Trends and patterns in blended learning research (1965–2022)

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Abstract

Blended learning (BL) applications, which are defined as a combination of online and face-to-face education processes and created with the strongest aspects of various teaching approaches, have attracted increasing attention particularly in recent years with the effect of the pandemic. Although blended learning studies, which have a wide range of content and variety of applications in the literature, have been examined by content analysis in many scientific studies, bibliometric studies that provide a comprehensive review of studies on BL and reveal a general map of scientific studies are extremely limited. The purpose of this research is to conduct a systematic analysis of BL studies around the world and to reveal general research trends by bibliometric method. In the scope of the research, 4,059 publications searched in the Scopus database between the years 1965—2022 were analyzed by VOSviewer and Leximancer software; the publications were examined from aspects such as year, subject, fund, citation, journal, country, common word, etc. An analysis of the research results reveals that studies on BL have increased in number in the literature since 2006; it has been found that the fields of social sciences, computer, medicine and engineering come to the forefront in the categorization of publications by subject, and the USA, UK, China and Australia are the most cited countries. As revealed by the findings of common word analysis, the studies mostly focus on the use of technology during the pandemic, current trends in education and technology, online learning environment and learner characteristics, teaching approaches, social media, motivation and medical education. Furthermore, it is understood that the most common terms in abstracts—keywords and titles of the studies reflect the learning process, the learner, the classroom environment, the model adopted, the system designed and medical education.

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1 Introduction

The rapid developments in technology, historical conditions, constantly changing demands of the labor market and economic developments have effects in the field of education as well as in many areas of our lives. All these conditions have effects not only on the purpose and objectives, but also on the epistemological and methodological approaches that guide the educational programs; the recent research on learning lay an emphasis on the need to combine methodologies (Castro-Rodríguez et al., 2021). In this context, blended learning (BL) practices stand as an innovative pedagogical option in the scientific literature (Quitián & González, 2020).

It is observed that BL practices have gained momentum with the pandemic process in the recent years, while maintaining their prevalence and importance in education practices by taking advantage of technological possibilities. BL has a variety of names mixed learning, blended learning, hybrid learning (Khan, 2005) as well as many different definitions in the international literature (Bersin Associates, 2003; Driscoll, 2002; Eastman, 2015; Horn & Staker, 2017; Maxwell, 2016; Medina, 2018; Porter et al., 2014). However, it is stated that the common point of these definitions is to combine the presentation environments and teaching methods in distance and face-to-face teaching (Graham et al., 2003) and to bring together the strengths of the two approaches (Graham, 2006). BL is defined as the combination of online and face-to-face education processes (Rooney, 2003).

A review of recent studies reveals that blended learning practices have had positive effects on learning and performance, which is supported by many examples of practice (Blended Learning Universe, 2022, Cambridge, 2020; Carpe Diem, 2012; Waterloo University, 2020) and scientific studies (Horn & Staker, 2017; Kokoulina, 2019; McCarthy, 2016; Noonoo, 2012). Singh (2021) suggests that BL not only offers more options in the teaching process, but is also more effective. BL environments support students' individual learning through collaborative efforts in the virtual environment, and help students and teachers connect more (Omar et al., 2021). It is stated that, within a pedagogically well-structured BL practice, instructors (1) center teaching and education, (2) have a student-centered pedagogical belief, (3) support change, (4) are open to experimentation, (5) can share their needs and concerns, 6) can reflect on themselves critically and (7) connect technologies to learning processes (Bruggeman et al., 2021). Thanks to BL, students, instructors and educational institutions, as the components of the education process, are able to achieve flexibility to distinguish the strengths and limitations of face-to-face and distance education when using them, and also to achieve flexibility in terms of speed, location, space and time with station and parallel teaching designs (Bozkurt & Sharma, 2021). BL practices enable students to develop their digital learning skills by using various technologies (Sahara et al., 2021). In the study by Limaymanta et al. (2021), it is noted that the complementation of information and communication technologies with teaching methods in approaches such as flipped education, active learning, BL, e-learning strengthens the effect of the learning process. Moreover, it is mentioned that using different types of learning activities can contribute to student participation and help students reach higher and more meaningful levels (Bliuc et al., 2007).

In addition to all its advantages, BL practices also have some limitations. Such limitations are customized on the basis of BL models as BL practices can be configured according to different models and in different scopes in line with pedagogical purposes and possibilities. Racheva (2019) stated that the models where education is mostly carried out in traditional classrooms and tasks such as individual assignments and additional activities are carried out online have the following limitations: rising costs, availability of fewer options for personalized learning, and teacher-centered configuration of education. The limitations shown for the models in which education is mostly provided in an asynchronous environment are stated as follows: low motivation due to social isolation, high dropout rates, and limited interaction and feedback. Whereas, the models where virtual web conferences are mainly used to deliver education address limitations such as dependence on proper functioning of the technology used and the limited number of students in the virtual classroom (Racheva, 2019). Moreover, the lack of ICT skills and infrastructure is among the challenges most commonly faced by teachers, students and institutions (Ashraf, et al., 2022). In addition, the concepts of *Cultural Adaptation*, and *Digital Divide*, which refers to the difference in information technologies of students with different socioeconomic levels, are also shown as limitations of blended learning applications (Graham, 2006).

Since face-to-face education had to be suspended in many institutions during the pandemic, e-learning activities in the global context were experienced within the scope of emergency remote teaching, which helped steer BL practices back to the agenda with strong emphasis. It is anticipated that the trend towards BL will continue with the return to physical classroom environments after the pandemic (Singh, 2021). BL has a wide scope and multidimensional structure (Khan, 2005). There are also numerous BL models to allow users and institutions to construct BL practices in line with their physical possibilities and pedagogic purposes (Horn &Staker, 2017; Prescott et al., 2018; TeachThought Staff, 2019). It is important that each of the planning, implementation and evaluation stages of the BL process is structured in view of those different dimensions and models. A detailed analysis and evaluation of the studies in the literature on BL is needed in order to be able to plan future configurations in the field of BL and predict what research opportunities will be like. Omar et al. (2021), also pointed out the high impact of citations from other researchers in this field on the studies on BL, and noted that comprehensive studies on BL are needed. A review on the position of BL activities in the literature from past to present, addressing research trends, citation rankings and trending topics on this subject will be significantly helpful for a holistic and comprehensive view of the literature. Furthermore, it is important to conduct comprehensive analyses of the studies in the literature so that future BL studies can be planned within this context.

2 Literature review

2.1 Development of BL

Blended learning applications have been in use with flexible learning practices in the literature since 1965. In his study on the flexible teaching laboratory in biochemistry,

Winzler ([1965](#)) developed a flexible and satisfactory laboratory program to provide the most meaningful and useful laboratory possible for students with different abilities and interests, and stated that the main aspect of the program is to switch to the laboratory after the didactic part of the course is completed. In their study on the results of rigid and flexible learning, Baker et al. ([1977](#)) stated that the use of a rigid coding strategy will cause difficulties in learning materials that cannot be included in this strategy, while a flexible strategy seems to be superior in the long run, though being not advantageous in the short run. Russon ([1983](#)) on the development of secretarial education laid an emphasis on the flexibility need of education so that trainees can adapt to changing office environment and learning needs of the individual can be met; it was also noted that flexible learning can satisfy the requirements of changing technology.

The need for flexible learning environments has created a new learning model by combining the strengths of face-to-face and e-learning environments. Osguthorpe and Graham ([2003](#)) noted that the distinctions between traditional face-to-face education and distance learning environments soon became blurred with the innovative use of technology since the 1990s, and that face-to-face and distance education systems were combined in blended learning. In a study performed by Mazur ([1997](#)) for peer teaching, an electronic platform was developed for students to do their reading at home. It was also aimed in that study to reinforce knowledge through cooperative learning activities and peer interaction in the classroom. Baker ([2016](#)) shared the lecture presentations with students before the class for the first time in 1995, ensuring students to work on these notes before the class time, thus reinforcing the time in the classroom with activities and introducing this method as Flipped Classroom. The model applied in these studies reflects Flipped Learning, which is currently included in the literature as one of the blended learning models (Correa, [2015](#)); these practices constitute the initial examples of blended learning. There are many models that suggest implementation of blended learning by building face-to-face and e-learning environments in different ways (such as rotation model, flexible model, a la carte model, enriched virtual model) (Horn & Staker, [2017](#)), and there are many sub-dimensions that should be evaluated within the scope of blended learning (Khan, [2005](#)).

