REVIEW ARTICLE

Volume 18 No. 3 2026

DOI: 10.21315/eimj2026.18.3.1

ARTICLE INFO

Submitted: 26-6-2025
Accepted: 26-3-2026
Online: 30-09-2026

Implementing Blended Learning in Health Professional Education: A Scoping Review

Narasimman Swaminathan[1,5], Latha Ravichandran[2], Sivakumar Ramachandran[3], Steve Milanese[4], Pitchaimani Govindharaj[5]

[1]*School of Rehabilitation and Medical Sciences, College of Health Sciences, University of Nizwa, SULTANATE OF OMAN*

[2]*Department of Health Professional Education, Sri Ramachandra Institute of Higher Education and Research, Chennai, Tamil Nadu, INDIA*

[3]*Sri Ramachandra Faculty of Physiotherapy, Sri Ramachandra Institute of Higher Education and Research, Chennai, Tamil Nadu, INDIA*

[4]*School of Health Sciences, Swinburne University of Technology, Victoria, AUSTRALIA*

[5]*Sri Ramachandra Faculty of Allied Health Sciences, Sri Ramachandra Institute of Higher Education and Research, Chennai, Tamil Nadu, INDIA*

To cite this article: Swaminathan N, Ravichandran L, Ramachandran S, Milanese S, Govindharaj P. Implementing blended learning in health professional education: a scoping review. Education in Medicine Journal. 2026;18(3):1–17. https://doi.org/10.21315/eimj2026.18.3.1

To link to this article: https://doi.org/10.21315/eimj2026.18.3.1

ABSTRACT

This systematic scoping review analysed the current status of blended learning (BL) in health professions education (HPE). The benefits and feasibility of implementing BL in HPE were documented. Literature screening identified the essentials of implementing BL in HPE. This study implemented the recommended frameworks for conducting scoping reviews. A search strategy was established using keywords associated with the defined participants: health professions education students, blended learning, and entry-level graduate programmes. The search was conducted in the Cochrane Central Register of Controlled Trials (CENTRAL), MEDLINE, Emcare, Embase, PsycINFO, Scopus, Education Research Information Center (ERIC), and ScienceDirect. The titles, abstracts, and full texts were screened by two independent reviewers using Covidence software. Data were extracted from the included records using a predetermined data extraction form by two independent reviewers. The extracted data were evaluated and summarised in tabular and diagrammatic formats. A total of 164 full texts were screened, of which 59 studies met the inclusion criteria and were included in the report synthesis. Most of the studies were conducted in developed countries. The majority of the included studies were conducted in medical and nursing courses. Most studies used a quasi-experimental or non-randomised experimental design, with only four randomised controlled studies. The included studies used various theoretical frameworks. There were only two mixed-methods studies. Various tools were used to assess the impact of BL. Low levels of student satisfaction, increased learning load, lack of faculty members' readiness and high costs were the challenges documented. Advantages, challenges, feasibility and methods of implementing BL were identified. Research gaps pertaining to BL in HPE were documented. Implementing BL in HPE may be feasible if designed and implemented according to multimodal theory.

Keywords: *Blended learning, Health professions education, Learning experience, Satisfaction, Implementation*

CORRESPONDING AUTHOR

Narasimman Swaminathan, School of Rehabilitation and Medical Sciences, College of Health Sciences, University of Nizwa, Sultanate of Oman

Email: naraswamin2001@gmail.com

© Malaysian Association of Education in Medicine and Health Sciences and Penerbit Universiti Sains Malaysia. 2026
This work is licensed under the terms of the Creative Commons Attribution (CC BY) (http://creativecommons.org/licenses/by/4.0/).

INTRODUCTION

Blended learning (BL) is a teaching method that combines online learning with traditional face-to-face instruction (1). By integrating the benefits of both approaches, a more effective educational experience can be created (2). This combination of online and in-person teaching is referred to as BL. Garrison and Kanuka (1) defined BL as the strategic integration of classroom-based learning with online learning experiences.

Health professions education (HPE) institutions, like other educational institutions, are incorporating information and communication technology (ICT) into their curriculum delivery (1–3). The use of ICT has become standard practice in HPE institutions, as today's students prefer technology-based learning (4–6). The COVID-19 pandemic further highlighted the importance of digital tools in education, as evidenced by published literature and personal experiences (4–6). During the pandemic, health professions educators learned to leverage ICT in imparting knowledge and skills (7). Even prior to the pandemic, educators in the health professions utilised various digital tools to engage learners and promote active learning (7,8).

As learners prefer digital teaching methods, educators may need to be trained to adapt teaching–learning (TL) methods accordingly. Providing a meaningful learning experience is always a challenge for educators, which can be overcome by understanding learners' characteristics and the need for learning, and then applying established learning theories in designing and delivering curriculum (7–9). Generation Z (Gen Z) learners, born between 1995 and 2012, are digital natives who prefer learning through digital technologies. The learning preferences of Gen Z differ significantly from those of other generations (8–10). The current generation of learners prefers active, collaborative learning methods over traditional didactic lectures (9–11). It has become necessary for HPE educators to adopt innovative learning techniques, and the successful implementation of such technology requires understanding and testing educational theories.

Various innovative methods using ICT have been tested in HPE, yielding mixed results. The authors used various digital tools, including social media, to create meaningful learning experiences (10, 11). E-learning, flipped classes and BL are the most common methods that have received attention in HPE (1). Concerns have been raised about the use of purely online learning in HPE (12). Graduates of HPE programmes are expected to demonstrate the competencies required for their domain. Competency is a combination of knowledge, skills and attitudes. The development of competencies requires supervised hands-on experience in a clinical environment. Considering the nature of HPE, online learning as an individual component may not be feasible or acceptable (12).

