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Review of the literature Open Access

The use of technology in healthcare education: a literature review

Tom Grimwood[1], Laura Snell[1]

Corresponding author: Dr Tom Grimwood tom.grimwood@cumbria.ac.uk

Institution: 1. University of Cumbria

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Abstract

This paper presents a literature review into the use of technology in healthcare education. A search of three electronic databases resulted in 20 articles for inclusion in the review. The articles were synthesised into a narrative review. The review identified four key themes across the literature: the types of technologies used in healthcare education; the integration of technology into the healthcare curriculum; the skills and knowledge of the healthcare educators; and the benefits of using technology for the learners. The literature demonstrated that a wide range of technologies are now used within healthcare education, and this requires educators to adapt their practice and develop their technical skills to be competent users. The successful integration of technology into healthcare curriculums can be beneficial for healthcare learners by developing their clinical and professional skills, and enhancing their learning experience.

Keywords: healthcare; technology; education; technology-enhanced learning; distance learning

Introduction

Technology is widely used in undergraduate and postgraduate education, along with continuing professional development courses. According to the Higher Education Funding Council for England (HEFCE, 2009), the benefits of using technology in education can be identified at three levels – efficiency, enhancement and transformation. The Department of Health's (DoH) technology-enhanced framework states: "Innovative educational technologies, such as e-learning, simulation and smart-phones, provide unprecedented opportunities for health and social care students, trainees and staff to acquire, develop and maintain the essential knowledge, skills, values and behaviours needed for safe and effective patient care" (DoH, 2011).

Simulation has been used in medical, dental and nursing education for more than 50 years (DoH, 2011), and e-learning has played a key role during the past two decades. However, the DoH reported "significant variation in the

provision and use of e-learning, simulation and newer technologies both geographically and between disciplines" (DoH, 2011). Furthermore, it was suggested that "opportunities for multidisciplinary and interprofessional learning are not being fully exploited" (DoH, 2011). In order to address this, Health Education England (HEE) launched the Technology Enhanced Learning (TEL) programme in 2013 with "a vision that patients and public in England benefit from a health and care workforce educated using the most effective evidence informed technology and techniques" (HEE website). In addition, the Association for Simulated Practice in Healthcare (ASPiH) published national standards for simulation-based education in healthcare (ASPiH, 2014, 2016), and recommendations have also been published for using simulation in core medical training (HEE, 2016) and commissioning TEL within the NHS (HEE [date unknown]).