2.2 BL & other learning practices

Face-to-face learning and e-learning environments have their advantages and disadvantages specific to their respective contexts. The challenges in face-to-face learning approach include, for example, instructor-centered teaching environment, difficulty of having individual feedbacks, teachers facing expectations of evaluating the teaching and process within a limited time, and difficulty of individual participation by each of the students in the learning process (Gülbahar et al., [2020](#)). It is more appropriate to examine the e-learning approach by separating it as first and second generation practices in the literature. Problems were observed in the first generation e-learning practices due to poor understanding of the dynamics of e-learning. Such problems include examples such as focusing rather on the presentation of physical

information, presenting face-to-face teaching content over the internet, limited availability of suitable teaching options, participation and social contact for learners (Singh, 2021). For the second generation e-learning practices, on the other hand, it is noted that learning designs were expanded and the methods used to convey information were developed (Singh, 2021). On the other hand, there is emphasis on the limitations of e-learning environments on a variety of aspects such as motivation, evaluation and ease of application, and safe and ethical teaching environment provided in face-to-face learning environments (Feng et al., 2021). There are numerous scientific studies containing comparisons of these two learning approaches with their own distinct features (Jasperson & Miller, 2018; Kumar et al., 2011; Lucky et al., 2019; Souza et al., 2018). However, it is seen that BL practices designed as a combination of the strong aspects of these two approaches continue to exist increasingly in the academic literature.

BL practices can also be confused with technology-enhanced learning practices as they include online and face-to-face learning environments. Whereas, BL practices involve leveraging the strengths of different teaching approaches beyond the use of technology to strengthen education. Another basic difference of BL from 'technology-enhanced learning' is the fact that the student has control over factors such as time, place, route and speed in the online learning part of BL (Horn & Staker, 2017). Technology-enhanced learning practices, however, do not necessitate such control. It is further indicated that the devices used in technology-enhanced learning are aimed to support traditional teaching, whereas the devices in BL are perceived as a tool for personalization opportunities (Maxwell, 2016).

2.3 Bibliometric analysis

Bibliometric analysis method is a popular research method used by researchers to review the past and future growth of scientific studies (Di-Stefano et al., 2010) and allowing an overview of the academic literature (Van-Nunen et al., 2018). Many indicators such as country of publication, subject area, journal, keywords are used to analyze trends and performance in bibliometric analyses (Chen & Ho, 2015). Bibliometric studies are employed for a variety of purposes, such as identifying the latest developments, trend topics, research directions (Wang et al., 2014), general reviews, and analyses by leading researchers, institutions and countries (Bjork et al., 2014) in a particular area of research. Bibliometric methods allow in-depth analysis of a myriad of researches and the utmost use of visual mapping (Li & Hale, 2016; Wang et al., 2014; Zupic & Cater, 2015). Bibliometric studies provide an accurate and objective method to measure the contribution of a research to the advancement of knowledge (Yang et al., 2013).

2.4 Systematic and bibliometric analyses of BL studies

With a wide range of content and diverse applications in the literature, BL studies have been examined with the content analysis method in many scientific studies and inferences have been made on their effectiveness. Rasheed et al

(2020) performed a systematic review of the challenges in the online component of blended learning. In frame of this study, they noted that students had difficulties in self-regulation and using learning technology, teachers were reluctant to integrate technology into face-to-face teaching, and educational institutions had difficulties in providing the suitable technology. Anthony et al (2020) also conducted a theoretical and systematic review of the acceptance and application of blended learning in higher education, and carried out meta-analysis of 94 BL research articles published from 2004 to 2020. Research findings revealed that BL practices consisted of activities, information, resources, evaluation and feedback for students, and technology, pedagogy, content and knowledge for lecturers. Furthermore, it was underlined that the technology acceptance model, the unified theory of acceptance and use of technology, the information system success model, and the diffusion of innovations theories are most commonly used theories in the research on the adoption of BL (Anthony et al., 2020). Vallée et al (2020) explored the status of blended learning in medical education compared to traditional learning through systematic review and meta-analysis, conducting a systematic review of blended learning in medical education on MED-LINE from January 1990 to July 2019. Research findings have demonstrated that blended learning consistently shows better effects on knowledge outcomes than traditional learning in health education. Upon an analysis of blended learning practices in nursing education with a scoping review, Jowsey et al (2020) discovered that blended learning makes positive effects on student achievement when delivered purposefully. They also emphasized that active engagement, learning support, family support, teacher communication and students' self-esteem are the keys to student success for blended learning environments.

Despite all this content analysis studies regarding blended learning, bibliometric studies that provide a comprehensive review of the literature and aim to collect data on the scientific production of studies on BL worldwide are extremely limited. In their study analyzing BL research trends with the bibliometric method, Arifin et al. (2021) carried out an analysis, via Publish or Perish software, of 200 studies published in Scopus between the years 2015–2020. The study involved a research on active researchers, countries, journals and methods in this field. In their research to assess the effect of BL on higher education, Castro-Rodriguez et al. (2021) carried out a content analysis on 119 open access publications in Scopus and WoS databases. Their conclusions included the statements that BL is applied in all scientific and professional fields, the learning model has a positive effect on motivation and learning effectiveness, and promotes student autonomy. Al Mamun et al. (2022) analyzed the use of flipped learning, a blended learning model, in engineering education with the bibliometric method, and underlined the effectiveness of the model by noting that this model has recently entered the exponential growth phase in engineering education. There are also different bibliometric studies conducted to reveal trends on flipped learning (Kushairi & Ahmi, 2021; Limaymanta et al., 2021; Yang et al., 2017). Yet, these studies are focused solely on the development of one model of blended learning.

2.5 Research gap and study objectives

This research is aimed at conducting an analysis of BL studies around the world with bibliometric method, and revealing general research trends. In this way, it will be possible to explore the development trends of BL, the most intriguing topics and resources, and the future aspects of BL. Studies in which the research conducted with different models of BL and in different scopes are analyzed within a wide time interval are extremely limited in the literature. The research differs from other bibliometric studies in the sense that it covers applications of different BL models of different levels, and presents an analysis of all the research conducted between 1965 and 2022 as shown in the Scopus database,. In this context, it is aimed to offer a more holistic and up-to-date view of the literature.

Within the scope of the research, answers are sought to the following questions: As for the analyzed studies on BL;

a. How is the distribution of the number of reviewed publications by year, subject area and sponsoring organizations?
b. How are journals, countries and publications ranked by citation?
c. What kind of a structure is revealed by common word analysis?

3 Method

Bibliometric analysis technique was used in this research to determine the main research trends in the field of blended learning. Many review techniques such as narrative review, systematic review, integrative review, meta-analysis, semi-systematic review are mentioned in the literature (Snyder, 2019). The reason for the selection of the bibliometric analysis technique for this research is that the technique has the potential to provide richer insights by quantitatively synthesizing research topics in any discipline through citation mapping (Zupic & Cater, 2015).

Bibliometric analysis method is a popular research method used by researchers to review the past and future growth of scientific studies (Di-Stefano et al., 2010) and allowing an overview of the academic literature (Van-Nunen et al., 2018). Bibliometric studies are employed for a variety of purposes, such as identifying the latest developments, research directions, main topics (Wang et al., 2014), general reviews, and analyses by leading researchers (Bjork et al., 2014) in a particular area of research. Bibliometric methods, which are employed for purposes such as general reviews of developments and trending topics in a research field, as well as for analysis of leading researchers, institutions and countries, allow in-depth analysis of a myriad of researches making the utmost use of visual mapping (Li & Hale, 2016; Wang et al., 2014; Zupic & Cater, 2015).

The review process under this research can be formed into a scheme in Fig. 1:
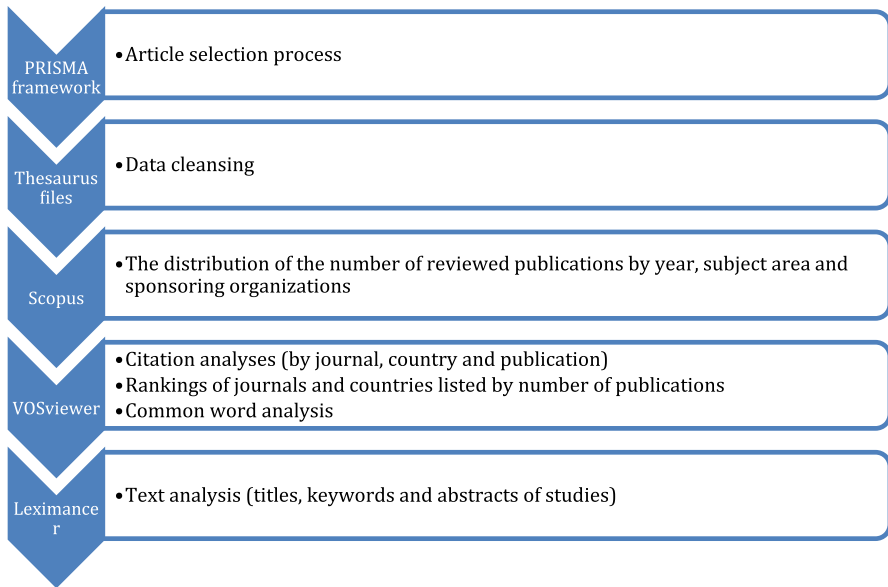
Fig. 1 Bibliometric mapping- review methodology

3.1 Data collection process

Scopus database was used for the selection of articles on BL within the scope of this study. Scopus was selected as the database as it is one of the largest scientific literature databases in the world (Bar-Ilan, 2008; Burnham, 2006), it provides the widest coverage of citation and abstract literature (Ahmi et al., 2019), and it is used as a data source to describe the dynamics of science and technology in many of the bibliometric studies in the literature (Cheng et al., 2014; Gupta & Dhawan, 2009, 2020; Köseoğlu & Bozkurt, 2018; Tibaná-Herrera et al., 2018). Logical operators and keywords were used in the search, which was structured according to the PRISMA framework as shown in Fig. 2 (Page et al., 2020).

