Human Resources for Health

REVIEW

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Effectiveness of eLearning programme for capacity building of healthcare professionals: a systematic review

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Abstract

Background The effectiveness of eLearning in enhancing healthcare professionals' capacity has received substantial attention globally. This review sought to synthesis evidence on the effectiveness of various types of eLearning programmes, and the facilitators and barriers to its use.

Methods The review was guided by Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. Four main databases (PubMed, Web of Science, JSTOR, and Scopus) in July 2023 and 44 articles met the eligibility criteria and were included in the review. The JBI critical appraisal checklist was used to appraise the methodological quality of the studies. The data were examined using narrative review to determine the effectiveness of the intervention as well as the barriers and facilitators to its use.

Results This review found that asynchronous, synchronous, blended, and self-learning methodologies are effective eLearning approaches for continuous professional development. Previous positive experiences, user-friendly interfaces and relevance of the eLearning content to daily practice are critical elements that facilitate eLearning usage. Poor computer competence and literacy, lack of personal computers and high family duties were the main personal factors that hindered eLearning use. Some systemic barriers included; heavy workloads, shortage of specialised eLearning facilitators poor management involvement, and technical inadequacies within the ICT departments. Environmental issues such as poor infrastructure, including limited internet and frequent power outages acted as barriers.

Conclusion The review highlights the effectiveness of various eLearning approaches among health professionals and presents the disparities between developing and developed economies in relation to the facilitators and barriers.

Keywords eLearning, Capacity building, Healthcare professionals, Effectiveness, Barriers

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Introduction

Globally, healthcare professionals are tasked to provide high-quality patient- and community-centred care for improved health outcomes [2, 21, 29]. In the current fast-paced and ever-changing healthcare landscape, staying abreast of the latest medical advancements and best practices is essential in meeting patients' needs [22]. Hence, the continuous development of healthcare professionals has become increasingly vital to the global demands of healthcare. The purpose of the continued growth of healthcare is to provide a learning environment and an opportunity to enhance the knowledge and skills of healthcare professionals [29, 47]. This will enhance their capacity to provide patients with high-quality, evidence-based care [55]. Thus, eLearning has emerged as a promising approach to capacity building and an opportunity for continuous development for healthcare professionals. eLearning leverages digital technologies to deliver educational content and training programmes, offering flexibility and accessibility to healthcare providers with diverse specialities across diverse settings [11, 35].

For the past decade, the effectiveness of eLearning in enhancing healthcare professionals' capacity has received substantial attention from policymakers, global bodies, researchers, and educators [48]. The effectiveness of eLearning programmes refers to the extent to which electronic learning interventions, delivered through digital technologies and online platforms, achieve their intended outcomes in enhancing the knowledge, skills, clinical performance, and overall professional competence of healthcare professionals [46, 50]. Key indicators include knowledge acquisition, examining the depth and relevance of eLearning content, skill development, assessing practical competencies within participants' roles; clinical performance, gauging real-world application of knowledge and skills; and overall professional competence, encompassing holistic effectiveness in various dimensions of healthcare practice.

eLearning has become a robust tool for delivering educational materials, interactive sessions, and virtual training experiences for healthcare professionals [46, 47, 49, 57]. In this era of widespread availability of technological devices and internet connectivity, eLearning has become increasingly accessible [46, 47]. It has transformed how healthcare professionals access and engage with educational content [1, 19]. eLearning allows learners to customise their learning experiences, catering to individual preferences and learning styles [21, 53]. Also, through self-paced modules and interactive sessions, eLearning offers opportunities for personalised skill development and continuous professional growth and development [53]. Moreover, eLearning provides the flexibility to access educational content at learners' convenience. This flexibility enables learners to balance their professional commitments and learning pursuits effectively [36, 50].

Regardless of the benefits associated with eLearning programmes, there may be challenges that need to be explored, understood, and addressed to enable the effective implementation of eLearning programmes for the continued professional development (CPD) of healthcare workers [6, 50]. The challenges and effectiveness of eLearning programmes may have contextual variations. Thus, after decades of research into the implementation of eLearning for healthcare professionals, it is essential to assess the effectiveness and challenges facing eLearning programmes in the capacity building of healthcare professionals.

In this review, the effectiveness of the eLearning programme is measured by assessing the impact of eLearning on the continuous development and capacity building of healthcare workers, considering factors such as knowledge acquisition, skill enhancement, adaptability to diverse learning styles, and the overall contribution to improved patient care and health outcomes [36, 50]. Hence, this systematic review qualitatively evaluated the effectiveness of eLearning interventions on healthcare professionals' knowledge acquisition, skill development, clinical performance, and overall professional competence. By synthesising evidence from a diverse range of studies, the review aimed to identify the strengths and limitations of eLearning programmes for the capacity building of healthcare professionals. In addition, the researchers explored the factors influencing the successful implementation of eLearning programmes. The purpose is to gain valuable insights into healthcare education and continuous professional development. Furthermore, this review aimed to inform healthcare institutions, educators, and policymakers about the potential of eLearning as an essential tool in enhancing the capabilities of healthcare professionals, especially for those in resource-limited and hard-to-reach settings.

Methods

This review followed the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) and was guided by the guidelines of Arksey and O'Malley [5]. The procedures involve developing review questions, searching for relevant studies, selecting studies, extracting data, summarising data, synthesising results, reporting the results, and consultation [5].

Review questions

The review questions were:

1. What is the effectiveness of the eLearning programme for capacity building for healthcare professionals?
2. What are the facilitators and barriers to the effective implementation of eLearning programmes for healthcare professionals' continued education and development?

Search strategies

The search for relevant studies was conducted in six primary databases: PubMed (Platform: National Center for Biotechnology Information), Web of Science (Platform: Clarivate Analytics), JSTOR (Platform: ITHAKA), and Scopus (Platform: Elsevier). Additional search was conducted in: Google Scholar (Platform: Google), World Health Organization Library, Science Direct (Platform: Elsevier), Taylor and Francis (Platform: Taylor and Francis), and ProQuest.

The search was initially conducted in PubMed using Medical Subject Headings (MeSH) terms (see Table 1). The MeSH terms were developed using the Population, Intervention, Comparison, and Outcome (PICO) framework. These MeSH terms were then modified to suit the search in other data. A Chartered Digital Librarian, Kwame Kodua Ntim of Sam Jonah Library, University of Cape Coast, and his team were consulted during the data search and management of search results. The last search in all databases was conducted on July 30, 2023.

Study selection

Search records were transferred to the Mendeley software and duplicates were removed. Screening for eligible papers was done in three stages. In the first stage, titles and abstracts of search results were screened for relevance. This was done by 15 trained graduate students and supervised by authors. In the second phase, relevant papers were screened for full-text records, and reference lists of full-text records were further searched for other relevant papers. In the third phase of the screening process, full-text papers were screened based on the eligibility criteria by the authors. Details of eligibility criteria are presented in Table 2. Full-text papers were screened independently by PO and GBA and reviewed by MA. PRISMA flow diagram presents search results and the screening process (Fig. 1).