The integration of online learning with traditional face-to-face sessions might improve learning experiences and student engagement (2). To be considered BL, there must be a predefined plan that includes online learning, with activities and face-to-face encounters designed to facilitate higher-order learning (11). This study aimed to analyse the use of BL in HPE and identify research gaps. The main research questions were:

a. What is the current status of BL in HPE, according to the literature?
b. What are the advantages of BL in HPE?
c. How practical is the implementation of BL in HPE?
d. What strategies have HPE institutions used to implement and assess BL in this context?
e. Are there any gaps in the current literature that need to be addressed?

METHODS

Design

This study used a scoping review to analyse the research gaps and understand BL. Scoping reviews are often used to synthesise research evidence and map the existing evidence base in a focused area, including its nature, structure, and size. In contrast to systematic reviews, scoping reviews focus on broader questions and include all studies. They provide the researcher with broader, in-depth perspectives on the selected topic (15). Scoping reviews can be used to identify and analyse relevant literature and to map the essential concepts of the area of focus (16). Scoping reviews use transparent, rigorous methods to identify all potential literature sources, including secondary literature (17). This method is widely used in the literature, primarily if the topics of interest are extensive and complex. The results of a scoping review can serve as a foundation for further planning and execution of research in the area of focus (18).

This review followed the Joanna Briggs Institute (JBI) methodology for scoping reviews (19). Reporting was guided by the Preferred Reporting Items for Scoping Review (PRISMA-ScR) guidelines and checklist. A protocol for the scoping review was prepared following the guidelines.

Population

The population in this scoping review included HPE students and faculty members. HPE included medical, nursing, pharmacy and allied health sciences.

Concept

For the purpose of this review, BL in HPE refers to the integration of online and face-to-face teaching sessions. This review did not consider studies that included e-learning, online learning or flipped classrooms.

Context

As the aim of the study was to explore the use of BL in entry-level HPE programmes, we considered only bachelor's degree programmes. This review excluded postgraduate and other programmes that used BL. The search terms used and inclusion and exclusion criteria are summarised in Tables 1 and 2, respectively.

Table 1: Search terms used

Search terms used	("Undergraduate" OR "entry-level") AND ("health professionals' education" OR "allied health" OR "medical" OR "dental" OR "nursing" OR "physiotherapy" OR "optometry" OR "occupational therapy" OR "speech-language pathology") AND ("blended learning" OR "hybrid learning" OR "education* OR instruct* OR model* OR theory*)

Table 2: Inclusion and exclusion criteria

Criteria	Inclusion	Exclusion
Participants	Students and faculty members of HPE	Studies included other than HPE stakeholders
Concept	BL integration of online and face-to-face sessions	Studies used e-learning, online learning, flipped classrooms
Context	Entry-level graduate programmes of HPE	Other than entry-level graduate programmes, such as continuing professional development programmes, courses are offered outside the prescribed curriculum
Language	Studies published in English	Other languages
Studies	All types of primary studies have been published in peer-reviewed scientific journals	

Search Strategy

We used health professionals' education or allied health or medical or nursing or physiotherapy or optometry or occupational therapy or speech language pathology as search teams for the population. The search strategy was developed to answer the questions using the keywords as shown in Table 1. The following databases were searched: Cochrane Central Register of Controlled Trials (CENTRAL), MEDLINE through Ovid, Emcare, Embase, PsycINFO, Scopus, Education Research Information Center (ERIC) and ScienceDirect. The first search was undertaken on 13th November 2018 and updated on 14th October 2020. A detailed search strategy for the Ovid-Medline platform is provided as Appendix 1. The results were uploaded to the Covidence systematic review software. Cross-references from the included studies were verified. The search was updated on 3rd September 2025, based on the peer reviewer's suggestions.

Study Selection

Title and abstract screening followed by full-text screening was performed independently by two reviewers (NS and SR). The third reviewer (PG) resolved any conflicts, as required.

Data Extraction

A data extraction form was created in Covidence. One reviewer (NS) extracted the data using a predetermined template. Study ID, author details, the aim of the study, the methodology adopted, theoretical frameworks, outcome measures used and key findings were extracted from the included studies. The extracted data were later confirmed by an independent reviewer for accuracy (PG).

Data Synthesis

One author (NS) analysed and summarised data using graphs and tables. Two reviewers (SM and SR) confirmed the findings and verified them against the raw data. Systematic and scoping reviews were not included in the analysis, as the objective was to focus on primary research. However, the findings of secondary evidence were summarised and reported in the section on the impact of BL in HPE.

RESULTS

Search Outcome

PRISMA-ScR was used to report the search (20). The PRISMA-ScR chart (Figure 1) provides the details. Two independent reviewers, NS and SR, screened the title and abstract for inclusion using predetermined criteria. The entire process was completed using the Covidence systematic review software. The search retrieved 544 studies across the databases, and Covidence software removed 274 duplicates. Of the total, 113 full texts were screened, and 36 studies were included in the final analysis. The second phase of the search retrieved 666 studies, of which 51 were screened for full text. An additional 23 studies were included, bringing the total to 59 for the synthesis. Figures 2 and 3 show the distribution of included studies by country and health profession, respectively. Studies that used only online components to provide learning support, such as uploading videos, reading materials, quizzes, and discussions, were considered irrelevant.

