

## PAPER

# Knowledge Mapping of Blended Learning Classroom Environment Studies (1996–2023): A Bibliometric Analysis

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## ABSTRACT

The classroom environment has undergone a fundamental shift since the era of information and communication technologies, with blended learning (BL) gaining increasing attention in recent years. In light of the limited number of studies that have reviewed the integration of BL and classroom environments in scientific publications, the present study analyzed a total of 283 publications from the WOS database. This analysis provides a comprehensive bibliometric analysis, which reveals the following key findings: Firstly, research in this area has shown progressive development, indicating its maturation over time. Secondly, Garrison emerged as the author with the highest number of citations in 67 records, while Kim stood out as the most prominent author citing Garrison. Thirdly, the top three countries and journals that have made the most significant contributions to these studies are the United States, China, and Spain, along with the journals *Computers & Education*, *Internet and Higher Education*, and *the British Journal of Educational Technology*. Fourthly, the most cited articles are Boelens et al. (2017), O’Flaherty et al. (2015), Abeysekera et al. (2015), Bernard et al. (2014), Thai et al. (2017), and Rasheed et al. (2020). Finally, it was not until 2008 that more keywords such as “computer-mediated communication” (related to the technological environment), “cooperative or collaborative learning” (related to the social environment), “engagement,” and “self-efficacy” (related to the cognitive environment) began to receive more scholarly attention. The research on engagement is considered to be an emerging trend.

## KEYWORDS

bibliometric analysis, blended learning (BL), classroom environment, CiteSpace

## 1 INTRODUCTION

As new information and communication technologies (ICTs) have provided educators and learners with more innovative tools and methods to enhance the effectiveness of teaching and learning, the concept of blended learning (BL) has emerged. BL, as the deliberate combination of face-to-face and online learning experiences, incorporates technology and online learning materials into traditional classroom activities.

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It allows students to have some control over when, where, and how they learn in technological environments [1]. BL has also been recognized as the “third generation” of distance education systems. The first generation is correspondence education, which utilizes a one-way instructional delivery method including radio, mail, and television. The second generation is distance education with a single technology, such as computer-based or web-based learning [2]. According to the Centre for Educational Research and Innovation, BL courses are becoming increasingly significant, with ICTs being developed to complement, rather than replace, traditional forms of learning [3].

During the learning process, students’ academic performance can be affected by their perception of the classroom environment. A positive classroom environment can foster and enhance students’ motivation to learn [4–5]. The earliest study of classroom environments examined the formation of learner groups and social interaction [6]. Later, scholarly attention shifted to teacher leadership and the classroom environment, as well as the relationship between teachers’ and learners’ verbal behavior and interaction [7]. BL puts learners at the center of their learning processes, harnessing the power of technology to create more engaging, efficient, and success-oriented learning environments. In BL classrooms, learners access digital curriculum and receive traditional instruction in a physical environment, receiving benefits from both mediums [8]. The pedagogical goal of BL is to combine the social opportunities of a physical classroom environment with personalized, technologically-enhanced active learning in an online classroom setting [9].

Although previous studies have explored BL and classroom environments separately, there is a scarcity of research dedicated to conducting a systematic review of scientific publications that integrate these two concepts. As a popular and rigorous method for exploring and analyzing large volumes of scientific data, bibliometric analysis enables researchers to capture the evolutionary nuances of a specific field and shed light on emerging trends within that field [10]. This study aims to conduct a systematic review of the development of BL classroom environments in terms of publication output, authors, countries/regions, journals, keywords, and citations. The review will utilize CiteSpace software and Microsoft Excel for analysis. The specific questions to be addressed in the present study are as follows:

1. What is the general publication trend in the area of BL classroom environment?
2. Which authors, countries or regions, journals, and articles have made the most significant contributions to publications on BL classroom environment?
3. What are the hotspots within the field of BL classroom environment in different periods, and what is the emerging trend?

## 2 MATERIALS AND METHODS

### 2.1 Data collection

In this study, data analysis was performed on Social Sciences Citation Index (SSCI) journals collected from the Web of Science (WOS) database, a well-known multidisciplinary database platform [11]. The topics of “blended learning” and “classroom environment” were searched simultaneously, spanning from 1990 to May 7, 2023. An initial topic search resulted in 320 records published between 1996 and 2023. After filtering out fewer representative records, such as book reviews, proceedings papers, and notes, the dataset was reduced to 283 records with complete bibliometric information available.

## 2.2 Research tools

Bibliometric analysis, as a quantitative method for retrospectively and objectively examining published papers using secondary data acquired from digital databases, facilitates the evaluation of academic studies within a specific field [12].

As for specific research tools, CiteSpace (version 6.2.R4) was used to generate and analyze networks of co-cited references based on bibliographic records retrieved from the WOS database. Based on JAVA, CiteSpace is widely used for bibliometric analysis and visualization [13]. It was developed by Professor Chaomei Chen at the School of Computing and Information at Drexel University. It analyzes keywords in literature based on the principles of bibliometrics and explores and mines the dynamic process of scientific research, revealing the trend of scientific development [14].

In the present study, CiteSpace was primarily used for visualizing and detecting trends in publications, while Microsoft Excel was used for organizing data and creating diagrams.

## 3 RESULTS

### 3.1 Publication output

As illustrated in Table 1, out of the 283 publications, there were 123 journals, 842 authors, 569 institutions, and 144 countries or regions that contributed to the studies of the BL classroom environment from 1996 to 2023.

Figure 1 demonstrates that the initial paper in the WOS database surfaced in 1996, outlining the blended approach introduced by a successful bilingual special educator [15]. The blended approach creates learning environments characterized by rich dialogue that promote not only the acquisition of English as a second language but also metalinguistic and metacognitive strategies [15]. The number of articles published from 1996 to 2011 was less than ten, indicating that research on the BL classroom environment was in its infancy during that period of time. But in the year 2008, when BL was introduced, there was a significant increase in publications, marking a turning point [16]. And in the year 2012, there was a second peak, with the number of publications reaching 17. The most cited article during this time was Lin et al. (2012) [17]. It proposed a research framework that investigated the relationship between perceived fit and system factors that can motivate learners to utilize an e-learning system in a BL classroom environment [17].

The number in 2013 was lower than that in 2012, but it shows an overall upward trend until 2021, when it reaches the third peak with a count of 42. It can be said that the year 2021 marked the heyday of studying the BL classroom environment, with numerous scholars presenting their new insights. For example, Chiu [18] argues that student engagement in a BL classroom environment differs significantly from that in a traditional classroom environment. To address this difference, Chiu proposed digital support designs that aim to fulfill the three innate needs identified in self-determination theory (SDT): autonomy, relatedness, and competence. Rasheed et al. [19] argued that the primary challenge associated with the online component of BL is students' inability to effectively self-regulate their learning activities in online classroom environments. They propose an approach for scaffolding students' peer-learning self-regulation strategies.

The number of papers published in 2022 and 2023 has declined compared to the third peak in 2021. However, it should be noted that the number of publications in 2023 does not include the publications for the entire year. Therefore, it is not possible to predict a downward trend. As the number of publications in recent years is still higher than that in the initial stage, it proves that the research in this field has gradually matured.