The search was carried out on 22.02.2022, and the word matrix specified in Table 1 was used as keywords. The mention of the keywords in the title, keyword or abstract was determined as the criterion. 21,943 publications were found as a result of the search. The records that are not open access (n=16,200) and not in English language (n=269) were eliminated, and the remaining records were scanned; the publications that did not have an article format (n=1,406) were filtered and finally, 4,059 publications were included in the analysis.

3.2 Analysis of data

The analyses showing the distribution of the reviewed publications by year, subject area and sponsoring organizations were carried out on the basis of the data provided by Scopus. Bibliometric analyses were performed via the VOSviewer software
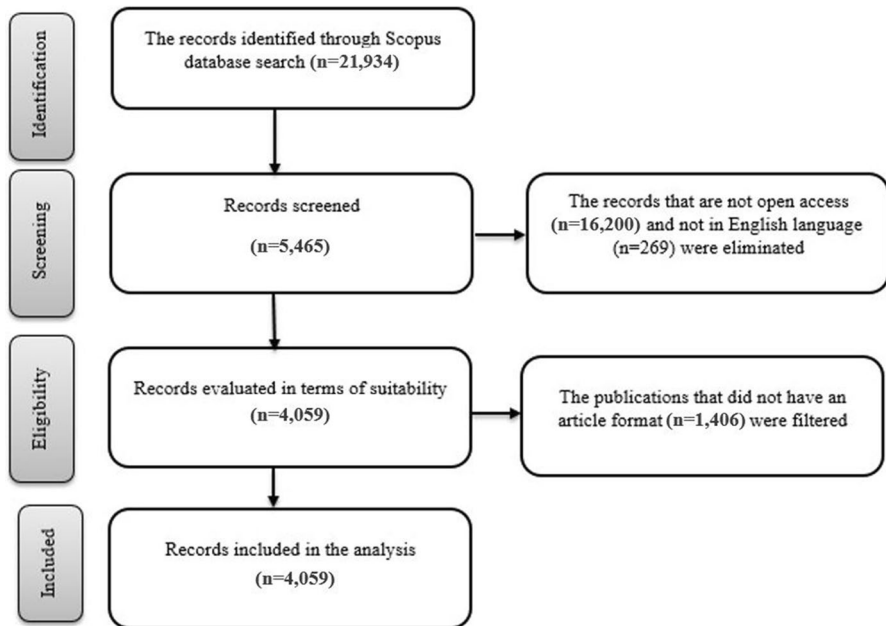
Fig. 2 Selection of the publications included in the research by PRISMA method

Table 1 Word matrix used for database search

Word Matrix	Learning	Education	Teaching	Instruction	Training	Class	Classroom
Blended	✓	✓	✓	✓	✓	✓	✓
Hybrid	✓	✓	✓	✓	✓	✓	✓
Flipped	✓	✓	✓	✓	✓	✓	✓
Flexible	✓	✓	✓	✓	✓	✓	✓
Hyflex	✓	✓	✓	✓	✓	✓	✓

(version 1.6.2; Van Eck & Waltman, 2014), and the bibliographic data of 4,059 publications downloaded from Scopus was analyzed by VOSViewer and Leximancer software. A wide range of distance-based, graphic-based and time-based methods and tools are employed to visualize bibliometric networks (Van Eck & Waltman, 2014). The main research areas in a scientific field can be identified and the relationship and exchange between these research areas can be clarified by means of mapping and clustering (Tibaná-Herrera et al., 2018). Leydesdorff et al. (2015) laid emphasis on the effectiveness of VOSviewer software in their journal mapping studies, particularly in terms of visualization of node labels on the map and multidimensional scaling. Leximancer, on the other hand, is a text mining program that provides an automatic form of analysis based on the properties of texts and has been increasingly used in types of research where large amounts of qualitative data are analyzed

(Cretchley et al., 2010; Jones & Diment, 2010). Leximancer software, which is used to automatically analyze textual data, enables visual display of selected data in the form of mind maps, network clouds and concept synonyms by using statistics-based algorithms (Smith & Humphreys, 2006). Moreover, Fisk et al. (2012) reported that computer aided content analysis is an effective method for mapping a research area.

In this context, citation analyses were performed via the VOSViewer software on basis of journal, country and publication, with rankings of journals and countries listed by number of publications, and common word analysis used. Keyword analysis of the publications included in the analysis was performed on Leximancer software. The data were examined in detail before each analysis on both of the software; 'thesaurus files' were created and used in the analysis for combining synonymous -similar words (e.g. e-learning and online learning) and for editing journal and country names that are expressed differently (e.g. U.S.A. instead of California).

3.3 Limitations

This study is limited to open access articles in English language on BL. Another limitation is related to the sole use of Scopus database. Only the part of the studies on BL that was searched in Scopus was included in the scope of study. Due to the large size of the data set obtained upon the search performed and the absence of irrelevant studies in the preliminary reviews, it was assumed that all of the articles covered BL. Although the small number of studies in the bibliometric analysis are not expected to affect the overall result, the fact that no individual review of each study was conducted in terms of suitability can be considered as a limitation regarding the structuring of the data set. Moreover, the bibliometric analysis method used is among the limitations of the research, in the sense that it reveals the social effects and executes the analyses by considering the metadata rather than the actual data of the studies (Bornmann, 2014; Mishra et al., 2021).

4 Findings

4.1 Distribution of the number of reviewed publications by year, subject area and sponsoring organizations

4.1.1 Distribution of the number of publications by year

The distribution of 4,059 publications by year, which was found upon examination of the publications included in the research, is shown in Fig. 3. As can be seen from Fig. 3, the highest number of publications on BL were produced in 2021. It was followed by the years 2020 and 2019, respectively. Considering the date of the search (22.02.2022), it can be suggested that the first months of 2022 are also an effective time period for BL studies in terms of their ratio, although an approximately 2-month period was analyzed for the year 2022.
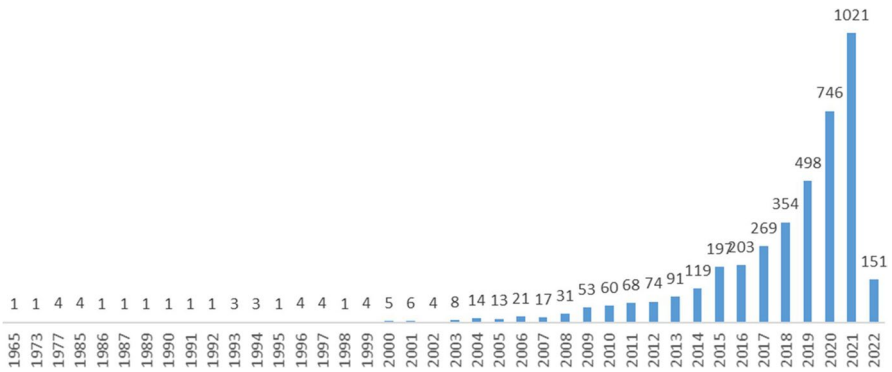
Fig. 3 Distribution of publications by year

It is considered that the increase in the number of publications as of 2019 is associated with the transition to emergency remote teaching due to the Covid-19 pandemic, and that social and economic developments around the world have affected BL studies. Also, the rapid development of technology and the increase in the rate of access to technological devices are also thought to have an effect on the described situation.

4.1.2 Distribution of the number of publications by subject area

The distribution of the publications included in the research by subject area is shown in Fig. 4. As can be seen from Fig. 4, the highest number of publications on BL is in the field of social sciences, which is followed by computer sciences, medicine and engineering.