Appraisal of studies

Briggs's critical appraisal tools, developed and updated by Joanna Briggs Institute (JBI) in 2020 were used to

Table 1 Search strategy for search conducted in PubMed

#1: Search to identify intervention (eLearning)	eLearning* [MeSH Term] OR Online learning* [MeSH Term] OR Digital learning* OR Virtual learning* OR Electronic learning* OR Internet-based learning* OR Web-based learning* OR Computer-based learning* OR Distance learning* OR Web-based education* OR Internet-based instruction Remote learning* Mobile learning* OR Cyberlearning* OR Digital education* OR Online education* OR Virtual education [MeSH Term]* OR Web-based training* OR Internet-based training* OR Computer-based training* OR Online training* OR Web-based instruction* OR Digital training* OR Online instruction [MeSH Term]* OR Internet-based education* OR Virtual training* OR Computer-assisted learning* OR eResource*
#2: Search to identify Outcome (Effectiveness)	Effectiveness* [MeSH Term] OR Efficacy* OR Efficiency* OR Impact* OR Success* OR Productivity* OR Performance* OR Achievement*OR Proficiency* OR Results* OR Outcomes* Patient safety* Reduced Mortality* Reduced disease prevalence* User satisfaction* OR Quality of care* OR Cost-effectiveness* OR Cost–benefit* OR improved knowledge* OR improved skills* OR better attitudes* responsiveness* Increase utilisation* Increase access to healthcare*
#3: Search to identify outcome (Barriers)	Barriers* [MeSH Term] OR Obstacles* [MeSH Term] OR Challenges* [MeSH Term] OR Hindrances* OR Impediments* OR Difficulties* OR Constraints* OR Limitations* [MeSH Term] OR Restraints* OR Blockades* OR Deterrents* OR Handicaps* OR Hurdles* OR Resistance* OR Problems* OR Disadvantages
#4: Search to identify outcome (Facilitators)	Facilitators* [MeSH Term] OR Enablers* OR protective factors* OR buffers* OR Support* OR Resilience [MeSH]* OR Enhancers* enabling factors* OR
#5: Search to identify the Population (Healthcare professionals)	Healthcare professionals* [MeSH Term] OR Medical professionals* OR Healthcare providers* OR Healthcare practitioners* [MeSH Term] OR Healthcare workers* [MeSH Term] OR Healthcare personnel* OR Medical practitioners* OR Medical staff* OR Clinicians* Public health workers* OR Caregivers* OR Allied health professionals* OR Nursing staff* OR Physicians* OR Doctors* OR Surgeons* OR Nurses* OR Pharmacists* OR Physical therapists* OR Occupational therapists* OR Speech-language pathologists* OR Radiographers* OR Radiologists* Mental healthcare workers* OR Mental practitioners*
#5: Search strategy 1	#1 AND #2 AND #5 Not Animal*
#6 Search strategy 2	#1AND #3 AND #5 Not Animal*
#7: Search strategy 3	#1AND #4 AND #5 Not Animal*
Filters activated	English Language; (Date: 01/01/2000- 30/07/2023)

Table 2 Eligibility criteria for screening of reviewed studies

Inclusion criteria	1. Papers conducted using study designs such as randomised controlled trials, cohort/longitudinal studies, cross-sectional surveys, qualitative designs, mixed-method designs, case–control designs, etc. 2. Papers that sampled in-service healthcare professionals for the eLearning programme 3. Papers that assessed the effectiveness and the barriers associated with the use of eLearning among healthcare professionals 4. Papers that compared eLearning and traditional training or no training among healthcare professionals 5. Grey literature (dissertation or thesis) 6. Papers published in the English language 7. All appraised studies
Exclusion criteria	1. Papers that did not report on variables of interest 2. Reviews, letters to editors, conference papers, preprint, opinions, manuscripts, abstracts, and pre-proofs 3. Papers conducted using pre-service or student healthcare professionals 4. Studies conducted in any other language apart from the English language

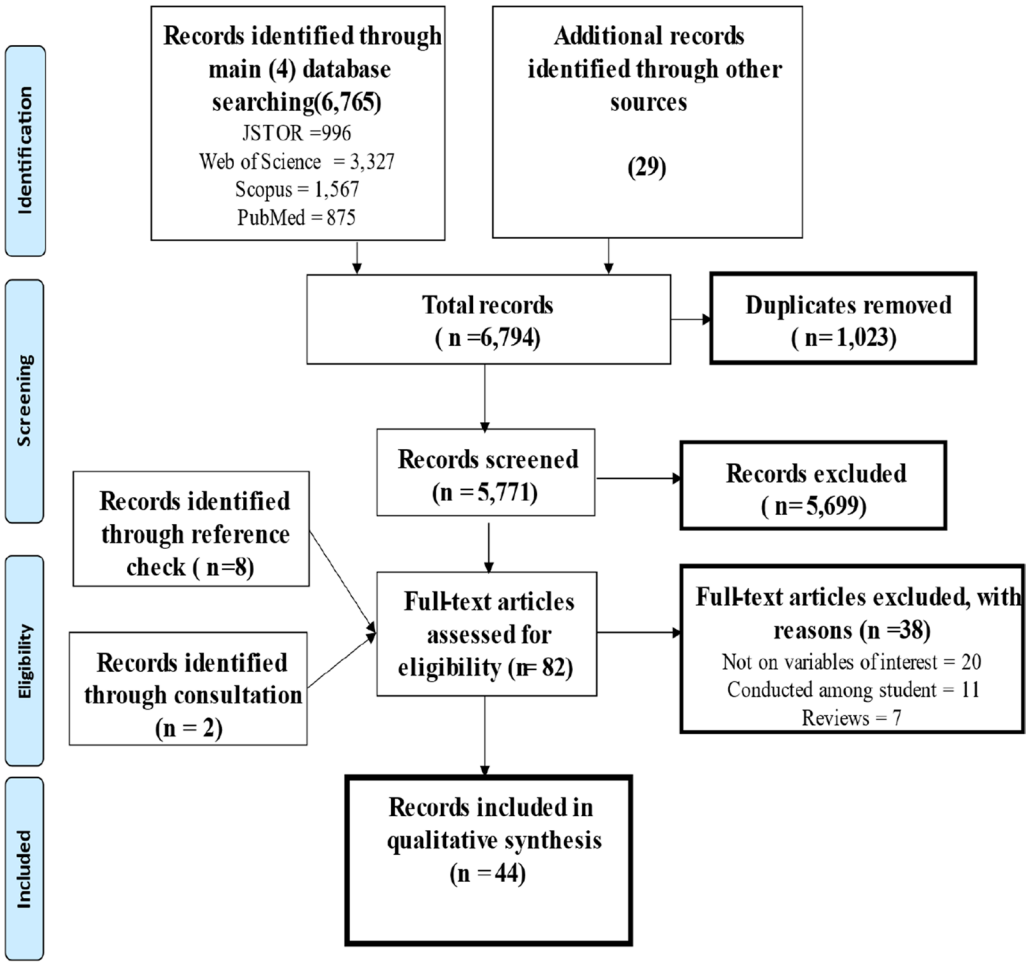

Fig. 1 PRISMA flow diagram for search results and screening process

appraise included studies [30]. The aim was to certify all reviewed studies. However, it is noteworthy that the quality appraisal was not meant to exclude full-text papers but to report the quality of all included studies for readership. This tool comprises checklists for evaluating the quality of qualitative studies, cross-sectional studies, randomised controlled trials, etc. Mixed Method Appraisal Tool (MMAT) version 2018 was used to appraise all included mixed-method studies [26]. The scoring procedures adopted by Amoadu et al. [3] were used in grading the included studies. Appraisals were conducted by PO and GBA, supervised by MA. Extracted

data were analysed using thematic content analysis, summarised, and qualitatively synthesised. See Appendix A for appraised studies.

Data extraction

Data were extracted independently by PO and GBA and reviewed by MA. This was done to ensure that extracted papers were reliable and accurate and inconsistencies between extractors were resolved during regular online meetings. We extracted the data based on authors, year of publication, the purpose of study, study design, population, sample, effectiveness, facilitators and barriers and critical appraisal score. See Appendix B for the data extraction form and characteristics of included studies.

Data synthesis

The authors gathered a diverse range of studies and extracted data from articles that address research questions regarding eLearning programme effectiveness, and the facilitators and barriers involved in its implementation. Once the data were compiled, the authors engaged in a thorough familiarisation process. This involved reading through the extracted data to become well-acquainted with the content. During this phase, authors worked on identifying key concepts, patterns, and recurring themes that emerge naturally from the extracted data.

Authors systematically labelled text sections with descriptive codes that encapsulated the essence of the extracted data. Once coding was underway, authors started collating related codes into preliminary themes like Effectiveness of eLearning" and "Facilitators and Barriers". The authors then critically reviewed and refined these preliminary themes to ensure they accurately represent the extracted data.