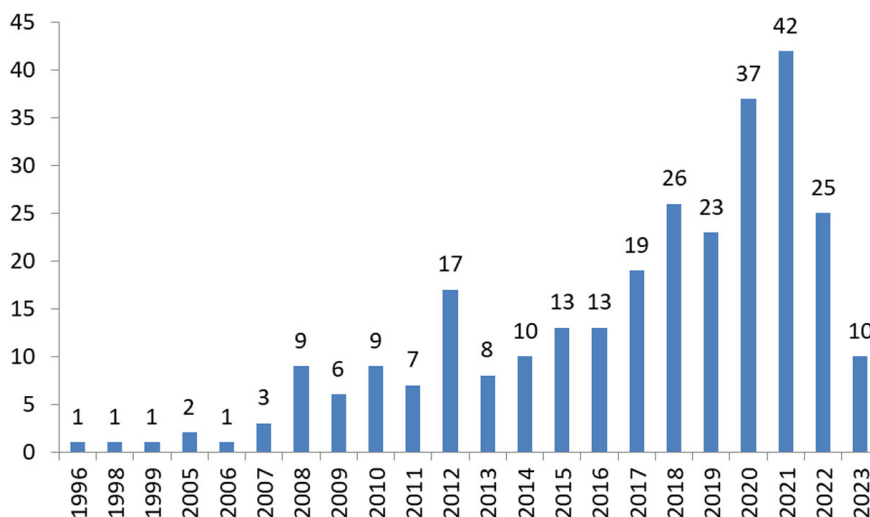


Fig. 1. Distribution of publications by years (1996–2023)

Table 1. Bibliographic statistics of 283 publications extracted from WOS (1996–2023)

Total Publications	Journals	Authors	Institutions	Countries/Regions
283	123	842	569	144

### 3.2 Authors

According to the data collected from the WOS database, a total of 842 scholars have contributed to publications in the field of BL classroom environments. Based on the results, it is apparent that although there were many scholars involved in the research, there was limited cooperation among them. Furthermore, there were hardly any highly prolific authors identified. The authors with the highest number of publications in this area were Tsai, C.W., Deboer, J., Berger, E., and Shen, P. D., each of whom had only three publications.

Nevertheless, by keeping an eye on the cited authors, some highly cited authors come into view, with the top ten being shown in Figure 2. The connections depicted in Figure 2 reveal that these authors were concurrently cited by others, with a notable observation that the majority of the top ten authors fall within this category. Among them, the most cited author is Garrison, who was referenced in 67 records. The top five records citing Garrison are shown in Table 2. Additionally, Kim is the most prominent citing author. Kim’s own article [20] developed a flipped classroom design framework and identified nine design principles based on the Revised Community of Inquiry Framework. This article has received 412 citations. Baeppler et al. [21] suggested that active BL classrooms, although they accommodate fewer students per square foot, are actually a more efficient use of physical space. Another cited article [16] mentioned previously was referenced as high as above 300,

arguing that the BL classroom setting has a positive effect on reducing dropout rates and increasing exam pass rates in the subject. Jara et al. [22] focused on demonstrating how an educational approach that incorporates virtual and remote laboratories, along with a BL methodology, can enhance students' experimental learning compared to traditional methods. Halverson et al. [23] conducted a thematic analysis of the most highly cited scholarship in the first decade of research on blended learning.

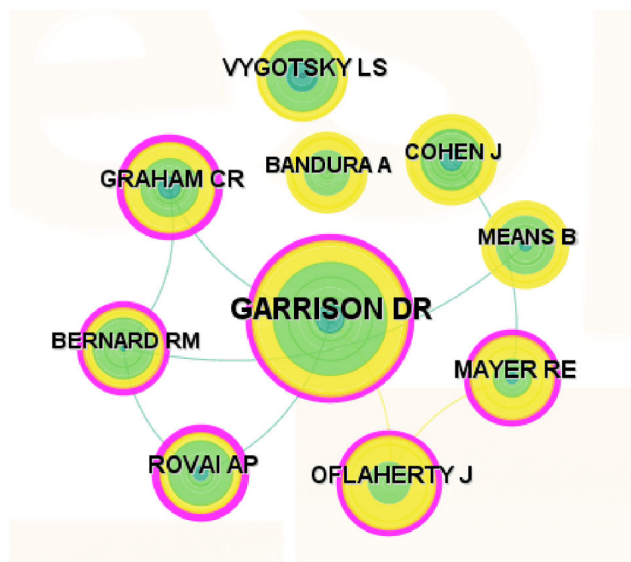


Fig. 2. Top 10 cited authors

Table 2. Top 5 citing articles that cited Garrison

R	Citation	Citing Article
1	412	Kim MK, 2014, INTERNET HIGH EDUC, V22, P37, DOI 10.1016/j.iheduc.2014.04.003
2	370	Baepler P, 2014, COMPUT EDUC, V78, P227, DOI 10.1016/j.compedu.2014.06.006
3	369	Victoria Lopez-Perez M, 2011, COMPUT EDUC, V56, P818, DOI 10.1016/j.compedu.2010.10.023
4	133	Jara CA, 2011, COMPUT EDUC, V57, P2451, DOI 10.1016/j.compedu.2011.07.003
5	130	Halverson LR, 2014, INTERNET HIGH EDUC, V20, P20, DOI 10.1016/j.iheduc.2013.09.004

Notes: R: Rank.

### 3.3 Countries or regions

The results reveal that 144 countries or regions contributed to the study of the BL classroom environment. The top 10 countries or regions in terms of the number of publications from 1996 to 2023 are as follows: the United States (66 publications, 23.32% of the total output), China (34, 12.01%), Spain (29, 10.25%), Taiwan (28, 9.89%), Australia (25, 8.83%), Turkey (13, 4.59%), England (11, 3.89%), Canada (9, 3.18%), Malaysia (8, 2.83%), and the Netherlands (7, 2.47%).

It can be seen from Table 3 that the United States has consistently held a prominent position in the BL classroom environment, both in the first 14 years and the following 14 years. It is worth mentioning that the two most prominent authors, Kim and Baepler, whose articles were highly cited by other authors and mentioned above in 3.2, are American.

China did not initially engage in research in this field for the first 14 years. However, in the following 14 years, China made significant efforts to catch up and can now be recognized as a rising star, ranking second with 34 articles. The most cited article [24] by Chinese scholars investigated the effects of student enrollment and learning motivation on learning performance in a BL classroom environment at the university level. Furthermore, Spain and Taiwan maintained their advantages and are listed in the top five in both stages. It should be noted that Australia also stood out for its strong growth during the period from 2010 to 2023, ranking fifth with a total of 25 publications. It can also be observed from Table 3 that the number of related publications since 2010 has significantly increased compared to previous years. It has jumped from single digits to double digits.

**Table 3.** Top five productive countries or regions (1996–2023)

1996–2009		2010–2023		1996–2023	
Countries/Regions	P	Countries/Regions	P	Countries/Regions	P
USA	7	USA	59	USA	66
England	3	China	34	China	34
Canada	2	Spain	27	Spain	29
Spain	2	Taiwan	26	Taiwan	28
Taiwan	2	Australia	25	Australia	25

Notes: P: Publications.