There are studies on BL in 27 different fields, which reveals the interdisciplinary nature of the field and the interest it attracts. The concentration of studies on the category of social sciences is largely attributable to the fact that studies in field of education are regarded within the category of social sciences. Moreover, studies concentrating on computer sciences, medicine and engineering indicate the fact that the combined use of online and face-to-face education environments is regarded relatively more important in these fields. The figure, demonstrating the usability of the BL process for other fields as well, points out the positive aspects and contributions of this learning approach.

4.1.3 Top funding sponsors

According to the analyzed research data, the top 10 organizations that sponsor the studies are presented in Fig. 5. As can be seen, the National Science Foundation ranked at the top of the sponsorship list with its support for 69 researches, followed by the National Natural Science Foundation of China and the National Institutes of Health.

The mentioned top-ranking organizations are among those that focus on basic research and education in the fields of science, engineering, natural sciences and
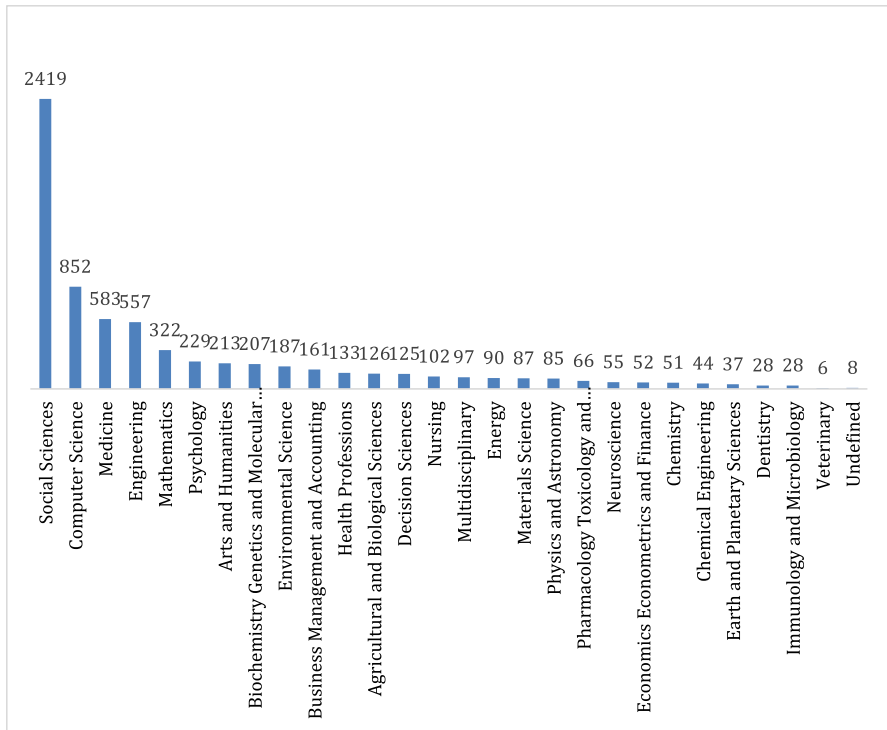
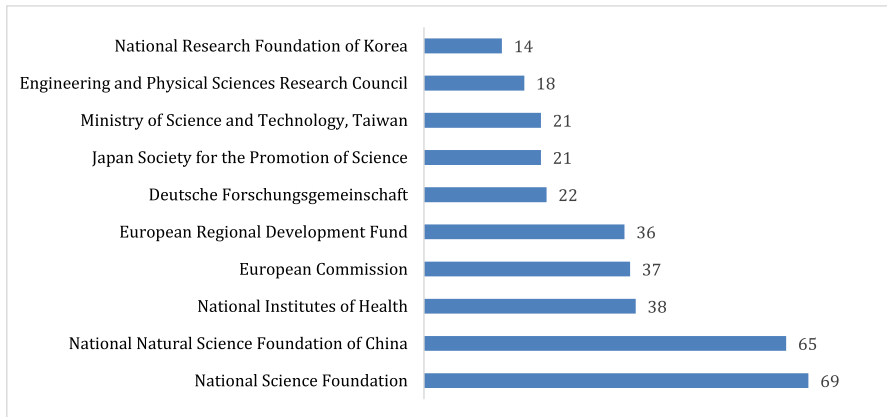**Fig. 4** Distribution of publications by subject area

Fig. 5 Distribution of the top funding sponsors

medicine, which obviously means that more funding could be found for the BL studies carried out in these fields. The fact that the top funding sponsors are based in the United States, China, Europe, Germany, Japan, Taiwan, Korea and England

demonstrates that BL policies and researches are given special importance and encouragement in these countries. When the countries of funding sponsors are examined, it is seen that the sponsors other than Taiwan are among the G20 countries, while all of the countries other than China, Taiwan and South Korea are among the G7 countries. Based on this information, it is understood that developed countries tend to have a significant status within the context of sponsorship.

4.2　Citation ranking of journals, countries and publications

4.2.1　Journals with highest citation and publication count

Table 2 presents the top 10 most cited journals listed among 1,387 journals in which the articles analyzed within the scope of the research were published. The most cited journal was International Review of Research in Open and Distance Learning with 2,282 citations, which was followed by Bmc Medical Education with 2,001 citations and Australasian Journal of Educational Technology with 1,717 citations. Journal Impact Factor (JIF), which is a measure of the importance or impact of a journal, and Journal Citation Indicator and Q indices of journals, which are normalized for different fields of research and their widely varying rates of publication and citation, and which allow easy interdisciplinary interpretation and comparison, and provide a single journal-level metric that can be easily interpreted and compared across disciplines (Journal Citation Reports, 2020).

It is seen that the subject areas of these most cited journals (in parallel with the data in Fig. 4 showing the distribution of publications by subject area) are related to social sciences, medicine and engineering, which cover the field of education.

The top 10 journals with the highest number of publication among journals in which the articles in scope of the research was published are provided in Table 3. The journal with the highest number of articles was International Journal of Emerging

Table 2 Journals with highest citation count

Journal Title	Number of publica- tion	Citation	JIF	JCI	JIF Q
International Review Of Research in open And Distance Learning	59	2,282	n/a	1.77	n/a
Bmc Medical Education	108	2,001	2,463	1.28	Q2
Australasian Journal of Education Technology	67	1,717	3,067	1.94	Q2
American Journal of Pharmaceutical Education	33	1,126	2,047	0.62	Q3
Computer & Education	17	1,050	8,538	3.44	Q1
International Journal of Emerging Technologies in Learning	146	1012	n/a	1.06	n/a
Higher Education Research and Development	5	745	3,851	2.16	Q1
Academic Medicine	8	741	6,893	2.14	Q1
IEEE Transaction On Neutral Networks	4	693	n/a	n/a	n/a

JIF: Journal Impact Factor; JCI: Journal Citation Indicator; JIF Q: JIF Quartile *(Source: Journal Citation Reports ™ 2020, Date: 13.06.2022)*

Technologies in Learning with 146 publications, which was followed by Bmc Medical Education with 108 publications and Education Sciences with 87 publications.

It is noted that International Journal of Emerging Technologies in Learning, Bmc Medical Education, Australasian Journal of Educational Technology and International Review of Research in Open and Distance Learning are listed not only among the most cited but also the most productive journals; the mentioned journals are seen to have both high citation counts and high publication counts. This can lead to the conclusion that studies on BL maintain their importance on educational technologies and medicine. Apparently, there is no relation between the ranking of publication count and JIF- JCI- Q rankings of the journals.

4.2.2 Ranking of countries by the number of citations and publications

Upon a review of the publications included in the research, Fig. 6 shows the ranking of the top 10 most cited countries from 138 countries, and Fig. 7 presents the country citation network map created on VOSviewer taking into account the total link strength of countries together with other countries. As can be seen, the country with the highest number of citations with its publications on BL is the U.S.A with 15,616 citations, which is followed by UK with 7,410 citations and Australia with 5,727 citations.

When the citation network map of the countries is examined, it is observed that USA, UK and China plays a central role, building up strong citation networks with each other as well as with other countries, and that, China's total link strength is lower than the USA and the UK, and located a little further from the center. This indicates that China has lower link strength with other countries.

The top 30 countries with the highest numbers of publication that are among those included in research are shown in Fig. 8.