Relevant information and findings extracted from the studies that directly support each theme were then organised. These extracted data points served as concrete evidence to answer the research questions. While interpreting these themes, their significance to the effectiveness of eLearning programmes and the various factors influencing their implementation were considered. Finally, the authors synthesised the findings for each research question, crafting a clear and concise narrative that directly addressed the core objectives of this review.

Results

Search results

The search in the four main databases (PubMed, Web of Science, JSTOR, and Scopus) produced 6765 records. The additional search conducted in other databases for relevant papers produced 29 records. The Mendeley software was used to remove 1023 duplicates. The screening of titles and abstracts led to the exclusion of 5699 records that were not relevant to this review. Thus, 72 full-text articles were available for further screening. Consultation with a librarian and checking the reference list of eligible full-text records produced an additional 10 records. In all, 44 records were included in this qualitative synthesis, and 38 records were excluded based on the eligibility criteria. See Figure for details on search results and screening process.

Characteristics of included studies

Reviewed studies sampled 40,223 healthcare providers. The studies employed various research designs, including cross-sectional designs in the United Kingdom, Taiwan, and globally [15, 38, 60], experimental designs in the USA, India, Ghana, Italy, Belgium, and others [1, 10, 12, 13, 18, 20, 28], longitudinal designs in sub-Saharan Africa and Italy [14, 45], mixed methods studies in Guinea, Ghana, China, Republic of Ireland, Northern Ireland, Australia, and Nigeria [7, 11, 17, 22, 36, 41, 42, 51, 58] qualitative designs in Ukraine, Malawi, South Africa, the USA, India, Uganda, and Rwanda [7, 11, 23–25, 40], and randomised controlled trials in the Netherlands, the UK, and Australia [9, 16, 27, 31, 32, 44, 56]. Thus, most of the reviewed studies were experimental designs (15) and mixed-method designs (11) (see details in Fig. 2). Majority of studies were conducted in the United Kingdom (6), United States of America (4), the Netherlands (4), Taiwan (3), Ireland (3), India (2), Ghana (2), Italy (2), Belgium (2), Kenya (20), Malawi (2), China (2), Australia (2) and a study each from other countries (see details in Fig. 3). Most studies explored self-learning (10) (see details in Fig. 4).

Appraisal results

The results of appraised studies were categorised into low, moderate, and high-risk. Details are presented in Fig. 5.

Operational definition of eLearning types found in studies

These operational definitions clarify the key characteristics and approaches associated with each type of eLearning, helping to differentiate them in the context of educational delivery.

1. Self-learning: self-learning, also known as self-paced learning, is an eLearning approach where learners have full control over their learning process. They can access course materials, modules, and resources independently, often without a schedule or instructor-led sessions. Learners can progress at their own pace, revisiting content as needed.

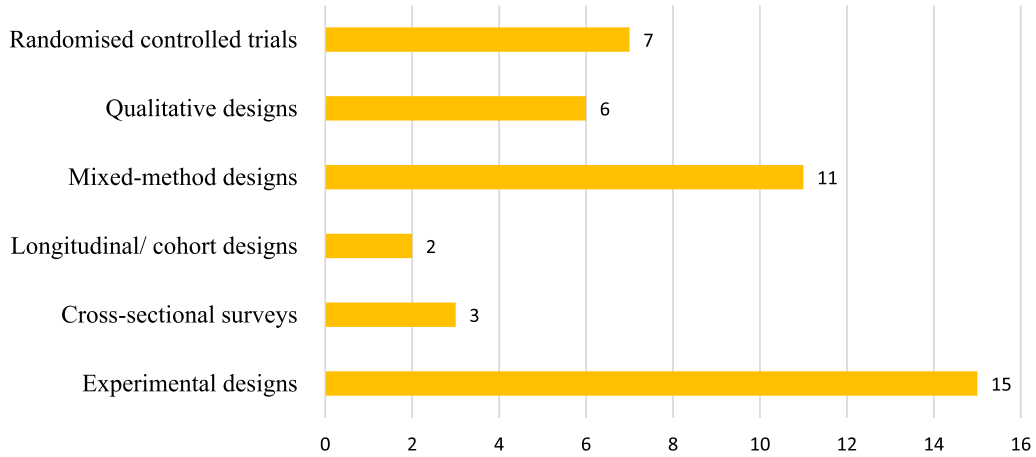

Fig. 2 Study designs included in the qualitative synthesis

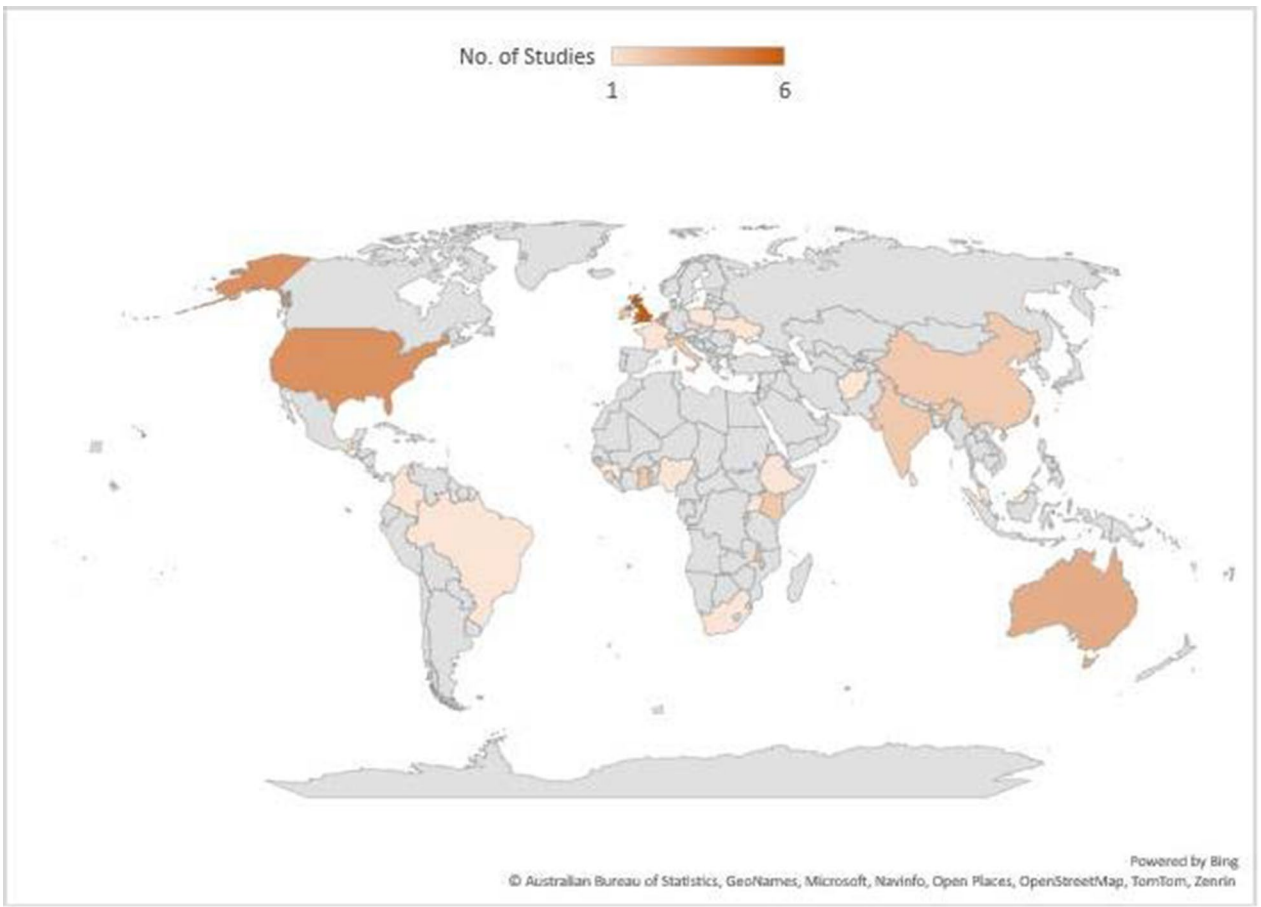

Fig. 3 Map of countries and continents where included studies were conducted

2. Asynchronous: Asynchronous eLearning is characterised by a lack of real-time interactions. Learners access course materials, lectures, and assignments at their convenience. Communication and collaboration often occur through discussion boards or email, without the need for simultaneous participation.

