

Developments and Emerging Trends of Blended Learning

A Document Co-citation Analysis (2003–2020)

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Abstract—This study aims to analyze and visualize the research hotspots, evolution, and emerging trends of blended learning in a holistic way. In this study, 1657 bibliometric records together with 48310 citations are collected from SCIE, SSCI and A&HCI databases. CiteSpace is adopted in the analysis and visualization. Results show: enhancing collaborative learning, pattern, and teacher training are the research hotspots in Period I, instructor perception, possible future direction, and research trend are the research hotspots in Period II, general science classroom, blended learning environment, and measuring student engagement are the research hotspots in Period III; the themes of covid-19 remain similar along the development, while the themes of digital health education change a lot; blended learning environment, online component, covid-19 pandemic, procrastinating behavior, active blended learning, and observed learning orientation are the emerging trends. These findings could provide research directions for future studies in blended learning.

Keywords—blended learning, research hotspots, evolution of topics, emerging trends, document co-citation analysis

1 Introduction

Blended learning has long been a hot discussed topic. But the term lacks a unified definition [1]. At the early stage, a blended learning module consisted of “a textbook with a specially designed multimedia CD-ROM, face-to-face tutorials and online discussion” [2]. Generally speaking, blended learning is a combination of face-to-face instruction and online instruction [3-5]. As for the percentages of time occupied by face-to-face instruction and online instruction respectively, there is no consensus. Bernard thought 50% or more of total course time must be face-to-face [6]. Since the outbreak of COVID-19 pandemic, blended learning attracts more attention [7].

CiteSpace is a software specialized in visual analysis of science mapping [8]. With its development, it is gradually applied to other disciplines, such as Environmental Sciences [9, 10], Management [11], Education & Educational Research [12, 13], Linguistics [14] and so on.

Although some review articles have given an overview of blended learning, they are limited to some certain themes [15-19]. Some are restricted to some certain disciplines [20-23]. Others can't employ quantitative methods due to vast number of literatures. To bridge this gap, in this study, we adopted CiteSpace to quantitatively analyze the development of blended learning. We retrieved 1657 bibliometric records together with 48310 citations from SCIE, SSCI and A&HCI databases. We divided the whole development into 3 periods: Period I (2003-2008), Period II (2009-2014), and Period III (2015-2020). We used functions of document co-citation analysis (DCA), label clusters year by year, and burst detection to explore the research hotspots in 3 periods respectively, track the evolution, and detect the emerging trends in a holistic view.

In this study, we aim to answer the following research questions:

- RQ1: What is the year-by-year distribution of documents?
The answer to RQ1 could help researchers explore the development trends of blended learning.
- RQ2: What are the research hotspots?
The answer to RQ2 could help researchers explore the topics attracting the most attention.
- RQ3: What is the evolution of blended learning?
The answer to RQ3 could help researchers identify the development of the topics.
- RQ4: What are the research fronts and emerging trends?
The answer to RQ4 could help researchers understand the future directions of blended learning.

2 Data acquisition and methods

2.1 Data acquisition

Web of Science (WoS) Core Collection is one of the most recognized multidisciplinary database platforms [24]. Therefore, SCIE, SSCI, A&HCI databases in WoS Core Collection were used to obtain professional literature [25]. In advanced search, we set the search query as: TS= "blended learn*" OR TS= blended teach*", language=English, document types = articles + reviews, time span = 1900 to 2020, database = SCIE, SSCI, A&HCI. A total of 1657 records were retrieved. The retrieval date was Jun 5, 2021. The references in these 1657 papers created a citation dataset of 48310 records which were used in the subsequent document co-citation analysis (DCA).

2.2 Methods

CiteSpace is a widely used software to conduct bibliometric analysis and visualization [26]. In our study, we used CiteSpace to explore the hot research topics, track the evolution and detect the emerging trends. First, we imported all records into CiteSpace to discard duplicates. No duplicates were found. And the earliest research in blended learning was in 2003. Then we conducted documents co-citation analysis.