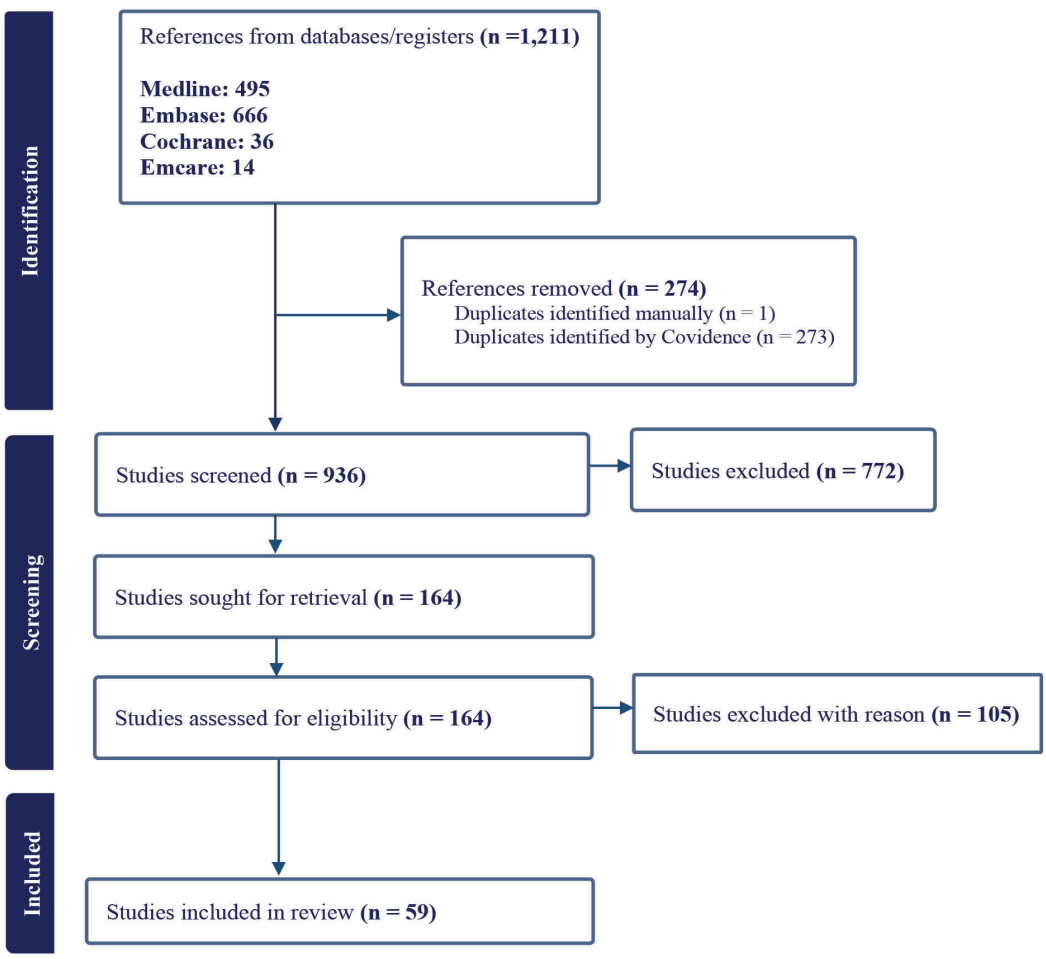


Figure 1: The PRISMA-ScR flow diagram provides details according to the stages of the scoping review.

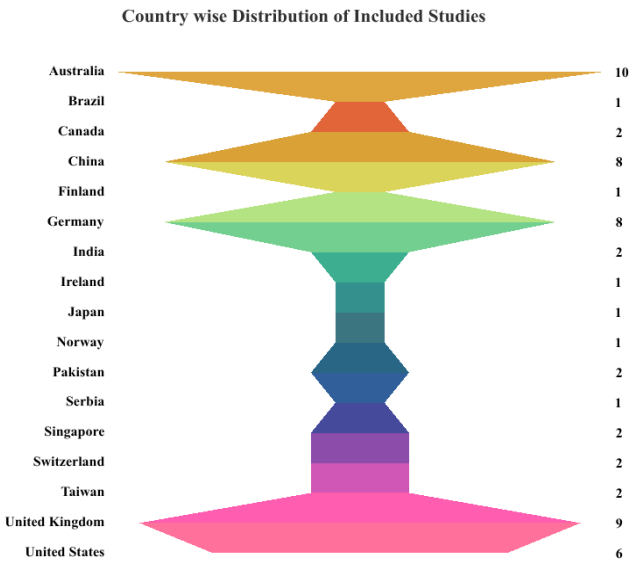


Figure 2: Distribution of included studies country-wise.

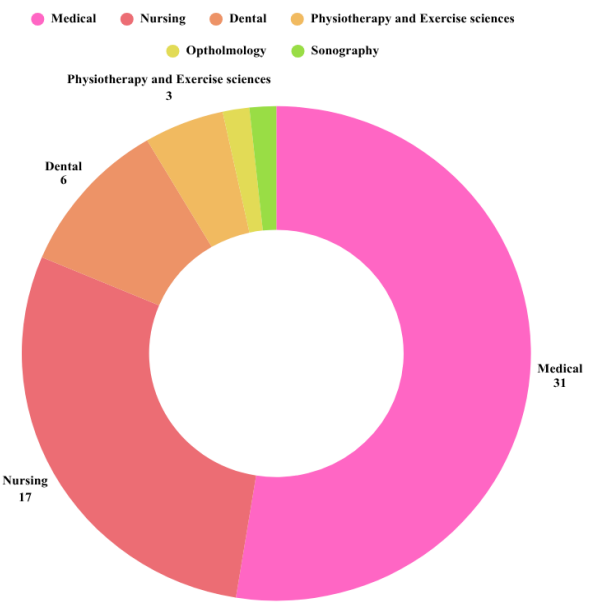


Figure 3: Distribution of included studies as per health profession.

DISCUSSION

Status of BL in HPE

Most studies on BL were conducted in developed countries, with only two from India (21,22). Figure 2 illustrates the distribution of studies by country. The majority of the included studies involved medical students (10) and nursing students (9). The increase in the number of studies during the updated search may be attributed to the impact of the COVID-19 pandemic (23–26). There were fewer studies in allied health sciences than in medicine and nursing.