### 3.4 Journals

The 283 articles selected in the present study are from 123 journals indexed in the SSCI in the WOS database. Table 4 demonstrates the top ten journals with the highest number of publications related to the BL classroom environment. It includes the percentage of their respective publications in the total number, as well as their impact factors and Journal Citation Reports (JCR) subject categories in 2022. Three prominent journals have substantially enriched the field of BL and classroom environments. *Computers & Education* leads the way with 185 publications, accounting for 65.37% of the total research output. *Internet and Higher Education* has made a substantial contribution with 150 publications (53%), followed by the *British Journal of Educational Technology* with 118 publications (41.70%). These journals have also demonstrated significant impact factors. *Computers & Education* boasts a high impact factor of 12, followed by *Internet and Higher Education* with 8.6, and the *British Journal of Educational Technology* with a respectable impact factor of 6.6.

As shown in Table 4, all of the journals, except for *Computers in Human Behavior*, focus on education and educational research. *Computers & Education* also covers computer science and interdisciplinary applications. It can be concluded that research on the BL classroom environment is closely linked to education, and it also requires interdisciplinary knowledge in fields such as computer science and psychology.

**Table 4.** Top 10 journals (1996–2023)

R	Journals	C	P	Impact Factors	JCR Subject Categories
1	<i>Computers &amp; Education</i>	185	65.37%	12	Computer Science, Interdisciplinary Applications
2	<i>Internet and Higher Education</i>	150	53%	8.6	Education & Educational Research
3	<i>British Journal of Educational Technology</i>	118	41.70%	6.6	
4	<i>Computers in Human Behavior</i>	92	32.51%	9.9	Psychology, Multidisciplinary; Psychology, Experimental
5	<i>Educational Technology &amp; Society</i>	83	29.33%	4	Education & Educational Research
6	<i>ETR&amp;D-Educational Technology Research and Development</i>	76	26.86%	5	
7	<i>Review and Educational Research</i>	67	23.67%	11.2	
8	<i>Journal of Computer Assisted Learning</i>	63	22.26%	5	
9	<i>International Review of Research in Open and Distributed Learning</i>	58	20.49%	3.4	
10	<i>Australasian Journal of Educational Technology</i>	51	18.02%	4.1	

Notes: R: Rank, C: Count, P: Percentage.

### 3.5 Keywords

Keywords, as a significant indicator, can clearly reflect the core ideas of research articles, proving to be vital for decoding themes of a specific discipline to some extent [25]. To illustrate the evolution of the BL classroom environment from 1996 to 2023, the CiteSpace software was used to create a timeline map (Figure 3) by applying the cluster year-by-year function [26]. According to their inherent connections, these keywords are categorized into 13 clusters. The three largest clusters are: #0 students, #1 improving classroom teaching, and #2 action research. The keywords with the highest frequency in each cluster are as follows: (#0) students, education, BL; (#1) improving classroom teaching, interactive learning environment, computer-mediated communication; (#2) technology, outcome, system; (#3) participation, satisfaction, self-efficacy; (#4) online learning, academic achievement, motivation; (#5) environment, perceptions, flipped classroom; (#6) design, media in education, pedagogical issues; (#7) collaborative learning, teaching and learning strategies, higher education; (#8) relatedness; (#9) teachers, environments, community; (#10) instruction, behaviors, achievement; (#11) strategy; (#13) cognitive load.

The cluster that scholars paid earliest attention to is #9 academic motivation, which is also the cluster that received the longest-lasting attention. The earliest keywords of #9 are “disorder” and “children,” both of which appeared in the

first article [15] in this field in the WOS database. Another keyword cluster, #2 action research, received its first attention in 2011 but faded away in 2018. It was a hotspot during that period of time. The active clusters until 2023 are #0 students, #9 academic motivation, and #11 scientific inquiry. By clicking on the latest keywords in these clusters and examining the node details more closely, it can be observed that the most recent articles are largely focused on the COVID-19 pandemic. This suggests that the pandemic has played a significant role in driving the advancement of research. The latest keyword in #0 is “AI education,” which appeared in Ng et al. (2023) [27]. The study proposes that the pandemic has accelerated a significant shift to online or blended teaching and learning, where teachers can utilize artificial intelligence (AI) technology to improve students’ academic performance. The keyword “agency” was mentioned in the ninth position this year, as found in Chen’s (2023) [28] study. The study describes the long-term importance of teachers’ self-reflective learning during their daily emergency remote teaching amidst the pandemic and how it contributed to the development of teacher agency.

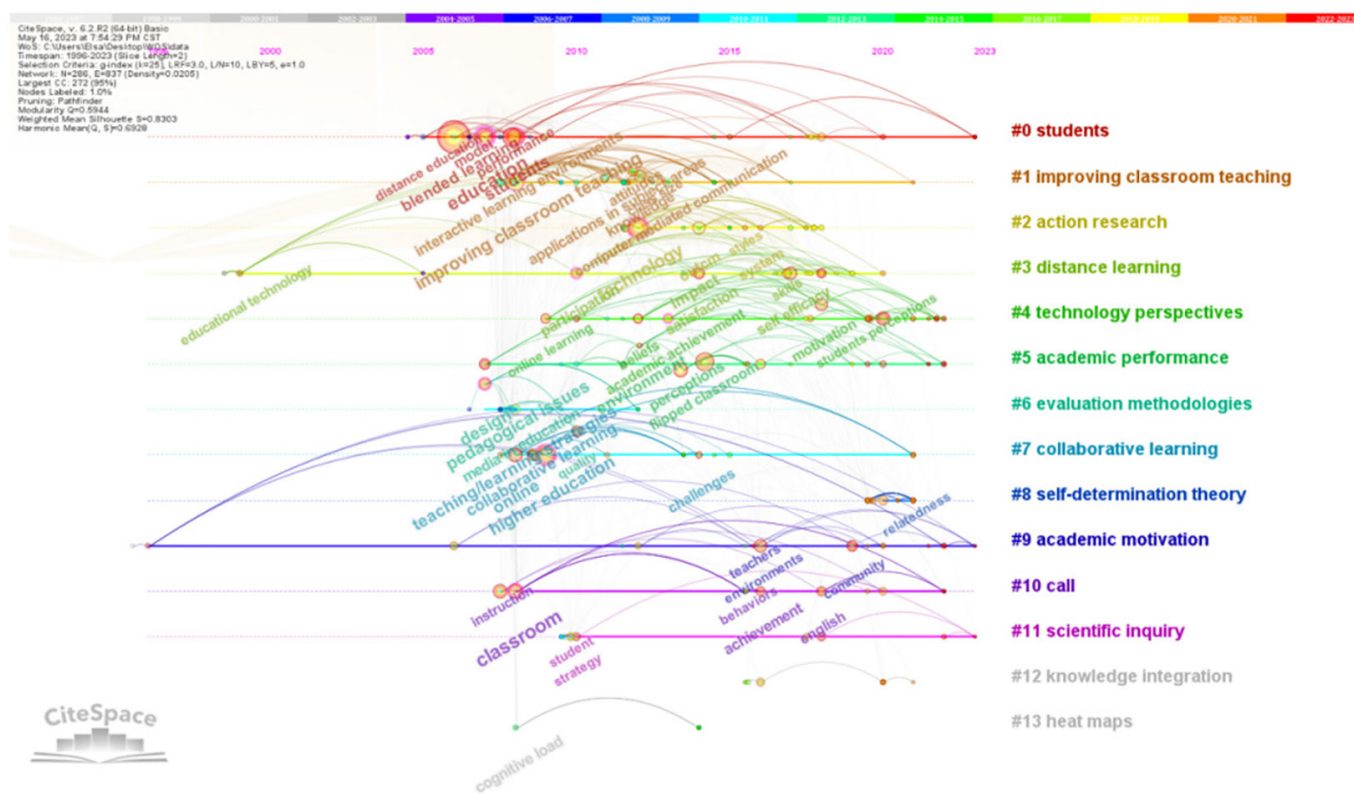


Fig. 3. The timeline map of keywords year-by-year (1996–2023)

