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Frameworks for integrating technology into optometric education

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1 CET point for UK optometrists

Introduction

Technology has driven a major societal change permeating the very traditions, beliefs and rituals of our social and work milieu. Following the revolution caused by the introduction of the Gutenberg printing press, the current digital epoch has been recognised as the second major event in history that has extended and enhanced access to information and learning (Brynjolfsson 2014; Topol 2015). Research shows that digital technologies can be used to provide educational opportunities that were not possible before this digital era. These technologies allow learning in contextualised settings and provide a variety of learning opportunities for those studying optometry (Yi 2016) and for those educating patients about eye care (Lee et al. 2007).

However, knowing how to integrate technology into learning has been described as a 'wicked' problem (Mishra and Koehler 2007). Research has demonstrated that educators may not be integrating technology effectively (Kurt et al. 2013). There is evidence that educators who do use technology primarily use it for low-level tasks (Chen et al. 2014; Hsu 2013). This paper discusses some areas where technology may be applied to teaching in optometry and describes two frameworks which can be used when considering how to integrate technology into learning.

Technology in optometry

The recently published *Foresight Project Report* (Manning et al. 2016) has described the potential impact of technology on the future practice of optometry. The report describes recent technological advances in the area of prevention and early intervention (eg three-dimensional binocular refraction, gaming technology for amblyopia treatment, optical coherence tomography (OCT) and ultrawide-field laser scanning ophthalmoscopes).

The *Foresight Project Report* also describes opportunities that are arising for patients to self-diagnose (including self-refraction) and to self-monitor eye conditions. The iSight test is an example of technology use for self-monitoring: it allows both the clinician and the patient to test visual acuity and monitor changes in age-related macular degeneration (Manning et al. 2016).

Information technology plays a rapidly expanding role in patient access to information, self-diagnosis and monitoring. Optometrists have a crucial role in advising about the reliability and accuracy of what is available. In this role, the optometrist becomes an educator, helping patients to understand and use the knowledge and opportunities made available by technology.

Benefits of technology integration in optometry education

Optometrists can find themselves acting as educators for fellow professionals/professionals in training (eg undergraduate students, pre-registration students, other optometrists, dispensing opticians, support staff). For the remainder of this paper fellow professionals/professionals in training will be referred to as 'students'. What follows is an outline of how the integration of technology can benefit students in four areas: knowledge application, skill acquisition, communication and collaboration.

Knowledge application and skill acquisition

Technology can provide the opportunity for learning activities specifically focused on the development of analytical skills rather than pure factual recall. For example, health informatics software can help students learn how to analyse data from complex imaging software such as magnetic resonance imaging scanning to study higher visual centres in the brain and examine retinal imaging data from OCT, retinal hyperspectral imaging and OCT angiography (Lam et al. 2008; Wormington 2003, 2009). Improved access to and skills in the use of informatics software will help optometry professionals make informed decisions about treatment options and patient management.

Another example of technology that can benefit ophthalmic learning is virtual reality (VR), where information can be visualised in three-dimensional simulated environments (Steinberg et al. 2007; Trelease and Nieder 2013). Repeated

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practice in a VR environment can facilitate optometry students' ability to interface with real-world clinical environments and can prepare optometry students to perform better-informed diagnosis, treatment and referral of patients (Gupta and Gupta 2016). Both health informatics software and VR move the educational focus in optometry education from students recalling facts to students developing effective analytical and critical thinking abilities to support them in understanding optometry (Noor-Ul-Amin 2013).

Communication and collaboration

In the past the only means of communication between a teacher and a student was found in the lecture hall. Today new digital technologies open possibilities for different kinds of learning relationships, different kinds of interaction and different genres and communicative purposes (Merchant 2012). Digital technologies provide numerous interactive platforms for communication such as chat rooms, Google hangouts for webinars and lectures, blogs and discussion forums. These tools open up communication avenues to allow more teacher-to-student and student-to-student interaction.

Digital technologies can enable collaborative learning by enhancing opportunities for stand-alone online learning, where the learning occurs entirely online; blended learning, using both online and in-person learning; and synchronous virtual classroom technology in which a group of students is engaged in online learning at the same time (Davis and Davis 2010).

Effective technology integration

What follows is an explanation of how optometrists can begin to think about integrating technology into both the classroom and the clinic. To achieve this goal, two frameworks will be shared, each explaining how to integrate technology effectively into settings where learning about optometry information is required. These frameworks can provide optometry professionals with an understanding of how technologies can be used for learning, and how choices of digital technology tools and applications can work in optometry settings. Two frameworks often used by educators to incorporate technology into the curriculum are the technological, pedagogical and content knowledge (TPACK) framework (Mishra and Koehler 2006) and the substitution, augmentation, modification and redefinition (SAMR) framework (Puentedura 2009).

TPACK

The TPACK framework is based on Shulman's (1986) original framework that highlighted the connection between pedagogy and content with a two-circle Venn diagram. Mishra and Koehler (2006) added technology to highlight that there were three areas of knowledge that a teacher should have – technology, pedagogy and content knowledge. These three types of knowledge are represented by a Venn diagram with three overlapping circles (Figure 1). In each of the three circles are the three categories of knowledge that an educator should have: content knowledge, pedagogical knowledge and technological knowledge.