Research Designs Adopted in the Included Studies

Most studies utilised a quasi-experimental or non-randomised experimental design, with 10 randomised controlled trials (25–34) and seven mixed-methods studies (35–41). Figure 4 summarises the research designs used in the included studies. A limited number of studies investigated the combined impact of BL and stakeholder satisfaction, and the quality of these studies varies. It is crucial to conduct rigorous studies, especially those employing mixed methods, to evaluate the effectiveness of BL. Therefore, it is justified to develop, implement and evaluate the effectiveness of a fully blended course across health profession programmes.

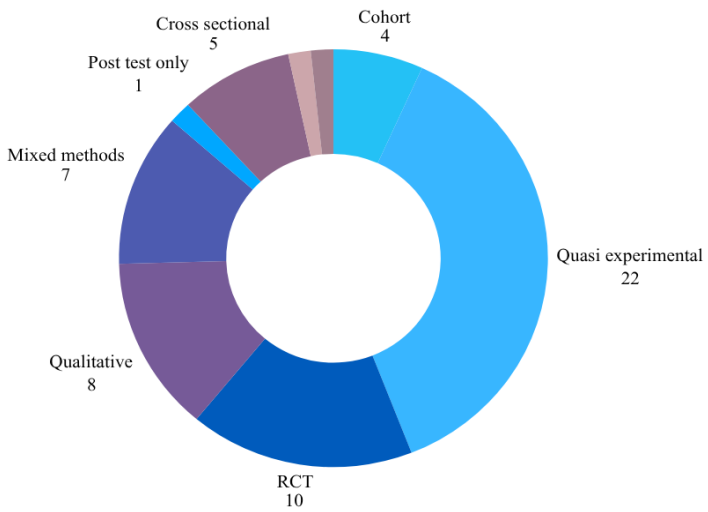


Figure 4: Research designs used in the included studies.

Theoretical Frameworks Adopted in the Published Literature on BL

Twelve of the included studies adopted a theoretical framework. Bandura's social cognitive theory (23,42) and Knowles' andragogic principles were used as the theoretical framework for implementing BL (43–45). Most of the included studies adopted minimalism, behaviourism, and constructivism (28,41,46–50). Some studies adopted blended pedagogies (24,26,51). Educational theories can improve the efficacy of technology in medical education. Providing a clear explanation of the educational theories that guide the design can help in understanding why certain technological interventions are more successful than others. Incorporating theory-driven educational interventions into technology for teaching and learning is a crucial step in advancing its use in medical education (52). Based on the analysis, it is recommended that the adoption of multimodal theory be considered when implementing BL in HPE.

Feasibility of Implementing BL

Studies from various countries have shown that implementing BL, ranging from a single module to a full programme, is feasible. While many studies focused on testing effectiveness and stakeholder satisfaction rather than directly assessing feasibility, the application of multimodal theories and principles enabled the planning and implementation of BL. By

examining the challenges identified in these studies, the implementation of BL can be facilitated. Research across countries has demonstrated the successful implementation of BL in HPE (21–23,48,53,54).

Challenges for Implementing BL in HPE

The challenges of implementing BL in HPE are similar to those identified in the literature review. Figure 5 illustrates the challenges to implementing BL. The identified challenges can be categorised from the perspectives of learners, educators, technology and institutions. Some studies have reported low student satisfaction levels, possibly due to a lack of prior exposure to BL (23,45,47). It is recommended that BL courses focus more on active learning techniques to enhance learner engagement. Challenges such as increased learning load and cognitive overload have been documented (27,35). Having too many learning activities and assignments could detract from the learning experience (25,35,47). Faculty members' reluctance to transition from traditional teaching methods to newer approaches and to adapt to technology has been noted as a challenge (48,55). A lack of training for faculty members in implementing BL was identified as a barrier (55,56). The initial cost of setting up the BL environment was also recognised as a challenge. Creating online content that aligns with adult learning principles can be challenging in HPE, as it requires a focus on technical aspects (45).

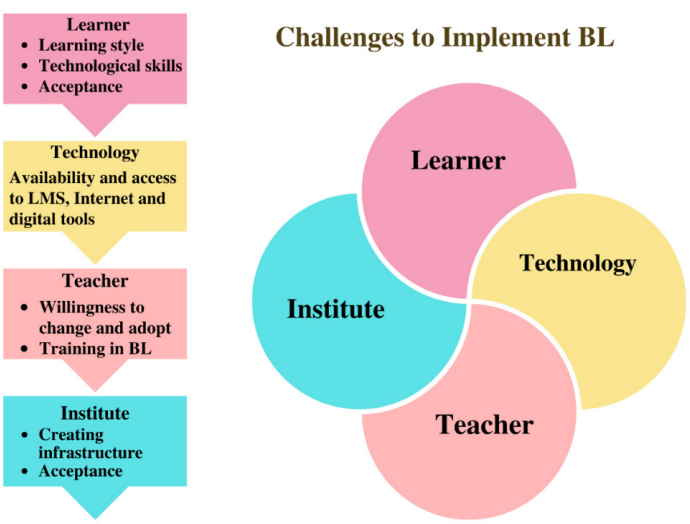


Figure 5: Challenges to implementing BL.

Strategies for Implementing BL

Analysing the included studies provided a direction for designing a BL course suitable for HPE. The planning of BL has five steps, as shown in Figure 6 (51,57).

