

Analysis of Blended Learning in Higher Education Based on CiteSpace (2001-2024)

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Abstract: This study presents a comprehensive bibliometric analysis of blended learning in higher education (BLHE) research published between 2001 and 2024. Using CiteSpace, 2,125 publications retrieved from the Web of Science Core Collection were analyzed to map the intellectual structure, thematic evolution, and research dynamics of the field. The results indicate a sustained growth in BLHE research since 2013, with peak productivity in 2018 and 2019, reflecting the increasing academic and institutional attention to blended learning in higher education. Conference proceedings emerged as prominent publication venues, underscoring the field's strong orientation toward practice-related innovation and the rapid dissemination of emerging ideas. Document co-citation analysis identified several that have shaped the development of BLHE, with Garrison and Kanuka's (2004) Community of Inquiry framework forming a central theoretical foundation. Cluster analysis revealed 11 major research themes, demonstrating a clear evolution from foundational models of blended learning toward more learner-centered and process-oriented approaches, including blended learning foundations, self-regulated learning, game-based learning, and work-integrated learning. These clusters highlight the multifaceted nature of BLHE research and its integration with various pedagogical approaches and technologies. Our analysis also uncovered several research gaps, including a need for more diverse cultural perspectives, longitudinal studies examining long-term impacts, and research on innovative assessment strategies in blended environments. While the field has made significant progress in understanding BLHE implementation, challenges remain in addressing cultural diversity and long-term effectiveness. This study provides researchers, educators, and policymakers with insights into the field's intellectual structure, emerging trends, and future directions. Beyond mapping research trends, the findings offer practical guidance for e-learning and blended learning practice by informing course design, supporting learner self-regulation, and guiding teacher development, while methodologically advancing the field through CiteSpace-based longitudinal and structural analysis that outlines a clear future research agenda. As blended learning continues to shape higher education, addressing identified research gaps will be crucial for developing more effective, inclusive, and transformative learning experiences.

Keywords: Blended learning in higher education, Bibliometric analysis, Research trends, Thematic evolution

1. Introduction

The educational landscape is evolving owing to technological advancements, historical occurrences, labour market transformations, and economic fluctuations. These pressures are transforming educational objectives and methodologies. Contemporary studies underscore the need for varied pedagogical methods (Markauskaite et al., 2024). In this context, blended learning (BL) has arisen as an innovative instructional method, receiving considerable attention in scholarly literature (Kang & Kim, 2021). The past global pandemic has accelerated the use of blended learning approaches, positioning them at the front of educational innovation. By using technology advancements, BL has preserved its relevance and reinforced its significance in contemporary educational systems. The concept of BL, also known as mixed or hybrid learning (Atwa et al., 2019) has been subject to numerous interpretations in international literature. Despite the variety of definitions that exist, a common thread emerges: BL aims to harmonize the strengths of distance and face-to-face teaching methodologies (Garrison & Kanuka, 2004). At its core, BL is characterized by the seamless integration of online and traditional in-person educational processes. This integration is not merely a theoretical concept but a practical approach that has been tested and refined over time. The dynamic nature of BL has become particularly evident with the changing structure of both learners and learning environments. The COVID-19 pandemic, which forced a rapid and widespread adoption of online learning, has served as a catalyst for this change. The experiences gained during this period have boldly underlined the utility and resilience of the blended learning model. As a result, such cases have indicated a significant shift towards preferring this model in the future, a tendency that is both observable and likely to continue growing (Bozkurt & Sharma, 2022; Pelletier et al., 2021; Cruz-Cárdenas et al., 2023; Hebebcı & Ozer, 2023).

