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Views and experiences of using advanced technologies in higher education of healthcare professionals: A systematic mixed-method review

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Introduction: While it is highly recommended to adopt technology in higher education of healthcare professionals, user experiences have not been widely studied. This review investigates the experience of using technology within healthcare higher education, in an attempt to gather useful insights into how use of such technologies can be improved.

Methods: Both quantitative and qualitative data was used for this mixed-method review.

Results: The findings revealed many benefits associated with technology use, which included; improved clinical competency, improved overall quality of education and improved peer networking. However, there were numerous factors which hindered the widespread adoption of advanced technology. These factors included; the high costs involved, a lack of adequate equipment and a lack of understanding in such technology.

Discussion: While the use of advanced technology for the training of healthcare professionals is generally embraced, it is not without problems. It is necessary for institutions to offer relevant and accessible support to both students and teachers, in order to improve the use of such technology in teaching and learning practice.

KEYWORDS

advanced technology, healthcare training, experiences, barriers, facilitators

Background

The 21st century generation, referred to as "millennials", has adopted technology-based activities that affect the way by which these individuals aim to learn (Chiou et al., 2017; Au-Yong-Oliveira et al., 2018; Martins et al., 2018). Current and modern teaching is becoming increasingly inclined to the use of advanced technologies owing to their vast advantages in easing the completion of day-to-day activities, such as information access, communication, shopping, socialization and media access (Kämpfen and Maurer, 2018; Martins et al., 2018). Technology-based gadgets, such as computers, smartphones, tablets, facilitate teaching and learning (Guze, 2015; Johnson et al., 2016) given their vast functions and advantages, such as portability, user-friendliness, customizability and accessibility (Mohmmed et al., 2017; Moreira et al., 2017). Given these characteristics, technology has taken shape in the teaching and learning sector, with a variety of gadgets and equipment being adopted, ranging from simple devices to complex and advanced ones.

In healthcare education, drivers of technology advancement emerge from healthcare needs, which are becoming increasingly demanding for a range of interventions, many of which are based on technology (Risling, 2017). Individuals engaged in the education of

healthcare professionals are therefore expected to ensure that practitioners are prepared for their future role by introducing relevant technologies to their learning (Guze, 2015; Risling, 2017). Curriculum developers in healthcare education are likewise being encouraged to embrace technology and incorporate its components, such as eHealth, electronic records and wearable technologies, in their courses to meet the demands of healthcare practice (Risling, 2017). Recent healthcare trends such as the COVID-19 outbreak has seen a bigger rise in the use of advanced technology, through virtual platforms in training healthcare professionals worldwide (Hosen et al., 2022; Jeffries et al., 2022).

The use of sophisticated technology in healthcare training settings has been successful on account of the value and experience it adds to both the teaching and learning processes and its widespread use within healthcare practice. Forums such as Moodle, Doodle and online news feeds are commonly used in teaching healthcare professions due to their functionalities, which enable easy viewing of teaching content and make teaching and learning increasingly accessible and transparent (Au-Yong-Oliveira et al., 2018; Sklar, 2019; Linderman et al., 2020) and these have seen an increased use during the COVID-19 pandemic (Hosen et al., 2022; Jeffries et al., 2022). These approaches are certainly suitable for the training of healthcare professionals, who undertake off-campus training regularly during clinical and community placements and thus require considerable training flexibility (Johnston et al., 2018). In addition, technology-based approaches are highly engaging, with some being capable of mimicking real-life situations. For example, robots and mannequins mimic real-life situations and are very essential in the training of healthcare students; as the tools enable them to learn health conditions before they interact with actual patients (Archibald and Barnard, 2018), thereby demonstrating a person-centered care approach that minimizes harm to patients (Ireland, 2017).

The adoption of technology in healthcare training has also been influenced by the changing healthcare environment, which now demands increasing independence and involvement of clients in their care. However, one of the critical ethical issues regards safety and confidentiality of its use (Guze, 2015), which has been reported to affect the quality of healthcare services provided (Mohmmed et al., 2017).

User experiences of technology use in higher education

The experience of using advanced technology has been relatively studied in various populations and has indicated positive acceptability and uptake. Despite some reported barriers, majority of users concede that technology is an indispensable educational tool whose use has numerous associated benefits. In healthcare education for example, technology has been commended for changing teachers' and students' experiences of teaching and learning, respectively. Johnston et al. (2018), who assessed how millennial nurses use YouTube to support their learning, stated that certain students believed that technology enabled them to easily understand a rather difficult course in bioscience. The video tools used in this study were perceived to further enhance revision, as the students would review the learnt content on an ongoing basis, thereby increasing students' retention and enhancing lifelong learning.