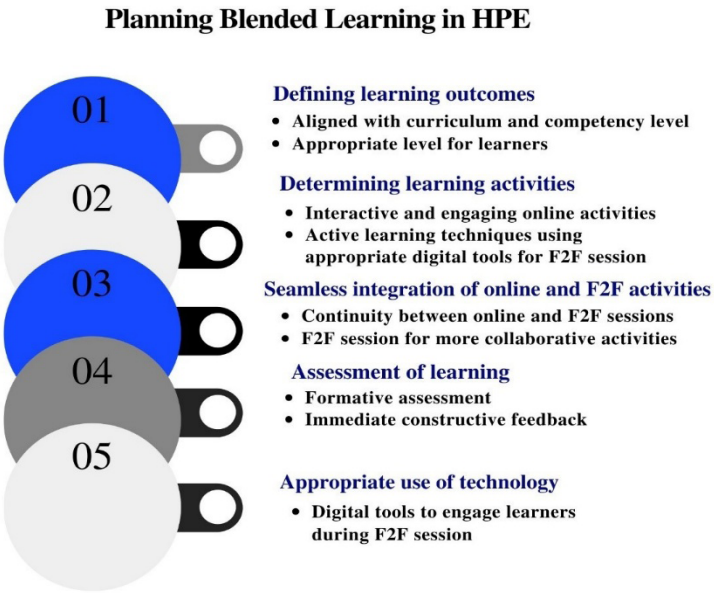


Figure 6: Planning of BL in HPE.

Defining learning outcomes aligned with the curriculum and learners' level is the first step in designing a BL module. The second step involves designing interactive learning activities and selecting digital tools to enhance learner engagement in both online and face-to-face sessions. The seamless integration of online and face-to-face learning is the crucial third step in BL. Finally, implementing appropriate assessments to provide immediate feedback is essential.

Learners who completed the BL course expressed that BL could not replace face-to-face training (58). As described, BL is more than just replacing face-to-face sessions with online sessions, as it requires proper planning and implementation. Content creation for online learning needs the most attention, as it serves as the basis for in-depth learning. Learners can understand the basics through self-directed online learning, whereas they require facilitation for higher-order thinking (33). Formative assessment with immediate feedback should be a component of BL, as preferred by learners (58).

The keys to implementing BL include understanding learners' and faculty members' readiness to adopt BL, creating blended courses that adhere to the principles, preparing engaging online content, integrating online and face-to-face learning, implementing formative assessment, providing feedback, planning the learning load, and creating the necessary infrastructure.

Outcome Measures Used in the BL Literature

Most studies used survey questionnaires to assess learner satisfaction. The Likert scale was the most common type used across studies. Some studies used specific tools to measure competencies based on learning outcomes, such as the ACE tool to assess Evidence-Based

Practice (EBP) competencies (34), the Comprehensive Osteopathic Medical Achievement Test (59), and the Communication Skills Attitude Scale (CSAS) (57). The knowledge acquired following the BL course was assessed using Multiple-Choice Questions (MCQs) and short essay questions. Two studies analysed students' reflections as the outcome (22,60). Focus group discussions (FGDs) and in-depth interviews were also used to identify the learners' perceptions (61). Videos viewed and discussion board hits were also used to assess learners' engagement with online content (62). It was understood that the outcomes had to include identifying a change in knowledge and skills; therefore, learning outcomes influenced the type of outcome. Methods such as FGD and in-depth interviews are useful for understanding learners' satisfaction and perception (63).

Key Findings

Designing and delivering BL must be based on a combination of educational theories. However, only a limited number of studies have incorporated educational theories into their BL designs. Well-designed blended courses have been shown to enhance student satisfaction. It is crucial to consider the learning workload when developing blended courses. The impact of BL on learning outcomes is comparable to that of traditional teaching methods, but its superiority over other methods remains under investigation. The feasibility of implementing BL in developing countries is supported by a few studies conducted in these regions. Most studies have focused on single modules rather than full courses integrated into the curriculum. There is a need for mixed-methods studies with appropriate outcome measures to further explore the effectiveness of BL.

Research Gaps Identified

Learners' readiness to adopt BL has not been extensively studied in low- and middle-income countries (LMICs). The infrastructure and educational environment in LMICs may impact the adoption of BL. Understanding students' readiness to embrace new teaching methods is crucial for the successful implementation of innovative approaches. Research on learner readiness for BL in LMICs is lacking, highlighting the need to assess this readiness across various health professions.

Existing studies on BL often focus on individual modules rather than full courses. Therefore, conducting studies that implement entire courses in a blended format and evaluating their impact on student satisfaction is essential. In addition, comparing the effectiveness of BL across student cohorts in achieving learning outcomes can provide valuable insights into its efficacy as a teaching method. Studies on BL often emphasise learning outcomes achieved through MCQs; however, it is important to clarify how these assessments align with intended learning outcomes. Furthermore, using standardised tools to evaluate competencies acquired through BL is essential for a comprehensive assessment of its effectiveness.

A limited number of studies have combined assessments of BL effectiveness with stakeholder satisfaction. Conducting rigorous research, particularly using mixed methods approaches, can provide a more comprehensive understanding of the impact of BL on learning outcomes and stakeholder satisfaction. Developing, implementing, and evaluating a full-blown blended course in a developing country is a justified endeavour that can yield valuable insights into the field of education.

Limitations of This Review

Regardless of the rigorous methods adopted, the search did not include grey literature. The search terms focused only on BL at graduate-level HPEs. Despite using truncations and Boolean logic to capture as many studies as possible, other search terms would have yielded different results. This review did not appraise the quality of the studies, as this was a scoping review.

Recommendations

This scoping review suggests that learners' and teachers' readiness to adopt BL should be evaluated prior to implementation. The success of BL depends on the preparation of engaging online content, which requires attention. Seamless integration of online and face-to-face sessions is one of BL' hallmarks and requires thoughtful planning. Appropriate outcome measures should be used to assess the effectiveness of BL in HPE in future studies.

