REVIEW ARTICLE

Blended Learning in Human Anatomy Education in Undergraduate Medical Programmes: A Review

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Abstract

Objective: This review aims to evaluate the trends, teaching-learning practices, strengths, limitations, and outcomes of the blended-learning approach in Anatomy education in undergraduate programmes in Medicine.

Methods: An electronic search for literature was done in the MEDLINE database. Original research articles on blended learning in Anatomy, in undergraduate medical programmes, published in English, and available in full text were included, and narrative description and synthesis were done.

Results: Seventeen articles were reviewed, and the majority were published in 2021 and 2022. Blended learning was used in all components of Anatomy courses with different combinations of face-to-face and online teaching-learning methods. Commonly cited benefits of blended learning were higher knowledge acquisition and consolidation, improved self-directed learning, flexibility in time, place and pace of learning, increased motivation, higher level of engagement, and more opportunities to review. The main problems were related to connectivity and interactivity during online instruction. Blended learning courses have generally improved the course outcomes in terms of students' cognitive gain, especially at the knowledge and comprehension level.

Conclusion: Several recommendations were derived from this review. These include proper needs analysis and planning, increasing awareness and provision of training to students and teachers, developing support systems for students and teachers, and continuous monitoring and review of the courses. The need for collaborative planning and development of learning material and teaching-learning activities, with appropriate quality and quantity of the content, systematic and timely delivery and regular evaluation and review were recognized. These recommendations will be useful in planning and successful implementation of blended learning in Human Anatomy courses in medical undergraduate programmes.

Keywords: Blended-learning, Human Anatomy, Medical education

Introduction

During the last few decades, there has been a pedagogical change in medical education shifting from a teacher-centered, classroom-based education to more student-centered and self-directed learning approaches with increasing use of technology, e-resources and online learning platforms for teaching, learning and assessment (1-3). The COVID-19 pandemic accelerated this transformation, in which most medical schools worldwide adopted online teaching and learning as a major form of curriculum delivery. The approaches and innovations during pandemic showed the possibility of utilizing online learning for the achievement of outcomes and objectives of medical education programmes more efficiently (4,5). However, the common argument is that medical education cannot be offered entirely online, because of the humanistic and practice-based nature of medical training (1). Therefore "blended learning" is becoming a norm in medical education, widely accepted as "the new normal" by medical educators worldwide (6).

Blended learning is described as the combination and integration of face-to-face and online instruction or learning experiences, which allows the use of multiple forms of instruction and communication to suit the different learning needs and learning styles of the community of learners (7). Recent systematic reviews and meta-analyses have shown the effectiveness of blended learning over traditional face-to-face teaching and learning in health professions education concerning educational and course outcomes (8,9). Another meta-analysis conducted in 2013 showed that there is no significant difference in the effectiveness of online learning over face-to-face instruction when offered in isolation, which highlighted the need for integration of face-to-face and online methods of instruction in a blended approach for a better educational outcome (10).

Over the years there has been a gradual decline in the number of course hours dedicated to Human Anatomy teaching (11). Resource constraints in terms of the number of anatomy teachers, student-teacher ratio, availability of space, and other educational materials such as human cadavers for dissections urged a transformation of instructional methods in Anatomy education. Anatomy curricula loaded with didactic lectures, dissections, and histology laboratory sessions are being converted to mixed-method of instruction with the integration of technology-based and online teaching-learning methods (11,12). The COVID-19 pandemic compelled Anatomy teachers to use online-learning methods to substitute or complement face-to-face instruction, which accelerated this pedagogical transformation (13,14). Considering the situational demands for the increasing use of blended-learning in human anatomy education in undergraduate programmes, it is important to review the current practices and their outcomes, prior to any form of curriculum reform to incorporate these blended-learning approaches. Therefore, we conducted this review to evaluate the teaching-learning practices, the strengths and limitations as perceived by the students and teachers, and the outcomes of the blended-learning approach in Human Anatomy education in undergraduate programmes in Medicine.

Methods

An electronic search for literature was done in February 2023, in MEDLINE database in PubMed (https://pubmed.ncbi.nlm.nih.gov) using the keywords and parentheses as specified in Table 1.