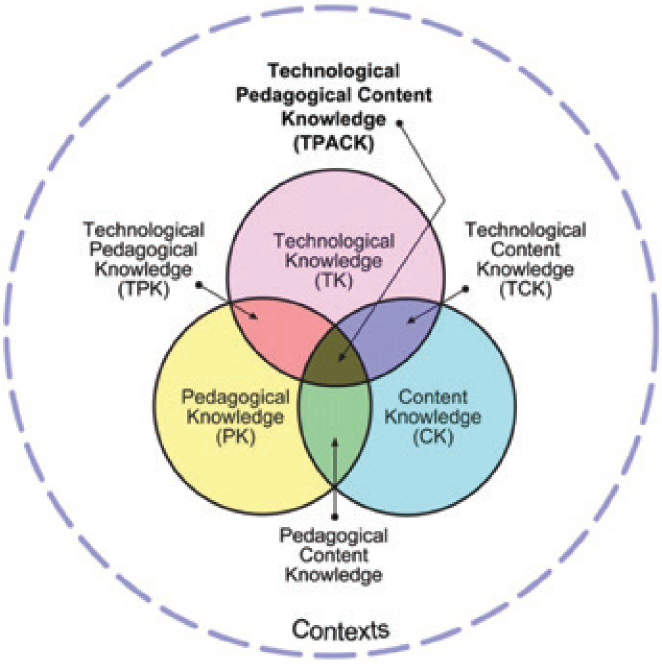

Figure 1. Mishra and Koehler's (2006) technological, pedagogical and content knowledge (TPACK) framework.

Content knowledge is the understanding about a particular subject area. For example, if an optometrist is teaching a group of learners or an individual patient about eye injuries, he/she needs to have a good grasp of typical eye injuries, treatments, tests, symptoms and other related factors.

The second circle is pedagogical knowledge. Pedagogy is the term used to describe the method and practice of teaching. It is a category of knowledge that an educator should have about teaching strategies. When teaching about eye injuries the educator needs to know which strategies work best for learners to understand what is being taught. For example, educators would look at what is being taught and determine if learners should work on their own or with partners, if descriptions or photographs work best, if videos or hands-on experiences with learners are the optimal way of learning.

The third circle is technological knowledge. This describes the knowledge the educator has about what technology can be used to help teach about a concept and how the learners should use that technology. The optometry educator needs to know what technologies the optometrist should use with learners, such as retinal camera, phoropter and autorefractor, and also what other technologies can be used in learning. These other technologies may include mobile phones and web-based programs. For example, if the educator is teaching learners about eye diseases and disorders, he or she may have them summarising their knowledge by developing a flashcard-type approach with one of the web-based programs, such as Quizlet, Brainscape and Cram, that allows learners to put information on to a virtual card, including images, video and other useful links.

With the three circles of knowledge – content, pedagogy and technology – the overarching message regarding the TPACK framework is that, when the three areas are working together, effective technology integration is achieved. In other words, the optometry educator would be thinking about what he or she is teaching and using the best approach to teach with the technology to help learners learn.

The TPACK framework also has a larger circle around the Venn diagram (dashed line). This is the context and is a reminder to educators that they need to think about the context in which they are teaching. You would use a very different approach when teaching ophthalmic students about care for eye injuries than when teaching a patient the same information. This overarching context makes a great difference to the level and type of content knowledge, pedagogical knowledge and technological knowledge that the ophthalmic educator uses.

It is important that educators understand that these are the three overarching factors that enable good teaching. This framework, with the interlocking sections, highlights that the three need to connect. Educators need to think carefully about their students and be sure to remember the context. The context is the age of the students and whether the students are members of the public or those in a typical classroom. This outer context circle is part of the framework but it is not always obvious and could be forgotten.

SAMR

The SAMR model (Puentedura 2009) is a different type of framework from TPACK and can be used to assist educators in thinking about technology integration. The SAMR model categorises technology use in four different ways which focus on how technology is used to benefit the learner (Figure 2). The four levels – substitution, augmentation, modification and redefinition – begin with a very basic use of technology and at each level the use of technology becomes more sophisticated.

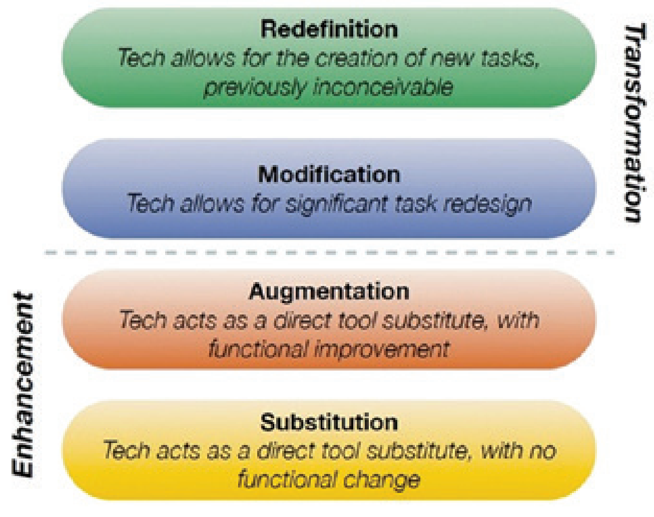

Figure 2. Puentedura's (2009) substitution, augmentation, modification and redefinition (SAMR) model.