A significant advantage of CiteSpace’s keyword analysis is that it can identify bursts whenever an article experiences a sudden increase in citations [29]. Citation burst analysis can be applied to the discovery of research fronts and emerging trends [30]. The top 30 keywords with the strongest citation bursts were extracted based on data from the WOS database from 1996 to 2023. As shown in Figure 4, the time interval is represented by blue, while the citation burst is indicated by red [31].

The keyword with the longest burst time is “computer-mediated communication,” lasting from 2008 to 2017. This indicates that it was highly popular during



that period. Donnelly [32] argued that it is crucial for designers and tutors in blended problem-based learning (PBL) to promote best practices for integrating instructional strategies in computer-mediated classroom environments. It can be clearly seen from Figure 4 that 2008 is a crucial year, as there are nine keywords that began to rise in this year. Possible deductions can be made, as stated in 3.1, that 2008 marked the first peak in the development of research on the BL classroom environment, coinciding with the introduction of BL in that year. “Cooperative or collaborative learning” is a keyword that has received significant attention, with numerous articles published between 2008 and 2015. Among these articles, the most cited ones are Brahimi et al. (2015) [33], Regueras et al. (2009) [34], and Scott et al. (2010) [35]. It was argued in [33] that the learning cycle is an ongoing process designed to enhance the quality of learning and promote collaboration among learners. What typically occurs is that “cooperative or collaborative learning” is often combined with “competitive learning,” as explored in [34], which examines the effectiveness of combining competitive learning with collaborative learning. Furthermore, some scholars have also focused on the connection between student cooperation and the use of resources in a BL classroom environment. As highlighted in [35], smart classrooms have been criticized for being a wasteful misallocation of resources. This is because they often include expensive multimedia equipment but offer limited facilities that can accommodate learners’ mobility, interaction, collaboration, and so on. Therefore, a cost-effective architecture was proposed in [35] to transform existing learning spaces into effective environments that facilitate improved learning and collaboration, ultimately creating an intelligent ambient learning classroom.

The keywords whose burst time extends to 2023 are “student engagement,” “performance,” “science,” and “achievement,” indicating that these topics have been of great concern in recent years. The most frequently cited articles in the WOS database related to these four keywords are Chiu (2021) [18], Victoria et al. (2011) [16], Fong et al. (2018) [36], and Li et al. (2017) [37], respectively. It should be noted that the keyword “engagement” did not start to gain popularity until the year 2020. However, it has experienced the strongest surge among the four keywords, making it the most significant trend in the past three years. “Engagement” refers to the level of attention, effort, participation, curiosity, interest, and passion demonstrated by students [38]. It is influenced by various factors, including teacher support and digital resources [39]. In [40], the study investigated the impact of scenario resources in a virtual reality environment on learning outcomes and engagement.

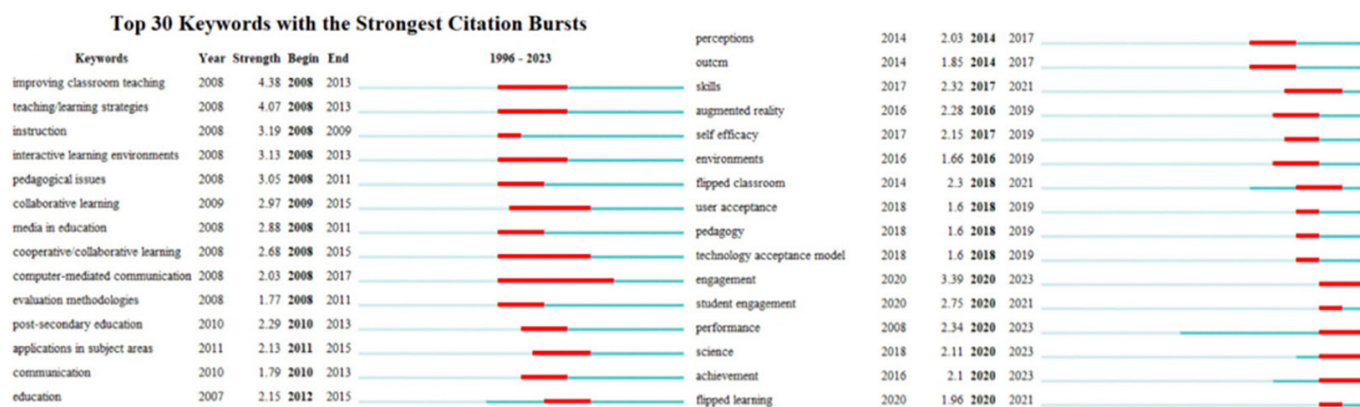


Fig. 4. Top 30 keywords with the strongest citation bursts

### 3.6 Citation

Citation analysis enables researchers to identify the most influential publications in a specific research field [10]. Co-citation analysis, on the other hand, helps reveal the intellectual structure of a research field by discovering thematically similar publications that are frequently cited together [41]. This allows scholars to notice thematic clusters.

As shown in Figure 5, CiteSpace automatically filters out clusters with less than 10 references. The remaining cited references were then clustered, resulting in the identification of five main clusters. These clusters, namely #0 call (computer-assisted language learning), #1 argument reality, #3 flipped learning, #6 educational design, and #8 distance learning, represent the most influential articles in their respective themes. It is worth noting that these thematic clusters have been the focus of scholarly research. The red node represents articles that have citation bursts, which will also be shown in detail in Figure 6. If the node periphery is purple, it signifies that the corresponding article is still being cited this year, indicating that it remains a topic of interest for researchers today.

Table 5 illustrates the top five references with the highest number of citations. Boelens et al. (2017) [42] top the list with 12 citations, revealing four key challenges in a BL classroom environment: incorporating flexibility, stimulating interaction, facilitating students' learning processes, and fostering an affective learning climate. The second study by O'Flaherty et al. (2015) [43] argues that the successful implementation of a flipped or blended classroom environment should consider effective student learning that enhances critical thinking and promotes student engagement both inside and outside the classroom. Abeysekera et al. (2015) [44] come third, in which a theoretical argument was constructed that flipped approaches might enhance student motivation and help manage cognitive load. Bernard et al. (2014) [45] and Thai et al. (2017) [46] are tied for fourth place with 7 citations. From a systematic perspective on technology integration, a meta-analysis [45] was conducted on a subgroup of comparative studies examining BL and classroom instruction (CI). The fifth place is occupied by Rasheed et al. (2020) [47], who aim to identify the challenges in the online component of a blended learning classroom environment from the perspectives of students, teachers, and educational institutions.