Table 1: Literature search syntax in PubMed Advanced Search Builder

Search: ((((((((("Basic sciences"[Title/Abstract]) OR (anatomy[Title/Abstract])) OR (histology[Title/Abstract])) OR (embryology[Title/Abstract])) OR ("developmental-anatomy"[Title/Abstract])) OR ("microscopic-anatomy"[Title/Abstract])) OR (neuroanatomy[Title/Abstract])) OR (neuroscience[Title/Abstract])) OR ("radiological-anatomy"[Title/Abstract]))) AND ((((((((((("blended learning"[Title/Abstract]) OR ("blended-learning"[Title/Abstract])) OR ("Hybrid learning"[Title/Abstract])) OR ("Hybrid-learning"[Title/Abstract])) OR ("Combined learning"[Title/Abstract])) OR ("Combined-learning"[Title/Abstract])) OR ("Mixed learning"[Title/Abstract])) OR ("Mixed-learning"[Title/Abstract])) OR ("Mixed-method learning"[Title/Abstract])) OR ("mixed method learning"[Title/Abstract])) OR ("Mixed-mode learning"[Title/Abstract])) OR ("Mixed mode learning"[Title/Abstract]))

Only the articles published in English were retrieved. Literature was not filtered by the year of publication, as the review aimed to identify the trends in publications related to blended learning. Titles and abstracts of the retrieved literature were screened first to exclude the publications that are not relevant to the scope and objectives of the review. Only the research articles with primary data were selected. Review articles, commentaries, viewpoint articles and book chapters were omitted in the initial screening. Full text of the articles selected after initial screening were retrieved and screened to identify the literature that is suitable for inclusion in the review.

During the title and abstract screening and full-text screening, articles that are not on undergraduate medical education, not on human anatomy education, or not having direct reference to Human Anatomy education, or not on blended learning (i.e., only on online learning or only comparing online vs. offline learning) were excluded. Extraction of data from the selected articles was done using a data extraction form prepared in Microsoft Excel. Data were summarized in graphical format and into tables, and a narrative review was done.

Results

A total of 79 publications were retrieved by initial database search. Forty-seven articles and 15 articles were excluded in the first and second stages of screening respectively. Seventeen original research papers were selected for the review (Figure 1).

Characteristics of the selected articles are presented in Table 2. Majority of the articles (n=12) were published in the year 2021 and 2022. All the reports were from single-center studies, which were mostly from medical schools in Asia (n=12). Majority of the studies were descriptive studies (n=14), among which nine studies compared the blended learning approach with a conventional

(face-to-face) and/or entirely online approach, either in a different group (intake) of students or in the same group of students at different points within the MBBS course. Three studies were experimental or interventional in design. The reports described the use of the blended-learning approach in different content areas within the Human Anatomy curriculum that include gross anatomy, histology, embryology, radiological anatomy and neuroscience (Figure 2).
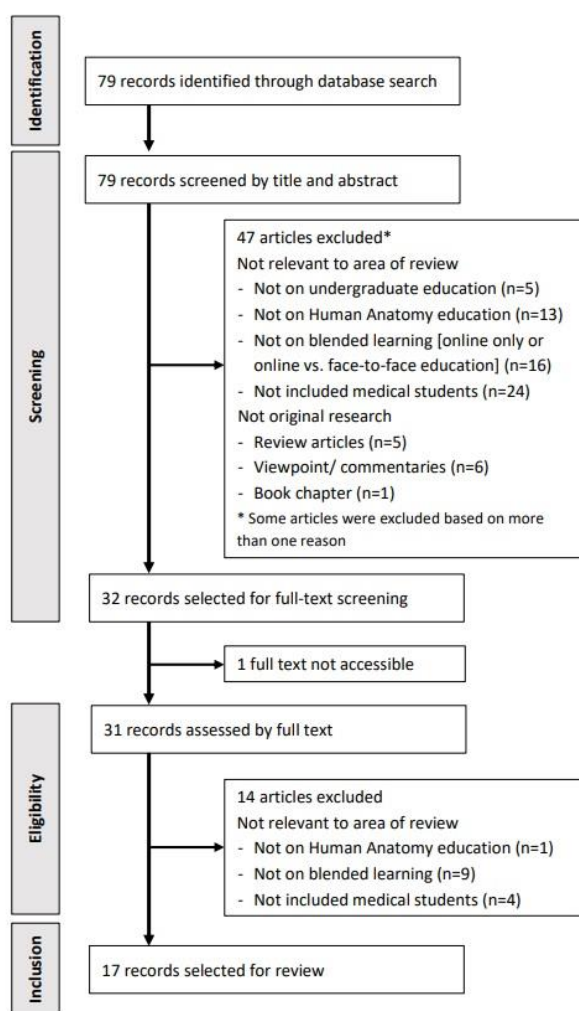