Methods

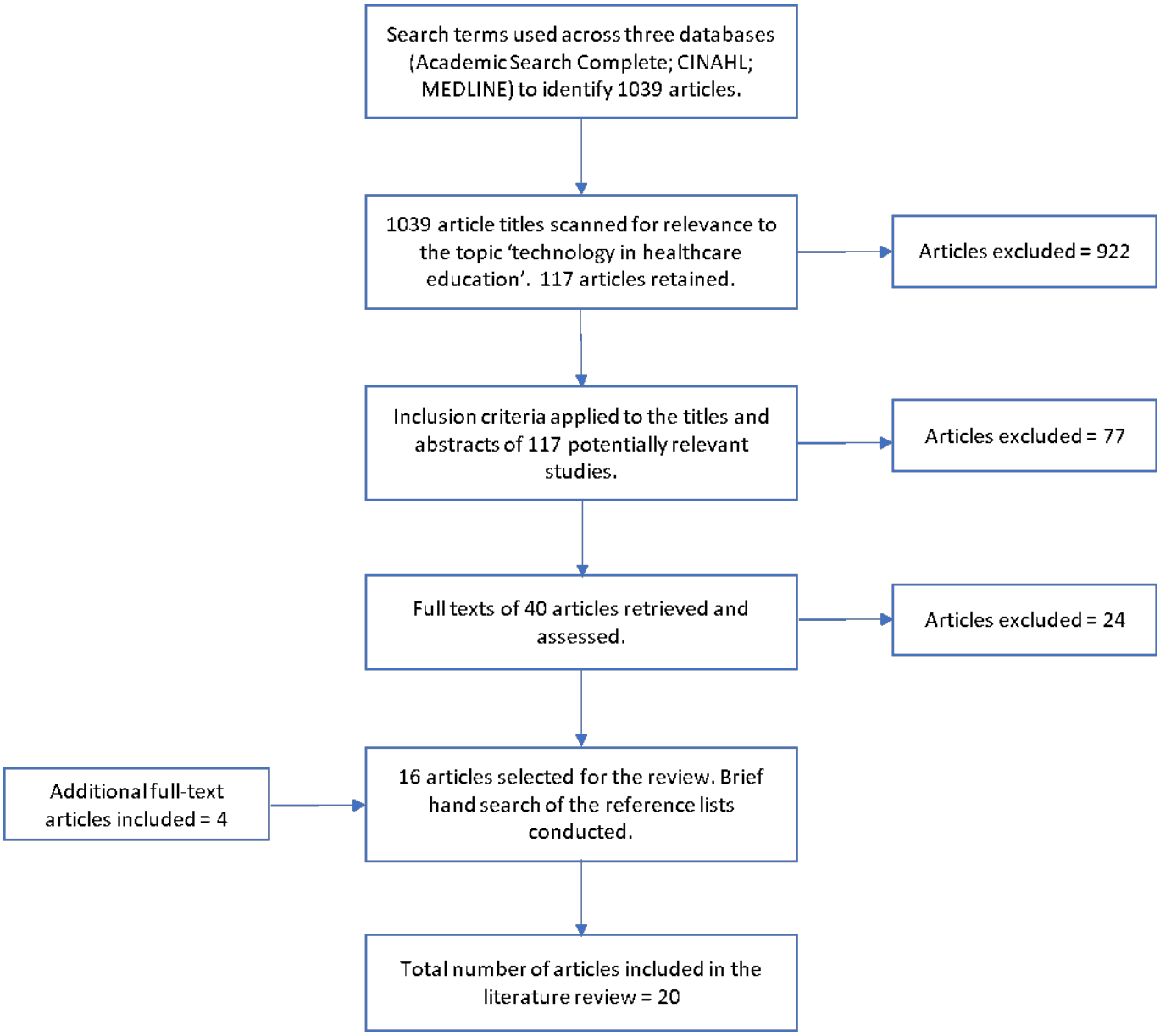
This literature review sought to explore the types of technologies used within healthcare education, the modes of delivery and successful outcomes, and what measures are used to assess and evaluate the use of technology. Three databases were used to conduct a systematic search for literature: Academic Search Complete, CINAHL and MEDLINE. The Boolean search operator 'AND' was used to combine the search term 'healthcare education' with the following terms: 'technology', 'mobile technology', 'simulation', 'virtual reality', 'social media', 'e-learning' and 'paramedic'. These search terms were applied to the abstract field across all three databases. The timeframe for the literature search was restricted to a ten-year period from 2009 to 2019, which followed the introduction of iPhone technology in 2007.

Studies that met the following criteria were included: academic or grey literature; UK or international studies; written in English; published between 2009 and 2019; qualitative and quantitative study designs, systematic reviews, guidelines/frameworks, primary and secondary research; studies focused on the use of technology (specifically mobile technologies, simulation, virtual reality, social media and e-learning) in undergraduate or postgraduate healthcare education.

Literature was excluded for the following reasons: not focused on the use of technology in healthcare education; not written in English; technology within specialist fields or for specific medical conditions; technology designed to be used by medical patients; commentary/opinion papers; and studies not generalizable to UK healthcare education.

As detailed in Figure 1, the literature search utilised a three-stage screening process. Full texts were excluded if they were not immediately available through the three online databases, OneSearch or Google Scholar. One of the articles identified through the hand search was published in 2008, which was outside the initial search timeframe, but provided a valuable guide to e-learning within healthcare education and was therefore included for review. The 20 articles identified for the literature review broadly explored a range of technologies within healthcare education: simulation (eight sources), e-learning (four sources), mobile technologies (three sources), multimedia (one source), classroom technology (one source), and the evaluation of technology-enhanced learning in healthcare education (three sources). The literature was summarised and synthesised to present a narrative review that explored the key themes relating to the use of technology in healthcare education.