It is worth noting here that out of the top five highly-cited articles, three belong to #3 flipped learning, which naturally raises the question of whether flipped learning is equivalent to blended learning. The question can be answered by referring to the publication [46], which investigated the varying effects of studying in a flipped classroom (FC) environment compared to different levels in a BL, a traditional learning (TL), and an e-learning (EL) classroom environment. Actually, the FC approach is a specific type of BL where students are provided with web-based lectures before attending classroom sessions [46]. This is one of the reasons why flipped learning has gained popularity in the field of blended learning. In an FC setting, lectures are delivered in an online classroom environment. Afterward, students are given exercises in the form of guiding questions, which they solve individually in a traditional classroom setting. On the other hand, in a BL setting, lectures are given in a traditional classroom environment, and the same exercises are then provided in an online classroom environment [46].

Figure 6 shows the top 10 references with the most significant citation bursts. The longest and strongest burst durations of references [43–44] highlight their enduring significance. Both of them belong to the cluster of flipped learning, which is considered to be the cornerstone of the BL classroom environment. Of the four references with a burst that extends to 2023, three of them [45–47] are among the previously mentioned top five highly-cited references, and the other one is Awidi (2019) [48].

Awidi (2019) found positive signs that a flipped classroom approach can improve students' learning experience and outcomes.

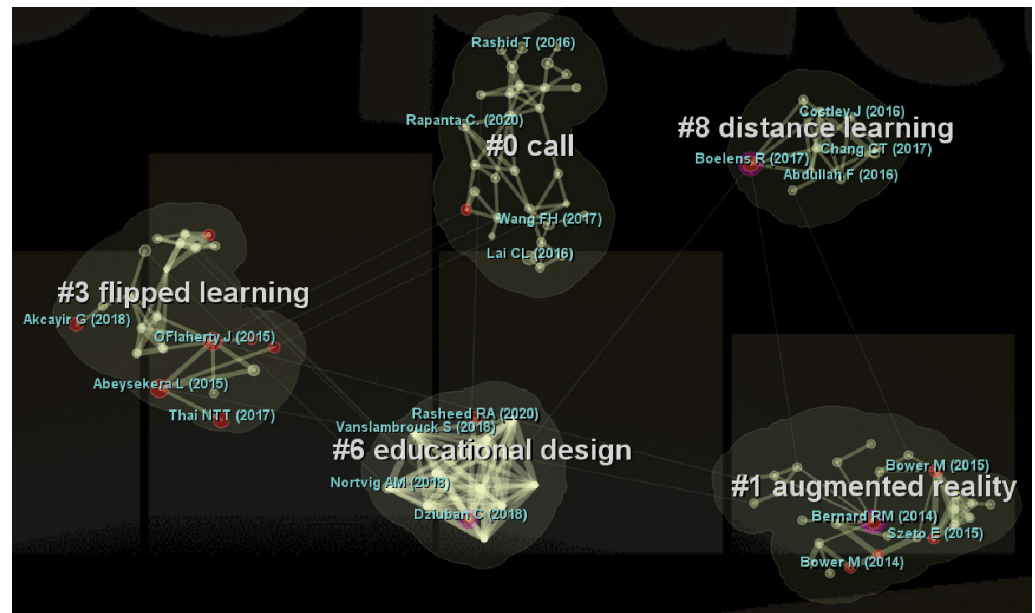


Fig. 5. Cluster map of highly cited references

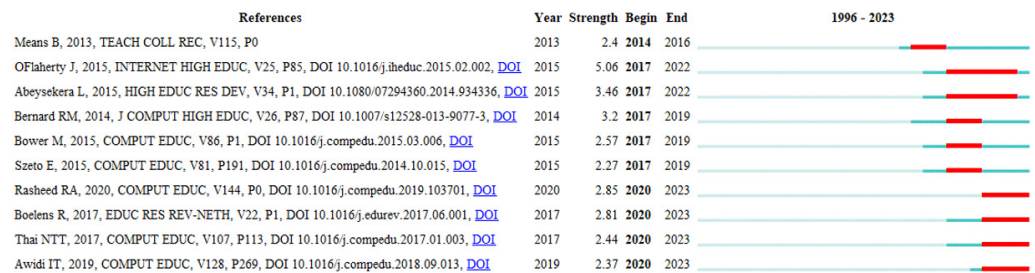


Fig. 6. Top 10 references with the strongest citation bursts

Table 5. Top 5 highly cited references

R	C	References	Title	Cluster
1	12	Boelens R, 2017, EDUC RES REV-NETH, V22, P1, DOI: 10.1016/j.edurev.2017.06.001	Four key challenges to the design of blended learning: A systematic literature review	#8 distance learning
2	11	OFlaherty J, 2015, INTERNET HIGH EDUC, V25, P85, DOI: 10.1016/j.iheduc.2015.02.002	The use of flipped classrooms in higher education: A scoping review	#3 flipped learning
3	8	Abeysekera L, 2015, HIGH EDUC RES DEV, V34, P1, DOI: 10.1080/07294360.2014.934336	Motivation and cognitive load in the flipped classroom: definition, rationale and a call for research	
4	7	Bernard RM, 2014, J COMPUT HIGH EDUC, V26, P87, DOI: 10.1007/s12528-013-9077-3	A meta-analysis of blended learning and technology use in higher education: from the general to the applied	#1 argument reality
4	7	Thai NTT, 2017, COMPUT EDUC, V107, P113, DOI: 10.1016/j.compedu.2017.01.003	The impact of a flipped classroom design on learning performance in higher education: Looking for the best "blend" of lectures and guiding questions with feedback	#3 flipped learning
5	6	Rasheed RA, 2020, COMPUT EDUC, V144, P0, DOI: 10.1016/j.compedu.2019.10371	Challenges in the online component of blended learning: A systematic review	#6 education design

Notes: R: Rank, C: Count.

## 4 DISCUSSION

Blended learning in the classroom environment has been extensively discussed in various publications over the years. However, there is still a fragmented understanding of the overall landscape and current research on the topic. The present study aims to bridge this gap by conducting a comprehensive bibliometric analysis to uncover the evolution of studies on BL classroom environments from 1996 to 2023. In the present study, a total of 283 publications concerning these studies were extracted from the WOS database and evaluated. Now, attempts can be made to discuss the answers to questions raised before conducting the bibliometric analysis:

**General publication trend:** On the whole, research in this area has progressed steadily, and the number of publications has increased. There was a relatively slow growth rate from 1996 to 2007, but since 2012, there has been a rapid increase. The number of publications reached its peak at of 42 in 2021. The research publications on blended learning classroom environments experienced significant peaks in different periods. The year 2008 marked the first peak when BL was introduced, followed by another spike in 2012. However, it was in 2021 that the study of blended learning classroom environments reached its pinnacle. Results also indicate that research in this field has gradually matured, with the number of publications in recent years still higher than that in the initial stage.