Table 3 Journals with highest publication count

Journal Title	Number of publications	Citation	JIF	JCI	JIF Q
International Journal Of Emerging Technologies in Learning	146	1,012	n/a	1,06	n/a
Bmc Medical Education	108	2,001	2,463	1,28	Q2
Education Sciences	87	599	n/a	1,03	n/a
Australasian Journal of Educational Technology	67	1,717	3,067	1,94	Q2
Sustainability	67	442	3,251	0,56	Q2
International Review of Research in Open and Distance Learning	59	2,282	n/a	1,77	n/a
Plos One	47	632	3,240	0,57	Q2
IEEE Access	47	351	3,367	1,01	Q2
Turkish Online Journal of Distance Education	40	240	n/a	0,69	n/a

JIF: Journal Impact Factor; JCI: Journal Citation Indicator; JIF Q: JIF Quartile *(Source: Journal Citation Reports ™ 2020, Date: 13.06.2022)*
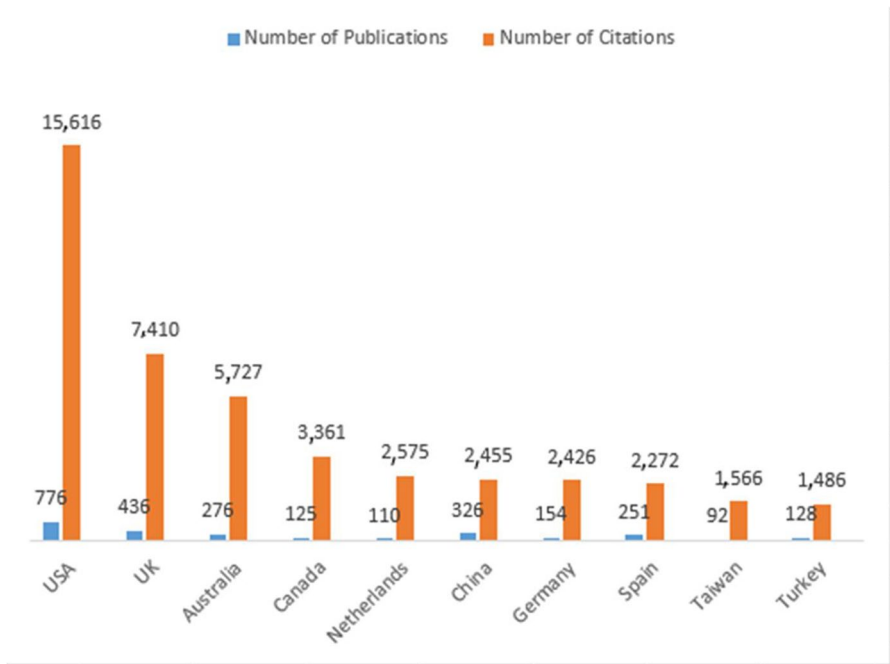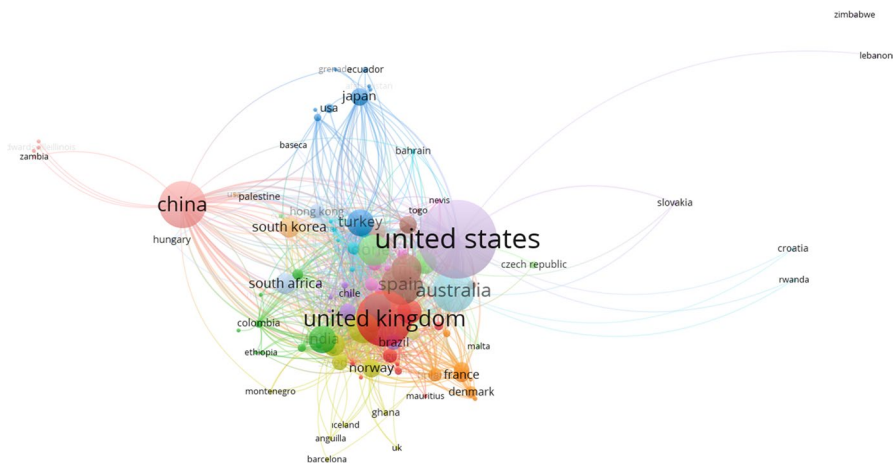
Fig. 6 Ranking of countries by citation

Fig. 7 Citation network map of countries

The United States, UK, China, Australia, Spain, Germany and Turkey are seen to be among the top 10 countries with the highest publication and citation count. It is worthy of note that, the U.S.A is ahead by a clear margin according to the analysis
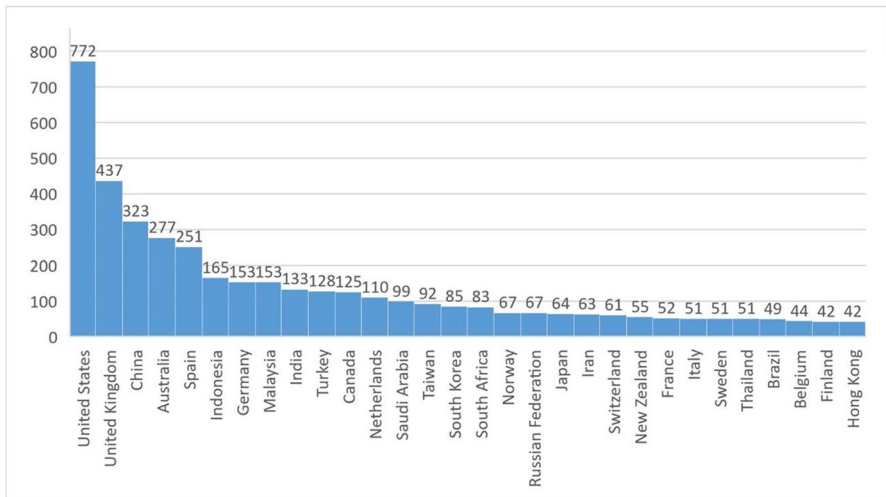
Fig. 8 Ranking of countries by number of publications

of country rankings by publication count, with its number of publications almost twice that of the UK, which comes after the U.S.A. Unlike the rankings by citation count, Fig. 8 includes Indonesia, Malaysia and India in the list of top 10 countries; however, despite the publication productivity of these countries, their citation rates are seen to be low (Indonesia ranks 15th with 1,064 citations, Malaysia ranks 12th with 1,137 citations, and India ranks 23rd with 642 citations).

4.2.3 Most cited publications

Table 4 presents the top 10 most cited articles listed among 4,059 articles included in the research.

An examination of the most cited articles reveals the intensity of studies on flipped learning, medical education and systematic review-meta-analysis method. Motivation, cognitive load, instructional design, Covid-19 pandemic, student learning and perception, feedback and learning analytics are also among the topics studied. Most of the studies belong to the years 2014–2015, which can be attributed to the fact that citation rates and therefore view rates of studies from previous years are higher. The most cited studies are mainly published in Q1 and Q2 journals, which is also an expected result.

4.3 Common word analysis

When the duplicate keywords in the examined publications were analyzed with VOSViewer, it was observed that 9,154 different keywords were used. Upon the analysis of the keywords repeated at least 20 times, 52 frequently used words were

Table 4 List of most cited publications

First Author	Year	Title	Source Title	Source/JIF Q	Citations
Abeysekera L	2015	Motivation and cognitive load in the flipped classroom: definition, rationale and a call for research	Higher Education Research and Development	Q1	686
Mclaughlin J.E	2014	The flipped classroom: A course redesign to foster learning and Medicine engagement in a health professions school	Academic Medicine	Q1	648
Jensen J.L	2015	Improvements from a flipped classroom may simply be the fruits of active learning	CBE Life Sciences Education	Q1	368
Chick R.C	2020	Using Technology to Maintain the Education of Residents During the COVID-19 Pandemic	Journal of Surgical Education	Q2	355
Chen Y	2014	Is FLIP enough? Or should we use the FLIPPED model instead	Computers and Education	Q1	282
Hew K.F	2018	Flipped classroom improves student learning in health professions education: A meta-analysis	BMC Medical Education	Q2	247
Mccutcheon K	2015	A systematic review evaluating the impact of online of blended learning vs. face-to-face learning of clinical skills in undergraduate nurse education	Journal of Advanced Nursing	Q1	234
Liu Q	2016	The effectiveness of blended learning in health professions: Systematic review and meta-analysis	Journal Medical Internet Research	Q1	233
Love B	2014	Student learning and perceptions in a flipped linear algebra course	International Journal of Mathematical Education in Science and Technology	n/a	227
Tempelaar D.T	2015	In search for the most informative data for feedback generation: Learning analytics in a data-rich context	Computers in Human Behavior	Q1	221

JIF: Journal Impact Factor; JCI: Journal Citation Indicator; JIF Q: JIF Quartile *(Source: Journal Citation Reports ™ 2020, Date: 13.06.2022)*

found. An examination of the common word analysis map shown in Fig. 9 reveals that 6 cluster structures are formed (yellow, turquoise, red, purple, blue, green).

Technology during the pandemic The yellow cluster appears to focus on the Covid-19 pandemic, online learning and BL. BL, covid-19 and online learning, as centrally positioned concepts with high link strength, demonstrate that studies on online and BL particularly during the pandemic are represented in this cluster. On the other hand, it is understood that the studies related to professional development, evaluation, simulation, technology-enhanced learning and dental education in this cluster are closely related to each other. It can be suggested that this cluster mainly focuses on technology use and development trends during the pandemic.