Many studies have evaluated the application of technology models in higher education and found these successful. A study on the success of an educational management information system (EMIS) in higher education (Martins et al., 2018) established that the use of the EMIS was accepted by students and reportedly increased their satisfaction with the learning process. A related study by Hamidi and Chavoshi (2018), which assessed the factors associated with the adoption of mobile learning in higher education, revealed that mobile learning is a highly acceptable and successful approach that has numerous advantages associated with its adoption, such as ease of use, perceived usefulness and trustworthiness. Another study evaluated the acceptance of mobile technology use among practicing nurses in Germany and found high acceptance and considerable use of mobile technology among the nurses, with factors such as ease of use and perceived usefulness as the main motivating factors for its acceptance (Schmeer et al., 2016). It can therefore be asserted that technology use in higher education could enhance educational efficiency and result in positive learning outcomes.

A systematic review that aimed to assess the effectiveness of using human patient mannequin simulators in teaching undergraduate nursing students in Australia revealed that these technologies highly increased students' satisfaction with learning and were important in teaching particular skills, such as psychomotor skills (Lapkin et al., 2010). These findings indicate that advanced technology not only benefits acquisition of technical skills during the learning situation but can enable students to achieve transferable skills during the simulation experience.

Barriers associated with technology use in higher education

Despite its usefulness, technology use is associated with numerous barriers and challenges that may hinder the use of technology use in education. Concerns include those about increased costs (Mohmmed et al., 2017), having to adopt new curriculums and learning new technologies and teaching techniques (Johnson et al., 2016).

In their review, Lapkin et al. (2010), explained that despite the potential usefulness of high-technology mannequins in the teaching of nursing students, there is a lack of evidence regarding how the use of such tools will facilitate the acquisition of clinical reasoning skills and about whether the skills used will be helpful in the future practice of students. Hence, some authors have suggested that while we need to adopt technology in the higher education of healthcare professionals, its usefulness and the need to integrate it with conventional, non-technological teaching approaches must be reconsidered (Goodchild, 2018). Moreover, as this intervention is relatively new, additional research should be undertaken to evaluate its usefulness and impact on the teaching of healthcare professionals and their future practice (Laschinger et al., 2008). River et al. (2016) also recommended the conduct of added research

on the barriers to the use of technology and the impact of technology on student learning outcomes.

We performed an initial search on three databases, namely, JBI Database of Systematic Reviews and Implementation Reports, Cochrane Database of Systematic Reviews and PubMed, to identify any existing review on our study topic and found four related works. However, none of these reviews could adequately address our review aim. For example, the review by Webb et al. (2017) assessed the utility and impact of information communication technology on enhancing student performance and the learning environment of nursing students. The review by Watts (2018) only assessed the use of social media among radiological students. The review by Jelec et al. (2016) evaluated the application of modern technology in nursing and how it affects the nursing profession, and the review by Lapkin et al. (2010) assessed the effectiveness of using human patient mannequin simulators in teaching undergraduate nursing students in Australia. While these reviews are informative and highlight important aspects of using technology in the higher education of healthcare professionals, they cover limited contexts and scope, as the majority focuses on the nursing profession. By contrast, the current review expands the understanding of the adoption of advanced technologies within higher-education institutions that teach various healthcare-related professions.

Methods

Inclusion criteria

This review included studies that targeted current and/or former students (within the past 5 years) and educators who have been teaching for at least 6 months. Healthcare-related courses, such as nursing, medicine (MBChB), dentistry, medical laboratory science/technology and pharmacy, were targeted. Studies conducted across all healthcare institutions of higher learning in the world were included. We covered students undertaking undergraduate degrees. Hence, studies that included students at diploma, master and PhD levels were not considered. The decision to include only undergraduate students was due to the specific and clearly aligned nature of undergraduate programs compared with the diploma and PhD programs.

The qualitative component of this review sought to establish the experiences, views, perceptions, beliefs, understandings, practices and opinions regarding the use of advanced technologies. Aspects that were assessed included facilitators, barriers and challenges related to the use of advanced technologies in healthcare training. The quantitative component of this review focused on studies that assessed/compared various advanced technologies. Works that aimed to establish the impact of various technologies on learning outcomes were of particular interest.