Figure 1: PRISMA flow diagram of the literature review process

A variety of computer-based and online methods have been used in combination with the traditional, face-to-face instructional methods such as lectures, cadaveric dissections and laboratory sessions, tutorials, small group discussions, problem-based learning and case-based learning sessions. The computer-assisted and online methods used in the blended approach in human anatomy education showed a wider range that included recorded lectures, videos, web-based resources, online quizzes, web-based online modules and massive open online courses in Anatomy.

Different face-to-face and online teaching-teaching methods utilized in the blended approach in Human Anatomy education in these studies are presented in Figure 2.

The majority of the studies (n=14) included in this report have evaluated the perceptions of the students regarding the blended-learning approach in Human Anatomy courses through feedback surveys. Perceived strengths and benefits of blended learning in Anatomy education can be grouped into three common themes; namely, the strengths/benefits related to the acquisition and development of learning competencies, related to the learning process, and the instructional material. The most commonly reported benefits of blended learning were the improvement of anatomy knowledge and knowledge consolidation (16,17,19,25-28), promotion of self-directed learning (16,20,22,25,27), flexibility in time, place and pace of learning (16,18,20,22,24,25,27),

Table 2: Characteristics of the articles selected for the review

Reference	Country	Type of study	Subject area	Study population/samples	Sample size (No. of students in the comparison group)
Shaffer and Small, 2004 (15)	USA	Descriptive - comparative	Radiological anatomy	Year 1 medical students (3 intakes - 2 blended)	171 + 169 (168)
Schmidt et al., 2011 (16)	Germany	Descriptive	Microscopic anatomy	Year 1-3 medical students [+dental and molecular medicine]	275 [total 369 students]
Anwar et al., 2017 (17)	Saudi Arabia	Descriptive - comparative	Neuroscience	Year 2 medical students (2 intakes - 1 blended group)	197 (160)
Singh and Min, 2017 (18)	Malaysia	Descriptive - comparative	Gross anatomy of the heart	Year 1 medical students (2 intakes - 1 blended)	200 (197)
Pickering and Swinnerton, 2019 (19)	United Kingdom	Descriptive	Abdominal, gastrointestinal and urinary system anatomy	Year 1 medical students	192
Yoo et al., 2020 (20)	South Korea	Descriptive - comparative	Gross anatomy	Year 3 (pre-clerkship) medical students (2 intakes- 1 blended group)	108 (104)
Nagaraj et al., 2021 (21)	India	Descriptive	Radiological anatomy	Year 1 medical students	150
El Sadik and Al Abdulmonem, 2021 (22)	Saudi Arabia	Descriptive - comparative	Musculoskeletal anatomy	Year 1 female medical students (2 intakes – 1 blended group)	49 (46)
Nathaniel and Black, 2021 (23)	USA	Descriptive	Neuroscience	Year 1 medical students	102

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Nathaniel et al., 2021 (24)	USA	Descriptive - comparative	Neuroscience	Year 1 medical (2 intakes - 1 blended)	102 (102)
Sarkar, Sharma and Raheja, 2021 (25)	India	Descriptive	Gross Anatomy	Phase 1 medical students	125
Aristotle, Subramanian and Jayakumar, 2021 (26)	India	Experimental	Histology	Year 1 medical students	150
Bhat et al., 2022 (27)	India	Randomized, interventional	Anatomy of the heart	Phase 1 medical students (3 groups; conventional, online and blended)	150
Guo et al., 2022 (28)	China	Descriptive-comparative	Embryology	International medical students in the preclinical phase	43 (48)
Zhong et al., 2022 (29)	China	Descriptive - comparative	Histology	Year 1 medical students (3 groups; 2 blended)	93 + 146 (89)
El-Din et al., 2022 (30)	Bahrain	Descriptive - comparative	Gross anatomy	Same group of medical students at Year 1 (face-to-face), year 2 (online) and year 3 (blended)	187
Gong et al., 2022 (31)	China	Experimental	Embryology	Year 1 medical students	83 (85)