Current trends in education and technology The turquoise cluster contains the words deep learning, learning management systems, machine learning, team-based learning and technology. It is considered that this cluster generally focuses
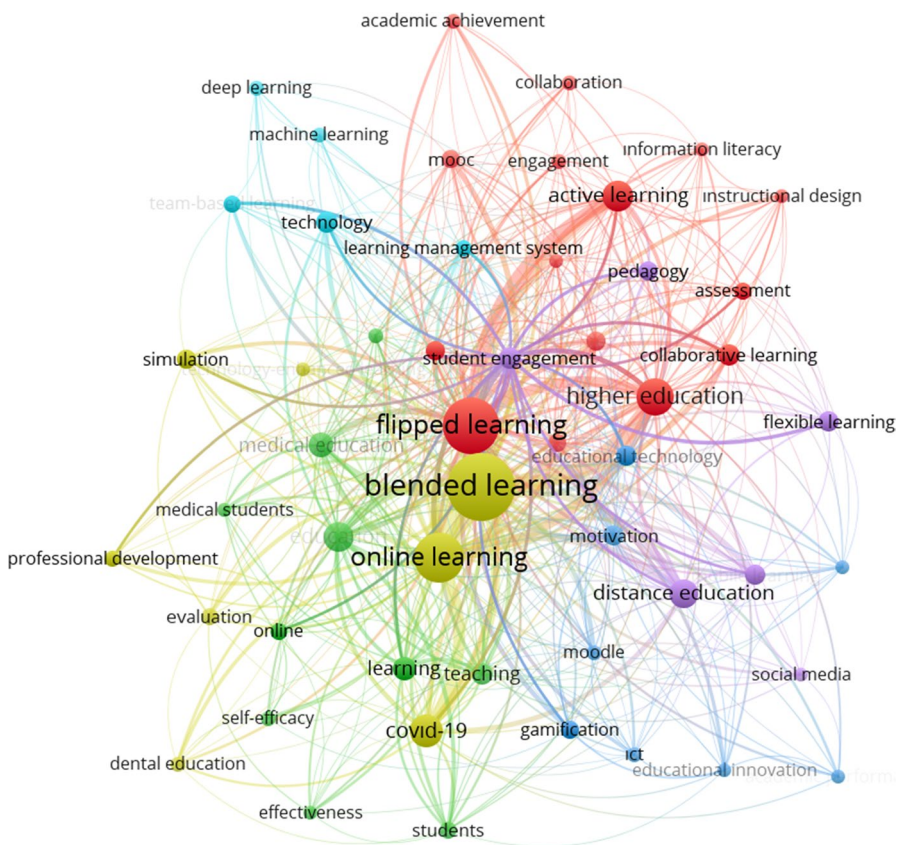

Fig. 9 Common word analysis map (keyword analysis) created by VOSViewer

on current trends in education and technology, placing emphasis on pedagogically up-to-date and necessary competences and skills. The concept of learning management systems is closely positioned to the terms mooc, self-directed learning, student engagement and problem-based learning in the red cluster, which shows that these terms are often studied together.

Online learning environment and learner characteristics The red cluster, having a large structure as compared to other clusters, contains the concepts 'flipped learning' and 'higher education' in central position with high link strength, which demonstrates that studies related to flipped learning experiences in higher education are predominant in this cluster. An examination of other commonly used keywords reveals that topics such as academic achievement, active learning, assessment, collaboration, collaborative learning, engagement, information literacy, instructional design, learning analytics, moocs, problem-based learning, self-directed and self-regulated learning are studied. In the light of this information, it can be said that this cluster focuses on the characteristics of online learning environment and of learners. Skills such as collaboration, active learning, information literacy, engagement, self-management and self-regulation are frequently studies topics under the category of learner characteristics, which ids noteworthy as it demonstrates the increasing importance of the mentioned skills. The concepts of instructional design and learning analytics also demonstrate that studies on the design and evaluation of learning environments are frequently carried out. Given the close relation of the terms flipped learning, BL, and online learning, it can be said that these concepts are often studied together.

Teaching approaches and social media The purple cluster is seen to cover the terms remote teaching, flexible learning, mobile learning, pedagogy, social media and student engagement. In this frame, it can be suggested that there is focus on the relationship of different teaching approaches and social media with pedagogy in this cluster. Particularly the fact that the terms 'student engagement' and 'pedagogy' are intertwined with the red cluster, shows that the terms are also often studied together with the terms in the other cluster.

Educational technologies and motivation The blue cluster is seen to contain the terms academic performance, motivation, educational innovation, educational technology, engineering education, gamification, information technologies and moodle. It is seen that the cluster generally focuses on subjects related to educational technologies, and that success and motivation elements are among the subjects studied together.

Medical education The green cluster contains the concepts of curriculum, education, effectiveness, learning, medical education, medical students, online, students, teaching, and self-efficacy. Apparently, this cluster covers subjects related to education and health sciences education in general.

4.4 Text analysis

The titles, keywords and abstracts of the articles included in the study were subjected to text analysis on Leximancer software; the concept map created upon the analysis is given in Fig. 10. Abstracts, titles and keywords of the articles were specifically chosen for the analysis since those parts have a high textual density and reflect the basic concepts. Leximancer allows display of basic concepts in the analyzed text and creation of concept maps showing the relationship between the concepts based on the frequency of co-occurrence of the words, and defines thematic regions shown with colored circles according to the most prominent concept in the region, depending on the relationship between the concepts (Zawacki-Richter et al., 2018).

As can be seen from Fig. 10, the following eight themes were obtained from the analysis of the abstracts-keywords and titles of the analyzed studies: Student, Classroom, Model, Network, System, Learning, Education and Medical. As we find out from these themes, educational studies are often discussed in contexts such as Covid- management-development-support- digitalization—quality and
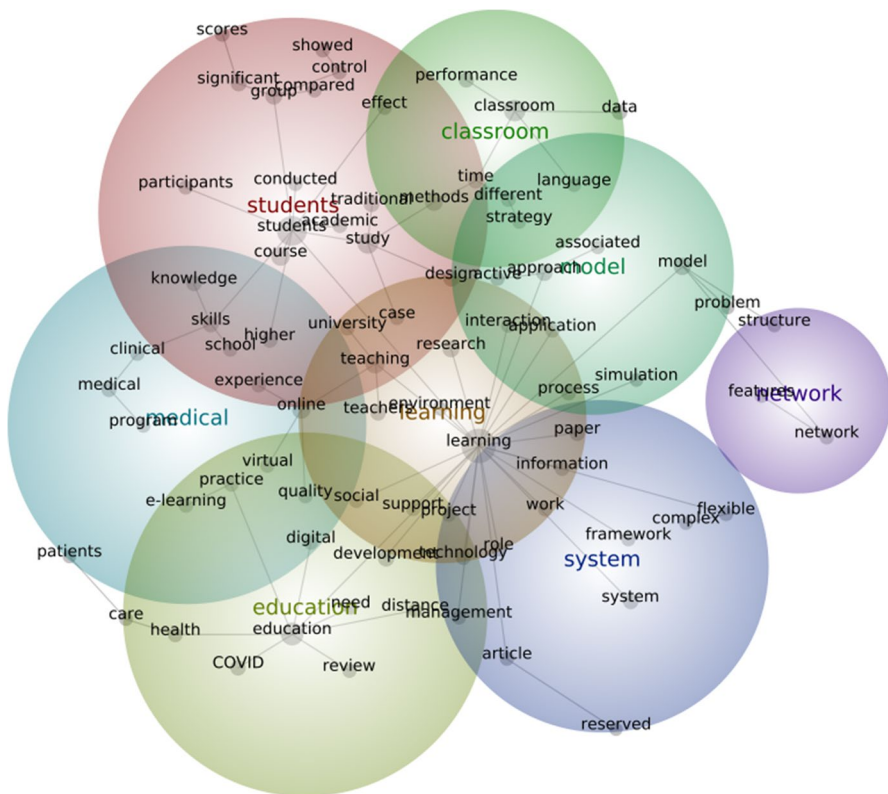

Fig. 10 Thematic concept map created with Leximancer, providing lexical analysis of keywords, titles and abstracts

Fig. 11 Levels of importance of the themes in the thematic concept map created by Leximancer

Theme	Hits	
learning	22204	
students	19051	
classroom	13175	
education	13006	
model	8765	
medical	6568	
system	6038	
network	1534	