In the realm of higher education, blended learning has become increasingly pivotal (Harasim, 2000). Universities and colleges worldwide are recognizing its potential to enhance the learning experience and outcomes for students (Adebayo et al., 2019). By combining the flexibility and resource-rich environment of online platforms with the interpersonal dynamics of face-to-face instruction, Blended Learning in Higher Education (BLHE) has offered a unique opportunity to cater to diverse learning styles and needs (Bhowmik, Meyer & Phillips, 2019). It has allowed for the optimization of both independent study and collaborative learning, preparing students for the digital-forward yet human-centric workplaces of the future (Stepanova, 2020). Moreover, BLHE has not merely been a matter of integrating technology; it has been a fundamental change in the pedagogical approach that promotes digital literacy, critical thinking, and active learning, all of which are essential in the knowledge economy of today (Laufer et al., 2021). As higher education institutions grow, BL has emerged as a fundamental innovation, aiming to reconcile conventional academic excellence with the requirements of our increasingly linked and digital landscape (Harasim, 2000). Furthermore, its significance in higher education has grown exponentially, arousing the interest of scholars from various disciplines including education, psychology, technology, and sociology (Just, 2021; Ma & Lee, 2021). The complex characteristics of BL have resulted in a substantial and varied body of research, indicating its capacity to transform educational practices in higher education globally. BL has significantly evolved since its inception, influenced by technological breakthroughs and shifting pedagogical methodologies. Over the past two decades, researchers from different fields have contributed to our understanding of blended learning, exploring its impact on student engagement, learning outcomes, and institutional effectiveness (Bhowmik, Meyer & Phillips, 2019; Cacciamani, Perrucci & Fujita, 2021; Zhu, Berri & Zhang, 2021).

Blended learning in higher education (BLHE) has been the subject of numerous review papers in recent years, each addressing different subtopics within this broad field of inquiry. For instance, Balakrishnan et al. (2021) conducted a systematic review and meta-analysis focusing on the effectiveness of blended learning in pharmacy education, demonstrating significant enhancements in knowledge and abilities among pharmacy students compared to conventional teaching approaches. Short et al. (2021) performed a systematic mapping evaluation of research trends regarding teacher preparation for K-12 mixed contexts, highlighting the insufficient emphasis on K-12 blended learning and underscoring the need for more extensive studies in this domain. While these reviews provided valuable insights into specific aspects of blended learning, they do not offer a comprehensive bibliometric analysis of the field. Some researchers have attempted to address this gap. Specifically, Ibarra-Vargas, Awad and Velásquez (2023) undertook a bibliometric and cluster analysis of blended learning literature, establishing six topic groupings and emphasizing the prevalence of qualitative studies of hybrid course experiences. Similarly, Limaymanta et al. (2021) carried out a bibliometric analysis of the flipped classroom in higher education, proposing a framework for its implementation in various learning modalities. More recently, Cruz-Cárdenas et al. (2023) and Hebebcı and Ozer (2023) have conducted bibliometric analyses specifically focusing on BLHE. Cruz-Cárdenas's study identified four main areas of interest, including the impact of COVID-19, the effectiveness of blended learning, its organization and design, and the technological tools used. Hebebcı and Ozer's analysis mapped the development of blended learning research from 2005 to 2021, identifying key contributing countries and authors.

Despite these efforts, bibliometric studies in education are characterised by several methodological constraints. The findings of bibliometric studies in education are highly contingent on the choice of database which represents a key source of structural bias. As recent comparative evaluations suggest, major bibliographic databases differ substantially in their indexing policies, disciplinary coverage, language scope, and treatment of publication types (Gusenbauer, 2024). Web of Science (WoS), for example, offers comprehensive coverage of high-impact journals inclusion criteria, ensuring the reliability and academic quality of retrieved documents. However, its focus on English-language, high-impact, and international journals introduces structural biases that tend to underrepresent regional, practitioner-oriented, and non-English scholarship in education and e-learning (Singh et al., 2020). In contrast, databases such as Scopus provide broader journal coverage and often include more education and educational-technology journals as well as conference proceedings, thereby capturing more applied and context-specific research (Singh et al., 2020; Guerrero-Bote et al., 2021). As systematic reviews in education suggest, relying on a single source like WoS may narrow the scope of literature retrieval and risk missing relevant studies, especially those published in non-mainstream or non-English outlets Zawacki-Richter et al. (2019). Furthermore, empirical evidence shows that discipline-specific education databases outperform general multidisciplinary sources in retrieving relevant literature for systematic reviews in education, suggesting that a combination of specialized and general databases may yield the most comprehensive coverage (Heck, Keller & Rittberger, 2024). Despite the documented limitations of relying on a single database—particularly the underrepresentation of regional, practitioner-oriented, and non-English publications—Web of Science (WoS)