more opportunities for revision (19-21), and increased motivation (16,18,25,30), and higher level of engagement and participation (18,19,25,30). Learning materials that were user-friendly, clear and focused (15,16,22,25,27), and the material that were clinically oriented (21,25) were perceived beneficial in learning. Higher accessibility of the learning material in the online format was another reported benefit in blended learning (21,27). Commonly reported problems in the blended learning approach were related to connectivity (15,21,27) and interactivity (18,20,27) during online instruction.
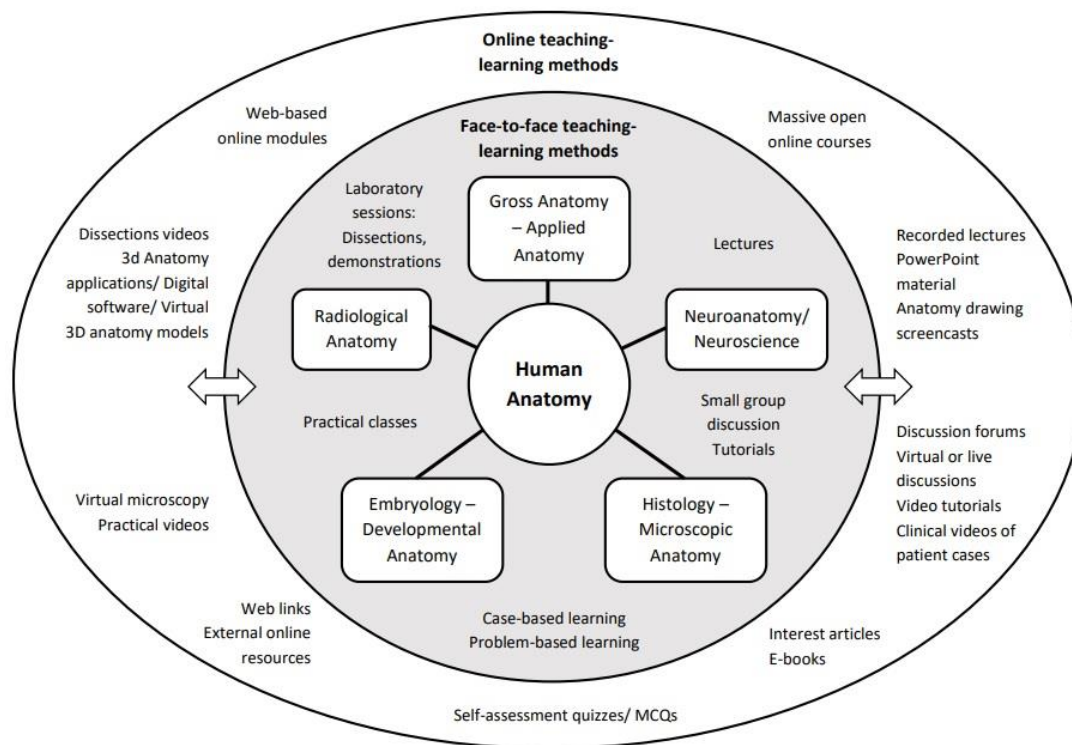
Figure 2: Teaching-learning methods used in blended approach in human anatomy education

Problems related to course structure such as inadequate time allocation (15,25) and higher workload (22), and poor quality of instructional material (15) were also reported. The strengths and benefits, and problems of the blended learning approach in Anatomy education as perceived by medical students are summarized in Table 3. Only two studies have assessed the teachers' perceptions regarding the blended learning approach, which reported positive attitudes of Anatomy teachers and perceived benefits in developing online teaching skills (22,27).

Thirteen studies have evaluated the learning outcome of the blended learning approach in Human Anatomy education, mainly in terms of knowledge gain. Most of the studies reported improved students' performance in blended learning, reflected in higher grades, scores or pass rates in formative and/or summative assessments in Anatomy (17,18,20-23,26-29,31). Two of these studies reported improved performance in the assessment of higher level (i.e., application and analysis) in the cognitive domain (22,31).