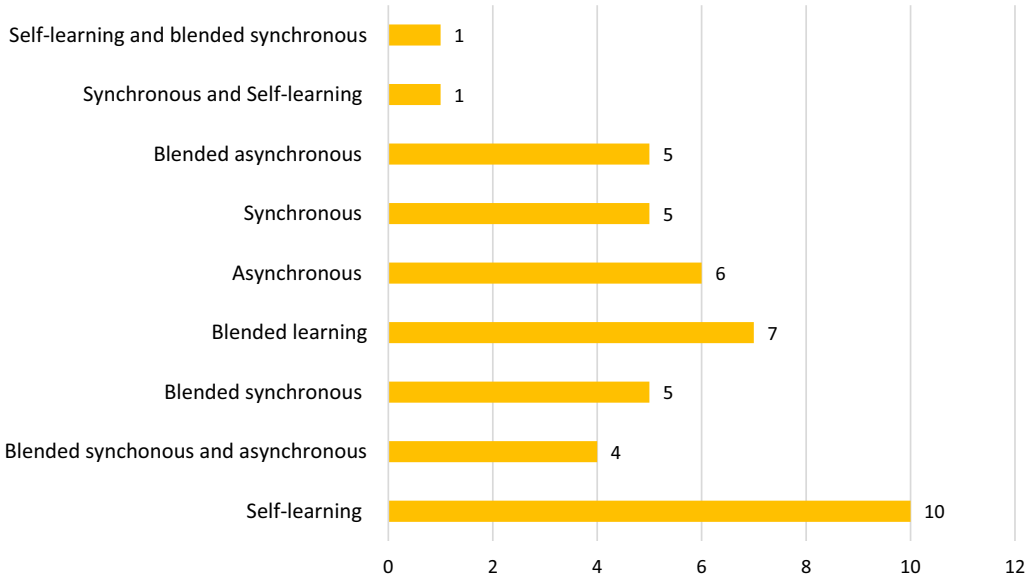

Fig. 4 eLearning types explored by reviewed studies

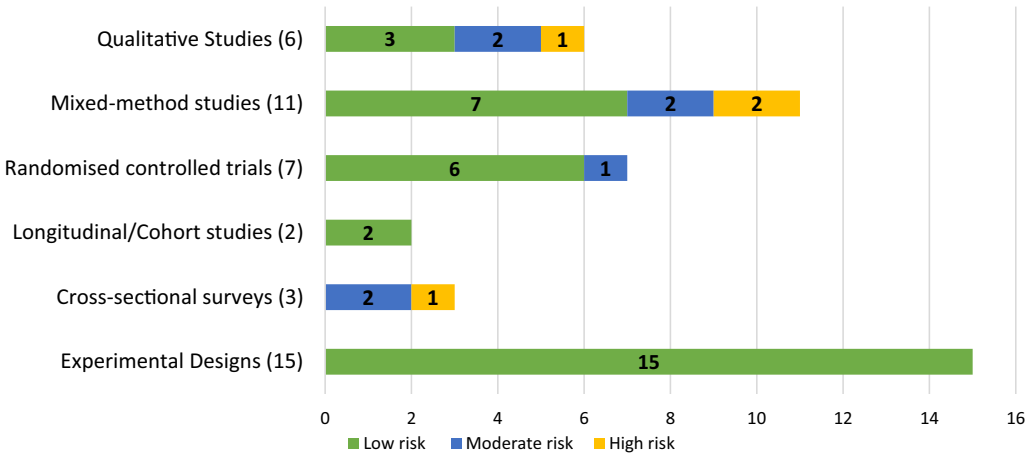

Fig. 5 Appraisal of reviewed studies

3. Synchronous: Synchronous eLearning involves real-time interactions between learners and instructors or peers. This can include live webinars, video conferences, or virtual classrooms where participants engage simultaneously, promoting immediate feedback and active engagement.
4. Blended asynchronous: Blended asynchronous eLearning combines asynchronous learning activities with limited synchronous components. Learners can access self-paced content and resources, but occasional synchronous interactions, such as live Q&A sessions or group discussions, may occur.
5. Blended synchronous and asynchronous: Blended synchronous and asynchronous eLearning combines two distinct modes of learning. Synchronous components involve real-time interactions, such as live webinars, video conferences, or chat sessions, where learners and instructors engage simultaneously. Asynchronous components include self-paced activities, such as prerecorded lectures or discussion forums, allowing learners to access content at their convenience.
6. Blended synchronous: Blended synchronous eLearning integrates real-time, instructor-led activities with

asynchronous components. Learners participate in live sessions, discussions, or virtual classrooms at scheduled times, enhancing engagement and interaction. However, some content and activities may be available asynchronously to accommodate different learning styles and time zones.

7. Blended learning: Blended learning combines traditional face-to-face instruction with online elements. It offers a mix of in-person classroom sessions and eLearning components, allowing learners to access resources, collaborate online, engage in digital activities, and attend physical classes.
8. Synchronous and self-learning: Synchronous and self-learning, also known as mixed-mode learning, allows learners to engage in real-time, instructor-led sessions and self-paced activities. This approach provides flexibility while maintaining structured, interactive learning opportunities.
9. Self-learning and blended synchronous: Self-learning and blended synchronous eLearning combine self-paced learning with scheduled synchronous interactions. Learners can access content independently while participating in live sessions, discussions, or collaborative activities when required.

Effectiveness of eLearning programmes among healthcare providers

Table 3 presents data on the effectiveness of eLearning programme among healthcare providers. The table shows that, asynchronous eLearning has proven to be highly effective in advancing healthcare professionals' knowledge, attitudes, and practices. Chase et al. [10] demonstrated its impact on increasing knowledge and confidence among oncology healthcare providers, specifically in smoking cessation. Colaceci et al. [13] highlighted significant improvements in healthcare providers' awareness and positive attitudes toward breastfeeding through asynchronous eLearning, showcasing its positive influence on healthcare practices. The study by Erlandsson et al. [20] emphasised the role of asynchronous eLearning in skill development, introducing dynamic birthing positions and enhancing the capacity of midwives in labour rooms. Additionally, Delf [17] showcased the improvement in reporting radionuclide bone scans among allied health workers, indicating the positive impact of asynchronous eLearning on specialised clinical skills. Colaceci et al. [14] demonstrated the long-term effectiveness of asynchronous eLearning in shaping healthcare providers' attitudes and practices related to infant nutrition, particularly in promoting and supporting breastfeeding. Moreover, Barteit et al. [7] explored self-directed asynchronous eLearning, resulting in improved clinical skills for patient management in a Malawian tertiary hospital.

Synchronous eLearning

Synchronous eLearning has demonstrated positive impacts on various healthcare practices, contributing to enhanced outcomes. Choi et al. [12] showcased its effectiveness in improving care practices for severe acute malnutrition in resource-poor countries, emphasising its role in advancing healthcare practices. Fourré et al. [22] observed increased knowledge and the development of positive beliefs regarding lower back pain management through synchronous eLearning, highlighting its educational benefits in specialised healthcare areas. Chang et al. [9] implemented a successful eLearning programme for nurses in Taiwan, revealing overall satisfaction with the programme. However, the study identified statistically significant differences between eLearning platforms and face-to-face settings, particularly in teaching and learning methods and communication. Detroyer et al. [18] investigated the impact of a delirium eLearning tool on healthcare workers' delirium recognition, knowledge, and care practices, revealing improved recognition and knowledge through synchronous eLearning approaches.