For the qualitative component we considered studies that focused on various qualitative designs, such as phenomenology, ethnography, grounded theory and action research, in assessing views and experiences with the use of advanced technologies. On the other hand, the quantitative component considered all quantitative designs, such as randomized controlled trials, non-randomized controlled trials, analytical observational studies (such as prospective and retrospective cohort studies), case-control studies, analytical cross-sectional studies and descriptive observational studies (such as case series), that investigated views and experiences with the use of advanced technologies. Articles based on systematic reviews, gray literature, case reports and editorials were not included. Only articles that were written in the English language and achieved 25% in Mixed Methods Appraisal Tool (MMAT) were included in our review (Pluye et al., 2009; Pluye, 2011).

TABLE 1 Search strategy.

Key words	Synonyms/related words/
Experience*	Experience* OR view* OR perception* OR belief* OR understanding* OR practice* OR opinion*
Challenge*	Challenge*OR Barrier* OR obstacle* OR problem* OR hinderance*
Facilitator*	Facilitator* OR Motivation* OR benefit*
Advanced technolog*	Advanced technolog* OR Technolog* OR e?learning OR ICT
Higher education	Higher education OR University OR college*OR institution*OR school
Health?care professional*	Health?care professional* OR Health?worker*OR nurse*OR doctor* OR medic* OR dentist*

Search strategy and quality assessment

The search strategy aimed to identify both published and unpublished papers. A three-step search strategy was executed for each component in this review. A limited initial search on MEDLINE and CINAHL was undertaken, followed by an analysis of the text contained in the titles and abstracts and of the index terms used to describe the identified articles. A second search was performed using all identified keywords and index terms across all the included databases. A third phase involved a search of the reference lists of all the identified reports and articles to find any additional studies. Various databases were searched to identify papers, including CINAHL, Embase, Scopus, MEDLINE, ProQuest, PsycINFO, ScienceDirect, and Web of Science. A search strategy (Table 1) was used to search for eligible studies. The keywords indicated were used alone or combined with others through the Boolean system.

The papers selected for retrieval were assessed by two independent reviewers for methodological validity before being included in the review. This was done using MMAT version 2011 (Pluye et al., 2009; Pluye, 2011) (Appendix 1). MMAT is a valid tool for assessing the quality of mixed-method studies (Pace et al., 2012); hence, we adopted it for the quality assessment of the studies included in this review. MMAT scores the quality of papers from 0 to 100% on the basis of its criteria. This review considered grades of 25% or lower to be indicative of poor quality, and papers with such scores should be excluded. However, no study was removed in accordance with this criterion. No disagreements occurred between the reviewers regarding the quality assessment outcomes.

Data extraction and synthesis

Data was extracted using a modified JBI data extraction tool that extracts both quantitative and qualitative data. The data extracted included the phenomena of interest, populations, study methods, contexts and outcomes of significance to the review questions and specific objectives. Data extraction also involved summarizing the key findings of the included studies. For enhanced reporting of the review findings, the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist and flowchart were used (Moher et al., 2009). Then, one reviewer extracted the data and discussed this with the co-reviewers.

Qualitative and quantitative data was synthesized using a thematic analysis approach, which is suitable for analyzing literature reviews involving quantitative and qualitative data due to its ability to capture themes from various study designs (Dahan-Oliel et al., 2012). This approach allowed the synthesis to be performed in an inductive manner, where themes were generated from the data according to their meanings. This process was implemented by extracting the findings from all the included studies in a Microsoft Word document, followed by a manual coding process, where the findings extracted from the primary studies were categorized. Generated categories were then discussed by the reviewers, organized and consolidated into meaningful condensed themes (Dahan-Oliel et al., 2012). The final themes expressed the patterns of qualitative and quantitative evidence of the experiences of using technology in the higher education of healthcare professionals.

Results

Upon a comprehensive literature search of eight databases (CINAHL, Embase, Scopus, MEDLINE, ProQuest, PsycINFO, ScienceDirect, and Web of Science, 2,070 articles were identified. Eighty-nine (89) duplicates were removed, leaving 1,981 articles to be assessed. Then, 1,749 articles were excluded after a review of titles, and 205 were removed after a review of abstracts, leaving 27 articles for full text review. Of these, 18 were excluded for not meeting the inclusion criteria, leaving 9 studies eligible for inclusion in the review. Through a reading of the reference lists of these eligible studies, 5 additional eligible papers were identified. Overall, 14 eligible papers were assessed for quality, and they were all included in the review. Figure 1 presents details about the search results and the screening of the eligible papers.