Discussion

This review recognized the increasing trend of using a blended learning approach in Human Anatomy education in undergraduate medical curricula, as evidenced by the majority of reports published in 2021 and 2022 during the COVID-19 pandemic. We observed the possibility of using computer-based and online learning resources to supplement the traditional face-to-face teaching-learning

Table 3: Strengths and benefits, and problems in blended learning approach in Human Anatomy education, as perceived by undergraduates in medical courses

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Strengths and benefits of blended learning

Related to acquisition and development of learning competencies
- Knowledge acquisition and consolidation (16,17,19,25-28)
- Self-directed, and active learning (16,20,22,25,27)
- Deep learning (25)
- Self-development, self-control and accountability in learning (27)

Related to the learning process
- Flexibility in time of learning (18,20,25,27)
- Self-paced learning (18,21,22,27)
- Flexibility in place of learning (16,18,27)
- Learning according to individual learning style (20,26,29)
- Increased motivation (16,18,25,30)
- Participation, engagement and interaction (18,19,25,30)
- Repeated review and revision (19-21)
- Self-evaluation (22)
- Goal setting (19)
- Improved attention (25)
- Better retention and memory (26)

Related to study material
- User-friendliness (15,16,22,27)
- Higher accessibility (21,27)
- Clarity (15,16,25)
- Relevance and focus (15,25)
- Clinical orientation (21,25)
- Variety (27)

Problems in blended learning

- Lack of interactivity (18,20,27)
- Poor connectivity (15,24,27)
- Inadequate time allocation (15,25)
- Poor quality of online material (15)
- Unpreparedness/ fear of independent learning (22)
- Higher perceived workload (22)
- Procrastination (18)

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activities in all the different components/subjects in Human Anatomy curricula. However, the comparative analysis of the effects and outcomes of different combinations of face-to-face and online teaching-learning methods was beyond the scope of this review. Such a comparison will be inappropriate considering the difference in study methodologies (such as study design, control/comparison groups) and the outcomes evaluated in these studies.

In most of the studies reported, the shift to the blended approach in Anatomy teaching was driven by the constraints and demands on medical schools to continue the teaching programmes during the COVID-19 pandemic. Still, this pedagogical transformation has provided added benefits in enhancing students' learning autonomy by promoting self-directed learning, providing flexibility in learning and motivation for learning, in addition to the benefits in knowledge acquisition and consolidation. Integration of face-to-face teaching-learning methods with online methods resulted in increased participation and engagement in learning, with increased communication and interaction with teachers and peers beyond the boundaries of classrooms and timetables, in a relaxed, non-threatening environment. These findings of the review are in agreement with the assertion of a previous review, that blended learning in Human Anatomy education facilitates the development of transversal competencies of the students providing more opportunities for the achievement of overall outcomes of the undergraduate medical education programmes (32). However, the lack of interactivity was reported as a problem in the blended learning

approach in Human Anatomy education in some studies (18,20,27), mainly due to the replacement of some physical teaching-learning activities with online activities, reducing the time for face-to-face interaction with teachers and peers. This highlights the need for careful selection, planning and delivery of online teaching-learning activities and online learning material in a way that promotes communication and interaction among students and with the teachers. Most of the studies reported the continuation of the traditional practice of gross anatomy, histology, radiological anatomy and living anatomy laboratory sessions with instructor-led discussions, small group discussions and small group laboratory activities that provided opportunities for collaboration and communication, and these were well-received by the students in the blended learning courses (15-19,21-24,26,28,29). Several studies reported the use of online discussions forums to compensate for reduced time allocation for in-class interactions (18,22,24,31), and possibility of using social networking and messaging applications to improve communication and interaction in the blended learning approach was also shown (20). Another study reported that educational value of the online discussion forums was increased by the presence of the teacher, compared to the discussion forums that are entirely driven by the students (31). Other issues related to students' participation identified in this review includes unpreparedness and fear of independent learning (22) and procrastination (18). Conducting student's awareness sessions to promote accountability, monitoring students' participation and progression, and

personal mentoring and coaching for students were recommended to address these challenges in blended learning (22,25,27).

One of the objectives of the blended learning in anatomy education is the effective utilization of the limited time allocated for Anatomy teaching and learning in the medical curricula nowadays. However, few studies reported the higher perceived workload and time requirement by the students in the blended Anatomy courses (15,22,25). Some studies provided recommendations for delivering the online content earlier and well ahead of the face-to-face teaching-learning activities (24,25), and reduction of duration and information density of the online sessions (15,25).