3 Results

3.1 The distribution of publication outputs year by year

The development of a discipline can be represented by its distribution of publication outputs; in other words, an increase in the number of publications shows an increase in the scientific knowledge [27]. Based on the retrieved 1657 records, a histogram of publications per year is created by using EXCEL (Figure 1). Figure 1 reveals that there has been a steady rise in the number of publications since 2003. The number reaches the peak of 276 in 2020. We use Excel forecast function to predict the number of publications in 2021 and 2022. “The forecast function is an inbuilt feature in Microsoft-Excel” and works on time-oriented dataset and gives future values of dataset which can be used to make real time decisions [28]. As shown in Figure 1 the number of publications in the field of blended learning is expected to increase in the following two years, which indicates a continuous concern on this field by scholars.

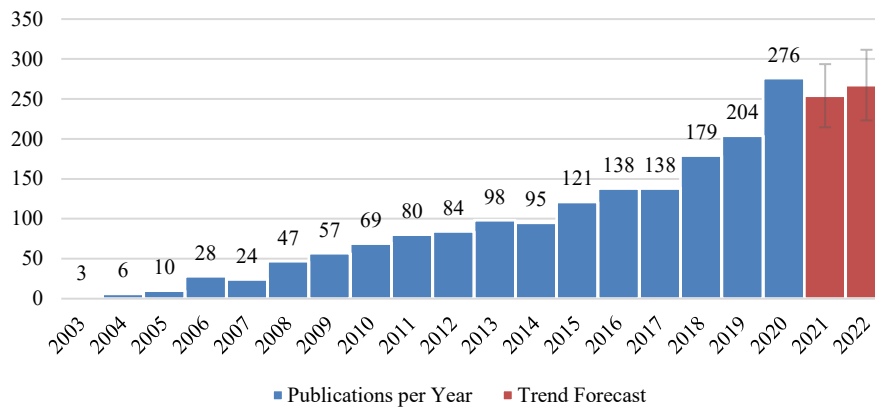


Fig. 1. Publications per year in the field of blended learning

3.2 Hot research topics

To illustrate the development of blended learning, we divide the whole development into 3 periods: 2003 to 2008 as Period I, 2009 to 2014 as Period II, 2015 to 2020 as Period III. We compare the research topics in the 3 periods by using DCA.

DCA in Period I form 244 clusters in total, including 1647 nodes, 5076 links. The modularity Q is 0.9549, which means that the specialties in blended learning are clearly defined [29]. The mean silhouette score is 0.9905, suggesting that the homogeneity of the cluster members is very high [30]. In this research we take the 4 largest clusters in Period I for analysis (Table 1).

Table 1. The four largest clusters of co-cited references (Period I)

Cluster ID	Size	Silhouette	Mean (Year)	Label (LSI)	Label (LLR)	Major citers
3	51	0.978	2004	enhancing collaborative learning in a blended learning environment: applying a process planning model	enhancing collaborative learning (3.38, 0.1)	(35) Nel, L. (2006) Enhancing collaborative learning in a blended learning environment: applying a process planning model
5	44	1	2003	face-to-face contact at the midpoint of an online collaboration: its impact on the patterns of participation, interaction, affect, and behavior over time	pattern (1.8, 0.5)	(28) Michinov, N. (2008) Face-to-face contact at the midpoint of an online collaboration: its impact on the patterns of participation, interaction, affect, and behavior over time
10	37	0.991	2003	online or face-to-face? experimenting with different techniques in teacher training	teacher training (4.43, 0.05)	(37) Delfino, M. (2007) Online or face-to-face? experimenting with different techniques in teacher training
17	23	1	2005	using email to enable e(3) (effective, efficient, and engaging) learning	learning (3.38, 0.1)	(23) Kim, CM (2008) Using email to enable e(3) (effective, efficient, and engaging) learning

According to the timeline view in Period I (Figure 2), #3 enhancing collaborative learning, #5 pattern and #10 teacher training were the research topics prior to 2003. The largest cluster #3 has 51 members and a silhouette value of 0.978. The most active citer to the cluster is [31] in which Nel conducted the third cycle of an action inquiry focusing on student collaboration in a blended learning environment. The research was originally based on the Action Learning and Action Research model proposed by Zuber-Skerritt [32]. The duration of #3 is from 2001 to 2008.