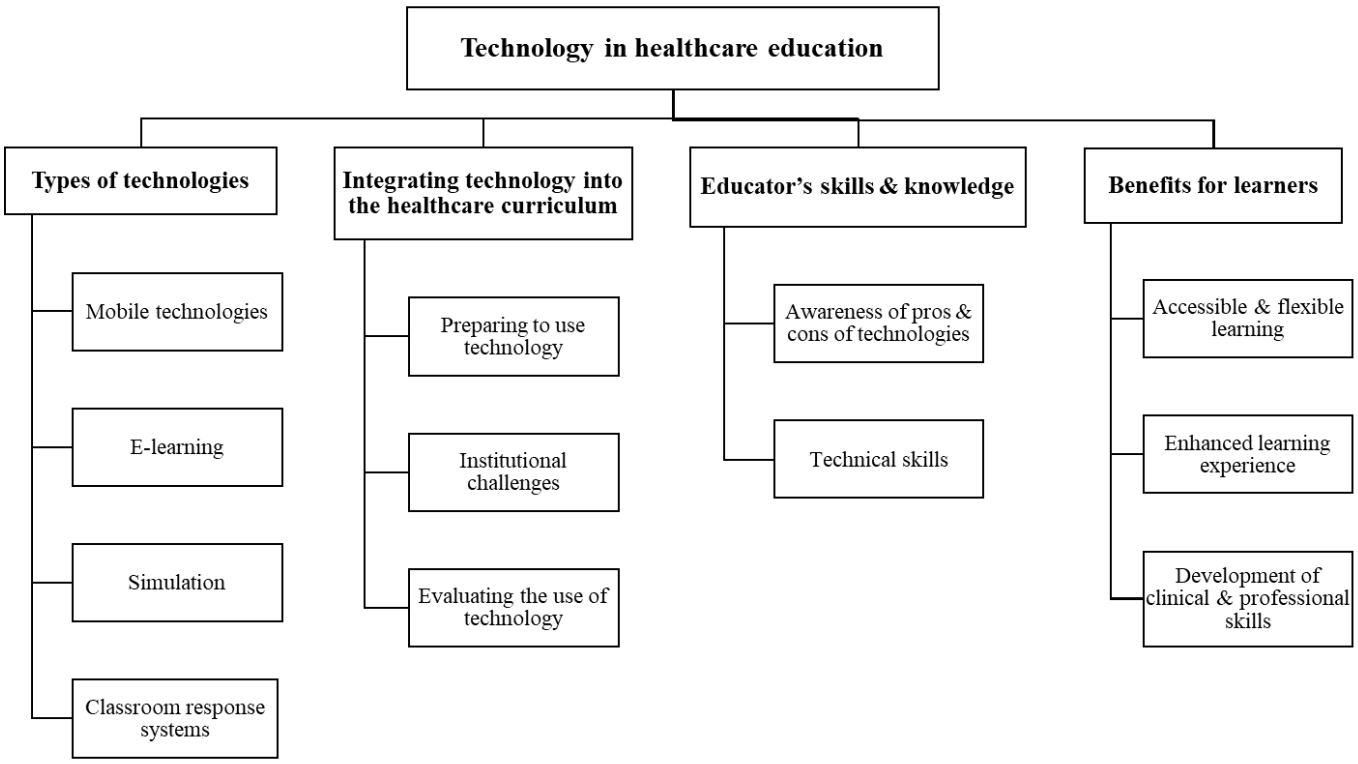
Figure 1: Literature review screening process



Results

Four themes were identified across the literature: the types of technologies used in healthcare education; the integration of technology into the healthcare curriculum; the skills and knowledge of the healthcare educators; and the benefits of using technology for the learners. The themes are presented in Figure 2 below, and are arranged in a schematic sequence from left to right to reflect the design of educational programmes, from identification of available technologies (left-hand side), through aspects of implementation and delivery, and finally reaching benefits for learners (right-hand side).