Blended eLearning types

Blended asynchronous Blended asynchronous eLearning has demonstrated notable effectiveness in various healthcare contexts. Nesterowicz et al. [37] showcased its viability for continuing education in pharmacy, leading to increased knowledge among participants. Similarly, Chernysh et al. [11] reported improved knowledge and awareness among maternal and child health (MCH) providers in Ukraine through eLearning. Furthermore, the study by Kulier et al. [32] comparing an integrated eLearning course on evidence-based medicine to traditional lectures for postgraduates in the UK and the Netherlands revealed no statistically significant differences between the two methods, highlighting the flexibility offered by eLearning.

Blended asynchronous and synchronous In blended asynchronous and synchronous eLearning, Jones et al. [31] reported that physiotherapists exhibited a high level of confidence and readiness to apply their newly acquired skills and knowledge in patient consultations, highlighting the practicality of this approach. The studies collectively showcase the value of blended asynchronous and synchronous eLearning in improving healthcare providers' competence and readiness for real-world applications.

Table 3 Effectiveness of eLearning among healthcare providers

Type of eLearning	Study objective	Indicator of effectiveness	Authors
Self-learning	To examine the satisfaction and motivation of healthcare providers in using OPEN Pediatrics (open-access medical eLearning platform)	Paediatricians reported a high frequency of motivation to access the platforms	[15]
Blended synchronous	To improve knowledge of health providers related to four major mental health problems	Significant increase in knowledge was reported	[52]
Blended learning	Assess HIV-TB eLearning impact on providers' satisfaction, skills, and practice	eLearning was an acceptable and effective modulus of capacity building and developing communities of practice to strengthen integrated care	[1]
Asynchronous	To evaluate the use of an evidence-based, smoking cessation eLearning education programme for oncology healthcare providers	The healthcare providers increased in knowledge and in confidence in successfully helping the patients to quit smoking	[10]
Synchronous	To investigate whether eLearning use among healthcare providers in resource-poor countries lead to improved diagnosis, management, and survival of children with severe acute malnutrition (SAM)	Improved care practices for children with SAM	[12]
Asynchronous	To assess if eLearning was effective in improving healthcare providers' attitudes and practices	There was an improvement in the awareness and positive attitudes toward breastfeeding	[13]
Synchronous and self-learning	To determine the effect of a delirium eLearning tool on healthcare workers' delirium recognition, knowledge, and care	Improved healthcare workers' delirium recognition and knowledge	[18]
Asynchronous	To determine the feasibility of using an internet-based capacity building programme contributing to effective midwifery practices in the labour rooms	Introduction of dynamic birthing positions and improved capacity of midwives to be more proactive when working in interdisciplinary teams	[20]
Self-learning	To investigate the effect of the E-SOLAS training programme on physiotherapy managers' confidence and knowledge in service delivering	There were significant increases in physiotherapists' confidence and knowledge in delivery of all E-SOLAS intervention components	[28]
Blended asynchronous	To assess if e-courses were a viable method of providing continuing education in pharmacy	Knowledge increased after participation	[37]
Self-learning	Assess 'Breastfeeding Basics' impact on MCH providers' knowledge and baseline user knowledge	Improved knowledge	[39]
Blended synchronous and asynchronous	To verify if eLearning was able to enhance healthcare professionals' alcohol-related problems knowledge	A significant increase in alcohol-related problems knowledge	[43]
Self-learning	To explore the changes in healthcare providers' learning outcomes related to evidence-based breastfeeding support and promotion	Improved knowledge and self-efficacy	[59]
Blended synchronous	Assesses eLearning's impact on healthcare professionals' sexual attitudes and beliefs	Improvements in attitude and perceived knowledge and awareness of prostate cancers' impact on sexual well-being	[34]
Blended learning	To introduce eLearning in advanced cardiac life support among healthcare professionals and assess its effectiveness	Effective in increasing the knowledge level on cardiac life support	[4]
Asynchronous	To evaluate the long-term effectiveness of an online national programme on infant nutrition for HCPs	Effectiveness in improving attitude and practice regarding the protection, promotion, and support of breastfeeding	[14]
Blended synchronous	To assess the feasibility and acceptability of Web-based training to support HIV education across multiple SSA countries	Increased attendance from 40 participants in Month 1 to over 160 in Month 10	[45]
Blended learning	To evaluate whether an eLearning training programme can improve TB health personnel's knowledge and behaviour in China	Improved knowledge	[58]
Blended synchronous and asynchronous	To evaluate the effectiveness of eLearning in improving practices among healthcare providers	Effective in reinforcing the competence of healthcare providers	[54]

Table 3 (continued)

Type of eLearning	Study objective	Indicator of effectiveness	Authors
Blended learning	To identify the satisfaction among healthcare providers on eLearning platforms	Learners' satisfaction	[33]
Self-learning	To describe the results of the nationwide deployment of the InStrat COVID-19 tutorial app to frontline health workers as a public health intervention during the COVID-19 pandemic in Nigeria	Improved knowledge	[42]
Self-leaning	To examine mental health clinicians	Effective at enhancing participants' practices, such as assessing the impact of mental illness on parenting and child development and providing information and resources to families	[56]
Asynchronous	To examine eLearning effectiveness in helping allied health workers in the UK to report radionuclide bone scans	Improvement reporting of radionuclide bone scans	[17]
Synchronous	To evaluate the feasibility of implementing an interactive eLearning module on the management of lower back pain (LBP) in healthcare professionals in France and Belgium	Increase level of knowledge and positive beliefs about LBP	[22]
Blended asynchronous	To examine the effectiveness of implementing eLearning for MCH providers in Ukraine	Improved knowledge and awareness	[11]
Asynchronous	To examine self-directed eLearning at a tertiary hospital in Malawi	Improved clinical skills in patient management	[7]
Blended learning	To assess the influence of eLearning on the performance of healthcare providers in South Africa	Improved knowledge and skills	[40]
Blended asynchronous	Assesses the educational impact of an integrated eLearning course on EBM among postgraduates compared to a traditional lecture-based course in the UK and the Netherlands	No statistically significant difference between blended asynchronous and face-to-face lectures	[32]
Self-learning	To determine whether eLearning can be an effective means of improving the implementation of a quality improvement project in delirium care	Improved knowledge and screening of older patients with delirium	[56]
Synchronous	To develop an eLearning education programme for staff nurses at a 700-bed teaching medical centre in Taiwan	Nurses were satisfied with the eLearning programme. All nurses' knowledge was high, and all passed nursing care skills. However, statistically significant differences were found only in teaching and learning and communication among nurses in eLearning platforms and face-to-face	[9]
Blended asynchronous and synchronous	To explore physiotherapists' experiences with and perceptions of an eLearning programme	Physiotherapists expressed a high level of confidence and readiness to go into their first patient consultations using their new skills and knowledge they had acquired	[31]
Self-learning	To evaluate the effect of eLearning on knowledge on mental health issues as compared to lecture-based learning among occupational physicians in the Netherlands	Improved knowledge and care practices	[27]
Blended asynchronous	To examine the relationship between the use of an eLearning simulation programme (Microsim) prior to attending an Advanced Life Support (ALS) Course and the subsequent relationship to candidate performance in the UK	Improved understanding of ALS theory and skills	[44]

Table 3 (continued)

Type of eLearning	Study objective	Indicator of effectiveness	Authors
Blended synchronous	The effect of an eLearning-supported Train-the-Trainer programme on implementation of suicide guidelines in mental health care in the Netherlands	Improved care practices for suicidal patients among mental healthcare providers	[16]

Blended (eLearning and face-to-face)

Blended learning, incorporating elements of eLearning, has demonstrated significant positive impacts on healthcare education across diverse contexts. Agarwal et al. [1] explored the effectiveness of HIV-TB eLearning, revealing its acceptability and efficacy in capacity building for healthcare providers and community development. In the realm of advanced cardiac life support, Abdullah et al. [4] introduced eLearning, resulting in increased knowledge levels in this critical area. Oluwadele [40] reported improvements in knowledge and skills among healthcare providers in South Africa attributed to eLearning. Moreover, Wang et al. [58] demonstrated the effectiveness of eLearning in enhancing knowledge and behaviour among TB health personnel in China.