The second largest cluster #5 has 44 members and a silhouette value of 1. The most active citer to the cluster is [33] in which Michinov found a face-to-face contact had a positive impact on the patterns of participation. The duration of #5 is from 2001 to 2007.

The third largest cluster #10 has 37 members and a silhouette value of 0.991. The most active citer to the cluster is [34] in which Delfino proposed possible directions for further research in facilitating the infusion of online techniques in initial teacher training. The duration of #10 is from 2002 to 2006.

The fourth largest cluster #17 has 23 members and a silhouette value of 1. The most active citer to the cluster is [35] in which Kim argued that the use of email can make learning more effective, efficient, and engaging. The duration of #17 is from 2003 to 2008. Therefore, #3 enhancing collaborative learning and #17 learning remain the emerging trends in Period I.

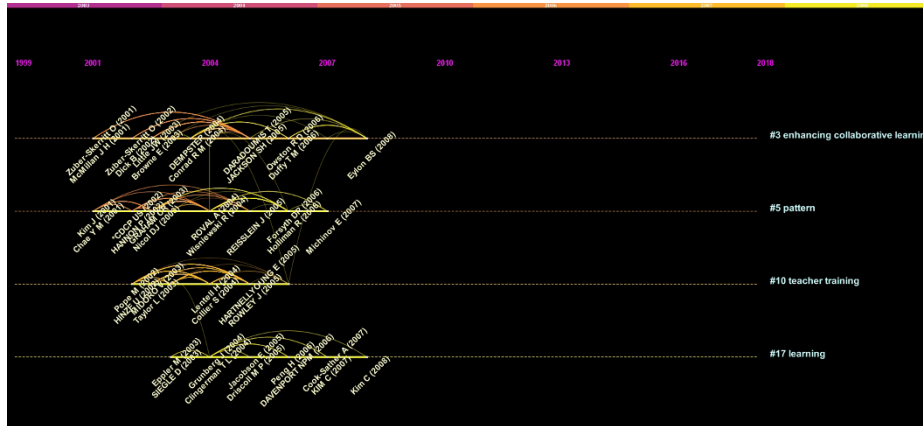


Fig. 2. DCA timeline view in Period I (2003-2008)

DCA in Period II form 950 clusters in total, including 6133 nodes, 20270 links. The modularity Q is 0.9647, and the mean silhouette score is 0.9845. In this research we take the 5 largest clusters in Period II for analysis (Table 2).

Table 2. The five largest clusters of co-cited references (Period II)

Cluster ID	Size	Silhouette	Mean (Year)	Label (LSI)	Label (LLR)	Major citers
0	190	0.982	2008	learning outcome	instructor perception (43.65, 1.0E-4)	(32) Roby, T. (2013) Shaping the online experience: how administrators can influence student and instructor perceptions through policy and practice
1	153	0.969	2006	blended learning	possible future direction (28.64, 1.0E-4)	(122) Arbaugh, J B (2009.0) Research in online and blended learning in the business disciplines: key findings and possible future directions
2	134	0.938	2008	blended learning	research trend (38.38, 1.0E-4)	(45) Drysdale, J. S. (2013) An analysis of research trends in dissertations and theses studying blended learning
3	131	0.985	2009	blended learning environment	individualized English listening (33.86, 1.0E-4)	(33) Yang, YT (2013) A blended learning environment for individualized English listening and speaking integrating critical thinking
4	129	0.978	2008	online formative assessment	online formative assessment (40.25, 1.0E-4)	(50) Gikandi, J. W. (2011) Online formative assessment in higher education: a review of the literature

According to the timeline view in Period II (Figure 3), #0 instructor perception, #1 possible future direction, #2 research trend and #4 online formative assessment start in 2004. #3 individualized English listening start in 2005. The largest cluster #0 has 190 members and a silhouette value of 0.982. The most active citer to the cluster is [36]. This paper identified factors that enhanced student and instructor experiences in online

environments [36]. It is worth noting that the duration of #0 is from 2004 to 2019. Therefore, #0 instructor perception remain the emerging trend in Period II.