Figure 2: Schematic sequence of literature themes



Types of technologies used in healthcare education

Mobile technologies

Mobile technologies typically include handheld, portable devices such as smartphones, iPads, tablets and e-readers. Between 2002 and 2012, personal digital assistants (PDAs) were one of the most commonly used mobile technologies within healthcare (Guo *et al.*, 2015), but PDAs have now been largely superseded by smartphone technology. Mobile devices can be used for a myriad of reasons within healthcare education: gathering information (e.g. through accessing drug reference guides or medical literature); supporting clinical decision-making (e.g. the use of medical calculators or disease diagnosis aids); accessing patient records and recording or monitoring patient data; receiving alerts (similar to a pager device); time management through calendar applications; scanning documents; making notes and word processing; recording audio or dictating notes; and communicating with others through engaging with social media, phone calls, text or email (Ellaway and Masters, 2008; Wallace *et al.*, 2012; Guo *et al.*, 2015; Masters *et al.*, 2016). A range of medical software apps are now available for healthcare professionals to download onto the various handheld devices, for example: ICD10, Medscape, PubMed, British National Formulary, Pepid, Skyscape and Dynamed (Wallace *et al.*, 2012; Masters *et al.*, 2016).

E-learning

E-learning is a common educational approach which uses the internet as a means of educating and connecting with learners. E-learning involves "a pedagogical approach that typically aspires to be flexible, engaging and learner–centred; one that encourages interaction (staff–staff, staff–student, student–student), and collaboration and

communication..." (Ellaway and Masters, 2008). E-learning can be synchronous and asynchronous, and can provide access to a broad range of resources: course materials, multimedia tutorials/videos, educational websites, podcasts, online simulations, and virtual learning environments that might contain discussion boards or assessment tools. Although some education programmes can be provided entirely through e-learning, it is common for healthcare education to take the form of 'blended learning' with both online and face-to-face teaching and resources. However, there is often a lack of consistency with the technologies used within a blended learning approach (Rowe *et al.,* 2012).

Simulation

Simulation provides a realistic scenario for learners to practise clinical skills in a "controlled environment" (Motola *et al*., 2013). Three types of simulation are typically used in healthcare education: low-fidelity, mid-fidelity and high-fidelity (Harder, 2010). Low-fidelity simulation includes role play, a task trainer or non-computerised technology which is used to teach basic technical skills. Mid-fidelity simulation can include computer games, technology which has some realistic feature (such as a pulse or breathing sounds) or the use of standardised patients. High-fidelity simulation tends to be the most realistic with computerised human patient manikins (Harder, 2010; Gough *et al*., 2012; Motola *et al*., 2013; Murdoch *et al*., 2014). Some programmes also use fully equipped simulation environments e.g. operating theatres, dental simulation suites and simulation ambulances. In addition, virtual reality simulation "re-creates real life scenarios" in "a virtual clinical environment" (Duff *et al*., 2016) and can simulate a specific healthcare setting (e.g. a hospital) or enable users to interact in a virtual world, such as Second Life (Liaw *et al*., 2018). Augmented reality is a simulation technology which enables virtual objects to "be embedded in a real physical context" (Zhu *et al*., 2014).

Classroom response systems

Classroom response systems, commonly known as 'clickers', are a two-way technology that enable learners to respond to questions and view the responses, which are often displayed as a bar chart, live in the classroom (De Gagne, 2011).

