SPECIAL FEATURE

What role do alternative realities play in educating dentists?

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By Caroline Holland

The education of dentists is at a crossroads. Traditional and progressive modes of teaching are on offer. Advancing technology has led to the development of simulators which dentists in training can use to build up experience before they go near a patient. In 2011, King's College London Dental Institute won an award for its hapTEL (haptics in technology-enhanced learning) while Plymouth University's dental degree was created with a Simulated Dental Learning Environment as a key aspect of the course.

Simulators employ haptic technology – a feedback system which introduces the sensation of touch – to allow the user to feel what it's like, for instance, to administer an ID block or cut a cavity. Dental students hold the handpiece and as they move it they can observe a digital version of their handpiece on the screen in front of them while simultaneously experiencing the sensation of drilling into a tooth.

There are other technologies which are being tested for educational purposes. Foremost is augmented reality (AR), a technology which keeps students in their own space but adds in a graphical layer to enhance their real world view. In contrast, the better-known virtual reality (VR) usually involves a headset or headphones and creates a separate, immersive reality which is less conducive to the classroom or lecture hall. But the two technologies can converge and although less practical in the class room, VR still has an important role to play in training dentists and surgeons.

Yesh Pulijala has just completed his PhD at the University of Huddersfield and demonstrated that undergraduates who experience immersive virtual reality (iVR) were more confident and knowledgeable than those who followed a computer presentation.[1]

The study group in the trial were given Oculus Rift headsets with Leap Motion controllers mounted onto them. Leap Motion is a sensor which allows the user to use their hands to interact but without touching anything. Their fingers operate like a mouse but require no contact. The Oculus Rift had been adapted for the study to show a maxillofacial surgical procedure.

Working together, the two devices enabled the dentists in the study group to view a Le Fort osteotomy and use their hands to direct activities, checking the patient's notes, for example, or to move around the virtual room. Meanwhile, the control group viewed the procedure via PowerPoint.

Yesh references a 1978 paper[2] that shows that 75% of learning is cognitive and 25% technical. He said: 'First you must teach your eyes to see and then your hands to touch. I think that's very important and in terms of understanding, you must know surgery from A-Z before you learn to physically do it.'

When it comes to educating dentists, the acquisition of experience is critical however, and the development of appropriate technology for the teaching of medical and dental students seems to have been slow to take off.

As far back as 2008, Chief Medical Officer Liam Donaldson advocated that there should be a national centre for simulation.[3] This would allow for a whole swathe of medical and dental professionals to acquire a range of skills, whether in delivering injections or carrying out surgery. But this has not come to fruition.

There is plenty of evidence of novel approaches being tested but in different ways in different centres and none has so far become established. Companies in the haptic field view the dental and the aeronautical industries with great interest. The tiny area in which a dentist must work and the skill and dexterity required make the profession receptive to the development of teaching technology.

Chris Stokes is a senior university teacher in Sheffield University's School of Clinical Dentistry and he leads on the teaching of digital skills. Chris believes that augmented reality will ultimately be the way forward in the teaching of dentists of the future. But it was tried and tested too early.

'It was fun and engaging but there were too many barriers. It was unwieldy. People like to touch things in dentistry.'

Initially, it meant working from an iPad on which the teaching notes were stored and then they would use a QR marker to create an AR 'pop-up'. The trouble was that the image size was limited to the device they were using and getting the lighting right in order to view the AR image was problematic. He moved onto a more conventional flat display of three-dimensional objects, saying of AR: 'It was great for novelty, but at the time it was a distraction from the learning rather than an aid in the way I was using it.'

He references the hype curve to describe the evolution of AR. The curve has five phases that may well be familiar to any dentist who has had high hopes of a new technology. First you have the concept or technology trigger, then a sharp upward movement to reach the peak of inflated expectations followed by a downward move to the trough of disillusionment before moving up the slope of enlightenment which finally levels out and forms the plateau of productivity.

Video games, he says, were a driving force which probably helped drive up inflated expectations of how virtual and augmented reality might work in the clinical and teaching spheres. Early iterations of simulators provided an immersive experience which weren't appropriate for a classroom of trainee dentists. They had virtual reality headsets which everyone wore to view a virtual reality world but the undergraduates could not see their tutor or their class mates.

'What you want is a technology that keeps you in your space in the classroom along with your tutor and your fellow students but then adds to what you can see. This is what augmented reality can now do which is why we are going back into it.'

At Sheffield Dental School a group is now undertaking collaborative research with the Department of Computer Science and HRV, a commercial supplier of medical simulators. PhD researcher Ashley Towers is working closely with the dental team on a number of research projects to find how these technologies can be employed to the greatest effect for

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teaching operative dentistry and what their limits are.

Said Chris: 'We are tackling this from the paedagogical angle and working with students so we understand how haptics helps their clinical skills and also how they can learn faster and what gives them the feedback they need. My personal prediction is that we find the majority of dental students are at home with the technology but there are a few who are not comfortable. Visualisation of 3D can make some people feel nauseous. There is an accessibility issue we need to understand.'

What's interesting to observe, says Chris, is the difference made by prior experience of the technology as it comes into the mainstream, with the assumption that video-gamers may be likely to adapt more quickly.

At Sheffield, students are using HRV VirTeaSy simulators in their first three years of study as part of their standard training. But the teaching team are working on ways in which the haptic software can routinely incorporate the scans of patients who the students will see in the clinics. 'Imagine having a tricky crown prep ahead of you and being able to prepare for it using an accurate scan of the patient who will be in your chair,' says Chris.

Dr Alastair Barrow believes that when haptic technology is standardised across all medical and dental education, the speed of its development will accelerate. Alastair was a researcher on the hapTEL project, running the technology side, before going to Imperial College to work on developing technology for laparoscopic and endoscopic procedures.

What was learned, he said, was that simulators working with AR and VR are beneficial to clinical training but there were adoption problems. Alastair is now MD of the technology start-up Generic Robotics and working to break down the silos that have developed due to professions and institutes investing in their own bespoke technology. Sometimes, he says, different departments in the same university have technology which has its own warranty and requires its own expert. Such an approach is not viable in the long term.

Generic Robotics is making general purpose simulator platforms which are available to developers to add their own software modules, whether for veterinary, surgical or dental procedures.

Technology which is translatable must be the future, especially in a relatively small profession like dentistry.

Ben Underwood, developer of the BrushDJ app and an NHS innovation accelerator fellow, believes that both VR and AR are destined to be transformative in patient education. His app, a toothbrushing timer which promotes oral hygiene in a fun way, is built around music, the most universal of languages. The app has been downloaded in more than 190 countries. Simplicity and ongoing evolution of the technology have been key.

If progress in developing universal dental training technology has been slow, it's been for the best of reasons, making sure it's fully tried and tested. As this year progresses, it seems likely that alternative realities are going to play an ever greater role in educating dentists of the future.

1. Pulijala Y, Ma M, Pears M, Peebles D, Ayoub A. Effectiveness of immersive virtual reality in surgical training - a randomized control trial. *J Oral Maxillofac Surg* 2017; doi: 10.1016/j.joms.2017.10.002 [Epub ahead of print].
2. Spencer F C. Teaching and measuring surgical techniques – the technical evaluation of competence. *Bull Am Coll Surg* 1978; **63:** 9–12.
3. BBC News. Simulators key to doctor training. 16 March 2009. Available at: http://news.bbc.co.uk/1/hi/health/7942750.stm (accessed December 2017).

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