The second largest cluster #1 has 153 members and a silhouette value of 0.969. The most active citer to the cluster is from Arbaugh, J B (2009). Their paper reviewed the state of research of online and blended learning in the disciplines of business and identified opportunities for meaningful future research [37]. The duration of #1 is from 2004 to 2011.

The third largest cluster #2 has 134 members and a silhouette value of 0.938. The most active citer to the cluster is from Drysdale (2013). They summarized the trends of growth and context of blended learning through analyzing the research of 205 doctoral dissertations and masters' theses [38]. The duration of #2 is from 2004 to 2014.

The fourth largest cluster #3 has 131 members and a silhouette value of 0.985. The most active citer to the cluster is from Ya-Ting Carolyn Yang (2013). They studied the effectiveness of integrating critical thinking into individualized English listening and speaking instruction with Moodle [39]. The duration of #3 is from 2005 to 2014. From 2005, researchers have begun to pay attention to integrate blended approaches in language learning.

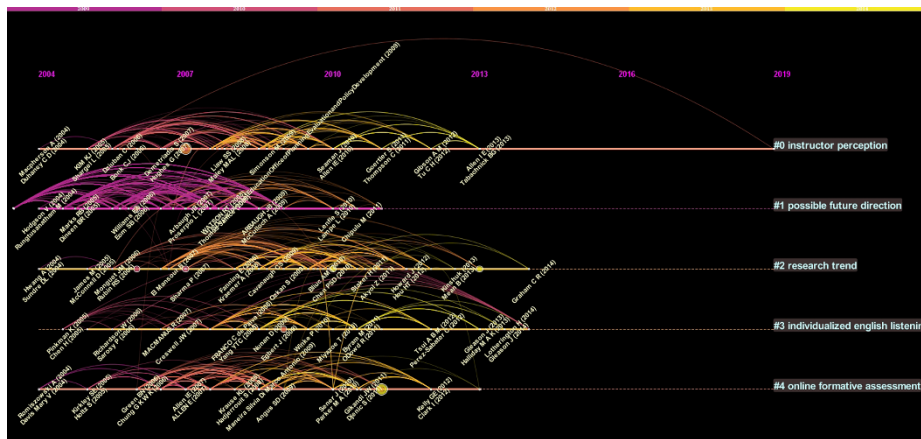


Fig. 3. DCA timeline view in Period II (2009-2014)

DCA in Period III form 83 clusters in total, including 836 nodes, 3099 links. The modularity Q is 0.7724, and the mean silhouette score is 0.9002. In this research we take the 5 largest clusters in Period III for analysis (Table 3).

According to the timeline view in Period III (2015-2020) (Figure 4), #0 general science classroom, #2 measuring student engagement started in 2010. #1 blended learning environment started in 2013. The largest cluster #0 has 107 members and a silhouette value of 0.781. The most active citer to the cluster is from Rasheed (2020). They identified that challenges students faced were self-regulation and using learning technologies, challenges teachers faced were the use of technology in teaching, challenges educational institutions faced were the provision of suitable instructional technology and effective training support to teachers [40]. The duration of #0 is from 2010 to 2018.