remains the most widely used and methodologically stable data source in bibliometric studies in education. WoS provides high-quality, well-standardized metadata and applies stringent journal selection criteria, which are crucial for generating reliable co-citation, co-word, and clustering networks using CiteSpace (Pranckutė, 2021). CiteSpace is optimally designed to process the field-tagged ISI format used by WoS, whereas others databases like Scopus exports often require substantial preprocessing or contain incomplete cited-reference information, which can compromise the reliability of longitudinal and network-based analyses in education bibliometrics (Pranckutė, 2021). Moreover, the core international journals that shape the intellectual structure of educational technology and blended learning research are predominantly indexed in WoS.

Recent bibliometric studies of BLHE have frequently relied on co-word analysis to map thematic structures. However, co-word methods present several domain-specific limitations in the BLHE context. First, terminology in BLHE is inconsistent—blended, hybrid, flipped and technology-enhanced learning are often used interchangeably—resulting in fragmented clusters unless rigorous keyword harmonization is applied (Dziuban et al., 2018; Corrin et al., 2022). Then, co-word relies on author-defined keywords and therefore can reflect authors' keyword selection choices rather than the field's conceptual architecture (Zupic & Čater, 2015). For instance, some list only content-specific term, such as flipped classroom, whereas others include methodological or contextual descriptors such as “case study” or “higher education” resulting in unstable clustering and inflated noise within co-word networks (Corrin et al., 2022). Furthermore, methodological choices (keyword frequency thresholds, normalization and similarity measures) strongly affect cluster solutions and are frequently underreported, undermining result reproducibility (Aria & Cuccurullo, 2017). Collectively, these limitations recommend that BLHE bibliometric studies explicitly report keyword cleaning protocols.

Building upon this existing body of research, the present study aims to contribute an updated perspective to the field's bibliometric analysis of BLHE. While recent reviews have made significant strides, this study differentiates itself in two key aspects. Firstly, while both Cruz-Cárdenas et al. (2023) and Hebebcı and Ozer (2022) utilized VOSviewer for their analyses. Although VOSviewer is highly effective for generating static and stable network layouts and clustering large co-author or co-occurrence structures (van Eck & Waltman, 2010), it offers limited functions for visualizing the temporal evolution of a field. CiteSpace, by contrast, provides advanced analytical features such as burst detection, time-sliced co-citation analysis, and timeline visualizations that reveal developmental trajectories and turning points in scientific literature (Chen, 2006, Chen, 2016). Education research has seen a significant adoption of CiteSpace, as evidenced by studies like Chu et al. (2023) on STEM interventions and Geng (2024) on Chinese cultural integration in English education. This methodological variation offers an alternative approach to visualizing and analyzing the research landscape in BLHE. Secondly, this analysis extends the temporal scope to incorporate research conducted after the onset of the COVID-19 pandemic. This addresses a future research direction suggested by Hebebcı and Ozer (2023), who proposed examining post-COVID-19 studies. By including this more recent data, the present study offers a more current perspective on BLHE, complementing the COVID-19 impact area identified by Cruz-Cárdenas et al. (2023). Through these approaches, this study aims to provide a comprehensive and up-to-date bibliometric analysis of BLHE, contributing to the ongoing development of this interdisciplinary field. Specifically, this CiteSpace-assisted review seeks to uncover prolific journals and conference proceedings, prominent researchers, significant institutions, and dynamic research issues, while creating a visual representation of related terms and dominant topics using keyword co-occurrence analysis. To achieve these objectives, the following research questions are proposed:

RQ1: What are the key trends and patterns in the development of blended learning research in higher education over the past two decades?

