based dental education. Phantom head and artificial teeth are usually used in the traditional dental simulation training. However, the ethical constraint for the use of human teeth and the diversity on anatomy or pathology of each tooth were concerned in the simulation-based curriculum.[1]

With the continuous innovation of digital simulation technology in dentistry, haptic technology can create the mechanical force feed-back stimulation and also let the users generate the tactile sensation from virtual objects.[2] With haptic technology combined with realistic scenes and models, the users can have unlimited practice under virtual reality (VR) environments. The haptic 3D VR dental simulator Simodont® (Nissin Inc., Nieuw-Vennep, Netherlands) has become a new mode to facilitate traditional dental education in psychomotor skill and critical learning.[3–5]

In this article, the authors presented the advantages, experiences, and potential sustainability of Simodont® from School of Dentistry, Chung Shan Medical University (CSMU). The advantages of Simodont® such as haptic 3D VR environment, eco-friendly, multimodal feedback and assessment, and clinical relevant customized cases for learning and training were emphasized and discussed as follows.

Early simulator was a 2D visual simulation of real or fictional environment.[2] The use of 2D visual simulator in dentistry, it is visually impaired in the judgment of position, size, and depth.[3] The 3D visual simulator Simodont® may become more clinical relevant with various senses of touch in tooth structure.[2] In addition, drilling sound, spot light, water spray, hand switching, and bleeding from pulp chamber are also imitated as clinical situations. These immersive simulations will let the users with more real interaction experience.

Traditional dental simulation training tools include phantom head, various instruments, and artificial teeth. Single-use plastic tooth makes the environmental unfriendly. In addition, the small plastic particles from artificial tooth preparation can cause environmental pollution. However, Simodont® can provide repeated practice without any waste disposal to move towards eco-friendly dentistry or the so-called "green dentistry". In addition, trainees can unlimited practice without purchase any plastic tooth for reducing the gap between rich and poor.

Abundant feedback methods are supplied in Simodont® such as automatic scoring, level setting, interactive question forms, and post-operation feedback.[2–4] Simodont® also offers a self-assessment tool to quantify the learning outcome of trainees by themselves.[2,4] During current COVID-19 dilemma, these characteristics of Simodont® let

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it be a good alternative for the maintenance of regular dental education.[5]

A novel module Courseware (Nissin Inc., Nieuw-Vennep, Netherlands) in Simodont® allows tutors to customize the high-resolution stereoscopic dental models from real patients.[4] Then, the trainee can prepare real patients in the VR environment. This simulation environment setup has been applied in cavity preparation[4] and tooth preparation.[6] This method would enhance the patient safety during dental healthcare environments. In addition, it may also meet the concept of "patient-centered care" or "personalized medicine" for improving dental health outcomes for individual patients.

In Taiwan, School of Dentistry, CSMU is the first dental school to integrate this haptic 3D VR technology into its curriculum since 2019. With the implementation of the Simodont®, CSMU is moving into a new era at the forefront of VR in dental education. The stepwise curriculum mapping for Simodont® were divided into 3 directions: (1) Early exposure for low grade students in the class of dental anatomy; (2) Virtual pre-clinical simulation lab for middle grade students' learning in the class of operative dentistry, endodontics, fixed prosthodontics, and pediatric dentistry; (3) Clinical lab for dental interns and post-graduate training for dentists in cavity preparation, assess cavity preparation, and crown preparation procedures. From the recent surveys, Simodont® was found to be a good educational tool in pre-clinical simulation learning[7] as well as in post-graduate training program.[6] Simodont® greatly increases the opportunities for more realistic practice which will result in improved skills for better patient care in the future.

Nowadays, for university how to achieve 17 Sustainable Development Goals (SDGs) (listed in supplementary)[8] is a hot issue. Education is an essential component of SDGs, especial in dentistry. Recently, oral health was reported to be the first step to achieve SDG3 (Good health and well-being).[9] The proposed potential achievements of implementation of Simodont® into dental curriculum for SDGs were shown in Table 1. The transition from traditional simulation lab to 3D VR simulation lab in School of Dentistry, CSMU can reach the SDG4 (Quality education).[8] By the embedding of quality education with haptic 3D VR technology, this could facilitate SDG3,[8] SDG10 (Reduced inequalities),[8] and SDG 12 (Responsible consumption) target 12.5 (By 2030, substantially reduce waste generation through prevention, reduction, recycling, and reuse)[8] to prompt sustainable development in CSMU.

Taken together, the implementation of haptic 3D VR simulator into dental curriculum could provide students more sufficient experience in pre-clinical learning and training to ensure patient safety when they go to clinic for treating their own patients. In addition, the curriculum reform may also contribute to the sustainability in dentistry.

Table 1 The potential sustainability of Simodont® within dental curriculum.

SDG	Achievement
3 (good health)	Personalized dentistry
4 (quality education)	Quality dental curriculum
10 (reduced inequality)	Fair usage policy
12 target 12.5 (substantially reduce waste generation)	Eco-friendly dentistry

Declaration of competing interest

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

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jds.2022.02.011.

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