Table 3. The five largest clusters of co-cited references (Period III)

Cluster ID	Size	Silhouette	Mean (Year)	Label (LSI)	Label (LLR)	Major citers
0	107	0.781	2013	general science classroom	general science classroom (204.22, 1.0E-4)	(27) Rasheed, R.A. (2020) Challenges in the online component of blended learning: a systematic review
1	83	0.899	2015	blended learning environment	blended learning environment (174.22, 1.0E-4)	(24) Rasheed, R. A. (2020) Challenges in the online component of blended learning: a systematic review
2	68	0.959	2011	blended learning	measuring student engagement (105.19, 1.0E-4)	(13) Henrie, C. R. (2015) Measuring student engagement in technology-mediated learning: a review
3	60	0.88	2017	blended learning	online component (65.23, 1.0E-4)	(19) Rasheed, R. A. (2020) Challenges in the online component of blended learning: a systematic review
4	54	0.897	2018	covid-19 pandemic	covid-19 pandemic (112.12, 1.0E-4)	(13) Bond, M. (2020) Mapping research in student engagement and educational technology in higher education: a systematic evidence map

The second largest cluster #1 has 83 members and a silhouette value of 0.899. The most active citer to the cluster is from Rasheed (2020), the same in the cluster #0. The duration of #1 is from 2013 to 2020. Therefore, #1 blended learning environment remains the emerging trend in Period III.

The third largest cluster #2 has 68 members and a silhouette value of 0.959. The most active citer to the cluster is from Henrie (2015). In the review, they identified advantages and disadvantages of existing measures and outline potential methods to improve measuring students' engagement [41]. The duration of #2 is from 2010 to 2016.

The fourth largest cluster #3 has 60 members and a silhouette value of 0.88. The most active citer to the cluster is from Rasheed (2020), the same in #0 and #1. The duration of #3 is from 2014 to 2020. Obviously, online component is an emerging trend in Period III.

The fifth largest cluster #4 has 54 members and a silhouette value of 0.897. The most active citer to the cluster is from Bond (2020). They provided a synthesis of research related to student engagement theory, and mapped the student engagement in educational technology from 2007 to 2016 in empirical higher education research [42]. The duration of #4 is from 2014 to 2020. There is no doubt that covid-19 pandemic is an emerging trend in Period III.

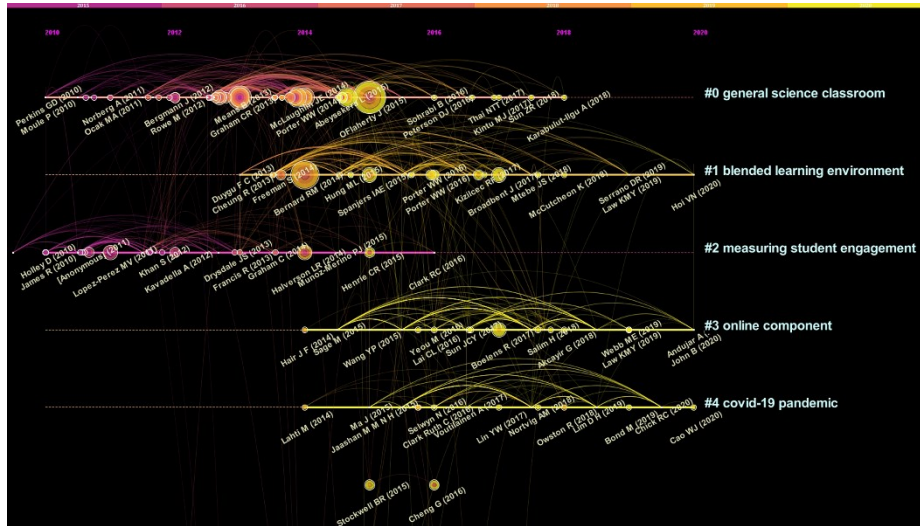


Fig. 4. DCA timeline view in Period III (2015-2020)

3.3 Evolution of research topics year by year

To illustrate the evolution of blended learning from 2003 to 2020, we applied the cluster year by year function [43] of CiteSpace to draw the timeline map (Figure 5). This research primarily focuses on the five largest clusters.