Integrating technology into the healthcare curriculum

Preparing to use technology

The literature indicates that the integration of technology into the healthcare curriculum requires specific planning, preparation and the adaptation of traditional teaching practices. Educators should focus on selecting the best tools to suit the specific learning goals of their existing healthcare programme (Rowe *et al*., 2012; Motola *et al*., 2013). This approach demands time, support and commitment from educators and the wider institution, and requires the educators to go through a process of planning, implementing and evaluating the technologies (Motola *et al*., 2013). In order for technology to be successfully integrated into healthcare education, the educators are required "to grasp the underlying principles governing their social and pedagogical uses, and then to create an environment in which these technologies can be effectively utilised..." (Masters *et al*., 2016).

Simulation technologies are most successful and sustainable when they are integrated into the existing curriculum model, resulting "in a more goal-directed and sustained use of the tool" (Motola *et al*., 2013). However, Zhu *et al*.'s (2014) review of augmented reality technology in healthcare education identified that often the technology was not actually integrated into the curriculum because traditional teaching strategies for practical skills (e.g. 'see one, do one

and teach one') continued to be prevalent.

Healthcare educators need to consider several factors when preparing to utilise technology: the first language of their learners and the availability of appropriate resources (Bala Krishnian *et al.*, 2016; Duff *et al.*, 2016); the learners' computer skills (Duff *et al.*, 2016); the availability of technical support and how the various technologies can be integrated into the institution's virtual learning environment (Masters *et al.*, 2016).

When using simulation, Motola *et al.* (2013) highlight the importance of planning time during the sessions for feedback and debriefing with the learners to discuss their learning and ensure that the learning outcomes have been met. The difficulty level of the simulation needs to be carefully matched with the needs of the learners and the specific learning outcomes for the task; if the simulation task is too complex, it can have a negative effect on the learning process (Motola *et al.*, 2013). Murdoch *et al.* (2014) and Gough *et al.* (2015) found that interprofessional simulation was most often used during the later stages of undergraduate programmes and therefore, consideration should be given to the "optimal timing" (Murdoch *et al.*, 2014) for integrating technology into healthcare curriculums.

Institutional challenges

The financial cost of purchasing and maintaining the various technologies, and providing the appropriate training and technical support to both the educators and learners, can be a potential challenge for institutions. For example, the literature highlighted the financial costs associated with classroom response systems (De Gagne, 2011), online virtual simulation (Duff *et al.*, 2016), interprofessional simulation-based education (Murdoch *et al.*, 2014; Gough *et al.,* 2015) and mobile technologies (Guo *et al.*, 2015). In addition, the sustainability of e-learning programmes can be a concern for some institutions (Reeves *et al.*, 2018); the appropriate e-learning tools/platforms must be available and capable which requires "investment in their technology and services infrastructure" (Lee *et al.*, 2011).

Evaluating the use of technology

Evaluations of technology used in healthcare education often focus on assessing learner satisfaction, the technology device itself, or pre-test and post-test scores (Harder, 2010; Gough *et al.*, 2015; Pickering and Joynes, 2016; Williams *et al.*, 2016; Nicoll *et al.*, 2018). Williams *et al.*'s (2016) study of paramedic students assessed the learners' satisfaction with simulation by utilising the Satisfaction with Simulation Experience Scale. Gough *et al.* (2015) and Harder (2010) identified that pre- and post-task assessments are often used to assess simulation-based education, and this was attributed to "a lack of formal evaluation tools" (Harder 2010). Guo *et al.*'s (2015) study noted a lack of evaluation into the use and integration of mobile technologies in healthcare education. In addition, it has been suggested that studies evaluating the role of technologies in healthcare education often fail to draw on relevant learning theories or models to justify their use of simulation (Murdoch *et al.*, 2014), multiuser virtual worlds (Liaw *et al.*, 2018) and augmented reality (Zhu *et al.*, 2014).