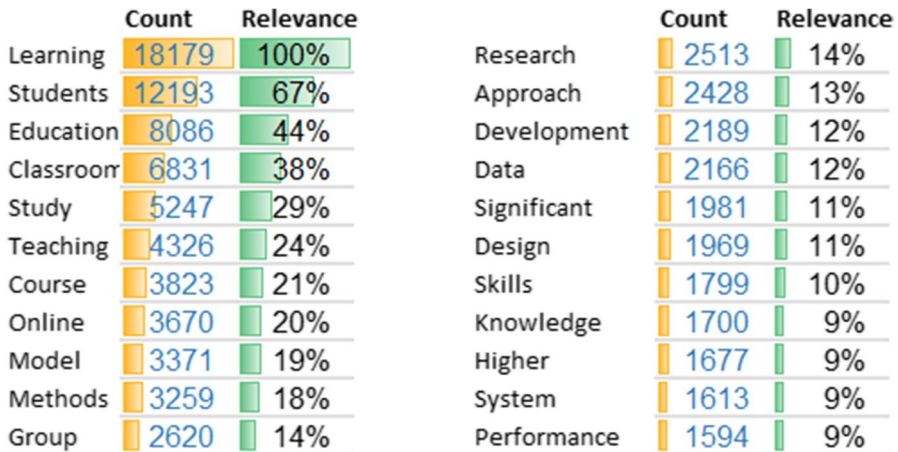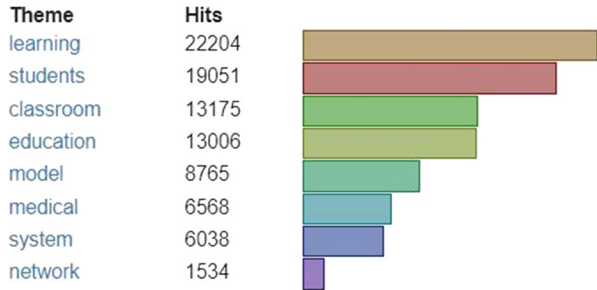|	Count	Relevance		Count	Relevance
Learning	18179	100%	Research	2513	14%
Students	12193	67%	Approach	2428	13%
Education	8086	44%	Development	2189	12%
Classroom	6831	38%	Data	2166	12%
Study	5247	29%	Significant	1981	11%
Teaching	4326	24%	Design	1969	11%
Course	3823	21%	Skills	1799	10%
Online	3670	20%	Knowledge	1700	9%
Model	3371	19%	Higher	1677	9%
Methods	3259	18%	System	1613	9%
Group	2620	14%	Performance	1594	9%

Fig. 12 Major concepts in the thematic concept map created by Leximancer

e-learning, BL studies are included in the field of health, and BL is a model that places the student, learning and education at the center. Furthermore, this thematic concept map demonstrates that the BL system can be constructed with flexible or complex frameworks, and that the classroom structure is addressed in BL studies within different contexts such as performance, time and strategy.

The themes in the thematic concept maps created by Leximancer are ranked by level of importance in Fig. 11, and the concepts that are prominent in terms of count and relevance are presented in Fig. 12.

When the findings presented in Figs. 11 and 12 are examined, it is seen that the concepts of Learning, Students, Classroom and Education stand out as the major concepts that also name the themes. This situation can be considered to indicate that mainly the pedagogical element is in the foreground in blended learning studies. The word 'medical' is among the most frequently repeated words, which can be interpreted to mean that blended learning is given special importance in health education and the Covid-19 process has a great impact on blended learning studies. When Fig. 12 is examined, it is seen that the model, methods, approach, design and system elements of blended learning are emphasized. This indicates

that it is regarded important to perform planning of blended learning practices in the literature with a particular approach and ensure their systematic structuring, and that there is emphasis, with a systematic approach, on the addressing of this learning style as a separate model. It can be said that the concepts such as group, research, development, skills and performance in Fig. 12 point to the development and collaborative aspect of BL.

4.5 Comparative analysis of common words and text analysis

As a result of the comparative analysis of the findings obtained from the common word analysis and text analysis, it was seen that the findings overlapped with each other, which is indicated in Fig. 13.

It can be seen from Fig. 13 that the scope of the analyzed BL studies is closely associated with elements related to education and technology, teaching approaches and the field of healthcare in general. This supports Fig. 4, which states that publications on blended learning focus on social sciences, computer sciences, and health sciences.

5 Discussion

A review of researches conducted on BL since 1965 shows that the field has gained more presence in the literature since 2006. The increase in presence of such research continued at the same pace in the following years; a rapid increase was noted in the number of studies, particularly in the period between 2019–2021. In their research that examined studies on BL over 801 publications dated between 1997–2021, Omar et al (2021) similarly reported that the literature on BL increased rapidly after 2004, particularly with a significantly high increase observed in the number of studies on BL between 2018–2020. It is reported in another bibliometric study that the annual number and speed of publications of researches on BL increased in the period from 2000 to 2018 (Raman et al., 2021). In parallel to these
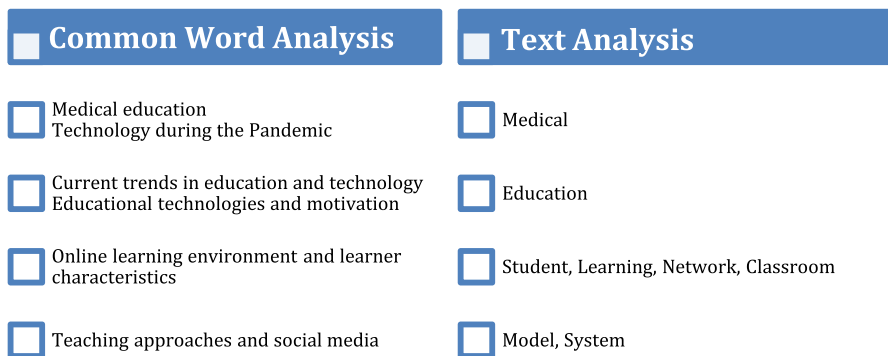
Common Word Analysis	Text Analysis
Medical education Technology during the Pandemic	Medical
Current trends in education and technology Educational technologies and motivation	Education
Online learning environment and learner characteristics	Student, Learning, Network, Classroom
Teaching approaches and social media	Model, System

Fig. 13 Comparative analysis of common word and text analysis

findings, the study by Yang et al. (2017) in which they examined the researches on flipped classroom between the years 2000–2015, reveals that there was a significant increase in the 2011–2015 period. The findings of this research is supported by the finding obtained by all those researches that BL has been receiving increasingly more attention and studied more. As stated in Graham's (2006) study, the prediction that blended learning will turn into a more dominant structure in the future and develop in a holistic way with face-to-face learning seems to be in parallel with the findings of this study in a historical sense. It is considered that the rising interest in studies on BL with the pandemic has a significant impact on the rapid increase in the number of those studies within the last three years.

Social sciences, computer sciences, medicine and engineering are the major fields in classification of publications on BL by subject. The findings of this study match with the most commonly studied top four fields regarding BL as demonstrated in the study by Omar et al. (2021). In a study on flipped classroom research, the major fields were listed as education, chemistry and medicine (Yang et al., 2017). Another study in which the research on e-learning is analyzed reveals that the predominant disciplines are social sciences, computer sciences and health sciences (Tibaná-Herrera et al., 2018). The prominence of social sciences can be associated with the fact that BL is a learning and teaching approach, and the prominence of computer sciences can be associated with its connection with technological processes. Most of the publications on open education practices (AEP) are in fields of social sciences (55.2%) and computer sciences (29.9%), which also supports this anticipation (Köseoğlu & Bozkurt, 2018). Whereas, the fact that medicine and engineering are the major fields in studies on BL may be due to the pandemic, cost of education and productivity. Furthermore, the fact that particularly applied trainings in medicine and engineering science are linked to BL processes increase the effect of BL publications (Nijakowski et al., 2021). The results of research conducted on BL in the field of health sciences also revealed positive differences compared to conventional teaching, which significantly contributes to the number of researches on BL in the field of health sciences (Arifin et al., 2021; Cheng et al., 2019; Sweileh, 2021). Omar et al. (2021) also pointed out the high number of studies on BL in the field of medicine, noting that such studies would be very beneficial if they focused on the competencies of medical graduates in the current digital health environment. It is stated that, apart from the major disciplines, there is a significant need for studies on BL in other disciplines (Siqueira & Alfinito, 2014). The high attention that the studies on BL attracted in practices for different disciplines can be considered as a sign of the anticipation that this field will remain increasingly important in the future.

The top 10 institutions that sponsor publications on BL are located in countries such as the USA, China, Europe, Germany, Japan, Taiwan, Korea and the UK. The UK and the USA are ranked among the top in terms of sponsorship in other studies on BL, which supports the findings of this study (Omar et al., 2021; Raman et al., 2021). It is stated by Yang et al. (2017) that the USA is the top funding sponsor in researches conducted on FC practices. There are also different studies in which the countries of funding sponsors in the field of educational technologies are listed as the UK, the USA, Australia, Taiwan, Netherlands and Canada (Bond et al., 2019; Chen et al., 2020). While the USA, China and Taiwan are the

top ranking countries listed in the results of another bibliometric study on CALL (Goksu et al., 2020), there is another study on e-learning in which the USA, Spain, England and China are listed as the most productive countries (Gao et al.., 2022). In the view of these findings in the literature, it is observed that the research findings are in parallel with the data obtained by other studies within the context of countries listed as the top funding sponsors. It is considered that listing of China among the major countries in terms of findings is attributable to the effects of the Covid-19 pandemic on the researches conducted on BL as well as to the fact that the pandemic originated from China.