From Figure 5 we could see the evolution of research topics in the field of blended learning. Clusters #0 covid-19 pandemic, and #1 digital health education collaboration are the two largest clusters, having 366 and 342 members respectively. They are still active in 2020. The duration of #0 is 15 years, from 2006 to 2020. The duration of #1 is 13 years, from 2008 to 2020. Cluster #2 possible future direction, having 191 members, began in 2002, and ended in 2011, lasting for 10 years. It is inactive now. Cluster #3 instructor perception, having 183 members, began in 2004, and ended in 2013, lasting for 10 years. Cluster #4 institutional adoption, having 150 members, began in 2006, and ended in 2016, lasting for 11 years.

Cluster #0 covid-19 pandemic and #1 digital health education collaboration are the two biggest clusters. They are the core research topics from 2003 to 2020. The year-by-year cluster label and topics of the five biggest clusters are shown as Table 4. The topics of #0 and #1 are similar. Blended learning is the core theme. The themes in Cluster #2 change a lot, from blended teacher, key findings, post-graduate courses, blended learning, to project management education. The themes in #3 change from science teacher, design features, geography modules, instructor perception to blended environments. The themes in #4 change from open university Malaysia, information system success, blended learning to social presence.

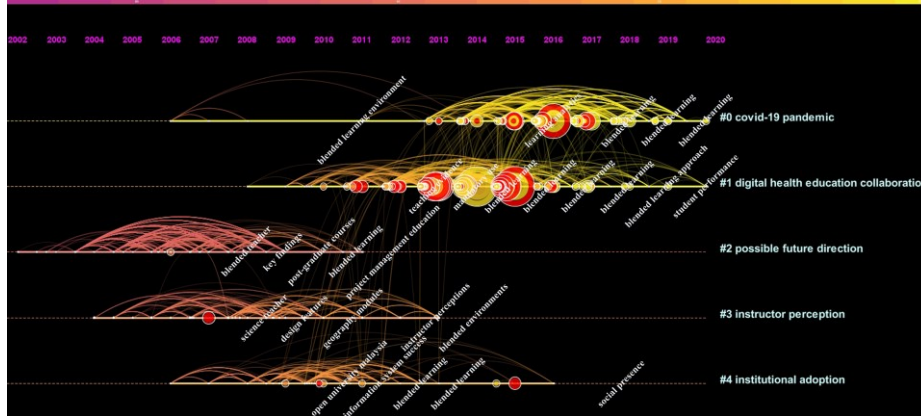


Fig. 5. The timeline map of research topics year by year (2003-2020)

According to Table 4, blended learning ranks the first in terms of the frequency of occurrence, followed by blended environment, blended teacher. The results show that blended learning covers a wide range of themes, and these themes interrelate with each other.

Table 4. Distribution of the research topics from 2003 to 2020 (#0-#4)

Cluster ID	#0	#1	#2	#3	#4
2008	-----	-----	blended teacher	-----	-----
2009	-----	-----	key findings	science teacher	-----
2010	-----	-----	post-graduate courses	design features	-----
2011	blended learning environment	-----	blended learning	geography modules	open university Malaysia
2012	-----	-----	project management education	-----	information system success
2013	-----	teaching evidence	-----	instructor perceptions	blended learning
2014	-----	mandatory use	-----	blended environments	blended learning
2015	-----	blended learning	-----	-----	-----
2016	learning analytics	blended learning	-----	-----	-----
2017	-----	blended learning	-----	-----	-----
2018	blended learning	blended learning	-----	-----	social presence
2019	blended learning	blended learning approach	-----	-----	-----
2020	blended learning	student performance	-----	-----	-----

3.4 Research fronts and emerging trends

Burst can be detected when articles are experienced with sharp increase in citations [44]. Therefore, the analysis of citation burst can be used to find the research fronts and emerging trends [45]. Based on DCA from 2003 to 2020, we extracted burst references which lasted to 2020. 45 references meet the requirements (Figure 6). The time interval is shown as blue. Citation burst is depicted as red. 11 references were published in 2014 (Period II), 19 in 2015, 9 in 2016, 5 in 2017 and 1 in 2018. All references have a burst time from 2018 to 2020.