Kirkpatrick's model of evaluation is a popular tool in education (Pickering and Joynes, 2016; Nicoll *et al.*, 2018), and was utilised by five of the studies included in the review (Murdoch *et al.*, 2014; Cook and Ellaway, 2015; Guo *et al.,* 2015; Reeves *et al.*, 2017; Liaw *et al.,* 2018). However, Nicoll *et al.* (2018) identified a lack of standard tools for evaluating technology-enhanced learning in healthcare education and emphasised the need for quality evaluation studies that provide "sufficient detail to support transferability or direct future TEL healthcare education programs' design and implementation". It has been suggested that adopting a standard approach to evaluating technology-enhanced learning in healthcare education would be beneficial for all those involved as it would prevent the duplication of tools across programmes and organisations, and increase opportunities for making comparisons across

different courses (Cook and Ellaway, 2015; Nicoll *et al.,* 2018).

Two of the reviewed studies attempted to address the need for a standard approach to the evaluation of technology-enhanced learning. Cook and Ellaway (2015) proposed an evaluation framework and designed three generic instruments to be used consistently across different healthcare programmes in order to evaluate the use and success of technology in healthcare education; the three questionnaires were designed to separately evaluate the perceptions of both the learners and educators involved in the programme, and the evaluation framework also suggested that the learners should be assessed at level 2 of Kirkpatrick's evaluation model. Pickering and Joynes (2016) designed a holistic model to evaluate technology resources and assess their impact in a specific context, and to address "the disconnect between the adoption of technology in curricula and its meaningful evaluation." The model has four levels: level 0 - a preliminary evaluation of need prior to developing the resource; level 1 - an assessment of learner satisfaction and learner gain; level 2 - an assessment of learner impact; level 3 - an evaluation of the impact of the resource on the institution. Pickering and Joynes' (2016) holistic model deliberately utilises a range of evaluation tools at each level e.g. student feedback, Likert-scale questionnaires, pre- and post-test measures, focus groups, usage metrics and investment analysis.

Educator's skills and knowledge

Awareness of pros and cons of technologies

The integration of technology in healthcare education requires educators to understand the potential pros and cons of using the various technologies, both in the classroom and healthcare practice, and to communicate this to the learners (Ellaway and Masters, 2008; Wallace *et al.*, 2012; Masters *et al.*, 2016). For example, small mobile devices are lightweight and portable which enables them to be carried easily on the body, but there is always the potential risk of the portable devices being damaged, lost or stolen, which creates a security risk as confidentiality can be breached, especially when patient data is stored on the devices (Ellaway and Masters, 2008; Wallace *et al.*, 2012; Guo *et al.*, 2015). Therefore, it is vital that healthcare educators make their learners aware of the need for password protection, file encryption and anti-virus software on mobile devices, and educate the learners about maintaining digital professionalism and confidentiality (Ellaway and Masters, 2008; Masters *et al.*, 2016). In addition, Masters *et al.* (2016) suggest that educators need to advise their learners about the appropriate mechanism for disinfecting the mobile device itself when being used in clinical environments.

Wallace *et al.* (2012) suggest that mobile devices have the potential to become a distraction in the classroom or clinical setting and disrupt normal healthcare practice as the "devices allow information to permeate everywhere." Furthermore, boundaries can become blurred when mobile devices are used for both personal and professional communication (Wallace *et al.*, 2012). It is therefore essential that healthcare educators advise their learners about the appropriate use of mobile devices, both in the classroom and in healthcare settings, and ensure that their learners can practice competently without always relying on the technology (Masters *et al.,* 2016).

The literature also indicates that healthcare educators need to be aware that the experience of e-learning can be isolating for some learners (Lee *et al.,* 2011; Reeves *et al.*, 2018); this can be addressed by ensuring that healthcare programmes provide regular opportunities for interactions with others (Lee *et al.*, 2011).

Technical skills

As technological glitches can be frustrating for learners (Reeve *et al.*, 2017), educators should be able to provide support with technical issues (Lee *et al.*, 2018; Liaw *et al.*, 2018). Institutions need to provide access to relevant

training so that educators can learn how to use the technology effectively and develop the necessary skills to conduct basic troubleshooting (Lee *et al.*, 2011). Furthermore, healthcare educators must be mindful of technological developments (Masters *et al.*, 2016) and continually "upgrade their technical skills" (Lee *et al.*, 2011).