Characteristics of included studies

In total, 14 papers were included in the review, namely, seven quantitative (Little, 2013; Wilkinson et al., 2013; Arzu et al., 2014; Van Schyndel, 2015; Heden and Ahlstrom, 2016; Hincapie et al., 2016; Dyer et al., 2018), five mixed-method (Long et al., 2016; Vogt and Schaffner, 2016; Feldacker et al., 2017; George et al., 2017; Johnston et al., 2018) and two qualitative studies (Todhunter, 2015; Mackay et al., 2017). Ten of these studies focused on the experiences of nurses, one on the experiences of medical doctors, one on the experiences of pharmacy students and two on the experiences of mixtures of nurses and paramedical students. Two of the included papers were academic theses; the first was at PhD level (Van Schyndel, 2015), and the other was at master's level (Little, 2013). The included studies were conducted from diverse contexts; five works were from the United States (US), three were from the United Kingdom (UK), one was from Turkey, one was from both the US and the Middle East, one was from New Zealand, one was from Sweden, one was from Sub-Saharan Africa (SSA) (from various countries, including Kenya, Namibia, Nigeria, Zambia, Cameroon, Ethiopia and Botswana) and one was from 60 countries (with Australia, the US, India, the UK and Canada being the top five in terms of survey response). Details about the included studies are presented in Appendix 2.

Quality appraisal findings

All papers appraised for quality passed the 25% cut-off MMAT score for inclusion. Hence, all appraised papers were included in the review. Nevertheless, a few limitations were noted in the included papers that could have affected the overall quality of the current review. For example, reflexivity was not appropriately indicated in the two qualitative papers (Todhunter, 2015; Mackay et al., 2017); some studies included small samples (Little, 2013; Vogt and Schaffner, 2016); some mixed-method papers (Long et al., 2016; Vogt and Schaffner, 2016) did not adequately describe the qualitative methodologies used.

Our review generated three categories, which were synthesized into the following themes: (i) facilitators of using advanced technology and (ii) challenges of using advanced technology.

Facilitators of using advanced technology

Technology is an indispensable tool in healthcare education. The review findings revealed that the facilitators of using advanced technology include its benefits and other factors that can enhance its utilization. Two categories represented this finding, namely, benefits of using advanced technology and enablers of using advanced technology.

Benefits of using advanced technology

Many benefits associated with the use of advanced technology were expressed. These included the ability of advanced technology to improve the clinical competency of healthcare professionals during practice; increased student engagement during the learning process, which improves the overall quality of education; improved patient care, safety and outcomes; improved research and evidence-based practice skills; improved peer networking, co-working and collaboration; improved learning experience and outputs; and an enhanced understanding of self-directed learning.

The usability of advanced technology is an important factor for learners to appreciate its adoption in their learning. Factors that enhanced the usability of advanced technology included its fast speed, ease of use and accessibility (e.g., easily accessible smartphones), as illustrated in the quote below.