The substitution category describes the use of technology for a task that could be accomplished just as easily without it. Technology provides no functional change to the learning task. For example, when teaching students about contact lens care, providing them with a link to a web-based copy of text instructions instead of a paper copy would be at the level of substitution. The paper copy of the instructions has just been substituted for a web-based version; no benefit is provided.

At the augmentation level of technology use, learners are provided with some additional learning benefit. For example, if a student who is learning about contact lens care was given a web link that had text and image instructions and frequently asked questions that linked to other similar resources, functional improvement is provided by the use of technology. Both the substitution and augmentation levels are at the lower end of the framework of technology use and are called enhancement.

The third category is modification. This describes activities where the technology allows for a significant task redesign. At this level the technology integration becomes transformative, requiring a redesign of the learning around the digital tool. In the case of the modification level, the digital tool has the ability to access environments outside the classroom. For example, the educator might give a link to a step-by-step video on how to look after contact lenses. This allows learners to watch the process at any time of the day; they can study the person demonstrating the actions they need to perform as many times as they need.

At the top of the framework is redefinition. This category describes tasks that could not be conducted without technology. An example might be a website that had a computer simulation that mimicked contact lens care. Learners could manipulate and choose things to do with the lenses in different orders, to which they will get immediate feedback as to whether they are correct or not. This is the redefinition phase as this would not be easily possible without technology. These top two categories of SAMR are jointly named transformation as they take advantage of those affordances that only technology can provide.

The SAMR framework helps educators think about how they are using technology in their teaching. It is a relatively simple framework but there can be challenges. For example, an educator trying to align an activity to the SAMR framework might place it at the category of augmentation, whereas another person might place it at the modification category. This divergence is due to the broad definitions for each category that can be perceived slightly differently depending on who is reviewing the activity and the argument that is developed.

The SAMR framework could be further developed to explain each category in great detail, although this may detract from its ease of use by educators. The SAMR framework can be considered an overarching guideline for educators to think about the use of technology and how it benefits the learner beyond teaching without technology.

Summary

To make the best use of technology for learning requires careful thought. In this paper, the TPACK and SAMR models are presented to enable educators to think about how to incorporate technology effectively. TPACK requires the educator to match the content, teaching approach and technology together for effective learning. The SAMR framework encourages educators to think about purposeful use of technology to go beyond what can be done with traditional teaching methods without technology.

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CET multiple choice questions

This article has been approved for one non-interactive point under the GOC's Enhanced CET Scheme. The reference and relevant competencies are stated at the head of the article. To gain your point visit the College's website www.college-optometrists.org/oip and complete the multiple choice questions online. The deadline for completion is 31 July 2019. Please note that the answers that you will find online are not presented in the same order as in the questions below, to comply with GOC requirements.

1. Which of the following is true about the TPACK model?

- It is based on work by Puentedura
- It does not encourage educators to think about the context in which they are teaching
- It requires educators to consider how content, pedagogy and technology should work together to enable effective learning
- It uses a two-circle Venn diagram

2. You are responsible for teaching clinical assistants how to perform visual field testing in the practice where you work. In previous years you have given each member of staff a paper handout but this time you have uploaded the handout to a website which contains links to further reading and a list of common questions. With regard to the SAMR framework, this would be considered:

- Substitution
- Transformation
- Augmentation
- Redefinition

3. Which of the following is false regarding the Foresight Report?

- It was published in 2016
- It mainly reports the effect of technology in the past
- It describes technological advances in the area of prevention
- It describes technological advances in the area of early intervention

4. Which of the following represents the application of TPACK in teaching university students about glaucoma detection?

- Consideration of optic nerve head imaging and analysis, knowledge of the ocular changes that occur with glaucoma, deciding whether to have students work together or alone
- Consideration of the knowledge of ocular changes that occur with glaucoma, deciding whether to have students work together or alone
- Consideration of how technology can transform the learning task
- Consideration of optic nerve head imaging and analysis, knowledge of the ocular changes that occur with glaucoma, deciding whether to have students work together or alone, thought given to the current level of knowledge the students have

5. In the SAMR model redefinition describes:

- Where technology acts as direct tool substitute
- Where technology allows the creation of previously inconceivable tasks
- Where technology allows for significant task re-design
- Where technology acts as a direct substitute but with functional improvement

6. In the SAMR framework the development of an artificial eye which could simulate a wide variety of retinal pathologies would be:

- Substitution
- Transformation
- Augmentation
- Redefinition

CPD exercise

After reading this article, can you identify areas in which your knowledge of frameworks for integrating technology into optometric education been enhanced?

How do you feel you can use this knowledge to offer better patient advice?

Are there any areas you still feel you need to study and how might you do this?

Which areas outlined in this article would you benefit from reading in more depth, and why?