Benefits for learners

Accessible and flexible learning

The flexibility of online learning is generally appreciated by learners (Lee *et al.*, 2011) as they can study whenever and wherever they choose. Duff *et al.* (2018) reported that online virtual simulation is accessible for learners because it can reduce barriers related to geography and time. In addition, Reeves *et al.* (2017) suggest that e-learning can reduce some of the time pressures typically experienced by health professionals when engaging in professional development. Although some learners might experience isolation with e-learning, it is generally viewed as comparable to traditional classroom teaching (Lee *et al.*, 2011; Reeves *et al.*, 2017).

Mobile technologies provide learners with a wide range of healthcare resources at their fingertips (Wallace *et al.*, 2012; Guo *et al.*, 2015; Masters *et al.*, 2016). The portability and small size of the handheld devices can enable healthcare learners to easily access learning and communication irrelevant of their location in lectures or clinical placements (Ellaway and Masters, 2008). Masters *et al.* (2016) suggest that the convenience of incorporating mobile technologies in healthcare education "means that opportunistic learning can be more easily layered into the learner's day." However, Wallace *et al.* (2012) noted that the rapid access to information afforded by mobile devices can potentially result in superficial learning and cause some healthcare learners to have concerns about how to identify trustworthy applications.

Enhanced learning experience

The literature indicates that incorporating a range of technologies into healthcare education can enhance the learning experience, increase the learner's access to information and engage them in active learning. For example, in the healthcare classroom, the use of clickers has the potential to "enhance learner engagement and participation" through encouraging active learning and promoting "knowledge retention and critical thinking skills" (De Gagne, 2011). The immediate feedback provided through the two-way clicker technology can also be beneficial for assessing the learners' understanding (De Gagne, 2011). Video-assisted learning (which can be facilitated either in the classroom or via e-learning) has been shown to increase the confidence of paramedics when learning emergency skills and encourage them to undertake independent learning (Bala Krishnian *et al.*, 2016).

Mobile devices can provide learners with easy access to a wide range of resources (e.g. medical apps and websites, drug guides, medical dictionaries or clinical guidelines) (Guo *et al.*, 2015; Masters *et al.*, 2016), which can increase engagement and learning, and improve access to patient information at the point of care (Guo *et al.*, 2015). Mobile technologies also have a valuable role in enhancing connections with peers, colleagues and educators (Masters *et al.*, 2016).

Ellaway and Masters (2008) suggest that simulators and virtual patients "can offer highly valid and authentic learning environments, they can be scalable and replayable, they can be made available on demand, and they can be highly immersive for the learner." These types of technologies can enable learners to manage the learning process and "pace themselves" (Ellaway and Masters, 2008). Multiuser virtual worlds can provide effective and enjoyable learning in healthcare education (Liaw *et al.*, 2018). In addition, augmented reality technologies can provide "authentic experiences" which engage the learners and accelerate their learning process, whilst decreasing the

amount of practice needed to achieve a task, reducing the failure rate and enabling "better understanding of spatial relationships" (Zhu *et al.*, 2014).

Development of professional and clinical skills

The literature contained several examples of how the integration of various technologies into healthcare education can enable learners to develop their clinical competencies, communication and professional skills.

Simulation can provide the opportunity for learners to experience a wide range of patients with various conditions in a multitude of settings (Motola *et al.*, 2013). Harder (2010) reported that simulation enhanced the learner's clinical skills, along with increasing their feelings of competence and confidence, and thus it was suggested that "simulation can help prepare clinically proficient health care professionals." Williams *et al.*'s (2016) reported generally high levels of satisfaction with simulation training for paramedics, and Duff *et al.* (2016) stated that online virtual simulation was "comparable to traditional simulation methods for both acquiring diagnostic reasoning skills and for skills assessment."

E-learning in healthcare education has the potential to improve collaborative learning and communication skills (Reeves *et al.,* 2017). Blended learning can enhance the healthcare learner's clinical competencies, reflective skills and clinical reasoning, as well as potentially bridging any gaps in learning between theory and practice (Rowe *et al.*, 2012).