Blended synchronous Blended synchronous eLearning approaches have been strategically employed to address specific healthcare challenges, yielding positive outcomes across various domains. Tirmizi et al. [52] demonstrated a significant increase in knowledge related to major mental health problems among healthcare providers through this method. McCaugan et al. [34] observed improvements in attitudes and awareness of the impact of prostate cancer on sexual well-being among healthcare professionals. In the context of web-based HIV education training in sub-Saharan African countries, Reid et al. [45] reported a successful increase in attendance, showcasing the potential of blended synchronous eLearning to enhance healthcare knowledge dissemination. Furthermore, De Beurs et al. [16] documented improved care practices for suicidal patients among mental healthcare providers through an eLearning-supported Train-the-Trainer programme. Pereira et al. [43] highlighted a significant increase in healthcare professionals' knowledge of alcohol-related problems facilitated by eLearning. Tsai et al. [54] reinforced the competence of healthcare providers using eLearning, contributing to enhanced practices.

Self-learning Self-learning within eLearning platforms has showcased its effectiveness across diverse healthcare education contexts, making significant contributions to knowledge acquisition, skill development, and competency enhancement. Notably, studies have highlighted its positive impact on mental health clinicians, enabling them to assess the influence of mental illness on parenting and child development [51]. Paediatricians engaging in self-learning through platforms like OPENPediatrics reported high motivation and improved knowledge [15]. Maternal and child health providers accessing programmes like 'Breastfeeding Basics' experienced enhanced knowledge, illustrating the success of self-learning in targeted educational modules [39]. Skill development was evident as physiotherapy managers participating in the E-SOLAS training programme reported significant increases in confidence and knowledge [28]. The role of self-learning during public health crises was exemplified by improved knowledge outcomes among frontline health workers using Nigeria's InStrat COVID-19 tutorial app [42]. Additionally, self-learning contributed to specialised fields, improving knowledge about mental health issues among occupational physicians [27] and enhancing delirium screening in quality improvement projects [56].

Facilitators and barriers to eLearning programme implementation

Facilitators

Personal factors, notably previous positive experiences [43], significantly motivate healthcare providers to engage with eLearning platforms. Furthermore, the ease of use and user-friendly interfaces are critical elements that encourage eLearning usage [23, 31, 33, 34, 36, 42]. The relevance of the eLearning content to daily medical practice is another crucial facilitator for its use [34, 36, 40, 45].

Peer support within the eLearning environment, as observed by Burkhardt et al. [8], creates a supportive and engaging atmosphere. Additionally, flexibility in scheduling and opportunities for personal and group interactions [22, 33, 40, 54] contribute significantly to effective eLearning experiences. Discussion forums further enhance engagement and knowledge sharing [40], while a self-regulated learning environment promotes autonomy and motivation [8]. Constructive feedback from facilitators is another valuable facilitator [40].

Institutional policies and resources also play a role. Political commitment to eLearning initiatives [25] and mandatory e-training requirements [38, 39] drive participation. Instructional support for facilitators [25] ensures a well-structured learning experience. The availability of standardised training materials [52] and adequate IT resources and facilities are essential for seamless eLearning delivery. Lastly, ongoing appraisal of the eLearning facility and learner needs help to maintain and improve the eLearning environment [56].

Barriers

Barriers to effective eLearning adoption among healthcare providers encompass a range of personal, systemic, and environmental factors. Personal factors include a lack of perceived need for eLearning [38], poor computer competence and literacy [7, 23, 25, 41, 42, 45, 60], absence of personal computers [7, 10, 24, 41, 45, 60], financial constraints [8, 36, 60], low self-control [60], high family duties [60], and concerns regarding low knowledge retention after eLearning programmes [14, 58].

Other barriers include time constraints [8, 24, 31, 40], resistance to change [11], language barriers [25, 40], dissatisfaction with eLearning content [11, 31, 58], heavy and conflicting content, and inadequate feedback within the eLearning environment [9, 23].

Environmental barriers include a lack of face-to-face interaction [10, 52], poor infrastructure, including limited internet access [8, 24, 40–42, 45, 60] and frequent power outages [40, 42]. Systemic challenges involve heavy workloads [60], lack of incentives [58, 60]), a shortage of specialised eLearning facilitators [41], poor management involvement [41], uneven supply of learning materials [58], disorganised governance of eLearning programmes [58], limited training materials [8], and resource constraints [25]. Technical inadequacies, such as those within the ICT departments, also contribute to these barriers [16]. See Table 4 for a thematic analysis of facilitators and barriers to effective eLearning implementation.

eLearning situations in developing and developed countries

In developing countries, the implementation of eLearning for healthcare practitioners faces a distinct set of challenges. Nigeria, for instance, encountered significant barriers to eLearning adoption among healthcare professionals. In the study conducted by Otu et al. [42], healthcare workers in Nigeria reported poor digital literacy, frequent electricity supply outages, and limited internet connectivity as major hindrances. Similar situations have been reported by Osman [41] in Ghana and Oluwadele [40] in South Africa. These studies noted that financial constraints and a need for user-friendliness in eLearning platforms further exacerbated the difficulties. A similar situation was observed in Malawi, where Barteit et al. [7] highlighted that limited access to personal computers, insufficient ICT training, and a general lack of interest in eLearning content posed substantial obstacles. Despite these challenges, the studies found that healthcare professionals in these settings recognised the importance of user-friendly platforms and responsive user support as effective facilitators for successful eLearning experiences.

Conversely, advanced countries like the United Kingdom and the United States exhibit a different spectrum of challenges and facilitators in the context of eLearning implementation for healthcare professionals. Nicolaou et al. [38] conducted a study in the United Kingdom, where healthcare professionals faced barriers such as a lack of perceived need for eLearning and varying levels of computer competence. Gagnon et al. [23] investigated physicians' beliefs regarding their completion of online programmes in the United States and identified barriers related to complexity and internet connectivity. In these advanced settings, some common facilitators included healthcare institutions' provision of mandatory online training programmes, as observed in the study by Pereira et al. [43]. Moreover, studies revealed that prior positive experiences with eLearning, the ease of use of eLearning resources, and the relevance of content to clinical practice were factors that facilitated successful eLearning adoption among healthcare professionals in these countries.

In the context of eLearning adoption, developed countries like the United Kingdom, the United States, and the Netherlands predominantly favour self-learning approaches, emphasising independent study through online resources [38]. Additionally, asynchronous learning methods, allowing flexibility in accessing educational materials, are widely employed in these regions [39]. They also commonly utilise blended learning encompassing synchronous and asynchronous components, striking a balance between real-time interaction and self-paced learning [31]. Conversely, in developing countries such as Afghanistan, India, and sub-Saharan Africa, eLearning often takes the form of blended synchronous approaches, integrating online sessions with traditional methods to overcome limited internet access barriers [1, 52]. Some regions, like Nigeria and Kenya, employ blended asynchronous models, combining self-paced materials with occasional synchronous elements [8, 45]. Synchronous eLearning, though challenging due to internet limitations, is observed in Ghana and Rwanda, emphasising real-time online sessions [25, 41]. Overall, the choice of eLearning type reflects the available infrastructure and the need to accommodate varying access to digital resources in these regions.