CONCLUSION

This literature review highlighted the potential benefits of BL in HPE. While various studies have demonstrated the advantages of BL in HPE, there remain research gaps that must be addressed. This scoping review suggests that implementing BL in HPE is feasible, but it requires careful planning, training and the development of the necessary infrastructure. The lack of rigorous studies underscores the need for well-designed mixed-methods studies to further explore the effectiveness of BL in HPE. A protocol prepared for this scoping review was registered with an Open Science Framework (https://doi.org/10.17605/OSF.IO/2CVPA). The date of registration was 25th September 2021.

ACKNOWLEDGEMENTS

The authors would like to acknowledge the librarian of Sri Ramachandra Institute of Higher Education and Research and the institute for providing necessary support to complete this scoping review. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

ETHICAL APPROVAL

The authors confirm that this review has been prepared in accordance with COPE guidelines and regulations. Given the nature of this article, IRB review was not required.

REFERENCES

1. Garrison DR, Kanuka H. Blended learning: uncovering its transformative potential in higher education. Internet High Educ. 2004;7(2):95–105. https://doi.org/10.1016/j.iheduc.2004.02.001

2. Okaz AA. Integrating blended learning in higher education. Procedia Soc Behav Sci. 2015;186:600–3. https://doi.org/10.1016/j.sbspro.2015.04.086

3. Ellaway R, Masters K. AMEE Guide 32: e-learning in medical education Part 1: learning, teaching and assessment. Med Teach. 2008;30(5):455–73. https://doi.org/10.1080/01421590802108331

4. Dhonncha EN, Murphy M. Learning new ways of teaching and assessment: the impact of COVID-19 on undergraduate dermatology education. Clin Exp Dermatol. 2021;46(1):170–1. https://doi.org/10.1111/ced.14364

5. Konrad S, Fitzgerald A, Deckers C. Nursing fundamentals - supporting clinical competency online during the COVID-19 pandemic. Teach Learn Nurs. 2020;16(1):53–6. https://doi.org/10.1016/j.teln.2020.07.005

6. Thibaut D, Schroeder KT. A case-based learning approach to online biochemistry labs during COVID-19. Biochem Mol Biol Educ. 2020;48(5):484–5. https://doi.org/10.1002/bmb.21408

7. Boysen 2nd PG, Daste L, Northern T. Multigenerational challenges and the future of graduate medical education. Ochsner J. 2016;16(1):101–7.

8. Hyll M, Schvarcz R, Manninen K. Exploring how medical students learn with the help of a digital presentation: a qualitative study. BMC Med Educ. 2019;19(1):210. https://doi.org/10.1186/s12909-019-1569-z

9. Roberts DH, Newman LR, Schwartzstein RM. Twelve tips for facilitating Millennials' learning. Med Teach. 2012;34(4):274–8. https://doi.org/10.3109/0142159x.2011.613498

10. Eckleberry-Hunt J, Lick D, Hunt R. Is medical education ready for Generation Z? J Grad Med Educ. 2018;10(4):378–81. https://doi.org/10.4300/JGME-D-18-00466.1

11. Desy JR, Reed DA, Wolanskyj AP. Milestones and millennials: a perfect pairing—competency-based medical education and the learning preferences of Generation Y. Mayo Clin Proc. 2017;92(2):243–50. https://doi.org/10.1016/j.mayocp.2016.10.026

12. Chipps J, Pimmer C, Brysiewicz P, Walters F, Linxen S, Ndebele T, et al. Using mobile phones and social media to facilitate education and support for rural-based midwives in South Africa. Curationis. 2015;38(2):1500. https://doi.org/10.4102/curationis.v38i2.1500

13. Diug B, Kendal E, Ilic D. Evaluating the use of twitter as a tool to increase engagement in medical education. Educ Health. 2016;29(3):223–30. https://doi.org/10.4103/1357-6283.204216

14. Cook DA, Levinson AJ, Garside S, Dupras DM, Erwin PJ, Montori VM. Internet-based learning in the health professions: a meta-analysis. JAMA. 2008;300(10):1181–96. https://doi.org/10.1001/jama.300.10.1181

15. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. Int J Soc Res Methodol. 2005;8(1):19–32. https://doi.org/10.1080/1364557032000119616

16. Mays N, Pope C, Popay J. Systematically reviewing qualitative and quantitative evidence to inform management and policy-making in the health field. J Health Serv Res Policy. 2005;10(1_suppl):6–20. https://doi.org/10.1258/1355819054308576

17. Davis K, Drey N, Gould D. What are scoping studies? A review of the nursing literature. Int J Nurs Stud. 2009;46(10):1386–400. https://doi.org/10.1016/j.ijnurstu.2009.02.010

18. Levac D, Colquhoun H, O'Brien KK. Scoping studies: advancing the methodology. Implementation Sci. 2010;5(1):69. https://doi.org/10.1186/1748-5908-5-69

19. Peters MDJ, Godfrey CM, Khalil H, McInerney P, Parker D, Soares CB. Guidance for conducting systematic scoping reviews. Int J Evid Based Healthc. 2015;13(3):141–6. https://doi.org/10.1097/xeb.0000000000000050

20. Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. Int J Surg. 2010;8(5):336–41. https://doi.org/10.1016/j.ijsu.2010.02.007

21. Nagaraj C, Yadurappa SB, Anantharaman LT, Ravindranath Y, Shankar N. Effectiveness of blended learning in radiological anatomy for first-year undergraduate medical students. Surg Radiol Anat. 2021;43(4):489–96. https://doi.org/10.1007/s00276-020-02572-x

22. Eachempati P, Kiran Kumar KS, Sumanth KN. Blended learning for reinforcing dental pharmacology in the clinical years: a qualitative analysis. Indian J Pharmacol. 2016;48(Suppl 1):S25–8. https://doi.org/10.4103/0253-7613.193315