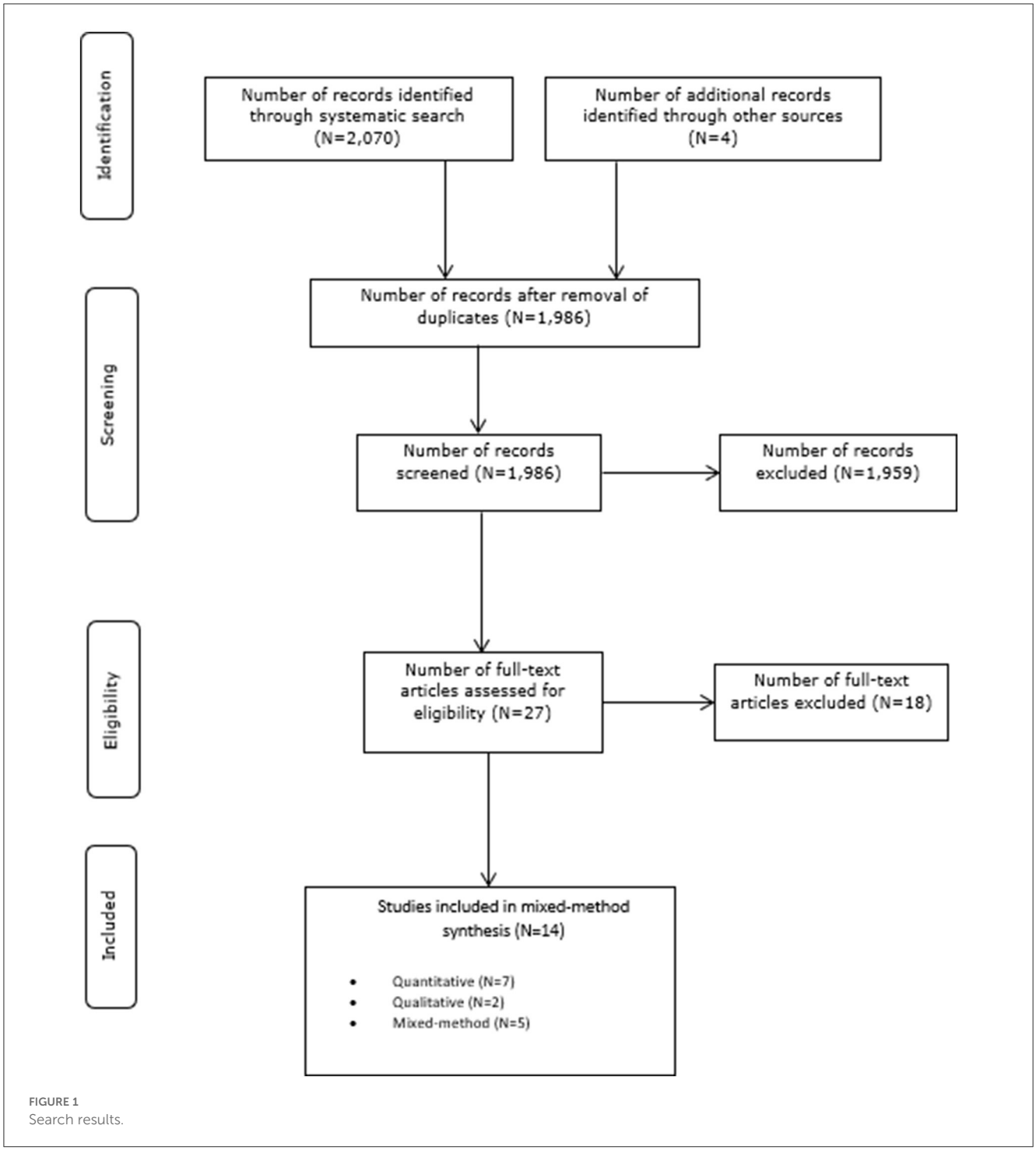

FIGURE 1
Search results.

> *"I think they are very helpful and a great advancement in nursing", "very quick and easy to use as a resource" and "they are very useful and meaningful, being that my peers and I are dependent on technology and smartphones"* (George et al., 2017).

Certain students expressed that using technology is essential for follow-up learning and revision, as taught information can easily be retrieved whenever needed.

> *"The YouTube clips are a life saver and I've often referred back to them for further understanding"* (Johnston et al., 2018).

The use of advanced technology, such as mannequins, in clinical learning can greatly reduce the risks associated with inexperienced student practitioners, as these technologies can be used to portray real-life situations. Consequently, patients are protected from injury caused by the limited experience of students.

> *"The training is doing a good job in improving patient safety and quality care delivery. This is a plus for the advancement of healthcare services in the developing countries"* (Feldacker et al., 2017).

Enablers of using advanced technology

The results of this review indicated that a number of factors should be addressed in order to fully utilize advanced technologies in the higher education of healthcare professionals. These factors included the need to provide adequate resources, such as good Internet connection and appropriate equipment; reduction of costs associated with technology use; recognition and appreciation of individuals who exert effort to learn technologies, especially courses that are outside the primary curriculum; and provision of access to technical support and mentorship on technology use, as many users will require expertise knowledge.

> *"Courses should have lower cost or be free and an expanded time frame (5%) to complete the course content would help with both time and technology constraints"* (Feldacker et al., 2017).

Challenges of using advanced technology

Numerous factors that hinder the widespread adoption of advanced technology in healthcare education were identified. These factors included the high costs involved, a lack of relevant or adequate equipment, a lack of knowledge or understanding of such technology, a dearth of technical support, failure of technology, heavy workloads combined with time constraints, negative user attitude toward technology use and generalized user aversion to change. These barriers were found to be of much importance within low-income settings, where facilities for advanced technologies are not well-established, as illustrated in the following quote.