When the journals in which BL researches are published are evaluated in terms of the number of citations and productivity, it is seen that the International Journal Of Emerging Technologies in Learning, International Review Of Research in Open And Distance Learning, Bmc Medical Education and Australasian Journal of Educational Technology are ranked among the top journals in terms of both citation and publication counts. The finding that shows the International Journal Of Emerging Technologies in Learning as the most productive journal in which researches conducted on e-learning between the years 1998–2020 are published (Gao et al., 2022) is consistent with the complementary aspects of BL and e-learning processes. A bibliometric analysis of 12.272 publications dated between 2015 and 2020 was performed in another study on e-learning. Similarly, Computers & Education and International Journal of Emerging Technologies in Learning were listed among the most influential journals. The distribution of citation count in this study does not match with the ranking of the journals with high JIF, JCI and Q values indicating the importance of journals, which is suggestive of the fact that some of the publications in the journals stand out in terms of citation count.

It is seen that the USA, UK, China and Australia are the most cited countries in publications on BL. When the citation network map of the countries is examined, it is observed that the USA, UK and China plays a central role, building up strong citation networks with each other as well as with other countries, and that, China's total link strength is lower than that of the USA and UK, and located a little further from the center. In their study analyzing the studies on BL between the years 2012–2021, Ashraf et al. (2022) noted that most of the studies concentrated on developed countries; they stated that China, the USA and Australia have the highest number of publications. Gao et al. (2022) also indicated that the countries with the highest publication count for studies on e-learning are concentrated in Europe and the USA. It is indicated that there is need for integrated cooperation between countries to facilitate the adoption of BL in developing countries (Ashraf et al., 2022). The fact that some regions of Asia and Africa are less included in the studies on BL can be associated with the investment in digital learning environments. Yao et al (2021) point out an inequality between these regions and others within the context of digital learning environments. In their examination of the regional cost requirements around the world from 2021 to 2030 in an effort to eliminate such inequality, they found out that there was a higher cost requirement in South Asia (USD 14.4 billion), East Asia and Pacific (USD 9.5 billion), and Eastern and Southern Africa (USD 6,9 billion) as compared to other regions. Providing regions with equal opportunities in terms of

digital learning can also have an effect on the number of studies on BL practices in other regions.

When BL studies are examined in terms of content, it is seen that the topics on the learning process and assessment have a key role in these studies. It is understood that the most common terms in abstracts—keywords and titles of the studies reflect the learning process, the learner, the classroom environment, the model adopted and the system designed. The concepts of assessment and learning analytics are among the most commonly used keywords. Feedback and learning analytics, on the other hand, are among the most cited article topics. The eight general dimensions by which BL is defined by Khan (2005) are seen to have features that match the themes created under the research within "pedagogical, technological, evaluation, management and institutional" contexts. In parallel with the research findings, there are various studies in which it is stated that e-learning, feedback, assessment and learning analytics are frequently addressed in the studies on BL (Chen et al., 2021) and the need for these areas is noted in respect of digital learning applications (Yao et al., 2021). It is worthy of note that ethics, interface design and resource support dimensions in Khan's BL framework are not among the major topics of this research. Due to the presence of face-to-face education environments as well as online environments in the studies on BL, this may be due to the fact that ethical concerns and issues related to interface design are not highlighted. Moreover, the dimension of resource support in BL may be less addressed in the studies due to the adoption of a BL model by the institution according to its own budget.

It is seen that pedagogical elements are frequently addressed in the research on BL. Teaching approaches, student participation, educational technologies and motivation element are among the major topics in the studies on BL. These elements were also addressed by Bruggeman et al. (2021) within the context of teacher's attitude towards BL, teacher-centered pedagogical approach and technology acceptance, and they were interpreted as the factors preventing educators from adopting the BL process. The study by Vaughan (2020) discusses research trends for BL in higher education from student, faculty, and administrative perspectives. While student perspective focuses on the concepts of learning, process, engagement, and skill, lecturer perspective focuses on course design, scholarship of teaching, and professional development dimensions. Administrative perspective, on the other hand, focuses on topics such as savings, alignment with the institutional vision and mission, and focusing on the entire curriculum rather than the classes. Vaughan (2020) addresses research trends on BL from student, faculty, and administrative perspectives, which supports the themes of student, classroom, education, system, and model obtained in the text analysis of this study. While listing the costs that low- and lower-middle-income countries should allocate for 'digital solutions' with 'engagement', Yao et al. (2021) allocate the highest share under that title to teacher skills improvement, content, and engagement, which similarly highlights the importance of pedagogical elements in BL practices.

The emphasis on the online dimension of the educational process in the studies on BL is also worthy of note. It was seen that the studies examined in this research underlined the use of technology during the pandemic, current trends in education and technology, and the online learning environment, and that 'the characteristics

of online learning environment and learners' emerged as a separate cluster structure. It is understood that the most cited articles in the publications are related to topics such as flipped learning, motivation, cognitive load, instructional design, and Covid-19. Similarly, it is emphasized that the keywords e-learning, online learning, collaborative learning and flipped classroom stand out in another study on BL (Omar et al., 2021). The study carried out by Chen et al. (2020) on educational technologies, in which they examined the last fifty years of research, listed technology-enhanced classroom pedagogy, BL, and online social communities as the subject areas among those mainly addressed, which are consistent with the findings of this research. "Online integration, personalization, online interaction and data practices", which are referred to as the four key components of BL in another study by Graham et al. (2019), are consistent with the theme "the characteristics of the online learning environment and learners" as mentioned in this study. Accordingly, it can be deduced that the proper construction of online learning environments is of utmost importance for the success of BL practices. At the same time, it should be noted that the themes of student, classroom, education, system and model, which stand out in the text analysis findings of this study, are the main elements that underscore the face-to-face learning process of BL. The importance of face-to-face learning environments in BL to support higher-order processing, social interaction and engagement (Buhl-Wiggers et al., 2023) should also not be underestimated.

6 Conclusion

BL provides flexibility for students, instructors and educational institutions in sequential and simultaneous planning of design, configuration of time, space, speed and route. With this flexibility, the strengths of physical and online learning can be merged and its limitations can be minimized. Transforming the learning process into an efficient and effective form can be possible with the realization of a good pedagogical and technological structuring process as well as flexibility. A technologically and pedagogically well-structured BL process will make significant contributions to the reduction of inequalities in education (Bozkurt & Sharma, 2021). The purpose of this research is to examine the literature on BL and to identify general trends.

Considering the technological developments and innovative teaching approaches in recent years, there is a need for an up-to-date extensive evaluation of the status of BL, which has the mentioned and similar contributions to educational environments, in the literature. The results of this study, which we designed on the basis of this need, provide a holistic insight of the literature on BL, manifesting the direction of development of this field. This research shows research trends for BL, presents the thematic analysis of the most common topics of research, and allows evaluation of the studies carried out with a holistic perspective. Research findings demonstrate that BL practices have an increasing research potential, most of the research on BL is concentrated on developed countries, various applications of BL are addressed in different scientific fields, and pedagogy and technology are among the key elements in BL practices. Besides, considerations of relatively new approaches to the learning process, assessment, and learning analytics are seen to be significant in the research

on BL. It is anticipated that revealing the current trend of BL practices will contribute to the identification of their future research potential.

Increasing the number of bibliometric studies in which publications in different databases will be included with a view to assess the effectiveness of the research on BL and to strengthen its position in the literature, is expected to be enriching for the field. Furthermore, it is recommended that the studies on BL in the literature be examined in different contexts such as IT leadership, privacy and cyber security, teacher competencies, and with different methods such as learning analytics, meta-analysis, social network analysis, and educational data mining.

6.1 Implications for practice or policy

- Researchers aiming to implement the blended learning process effectively need to be aware of the development trend of the blended learning literature and to know about the topics that the research mainly focuses on.
- Instructors are expected to have an idea about the changes in practices addressed in blended learning research, their role, impact and use on learning.
- Principals of educational institutions should have an understanding of the scope of information presented by the literature regarding the scope, model, system and features of blended learning practices, and develop supportive measures at their respective institutions.

Declarations

Conflict of interest The authors have no relevant financial or non-financial interests to disclose. Data will be made available on reasonable request.

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