Discussion

The effectiveness of eLearning programmes among healthcare providers varies based on the type of eLearning employed. Asynchronous eLearning has demonstrated positive outcomes in enhancing healthcare

Table 4 Facilitators and barriers to eLearning implementation

Main theme	Sub-themes	Specific factors	Authors
Facilitators	Personal factors	Previous positive experience	[43]
	eLearning usage	Ease of usage and interface	[23, 31, 33, 34, 36, 42]
		Relevance of content to practice	[34, 36, 40, 45]
		Peer support	[8]
		Flexible time	[22, 54]
	eLearning environment	Addition of face-to-face interaction	[36]
		Personal and group interaction	[33, 40]
		Presence of discussion forum	[40]
		Self-regulated learning environment	[8]
		Feedback from facilitators	[40]
	Policies/ resources	Political commitment	[25]
		Mandatory e-training	[38, 39]
		Instructional support for facilitators	[25]
		Availability of standardised training materials	[52]
		Availability of IT resources and facilities	
		Appraisal of eLearning facility and learners	[56]
Barriers	Personal factors	Lack of perceived need	[38]
		Poor computer competence/literacy	[7, 23, 25, 31, 41, 42, 45, 60]
		Lack of personal computer	[7, 10, 24, 41, 45, 60]
		Financial constraints	[8, 36, 60]
		Low self-control	[60]
		High family duties	[60]
		Low knowledge retention after eLearning programme	[14, 58]
		Lack of time	[8, 24, 31, 40]
		Fear of changes	[11]
		Language barrier	[25, 40]
	Poor eLearning content	Irrelevant content	[11, 31, 58]
		Heavy content	
		Conflicting schedules and content	[40]
	Poor eLearning environment	Lack of feedback from facilitators	[9, 23])
		Absence of facilitators in discussion forums	[36]
		Lack of face-to-face interaction	[10, 52]
	Poor infrastructure	Poor access to internet	[8, 24, 40–42, 45, 60]
		Frequent power outages	[40, 42]
	Policies/ resources	Heavy workload	[60]
		Lack of incentives	[58, 60]
		Lack of specialised -eLearning facilitators	[41]
		Poor management involvement	[41]
		Uneven supply of learning needs	[58]
		Disorganised governance of eLearning programmes	[58]
		Limited training materials	[8]
		Resources constraints	[25]
		Technical inadequacy of ICT department	[16]

knowledge and practices, with studies showing improvements in areas such as smoking cessation, breastfeeding awareness, and clinical skills. Synchronous eLearning has been effective in improving healthcare practices, particularly in resource-poor settings, and has shown benefits in knowledge acquisition and skill development. Blended eLearning types, including asynchronous and asynchronous–synchronous approaches, have also

successfully enhanced healthcare competence and readiness for real-world applications. Self-learning approaches have proven effective across various healthcare contexts, empowering healthcare providers with knowledge and skills. However, the adoption of eLearning programmes faces both facilitators and barriers, including factors related to personal, systemic, and environmental aspects. These challenges vary between developed and developing countries, with differences in infrastructure, digital literacy, and access to resources influencing the adoption and effectiveness of eLearning in healthcare education.

Effectiveness of eLearning implementation among healthcare professionals

As discussed in the provided text, eLearning programs' effectiveness among healthcare providers reveals significant insights into how asynchronous, synchronous, blended, and self-learning approaches impact healthcare knowledge, attitudes, and practices. Asynchronous eLearning, characterised by self-paced learning, offers flexibility and accessibility for healthcare professionals. Studies such as those by Chase et al. [10], Colaceci et al. [13], and Delf [17] demonstrate that asynchronous eLearning can effectively enhance knowledge and skill development in various healthcare domains. For example, the smoking cessation programme by Chase et al. increased both knowledge and confidence among oncology healthcare providers, empowering them to assist patients with smoking cessation. This is particularly important for public health and aligns with Sustainable Development Goal (SDG) 3 (Good Health and Wellbeing) by addressing tobacco-related health issues.

Additionally, asynchronous eLearning has improved awareness and attitudes toward crucial healthcare practices, such as breastfeeding [13] and clinical skill development [7]. For instance, Erlandsson et al. [20] highlighted the use of asynchronous eLearning to enhance the capacity of midwives in labour rooms, making them more proactive within interdisciplinary teams. This supports SDG 5 (Gender Equality) by advancing the role of midwives and promoting gender-inclusive healthcare practices. Synchronous eLearning, characterised by real-time interaction, is vital in healthcare education. Choi et al. [12] and Fourré et al. [22] demonstrated improvements in healthcare practices and knowledge acquisition, respectively, through synchronous eLearning. The study by Detroyer et al. [18] further emphasises the potential of synchronous eLearning in enhancing critical healthcare competencies, specifically in delirium recognition and care. These findings contribute to the continuous development of healthcare workers, which aligns with SDG 4 (Quality Education) by ensuring that healthcare professionals receive up-to-date and effective training.

Blended eLearning approaches, combining asynchronous and synchronous elements, offer a balanced approach to healthcare education. The study by Jones et al. [31] underscores the practicality of blended asynchronous and synchronous eLearning, which enhances healthcare providers' competence and readiness for real-world applications. Blended learning can be instrumental in achieving SDG 17 (Partnerships for the Goals) by fostering collaboration between healthcare institutions and eLearning providers to deliver comprehensive training programmes. Self-learning in eLearning platforms has consistently shown its effectiveness across various healthcare contexts [28, 42, 51]. It empowers healthcare providers to access relevant resources, develop clinical skills, and stay updated, contributing to SDG 3 by improving overall healthcare quality and accessibility. Furthermore, during public health crises, such as the COVID-19 pandemic, self-learning through platforms like the InStrat COVID-19 tutorial app [42] proves invaluable in rapidly disseminating critical information and supporting frontline health workers.

The findings from these studies provide valuable insights into the effectiveness of various eLearning approaches among healthcare providers. Asynchronous, synchronous, blended, and self-learning methods all have their merits in enhancing healthcare knowledge, attitudes, and practices. These findings have implications for healthcare practice, including the continuous development of healthcare workers, improved patient care, and progress toward achieving Sustainable Development Goals, particularly in health and education. To maximise the benefits of eLearning in healthcare, institutions, and policymakers should consider a diverse and adaptable approach to training and education that aligns with the unique needs and contexts of healthcare professionals worldwide.

Facilitators and barriers to eLearning implementation for healthcare providers

Facilitators, such as positive prior experiences and user-friendly interfaces, underscore the importance of user acceptance and satisfaction. Positive experiences can motivate healthcare providers to engage with eLearning platforms, while user-friendly interfaces ensure ease of navigation and accessibility, contributing to a positive user experience [34, 43]. The relevance of eLearning content to daily medical practice is crucial, as it aligns educational materials with the practical needs of healthcare professionals, making the learning experience more meaningful and applicable [45]. Peer support and interaction within the eLearning environment, as highlighted by Burkardt et al. [8], foster a sense of community and collaboration, which can enhance engagement

and knowledge sharing. Flexibility in scheduling and the availability of personal and group interactions offer healthcare providers opportunities for personalised learning experiences, accommodating varying preferences and learning styles [22, 33]. Discussion forums and self-regulated learning environments promote autonomy and motivation, enabling healthcare professionals to take ownership of their learning [8, 40]. Institutional support, including political commitment, mandatory e-training requirements, instructional support, and the availability of standardised training materials, plays a pivotal role in facilitating eLearning adoption [25, 39, 52]. Adequate IT resources and facilities are essential to ensure the seamless delivery of eLearning programmes, minimising technical obstacles. Ongoing appraisal of the eLearning facility and learner needs helps maintain and improve the quality of the learning environment, ensuring its relevance and effectiveness [56].

On the other hand, barriers to effective eLearning adoption among healthcare providers are multi-faceted. Personal barriers, including low computer competence and literacy, limited access to personal computers, financial constraints, and concerns about knowledge retention, underscore the importance of addressing the digital divide and promoting digital literacy [7, 14, 45, 60]. Time constraints, resistance to change, language barriers, dissatisfaction with content, and heavy workloads reflect the complexities of integrating eLearning into busy healthcare professionals' routines [11, 24]. Environmental barriers, such as limited internet access and power outages, are significant challenges, particularly in regions with inadequate infrastructure [8, 42, 45]. Systemic issues, such as a shortage of specialised eLearning facilitators, lack of incentives, poor management involvement, and resource constraints, highlight the need for comprehensive institutional support and strategic planning [41, 58]. Technical inadequacies within ICT departments further complicate eLearning implementation [16].