**The most contributing authors, countries or regions, journals and articles:** Despite the involvement of 842 scholars in these studies, there was limited collaboration among them, and very few prolific authors were found. The authors with the highest number of publications are Tsai, C.W., Deboer, J., Berger, E., and Shen, P.D., all of whom have just three publications in this area. The author with the highest number of citations is Garrison, who was cited in 67 records. Kim is the most prominent author who cites others. The United States, China, and Spain emerged as the top three contributors to these studies. While the United States has consistently held a prominent position in the field of blended learning classroom environments, China has made significant efforts to catch up and can be recognized as a rising star, securing the second position with 34 publications. The top three journals dedicated to this field are *Computers & Education* (185 publications, 65.37%), *Internet and Higher Education* (150 publications, 53%), and the *British Journal of Educational Technology* (118 publications, 41.70%), whose impact factors are as high as 12, 8.6, and 6.6, respectively. The findings indicate a strong correlation between research on BL classroom environments and the field of education. This research area also requires interdisciplinary knowledge from fields such as computer science and psychology. And it is the responsibility of educational institutions to provide the necessary training and technological support to both teachers and students in order to ensure the effective utilization of the available technology [47]. In addition, the articles by Boelens et al. (2017), O’Flaherty et al. (2015), Abeysekera et al. (2015), Bernard et al. (2014), Thai et al. (2017), and Rasheed et al. (2020) are identified as the most cited by scholars.

**Hotspots in different periods and the emerging trend:** The keywords that scholars initially focused on were “disorder” and “children” in the keyword cluster #9, academic motivation. This cluster also received the most prolonged attention, indicating that it is a topic of significant concern among scholars. As shown in Figures 1 and 4, it is clear that there were only a few studies conducted before 2008, resulting in a lack of significant research areas during that time. Not until 2008 did more research keywords, such as “computer-mediated communication” (related to the technological environment), “cooperative or collaborative learning”

(related to the social environment), “engagement,” and “self-efficacy” (related to the cognitive environment), arouse more scholarly attention. The keyword “engagement” is considered to be the most prominent topic in the past three years and is believed to be the emerging trend in research in this field. The reason why it has become an emerging trend may be because engagement is a prerequisite for successful learning [49]. However, the methods of fostering student engagement in a BL classroom environment are significantly different from those in a traditional face-to-face classroom environment. Additionally, sustaining student engagement in technology-based learning is challenging [50]. It is suggested in [18] that although self-determination theory (SDT) has been widely applied to motivate student engagement in both face-to-face and technological environments [51–54], there are also research gaps. Few studies based on SDT have investigated the design of technological environments [18]. However, there is a need for more SDT-based studies to understand how technology can support the need for improved motivation, leading to increased engagement and learning [53]. Results also suggest that the COVID-19 pandemic played a significant role in promoting the development of research on the BL classroom environment as educators attempted to integrate new technologies into their classrooms [55–58]. Therefore, educators in the post-pandemic context are in dire need of preparing themselves to become digitally ready. This will enable them to teach students essential skills such as information literacy, media literacy, and ICT competencies [27].

## 5 CONCLUSION

The bibliometric analysis of scientific publications offers a comprehensive perspective on the progress of research and serves as a powerful tool to identify emerging trends in a specific field. The present study collected data on publications related to the BL classroom environment from the WOS database. CiteSpace was used for visual analysis and trend detection, with Excel serving as an assistant tool for data organization and diagram drawing.

The bibliometric analysis reveals the following findings: Firstly, research in this area has progressed steadily overall, and it can be assumed that research in this field has gradually become more mature. Secondly, there are very few highly prolific authors, but Garrison emerged as the most cited author in 67 records, and Kim stood out as the most prominent citing author. Thirdly, the United States, China, and Spain were the top three contributing countries. In terms of publications in this area, the three leading journals were *Computers & Education*, *Internet and Higher Education*, and the *British Journal of Educational Technology*. Fourthly, the most cited articles are Boelens et al. (2017), O’Flaherty et al. (2015), Abeysekera et al. (2015), Bernard et al. (2014), Thai et al. (2017), and Rasheed et al. (2020). Finally, it was not until 2008 that more keywords such as “computer-mediated communication” (related to the technological environment), “cooperative or collaborative learning” (related to the social environment), “engagement,” and “self-efficacy” (related to the cognitive environment) began to receive more scholarly attention. Research on engagement was considered to be the emerging trend in the field of blended learning classroom environments. In addition, the COVID-19 pandemic has played a crucial role in driving the advancement of research in the field of BL classroom environments.

Although the present study may provide insights into observing and understanding the panorama and future direction of the BL classroom environment, it also has limitations that present opportunities for future endeavors. Firstly, the sample in the

present study was only captured from the WOS database, which may not include all the journals and articles on this topic. Secondly, although bibliometric analysis is considered scientific and objective, the interpretation of the results can be somewhat subjective. Thirdly, the count of citations generated by CiteSpace's analysis of cited references does not equal the actual number of citations in the WOS database. This discrepancy may be due to the fact that CiteSpace considers the co-citation relationship between authors, resulting in potentially different and somewhat inaccurate results.

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## 7 REFERENCES

- [1] D. R. Garrison and N. D. Vaughan, "Blended learning in higher education: Framework, principles, and guidelines," San Francisco, CA: Jossey-Bass, 2008. <https://doi.org/10.1002/9781118269558>
- [2] S. Hyo-Jeong and A. B. Thomas, "Student perceptions of collaborative learning, social presence and satisfaction in a blended learning environment: Relationships and critical factors," *Computers & Education*, vol. 51, no. 1, pp. 318–336, 2008. <https://doi.org/10.1016/j.compedu.2007.05.009>
- [3] P. Mitchell and P. Forer, "Blended learning: The perceptions of first-year geography students," *Journal of Geography in Higher Education*, vol. 34, no. 1, pp. 77–89, 2010. <https://doi.org/10.1080/03098260902982484>
- [4] H. Patrick, A. M. Ryan, and A. Kaplan, "Early adolescents' perceptions of the classroom social environment, motivational beliefs, and engagement," *Journal of Educational Psychology*, vol. 99, no. 1, pp. 83–98, 2007. <https://doi.org/10.1037/0022-0663.99.1.83>
- [5] A. M. Ryan and H. Patrick, "The classroom social environment and changes in adolescents' motivation and engagement during middle school," *American Educational Research Journal*, vol. 38, no. 2, pp. 437–460, 2001. <https://doi.org/10.3102/00028312038002437>
- [6] D. S. Thomas, *Some New Techniques for Studying Social Behavior*, New York, NY: Teachers College, Columbia University, 1929.
- [7] B. J. Fraser, *Classroom Environment*. London, UK: Croom Helm, 1986.
- [8] V. C. S. Rao, "Blended learning: A new hybrid teaching methodology," *Journal for Research Scholars and Professionals of English Language Teaching*, vol. 3, no. 13, pp. 1–6, 2019. <https://www.researchgate.net/publication/333485907>
- [9] A. Powell, J. Watson, P. Staley, S. Patrick, M. Horn, L. Fetzer, L. Hibbard, J. Oglesby, and S. Verma, "Blending learning: The evolution of online and face-to-face education from 2008–2015. Promising practices in blended and online Learning series," *International Association for K-12 Online Learning*, 2015. <https://files.eric.ed.gov/fulltext/ED560788>
- [10] N. Donthu, S. Kumar, D. Mukherjee, N. Pandey, and W. M. Lim, "How to conduct a bibliometric analysis: An overview and guidelines," *Journal of Business Research*, vol. 133, pp. 285–296, 2021. <https://doi.org/10.1016/j.jbusres.2021.04.070>
- [11] C. H. Limaymanta, L. Apaza-Tapia, E. Vidal, and O. Gregorio-Chaviano, "Flipped classroom in higher education: A bibliometric analysis and proposal of a framework for its implementation," *International Journal of Emerging Technologies in Learning (ijET)*, vol. 16, no. 9, pp. 133–148, 2021. <https://doi.org/10.3991/ijet.v16i09.21267>