23. Berga KA, Vadnais E, Nelson J, Johnston S, Buro K, Hu R, et al. Blended learning versus face-to-face learning in an undergraduate nursing health assessment course: a quasi-experimental study. Nurse Educ Today. 2021;96:104622. https://doi.org/10.1016/j.nedt.2020.104622

24. Patel B, Taggar JS. Virtual teaching of undergraduate primary care small groups during COVID-19. Educ Prim Care. 2021;32(5):296–302. https://doi.org/10.1080/14739879.2021.1920475

25. Nathaniel TI, Goodwin RL, Fowler L, McPhail B, Black Jr AC. An adaptive blended learning model for the implementation of an integrated medical neuroscience course during the COVID-19 pandemic. Anat Sci Educ. 2021;14(6):699–710. https://doi.org/10.1002/ase.2097

26. Teichgräber U, Ingwersen M, Mentzel H-J, Aschenbach R, Neumann R, Franiel T, et al. Impact of a heutagogical, multimedia-based teaching concept to promote self-determined, cooperative student learning in clinical radiology. Rofo. 2021;193(6):701–11.

27. Grundgeiger T, Ertle F, Diethei D, Mengelkamp C, Held V. Improving procedural skills acquisition of students during medical device training: experiments on e-Learning vs. e-learning with hands-on. Adv Health Sci Educ Theory Pract. 2022;28(1):127–46. https://doi.org/10.1007/s10459-022-10148-0

28. Park K-H, Yi Y. Mock trials and web-based education using malpractice cases: a randomised controlled trial. Collegian. 2023;30(2):293–9. https://doi.org/10.1016/j.colegn.2022.09.014

29. Weimer A, Recker F, Vieth T, Buggenhagen H, Schamberger C, Berthold R, et al. Undergraduate musculoskeletal ultrasound training based on current national guidelines—a prospective controlled study on transferability. BMC Med Educ. 2024;24(1):1193. https://doi.org/10.1186/s12909-024-06203-6

30. Liu Q, Yuan N, Wang Y, Sun B, Yang L, Wang Z, et al. A practice and exploration of blended learning in medical morphology during the post-COVID-19 pandemic era. BMC Med Educ. 2025;25(1):719. https://doi.org/10.1186/s12909-025-07280-x

31. Herrmann-Werner A, Weber H, Loda T, Keifenheim KE, Erschens R, Molbert SC, et al. "But Dr Google said..." - training medical students how to communicate with e-patients. Med Teach. 2019;41(12):1434–40. https://doi.org/10.1080/0142159x.2018.1555639

32. Jeganathan S, Fleming PS. Blended learning as an adjunct to tutor-led seminars in undergraduate orthodontics: a randomised controlled trial. Br Dent J. 2020;228(5):371–5. https://doi.org/10.1038/s41415-020-1332-1

33. Posey L, Pintz C. Transitioning a bachelor of science in nursing program to blended learning: successes, challenges and outcomes. Nurse Educ Pract. 2017;26:126–33. https://doi.org/10.1016/j.nepr.2016.10.006

34. Ilic D, Nordin RB, Glasziou P, Tilson JK, Villanueva E. A randomised controlled trial of a blended learning education intervention for teaching evidence-based medicine. BMC Med Educ. 2015;15:39. https://doi.org/10.1186/s12909-015-0321-6

35. Bridges S, Chang JWW, Chu CH, Gardner K. Blended learning in situated contexts: 3-year evaluation of an online peer review project. Eur J Dent Educ. 2014;18(3):170–9. https://doi.org/10.1111/eje.12082

36. Xu M-M, Tian Q, Yu S-H, Liu Y-T, Cao M-L, Zhang W. Cognitive engagement of nursing undergraduates in blended learning: a parallel mixed-methods study. Nurse Educ Today. 2023;130:105947. https://doi.org/10.1016/j.nedt.2023.105947

37. Gellisch M, Morosan-Puopolo G, Brand-Saberi B, Schäfer T. Adapting to new challenges in medical education: a three-step digitisation approach for blended learning. BMC Med Educ. 2024;24(1):585. https://doi.org/10.1186/s12909-024-05503-1

38. Jaleel A, Iqbal SP, Cheema KM, Iftikhar S, Bashir MZ. Navigating undergraduate medical education: a comparative evaluation of a fully online versus a hybrid model. BMC Med Educ. 2024;24(1):895. https://doi.org/10.1186/s12909-024-05865-6

39. Yang Y, Chen H, Sun H. Nursing undergraduate students' experiences and perceptions of blended learning in pediatric nursing: a mixed methods study. SAGE Open Nurs. 2024;10:23779608241274214. https://doi.org/10.1177/23779608241274214

40. Khong ML, Tanner JA. Surface and deep learning: a blended learning approach in preclinical years of medical school. BMC Med Educ. 2024;24(1):1029. https://doi.org/10.1186/s12909-024-05963-5

41. Pahinis K, Stokes CW, Walsh TF, Cannavina G. Evaluating a blended-learning course taught to different groups of learners in a dental school. J Dent Educ. 2007;71(2):269–78.

42. Bandura A. Social foundations of thought and action: a social cognitive theory. Englewood Cliffs, N.J.: Prentice-Hall; 1986.

43. Knowles MS, Holton III EF, Swanson RA. The adult learner: the definitive classic in adult education and human resource development. Oxford: Elsevier; 2012.