Addressing these facilitators and barriers is crucial for the successful implementation of eLearning programmes in healthcare education. Overcoming these challenges requires a multi-dimensional approach that encompasses digital literacy training, infrastructure development, institutional support, and the careful design of eLearning environments to meet the specific needs of healthcare providers. By doing so, healthcare organisations can harness the potential of eLearning to continuously develop their workforce, improve healthcare quality, and contribute to the achievement of SDGs related to health and education.

eLearning for healthcare providers in developing and developed economies

The disparities in eLearning adoption between developing and developed countries highlight the profound impact of socioeconomic and technological factors on healthcare education. In developing countries like Nigeria, Ghana, and South Africa, the challenges posed by poor digital literacy, unreliable electricity supply, and limited internet connectivity significantly impede healthcare professionals' access to eLearning resources. These barriers not only hinder continuous professional development, but also limit the dissemination of critical healthcare knowledge and skills. As a result, addressing these challenges becomes pivotal in the context of achieving SDGs, particularly SDG 3 (Good Health and Well-being). By investing in improving digital infrastructure, digital literacy programmes, and user-friendly eLearning platforms, developing countries can bridge the educational gap and empower healthcare providers to deliver higher quality care. Additionally, responsive user support and targeted financial support for eLearning initiatives can help overcome financial constraints and further facilitate effective eLearning experiences in these regions [7, 40–42].

Conversely, developed countries like the United Kingdom and the United States exhibit more favourable conditions for eLearning adoption among healthcare professionals. However, they face challenges related to the perceived need for eLearning, computer competence, and connectivity issues. In these settings, eLearning has the potential to not only enhance healthcare practitioners' knowledge and skills but also improve healthcare quality and patient outcomes. The implementation of mandatory online training programmes in healthcare institutions can ensure that healthcare providers stay up to date with the latest medical advancements, aligning with SDG 3. Furthermore, promoting prior positive experiences with eLearning, ensuring user-friendly interfaces, and aligning eLearning content with clinical practice needs can accelerate the adoption of technology-enhanced learning. These findings underscore the importance of tailored eLearning strategies that consider the challenges and opportunities presented by the digital landscape in developing and developed countries [31, 38, 43].

While developing countries grapple with infrastructure and digital literacy challenges, developed countries face issues related to attitudes towards eLearning and ensuring technology's seamless integration into healthcare education. To harness the full potential of eLearning in healthcare, efforts should focus on improving digital infrastructure, enhancing digital literacy, and promoting user-friendly eLearning environments. By doing so,

healthcare providers across the globe can benefit from continuous education, ultimately leading to improved healthcare delivery and better outcomes for individuals and communities, aligning with the broader objectives of the SDGs.

Limitations of this review and recommendations for future studies

The scope of this review was limited to papers published in the English language, which may have had an impact on the number of studies included. The authors have presented an analysis of eLearning programmes for healthcare professionals in both developed and developing countries. It is crucial to exercise caution when interpreting the findings and discussions within this context, as the conventional classification of some countries as developed or developing may not accurately reflect the diverse and evolving nature of these nations. Additionally, the authors conducted an appraisal of the included studies, but it is important to note that the quality of the studies did not influence their inclusion in this qualitative synthesis. The appraisal of methodological quality revealed that high-risk or low-quality studies were primarily found within qualitative, mixed-method, and cross-sectional studies. These studies are more susceptible to biases and methodological flaws, which in turn can compromise the reliability and trustworthiness of their findings. Consequently, the inclusion of such studies in a review can introduce bias into the synthesis of evidence, potentially leading to skewed or misleading conclusions. Moreover, findings from high-risk or low-quality studies may not be generalisable to broader populations or settings due to limitations in their design or execution. However, it is important to highlight that the authors handled low-quality studies with caution and transparency. They placed a greater emphasis on higher-quality evidence, which helps maintain the credibility of the review and ensures that it provides valuable insights for decision-makers and practitioners. All studies, including those of lower quality, were appraised and included to showcase the available evidence and provide an overview of the quality of evidence regarding eLearning implementation and its associated facilitators and barriers.

In the future, a meta-analysis could be considered to establish the overall effectiveness of eLearning globally and in specific regions. Additionally, future studies focusing on the effectiveness of eLearning among healthcare professionals should adopt robust research designs, such as randomised controlled trials and longitudinal studies. These designs can help establish the independent effects of eLearning programmes more conclusively, contributing to a stronger evidence base for informed decision-making in healthcare education and practice.

Policy and practice recommendations

Developing countries should prioritise investments in digital infrastructure, ensuring reliable internet connectivity and access to personal computers, especially among healthcare providers. Simultaneously, digital literacy programmes should be implemented to boost healthcare professionals' computer competence and confidence in navigating eLearning platforms. Tailoring eLearning content to align with the practical needs of healthcare providers closely fosters engagement and applicability. Furthermore, responsive user support should be readily available, especially in regions and countries facing technical difficulties, to mitigate barriers and ensure the success of eLearning initiatives. In developed countries, the promotion of mandatory and flexible eLearning programmes can help healthcare providers stay current with medical advancements, ultimately improving healthcare quality and patient outcomes. These recommendations collectively contribute to a more effective and equitable utilisation of eLearning in healthcare, supporting workforce development and progress towards SDGs related to health, education, and overall well-being.

Conclusion

This qualitative synthesis illuminates the multi-faceted landscape of eLearning implementation among healthcare professionals, highlighting the effectiveness of various eLearning approaches, the pivotal role of facilitators and barriers, and the disparities between developing and developed economies. Asynchronous, synchronous, blended, and self-learning methodologies have all demonstrated their merits in enhancing healthcare knowledge, attitudes, and practices, providing valuable tools for continuous professional development, and aligning with Sustainable Development Goals related to health and education. The presence of facilitators, such as positive experiences, user-friendly interfaces, and institutional support, underscores the importance of fostering a conducive eLearning environment. In contrast, barriers encompass personal, systemic, and environmental challenges that necessitate a comprehensive and adaptable approach to eLearning implementation. Furthermore, the profound disparities observed in developing and developed countries underscore the significance of addressing digital infrastructure and literacy issues to ensure equitable access to eLearning resources. Future research should adopt robust study designs, including randomised controlled trials and longitudinal studies, to establish the independent effects of eLearning programmes. These findings and recommendations collectively contribute to the enhancement of eLearning's role in healthcare

education, ultimately advancing healthcare quality and accessibility on a global scale.

Abbreviations

CPD	Continued Professional Development
ICT	Information Communication Technology
GBA	Gifty Ben Aryee
HIV	Human Immunodeficiency Virus
MA	Mustapha Amoadu
MeSH	Medical Subject Headings
MMAT	Mixed Method Appraisal Tool
PICO	Population, Intervention, Comparison, and Outcome
PO	Paul Obeng
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
SDG	Sustainable Development Goal
TB	Tuberculosis

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12960-024-00924-x.

Supplementary Material 1.

Supplementary Material 2.

Acknowledgements
Not applicable.

Author contributions
GFBA, DO and HNS conceptualised the study. PO, MA, JAB, SAA, and DFA designed the study, collected and analysed the data, and wrote the initial draft. DO and HNS supervised the work. Each author reviewed and endorsed the ultimate version of the manuscript for publication.

Funding
This work received no funding support.

Availability of data and materials
All data generated or analysed during this study are included in this published article (and its supplementary information files).

Declarations

Ethical approval and consent to participate
Not applicable.

Consent for publication
Not applicable.

Competing interest
The authors of the study have no competing interest to declare.

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Received: 11 December 2023 Accepted: 19 May 2024
Published online: 02 September 2024

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