Motola *et al.* (2013) highlighted the importance of teamwork in enhancing patient safety and explained that simulation is "increasingly being used in healthcare education to teach cognitive, psychomotor, and affective skills to individuals and teams." As miscommunication is reportedly the main reason for errors in healthcare, simulation exercises play a key role in educating healthcare students about how to communicate effectively with other professionals (Motola *et al.,* 2013). According to Liaw *et al.* (2018), the motivation for developing multiuser virtual worlds has been the improvement of patient safety and quality of care, along with "government or professional calls for collaborative teamwork and communication." The literature shows that interprofessional simulation scenarios and debriefing can support learners to develop their collaborative practice and reflect on the roles of other healthcare professionals (Gough *et al.,* 2012; Murdoch *et al.*, 2014). Common outcomes of interprofessional simulation for healthcare learners can include: "increased confidence, knowledge, leadership, teamwork and communication skills" (Gough *et al.*, 2015).

Summary and conclusions

The literature surveyed indicates that a wide range of technologies are currently used within healthcare education. Mobile devices are typically used to gather information, support clinical decision-making, update patient records, and communicate with others on both a social and professional basis. E-learning provides accessible and flexible learning, and healthcare education is often delivered through a blended learning approach. Simulation has been used in healthcare education for many years as it gives learners the opportunity to practise their clinical skills in a safe environment, and recent developments in technology have introduced virtual reality and augmented reality simulation. In addition, classroom response systems can be a useful tool for increasing the learner's engagement and understanding.

The successful utilisation of technology in healthcare education requires significant preparation and planning to ensure that the technology is fully integrated into the existing healthcare curriculum. Educators need to dedicate time to identifying the appropriate technologies to achieve the learning outcomes of the healthcare programme and must

be willing to adapt their teaching practice. In addition, the healthcare institutions need to support the educators with continually developing their knowledge and technical skills to ensure they are competent users of the technology, and can provide basic troubleshooting support for the learners. One of the main challenges for institutions can be the financial costs of purchasing, maintaining and sustaining the various technologies used in healthcare education.

The literature review highlighted a lack of standard tools for evaluating the use of technology-enhanced learning in healthcare education, with most evaluations to date having focused on learner satisfaction, the technology device, pre- and post-test scores, or Kirkpatrick's evaluation model. However, it is evident that the successful integration of technology in healthcare education can provide several benefits for the learners, such as: increasing their access to information; creating a flexible learning environment which removes barriers associated with time and geography; enhancing their engagement; and developing their clinical skills, confidence, communication skills and collaborative practice, which ultimately improves patient safety.

Limitations of this study included the restriction of the literature search to three electronic databases and a ten-year timeframe, and the availability of the previously published sources. Nevertheless, the literature review has demonstrated that technology-enhanced learning is now standard practice within healthcare education and this requires healthcare educators to be adaptive, knowledgeable and appropriately skilled. The successful integration of technology into healthcare curriculums has the potential to enhance the learning experience and develop the professional and clinical skills of healthcare learners.

Take Home Messages

- Utilising technologies in healthcare education can increase the learner's clinical and professional skills, and enhance their learning experience, if used appropriately.
- The integration of technologies requires preparation, planning and adaptations to teaching practice.
- Use of technology should be justified by a theory of learning and evaluated robustly.
- Educators need the technical skills to competently use the technology and support learners.

Notes On Contributors

Tom Grimwood, PhD, is Associate Professor in Social Philosophy and co-lead of Health and Society Knowledge Exchange (HASKE) within the Centre for Research in Health and Society at the University of Cumbria. ORCID: https://orcid.org/0000-0001-8099-6191

Laura Snell, PhD, is a part-time research fellow for HASKE and a freelance specialist support professional for deaf students.

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Figure 1. Source: the authors

Figure 2. Source: the authors

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Appendices

None.

Declarations

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Ethics Statement

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