44. Duque G, Demontiero O, Whereat S, Gunawardene P, Leung O, Webster P, et al. Evaluation of a blended learning model in geriatric medicine: a successful learning experience for medical students. Australas J Ageing. 2013;32(2):103–9. https://doi.org/10.1111/j.1741-6612.2012.00620.x

45. Blissitt AM. Blended learning versus traditional lecture in introductory nursing pathophysiology courses. J Nurs Educ. 2016;55(4):227–30. https://doi.org/10.3928/01484834-20160316-09

46. Custer T, Wampler K, Lambing L, Sayles H, Michael K. Lecture, online, flipped, and blended: a mixed-methods study on ultrasound student outcomes and perceptions. J Diagn Med Sonogr. 2022;38(6):487–96. https://doi.org/10.1177/87564793221106781

47. Fehl M, Gehres V, Geier AK, Mundt T, Klinge K, Frese T, et al. Medical students' adoption and evaluation of a completely digital general practice clerkship - cross-sectional survey and cohort comparison with face-to-face teaching. Med Educ Online. 2022;27(1):2028334. https://doi.org/10.1080/10872981.2022.2028334

48. Doyle AJ, Murphy CC, Boland F, Pawlikowska T, Gabhann-Dromgoole JN. Education in focus: significant improvements in student learning and satisfaction with ophthalmology teaching delivered using a blended learning approach. PLoS One. 2024;19(7):e0305755. https://doi.org/10.1371/journal.pone.0305755

49. Gong L, Song Y, Xu Y, Wang M, Ma H, Liu W, et al. The use of a technology-assisted and teacher-supervised online discussion platform to promote academic progress in blended embryology courses. BMC Med Educ. 2022;22(1):817. https://doi.org/10.1186/s12909-022-03890-x

50. Shan Y, Zhou X, Qi W, Liu X, Huang C. Innovations in teaching during the COVID-19 pandemic: comparisons of the impacts of different teaching approaches in psychiatric nursing on undergraduate nursing students. BMC Med Educ. 2023;23(1):827. https://doi.org/10.1186/s12909-023-04819-8

51. Green RA, Whitburn LY. Impact of introduction of blended learning in gross anatomy on student outcomes. Anat Sci Educ. 2016;9(5):422–30. https://doi.org/10.1002/ase.1602

52. Sandars J, Patel RS, Goh PS, Kokatailo PK, Lafferty N. The importance of educational theories for facilitating learning when using technology in medical education. Med Teach. 2015;37(11):1039–42. https://doi.org/10.3109/0142159X.2015.1019438

53. de Fatima Wardenski R, de Espindola MB, Struchiner M, Giannella TR. Blended learning in biochemistry education: analysis of medical students' perceptions. Biochem Mol Biol Educ. 2012;40(4):222–8. https://doi.org/10.1002/bmb.20618

54. Sadiq F, Rasa SI, Shami N, Seemadaud S, Bhatti S. Comparing effectiveness of collaborative blended learning and traditional teaching using students' final test scores. Pak J Med Health Sci. 2018;12(4):1428–31.

55. Howlett D, Vincent T, Watson G, Owens E, Webb R, Gainsborough N, et al. Blending online techniques with traditional face-to-face teaching methods to deliver final-year undergraduate radiology learning content. Eur J Radiol. 2011;78(3):334–41. https://doi.org/10.1016/j.ejrad.2009.07.028

56. Ilic D, Nordin RB, Glasziou P, Tilson JK, Villanueva E. Development and validation of the ACE tool: assessing medical trainees' competency in evidence-based medicine. BMC Med Educ. 2014;14:114. https://doi.org/10.1186/1472-6920-14-114

57. Shorey S, Kowitlawakul Y, Devi MK, Chen HC, Soong SKA, Ang E. Blended learning pedagogy designed for communication module among undergraduate nursing students: a quasi-experimental study. Nurse Educ Today. 2018;61:120–6. https://doi.org/10.1016/j.nedt.2017.11.011

58. Morton CE, Saleh SN, Smith SF, Hemani A, Ameen A, Bennie TD, et al. Blended learning: how can we optimise undergraduate student engagement? BMC Med Educ. 2016;16:195. https://doi.org/10.1186/s12909-016-0716-z

59. Langenau EE, Lee R, Fults M. Blended learning educational format for third-year pediatrics clinical rotation. J Am Osteopath Assoc. 2017;117(4):234–43. https://doi.org/10.7556/jaoa.2017.041

60. Shorey S, Siew AL, Ang E. Experiences of nursing undergraduates on a redesigned blended communication module: a descriptive qualitative study. Nurse Educ Today. 2018;61:77–82. https://doi.org/10.1016/j.nedt.2017.11.012

61. Hsu LL. Qualitative assessment of a blended learning intervention in an undergraduate nursing course. J Nurs Res. 2012;20(4):291–9. https://doi.org/10.1097/jnr.0b013e31827363bc

62. Green RA, Whitburn LY, Zacharias A, Byrne G, Hughes DL. The relationship between student engagement with online content and achievement in a blended learning anatomy course. Anat Sci Educ. 2018;11(5):471–7. https://doi.org/10.1002/ase.1761

63. Gough D. Weight of evidence: a framework for the appraisal of the quality and relevance of evidence. Res Pap Educ. 2007;22(2):213–28. https://doi.org/10.1080/02671520701296189

APPENDIX 1

Detailed Search Strategy on Ovid-Medline

1	Undergraduate.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, an, ui, sy
2	Entry level.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, an, ui, sy
3	Health professionals education.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, an, ui, s
4	Medical.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, an, ui, sy
5	Nursing.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, an, ui, sy
6	Physiotherapy.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, an, ui, sy
7	Dental.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, an, ui, sy
8	Allied Health sciences.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, an, ui, s
9	Physician assistant.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, an, ui, sy
10	Optometry.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, an, ui, sy
11	Speech language pathology.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, an, ui, s
12	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or
13	education.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, an, ui, sy
14	1 and 2 and 3 and
15	1 or
16	health professionals.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, an, ui, s
17	3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or
18	15 and
19	blended learning.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, an, ui, sy,
20	hybrid learning.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, an, ui, sy
21	flipped class.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, an, ui, sy
22	19 or