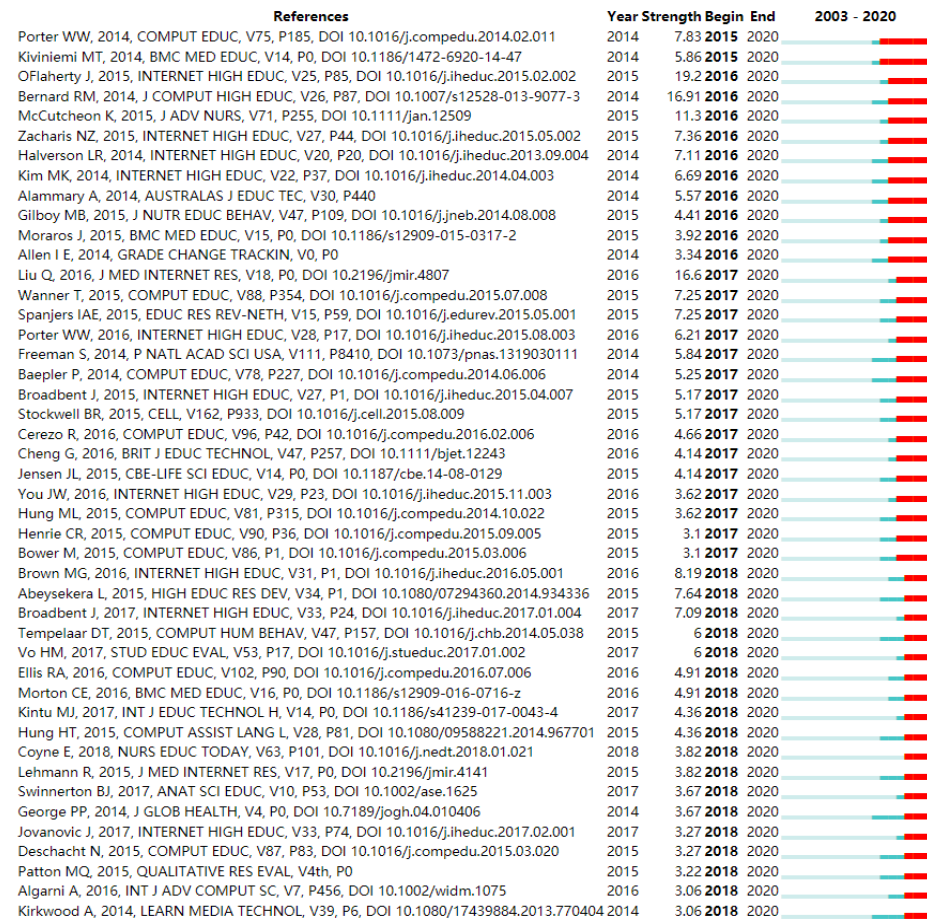


Fig. 6. References with the most recent burst until 2020

In terms of burst duration, Porter WW (2014) and Kiviniemi MT (2014) are the two references with the longest burst duration. Porter proposed “a framework for institutional blended learning adoption” and applied that framework to 11 US institutions [46]. Kiviniemi found “statistically increase in student performance under the blended

learning approach” in a graduate-level public health course using a quasi-experimental, non-equivalent control group design [47]. In terms of the strength of burst, O’ Flaherty J (2015) (19.2) ranks the first. It has a burst duration from 2016 to 2020. The scoping review provided a comprehensive overview of researches on the emergence of the flipped classroom, and the relationships to pedagogy and educational outcomes [48]. Bernard RM (2014) (16.91) ranks the second. It also has a burst duration from 2016 to 2020. A meta-analysis was employed to understand “the effectiveness of blended learning in higher education” [6]. Liu Q (2016) (16.6) is the fourth. It has a burst duration of 3 years, from 2017 to 2020. They found “blended learning appears to have a consistent positive effect” on knowledge acquisition in health professions through a quantitative synthesis evaluation [18]. McCutcheon K (2015) (11.3) ranks the fifth. It has a burst duration of 5 years, from 2016 to 2020. Their systematic review found that “the available evidence suggests that online learning for teaching clinical skills is” effective than traditional methods [49].