- [12] A. Rey-Martí, D. Ribeiro-Soriano, and D. Palacios-Marqués, “A bibliometric analysis of social entrepreneurship,” *Journal of Business Research*, vol. 69, no. 5, pp. 1651–1655, 2016. <https://doi.org/10.1016/j.jbusres.2015.10.033>
- [13] C. Chen, “CiteSpace II: Detecting and visualizing emerging trends and transient patterns in scientific literature,” *Journal of the American Society for Information Science and Technology*, vol. 57, no. 3, pp. 359–377, 2006. <https://doi.org/10.1002/asi.20317>
- [14] J. Li and C. Chen, *CiteSpace: Science and Technology. Text Mining and Visualization*, Beijing: Capital University of Economics and Business Press, 2016.
- [15] C. S. Bos and E. I. Reyes, “Conversations with a Latina teacher about education for language-minority students with special needs,” *The Elementary School Journal*, vol. 96, no. 3, pp. 343–351, 1996. <https://doi.org/10.1086/461832>
- [16] M. Victoria López-Pérez, M. Carmen Pérez-López, and L. Rodríguez-Ariza, “Blended learning in higher education: Students’ perceptions and their relation to outcomes,” *Computers & Education*, vol. 56, no. 3, pp. 818–826, 2011. <https://doi.org/10.1016/j.compedu.2010.10.023>
- [17] W. S. Lin and C. H. Wang, “Antecedences to continued intentions of adopting e-learning system in blended learning instruction: A contingency framework based on models of information system success and task-technology fit,” *Computers & Education*, vol. 58, no. 1, pp. 88–99, 2012. <https://doi.org/10.1016/j.compedu.2011.07.008>
- [18] T. K. F. Chiu, “Digital support for student engagement in blended learning based on self-determination theory,” *Computers in Human Behavior*, vol. 124, pp. 38–59, 2021. <https://doi.org/10.1016/j.chb.2021.106909>
- [19] R. A. Rasheed, A. Kamsin, and N. A. Abdullah, “An approach for scaffolding students peer-learning self-regulation strategy in the online component of blended learning,” *IEEE Access*, vol. 9, pp. 21–38, 2021. <https://doi.org/10.1109/ACCESS.2021.3059916>
- [20] M. K. Kim, S. M. Kim, O. Khera, and J. Getman, “The experience of three flipped classrooms in an urban university: An exploration of design principles,” *The Internet and Higher Education*, vol. 22, pp. 37–50, 2014. <https://doi.org/10.1016/j.iheduc.2014.04.003>
- [21] P. Baepler, J. D. Walker, and M. Driessen, “It’s not about seat time: Blending, flipping, and efficiency in active learning classrooms,” *Computers & Education*, vol. 78, pp. 227–236, 2014. <https://doi.org/10.1016/j.compedu.2014.06.006>
- [22] C. A. Jara, F. A. Candelas, S. T. Puente, and F. Torres, “Hands-on experiences of undergraduate students in Automatics and Robotics using a virtual and remote laboratory,” *Computers & Education*, vol. 57, no. 4, pp. 2451–2461, 2011. <https://doi.org/10.1016/j.compedu.2011.07.003>
- [23] L. R. Halverson, C. R. Graham, K. J. Spring, J. S. Drysdale, and C. R. Henrie, “A thematic analysis of the most highly cited scholarship in the first decade of blended learning research,” *The Internet and Higher Education*, vol. 20, pp. 20–34, 2014. <https://doi.org/10.1016/j.iheduc.2013.09.004>
- [24] K. M. Law, S. Geng, and T. Li, “Student enrollment, motivation and learning performance in a blended learning environment: The mediating effects of social, teaching, and cognitive presence,” *Computers & Education*, vol. 136, pp. 1–12, 2019. <https://doi.org/10.1016/j.compedu.2019.02.021>
- [25] X. Chen, J. Chen, D. Wu, Y. Xie, and J. Li, “Mapping the research trends by co-word analysis based on keywords from funded project,” *Procedia Computer Science*, 2016, vol. 91, pp. 547–555. <https://doi.org/10.1016/j.procs.2016.07.140>
- [26] C. Chen, “Science mapping: A systematic review of the literature,” *Journal of Data and Information Science*, vol. 2, no. 2, pp. 1–40, 2017. <https://doi.org/10.1515/jdis-2017-0006>
- [27] D. T. K. Ng, J. K. L. Leung, J. Su, R. C. W. Ng, and S. K. W. Chu, “Teachers’ AI digital competencies and twenty-first century skills in the post-pandemic world,” *Educational Technology Research and Development*, vol. 71, no. 1, pp. 137–161, 2023. <https://doi.org/10.1007/s11423-023-10203-6>