The review describes the positive impact of blended learning in human anatomy education in terms of learner satisfaction, and learning outcomes mainly in the lower levels of cognitive domain (i.e. knowledge and comprehension). Two studies reported that the medical students who followed blended learning courses in Anatomy performed better in questions designed at the application and analysis level (22,31). More research has to be conducted to evaluate the effect of blended learning in the achievement of higher-level learning outcomes in the cognitive domain and the higher level of the Kirkpatrick's evaluation model (i.e., behavior and results) (33). There are contrasting evidence regarding the impact of students' level of engagement with online content on their performance, and it is likely that not only the course-related factors, but also some external factors affect the students' level of engagement in online content, having

an indirect effect on the student's performance (19,34). One of these factors commonly cited in literatures was the problems related to access to online content, mainly due to the problems in connectivity (15,24,27), which has to be considered in designing the online material and deciding on the timeframe for online activities.

There is a scarcity of information related to attitudes and perceptions of teachers, and the challengers they encounter in the blended Human Anatomy courses. We recognized the need for future research to evaluate teachers' perspectives of blended learning in Human Anatomy education, which is vital for the planning and implementation of blended learning courses.

Based on the experience on blended learning in Human Anatomy education at many medical schools worldwide, several key points for the successful implementation of blended learning can be identified. First, a comprehensive needs analysis and an analysis of the contextual factors influencing the successful implementation should be conducted. A suitable model of blended learning has to be selected considering the needs and the contextual factors at each institution, and the overall programme and the curriculum structure and timeline. Awareness and training sessions should be conducted for the students, teachers and administrators of the courses to increase receptiveness, preparedness, and acceptance of the new models. Students' engagement, progression and achievement of learning goals should be continuously monitored. A formal mechanism for mentoring and coaching should be established. Regular

feedback from the students and teachers should be obtained and there should be a continuous review and evaluation of the programme. Moreover, there should be training opportunities and a support system for teachers/instructors in the blended learning programmes. Several recommendations with regard to the course material development, and the delivery of teaching-learning activities for blended learning courses in Anatomy originated from this review. Course material and teaching-learning activities should be planned and delivered in a way that promotes collaborative learning and communication. The type and amount of information and the quality of the material should be carefully reviewed by a panel of teachers and the timing of delivery should be carefully planned. Continuous reviewing, evaluation and obtaining students feedback on learning material were recommended. There should be regular and frequent formative assessments and other activities for self-evaluation and feedback.

This review is based on articles retrieved by searching a single database, therefore may have not produced an exhaustive list of relevant articles. A secondary search for cited references in selected articles and a search for grey literature were not done. We have followed the standard process of literature search and screening for systematic review but intended to produce a narrative review of the literature to provide an overview of the current practices, trends, strengths, and limitations of the blended learning approach in Human Anatomy education.

Conclusion

The review recognized the prevailing trend in using a blended learning approach in Human Anatomy education in medical undergraduate programmes, in many different settings both in Asia and the West. Possibility of employing blended learning in the delivery of all the components in Anatomy courses was observed, and various combinations of many different face-to-face and online instructional methods were used simultaneously or sequentially. Blended learning in Anatomy education was well-received by the students, citing many strengths or advantages, despite the problems in connectivity and interactivity experienced in some settings. Outcomes of the blended learning were generally positive, in terms of the students' satisfaction and cognitive gain, however the need for the evaluation of higher levels of course outcomes were recognized. Moreover, there is a requirement to evaluate teachers' perspectives in blended Human Anatomy courses. Several recommendations were derived from the discussion of findings of the reviewed articles. These include the conducting needs analysis, proper planning, increasing awareness and provision of training to students and teachers, developing support systems for students and teachers, and continuous monitoring and review of the courses. The learning material and teaching-learning activities have to be developed collaboratively, with appropriate quality and quantity of the content, delivered systematically in a timely manner, and should be regularly reviewed and adapted based on feedback. The findings and recommendations of this review will be useful in planning and successful implementation of blended learning in Human Anatomy courses in medical undergraduate programmes.

Availability of data and materials: All the relevant data and information are included in the manuscript, tables and figures. The matrix of sources reviewed during the study is available from the corresponding author upon request.

Authors' contributions: CSP carried out the literature survey and drafted the manuscript. KNM critically revised the manuscript and approved it. All authors read and approved the final manuscript.

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