Current research fronts in the field of blended learning include blended learning environment, online component, covid-19 pandemic, procrastinating behavior, active blended learning, and observed learning orientation. Blended learning environment was first appeared in [50] in which Pearson designed the Online Learning Environment Survey. Later, scholars began to investigate different aspects within the blended learning environment, such as collaborative learning in [31], student learning outcome in [51] and learning achievement in [52]. Since 2013 this topic has remained to be the research front.

Online component has become the research topics since 2014 as structural equation modelling (SEM) [53] came up. It attracted a lot of attention. The online component “may offer flexibility in terms of time and place” [15]. The appropriate use of technological tools could contribute to the development of successful learning environments with no constraints of time and space [54].

With the worldwide spread of COVID-19, to cope with the learning disruption, some scholars propose different kinds of blended learning approaches. Scaffolded inverse blended learning approach was described in [55]. Calderon proposed an integrated blended learning approach for physical education teachers and pre-service teachers [56]. Some scholars summarized difficulties imposed by COVID-19 pandemic on current education and came out solutions. [57] studied “students’ knowledge, attitudes, anxiety, and coping strategies during the COVID-19 pandemic”. Obviously, covid-19 is the research front and emerging trend.

4 Conclusions

In conclusion, we retrieved 1657 bibliometric records together with 48310 citations from SCIE, SSCI, A&HCI databases in WoS Core Collection, and discovered the research topics, tracked the evolution, and detected the emerging trends in the blended learning domain from 2003 to 2020 by employing CiteSpace. The conclusions of this study are as follows:

1. With the help of Excel, we mapped the distribution of publications year by year. There is a steady growth of publications in blended learning. The growth is predicted to continue in the next two years. All these show the continuous concerns on blended learning by scholars.
2. By comparing the research topics in Period I (2003-2008), Period II (2009-2014) and Period III (2014-2020), we find the research topics changed a lot in these 3 periods. In Period I, the research topics focused on enhancing collaborative learning, pattern, teacher training, and learning. In Period II, the research topics centered on instructor perception, possible future direction, research trend, individualized English listening, online formative assessment, inquiry framework, integrating Facebook, cost-benefit analysis, translator training, and professional development. In Period III, the research topics emphasized on general science classroom, blended learning environment, measuring student engagement, online component, covid-19 pandemic, computer programming, procrastinating behavior, active blended learning, systematic review, and evidence-based medicine.
3. Using the function of label clusters year by year, we tracked the evolution of clusters from 2003 to 2020. Covid-19 pandemic and digital health education collaboration are the core research topics. The themes of covid-19 pandemic include blended learning environment, learning analytics and blended learning. These themes remain similar. Starting from 2011, they are active until 2020. The themes of digital health education collaboration are composed of teaching evidence, mandatory use, blended learning, blended learning approach, and student performance. These themes change a lot. Starting from 2013, they are active until 2020.
4. With the timeline view of DCA clusters, we detected the research fronts and emerging trends of blended learning. In terms of burst duration, Porter WW (2014) and Kiviniemi MT (2014) rank the first. In terms of the strength of burst, OFlaherty J (2015), Bernard RM (2014), Liu Q (2016), and McCutcheon K (2015) are among the top 4. Based on these findings, current research fronts and emerging trends include blended learning environment, online component, covid-19 pandemic, procrastinating behavior, active blended learning, and observed learning orientation.

However, there are some deficiencies of this study. First, we used only SCIE, SSCI and A&HCI databases. Therefore, this study might not cover all blended learning studies. Future studies could expand to more databases to include more documents. Second, although this study detected major research hotspots and research fronts, deeper information on topics such as procrastinating behavior, active blended learning, and observed learning orientation is not provided.

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