> *"The idea is very good, but it can only work in the urban areas where there is light and internet services. I would prefer to take the course in person. Because there is poor internet access especially in my area"* (Feldacker et al., 2017).

Some students felt that certain technologies were time consuming and difficult to incorporate within their already busy schedules. In these cases, students preferred to study without the technology.

> *"How can I look at YouTube as well as all the other course resources?"* (Johnston et al., 2018).

Discussion

The use of technology in higher education has been accepted in healthcare training owing to its numerous advantages in both healthcare education and practice (Guze, 2015; Ireland, 2017; Archibald and Barnard, 2018). The current review indicates that technology is an essential tool in healthcare education; it is associated with numerous benefits, such as improved clinical competency; improved overall quality of education; improved patient care and outcomes; improved research and evidence-based practice skills; improved peer networking, co-working and collaboration; and improved learning experience and outputs for learners. These findings are consistent with those in previous studies. For example, the use of technology in the training of healthcare professionals has been reported to be advantageous in various aspects, such as demonstrating real-life situations (e.g., robots and mannequins) (Archibald and Barnard, 2018), improving psychomotor skills (Lapkin et al., 2010) and contributing to patient-centered care (Ireland, 2017). Therefore, incorporating technology in healthcare education can contribute to the care of patients and improve their outcomes. This evidence suggests that the training of healthcare professionals should embrace the use of advanced technologies in a manner that targets their use in healthcare practice. The current review findings also indicate that when technology is incorporated in the training of healthcare professionals, it is likely to improve future patient care. However, additional research should be performed to ascertain the effects of integrating technology in the training of healthcare professionals on patient outcomes. As our review shows, the use of technology in healthcare education has been driven by the need to incorporate these technologies in patient care. In modern healthcare practice, technology use is highly accepted, and the need for professionals to be adequately prepared for this task is fundamental (Risling, 2017).

Numerous factors that hinder the widespread adoption of advanced technology in healthcare education were identified. These factors included the high costs involved, a lack of relevant or adequate equipment, a lack of knowledge or understanding of such technology, a dearth of technical support, failure of technology, heavy workloads combined with time constraints, negative user attitude toward technology use and generalized user aversion to change. Previous studies reported related concerns, such as increased costs (Mohmmed et al., 2017), having to adopt new curriculums and learning new technologies and teaching techniques (Johnson et al., 2016), as barriers to using technology in training. In particular, our findings indicate that low-income settings are affected by specific barriers, such as Internet accessibility and related costs (Feldacker et al., 2017). Thus, special interventions should be designed to address the challenges encountered in low-income settings.

The results of our review further reveal that several factors need to be addressed to fully use advanced technologies in healthcare training. For example, the provision of adequate resources, reduction of the high costs associated with technology use, recognition of the effort of learners and provision of technical support and mentorship are needed in order to successfully implement technology in the education of healthcare professionals in higher institutions of learning. These findings highlight the need to continuously improve this new educational paradigm to strengthen its adoption in the higher education of healthcare professionals. Our review sets precedence for the need to avail incentives to both learners and educators

for adequate adoption of technology in higher education of healthcare professionals.

Study limitations and directions for future studies

We included papers globally yet technological advances stand at different levels in different countries. It is necessary that future research assesses how technology is applied in healthcare professional training and if variations exit in different geographical settings. In addition, our study was limited to exploring the views and experiences of using advanced technology. Future research should also seek to understand the influence of advanced technology on the education and training of professionals within the healthcare sector. Furthermore, studies are needed to ascertain the effects of incorporating technology in the training of healthcare professionals on patient outcomes.

Conclusion and implications

Emerging trends including pandemics such as COVID-19 have warranted the need to incorporate advanced technology in the training of healthcare professionals. Our study has indicated that advanced technology is generally accepted by both healthcare teachers and students as it may improve the teaching and learning experience and is likely to result into lifelong learning. While this trend is generally accepted, it does have certain challenges that require to be addressed for its success. Our study identifies the need for institutional support of both learners and educators in terms of training and aligning teaching with modern technology, and to ensure widespread availability of the technology to all required users.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

MA conducted the review. MA and SN designed, drafted, and revised the manuscript for intellectual content. Both authors contributed to the article and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/feduc.2023.1064697/full#supplementary-material

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