- [28] M. Chen, "Teaching in emergency remote classrooms: Reflections for professional learning," *Educational Research*, vol. 65, no. 1, pp. 64–81, 2023. <https://doi.org/10.1080/00131881.2023.2167729>
- [29] C. Chen, "A glimpse of the first eight months of the COVID-19 literature on Microsoft Academic Graph: Themes, citation contexts, and uncertainties," *Frontiers in Research Metrics and Analytics*, vol. 5, p. 607286, 2020. <https://doi.org/10.3389/frma.2020.607286>
- [30] X. Zhou, T. Li, and X. Ma, "A bibliometric analysis of comparative research on the evolution of international and Chinese green supply chain research hotspots and frontiers," *Environmental Science and Pollution Research*, vol. 28, pp. 6302–6323, 2021. <https://doi.org/10.1007/s11356-020-11947-x>
- [31] M. Zhang and G. Xiao, "A bibliometric analysis of online learning emotions from 2006 to 2023," *International Journal of Emerging Technologies in Learning (ijET)*, vol. 18, no. 13, pp. 220–233, 2023. <https://doi.org/10.3991/ijet.v18i13.39919>
- [32] R. Donnelly, "Interaction analysis in a 'Learning by Doing' problem-based professional development context," *Computer & Education*, vol. 55, no. 3, pp. 1357–1366, 2010. <https://doi.org/10.1016/j.compedu.2010.06.010>
- [33] T. Brahim and A. Sarirete, "Learning outside the classroom through MOOCs," *Computers in Human Behavior*, vol. 51, pp. 604–609, 2015. <https://doi.org/10.1016/j.chb.2015.03.013>
- [34] L. M. Regueras, E. Verdu, M. F. Munoz, M. A. Perez, J. P. de Castro, and M. J. Verdu, "Effects of competitive e-learning tools on higher education students: A case study," *IEEE Transactions on Education*, vol. 52, no. 2, pp. 279–285, 2009. <https://doi.org/10.1109/TE.2008.928198>
- [35] K. Scott and R. Benlamri, "Context-aware services for smart learning spaces," *IEEE Transactions on Learning Technologies*, vol. 3, no. 3, pp. 214–227, 2010. <https://doi.org/10.1109/TLT.2010.12>
- [36] C. Fong and J. D. Slotta, "Supporting communities of learners in the elementary classroom: The common knowledge learning environment," *Instructional Science*, vol. 46, no. 4, pp. 533–561, 2018. <https://doi.org/10.1007/s11251-018-9463-3>
- [37] L. Li and C. Tsai, "Accessing online learning material: Quantitative behavior patterns and their effects on motivation and learning performance," *Computers & Education*, vol. 114, pp. 286–297, 2017. <https://doi.org/10.1016/j.compedu.2017.07.007>
- [38] A. L. Reschly and S. L. Christenson, "Jingle, jangle, and conceptual haziness: Evolution and future directions of the engagement construct," in *Handbook of Research on Student Engagement*, Boston, MA: Springer US, 2012, pp. 3–19. [https://doi.org/10.1007/978-1-4614-2018-7\\_1](https://doi.org/10.1007/978-1-4614-2018-7_1)
- [39] T. K. F. Chiu, "Applying the self-determination theory (SDT) to explain student engagement in online learning during the COVID-19 pandemic," *Journal of Research on Technology in Education*, vol. 4, pp. 1–17, 2021. <https://doi.org/10.1080/15391523.2021.1891998>
- [40] Y. Xin, "Influence of learning engagement on learning effect under a virtual reality (VR) environment," *International Journal of Emerging Technologies in Learning (ijET)*, vol. 17, no. 5, pp. 226–237, 2022. <https://doi.org/10.3991/ijet.v17i05.29451>
- [41] B. Hjørland, "Facet analysis: The logical approach to knowledge organization," *Information Processing and Management*, vol. 49, no. 2, pp. 545–557, 2013. <https://doi.org/10.1016/j.ipm.2012.10.001>
- [42] R. Boelens, B. de Wever, and M. Voet, "Four key challenges to the design of blended learning: A systematic literature review," *Educational Research Review*, vol. 22, pp. 1–18, 2017. <https://doi.org/10.1016/j.edurev.2017.06.001>
- [43] J. O'Flaherty and C. Phillips, "The use of flipped classrooms in higher education: A scoping review," *The Internet and Higher Education*, vol. 25, pp. 85–95, 2015. <https://doi.org/10.1016/j.iheduc.2015.02.002>



- [44] L. Abeysekera and P. Dawson, "Motivation and cognitive load in the flipped classroom: Definition, rationale and a call for research," *Higher Education Research & Development*, vol. 34, no. 1, pp. 1–14, 2015. <https://doi.org/10.1080/07294360.2014.934336>
- [45] R. M. Bernard, E. Borokhovski, R. F. Schmid, R. M. Tamim, and P. C. Abrami, "A meta-analysis of blended learning and technology use in higher education: From the general to the applied," *Journal of Computing in Higher Education*, vol. 26, no. 1, pp. 87–122, 2014. <https://doi.org/10.1007/s12528-013-9077-3>
- [46] N. T. T. Thai, B. De Wever, and M. Valcke, "The impact of a flipped classroom design on learning performance in higher education: Looking for the best "blend" of lectures and guiding questions with feedback," *Computers & Education*, vol. 107, pp. 113–126, 2017. <https://doi.org/10.1016/j.compedu.2017.01.003>
- [47] R. A. Rasheed, A. Kamsin, and N. A. Abdullah, "Challenges in the online component of blended learning: A systematic review," *Computers & Education*, vol. 144, p. 103701, 2020. <https://doi.org/10.1016/j.compedu.2019.103701>
- [48] I. T. Awidi and M. Paynter, "The impact of a flipped classroom approach on student learning experience," *Computers & Education*, vol. 128, pp. 269–283, 2018. <https://doi.org/10.1016/j.compedu.2018.09.013>
- [49] Y. W. Lam, T. K. F. Hew, and T. K. F. Chiu, "Improving Hong Kong secondary school students' argumentative writing: Effects of a blended learning approach and gamification," *Language, Learning and Technology*, vol. 22, no. 1, pp. 97–118, 2018. <https://dx.doi.org/10.125/44583>
- [50] C. R. Henrie, L. R. Halverson, and C. R. Graham, "Measuring student engagement in technology-mediated learning: A review," *Computers & Education*, vol. 90, pp. 36–53, 2015. <https://doi.org/10.1016/j.compedu.2015.09.005>
- [51] E. A. Ruzek, C. A. Hafen, J. P. Allen, A. Gregory, A. Y. Mikami, and R. C. Pianta, "How teacher emotional support motivates students: The mediating roles of perceived peer relatedness, autonomy support, and competence," *Learning and Instruction*, vol. 42, pp. 95–103, 2016. <https://doi.org/10.1016/j.learninstruc.2016.01.004>
- [52] R. M. Ryan and E. L. Deci, "Self-determination theory: Basic psychological needs in motivation development and wellness," New York, NY: Guilford Press, 2017. <https://doi.org/10.1521/978.14625/28806>
- [53] R. M. Ryan and E. L. Deci, "Intrinsic and extrinsic motivation from a self-determination theory perspective: Definitions, theory, practices, and future directions," *Contemporary Educational Psychology*, vol. 61, pp. 101860, 2020. <https://doi.org/10.1016/j.cedpsych.2020.101860>
- [54] M. Standage, J. L. Duda, and N. Ntoumanis, "A test of self-determination theory in school physical education," *British Journal of Educational Psychology*, vol. 75, no. 3, pp. 411–433, 2005. <https://doi.org/10.1348/000709904X22359>
- [55] T. K. Ng, R. Reynolds, M. Y. H. Chan, X. H. Li, and S. K. W. Chu, "Business (teaching) as usual amid the COVID-19 pandemic: A case study of online teaching practice in Hong Kong," *Journal of Information Technology Education Research*, vol. 19, pp. 775–802, 2020. <https://doi.org/10.28945/4620>
- [56] F. Sartika, M. Ritonga, A. Lahmi, A. Rasyid, and S. R. Febriani, "Online learning in the low internet area, planning, strategies and problems faced by students during the Covid-19 period," *Artificial Intelligence for COVID-19*, pp. 413–421, 2021. [https://doi.org/10.1007/978-3-030-69744-0\\_23](https://doi.org/10.1007/978-3-030-69744-0_23)
- [57] P. Appiah-Kubi, K. Zouhri, E. Basile, and M. McCabe, "Analysis of engineering technology students' digital footprints in synchronous and asynchronous blended courses," *International Journal of Engineering Pedagogy (IJEP)*, vol. 12, no. 1, pp. 63–74, 2022. <https://doi.org/10.3991/ijep.v12i1.24571>

- [58] B. Whalley, D. France, J. Park, A. Mauchline, and K. Welsh, “Towards flexible personalized learning and the future educational system in the fourth industrial revolution in the wake of Covid-19,” *Higher Education Pedagogies*, vol. 6, no. 1, pp. 79–99, 2021. <https://doi.org/10.1080/23752696.2021.1883458>

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