RQ2: In what ways can the temporal and geospatial analysis of research output contribute to our understanding of the global diffusion and adoption of blended learning practices in higher education?

RQ3: To what extent can the cluster analysis of keywords and research topics identify critical research features and potential gaps in the current body of knowledge on BLHE?

Based on these research questions, it is hypothesized that the bibliometric analysis will reveal significant evolution in BLHE research, shifting from technological implementation to more nuanced explorations of pedagogical strategies and student outcomes. The study anticipates uncovering distinct patterns of global diffusion and identifying critical research features and potential gaps, particularly in areas related to faculty development and institutional policy-making.

2. Methodology

2.1 Data Collection

This study employed a comprehensive bibliometric analysis approach to examine the landscape of blended learning research in higher education. To ensure a robust and representative dataset, an advanced search was conducted in the Web of Science (WoS) Core Collection of Thomson Reuters. This database was selected due to its extensive coverage, rigorous indexing process, and compatibility with the chosen bibliometric analysis tools. The search encompassed multiple citation indices, including the Science Citation Index Expanded (SCIE), Social Sciences Citation Index (SSCI), Arts and Humanities Citation Index (AHCI), Conference Proceedings Citation Index (CPCI), and Emerging Sources Citation Index (ESCI). This multi-index approach allowed for a broad and interdisciplinary collection of literature pertinent to the research focus.

To capture the full spectrum of research on BLHE from 2001 to 2024, a comprehensive literature search was conducted. This time frame was chosen to encompass the early stages of blended learning adoption in higher education through to its current state, allowing for a thorough analysis of trends and developments over more than two decades. Prior research has shown that authors use several overlapping terms, including 'blended learning', 'hybrid learning' and 'technology-supported learning', often interchangeably in empirical and bibliometric work (Dziuban et al., 2018). Based on this review, the search strategy adopted controlled keyword variants that refer to comparable instructional formats combining online and face-to-face components. Therefore, a set of key search terms was carefully selected to ensure comprehensive coverage: 'blended learning', 'blended education', 'blended courses', 'integrated learning', 'hybrid learning', and 'higher education'. This selection was based on common terminology used in the field (Hrastinski, 2019). To ensure consistency, variant spellings and closely related expressions were consolidated under the most commonly used forms. For instance, earlier labels such as 'integrated learning' that appeared in pre-2010 literature were treated as conceptually aligned with 'blended learning' and were therefore included. Conversely, terms with broader or different meanings, such as 'technology-enhanced learning' or 'online learning' were excluded because they do not necessarily indicate a mixed-mode instructional design.

On July 22, 2024, an advanced search was executed in the Web of Science (WoS) database using the following search string: TS= (blended learning* OR blended education* OR blended course* OR integrated learning* OR hybrid learning*) AND (higher education). This strategy ensured the retrieval of articles containing the specified terms in their title, abstract, or keywords. The search was limited to research articles, specially systematic reviews and bibliometric analyses, to focus on original research and comprehensive syntheses of the field, a common practice in bibliometric studies (Zupic & Čater, 2015). Importantly, no language restrictions were applied, recognizing that valuable contributions might exist in non-English publications. Although no language restrictions were intentionally applied during the screen process, it must be acknowledged that the Web of Science (WoS) databases predominantly index English-language journals. As a result, publications in other language may still be underrepresented despite the inclusive search criteria. Furthermore, the exclusive use of WoS - despite its strong coverage and compatibility with scientometric tools - may have resulted in the omission if relevant literature available only in Scopus, ERIC, or Google Scholar. These limitations should be considered when interpreting the findings.

The initial search yielded 2144 results from WoS. A meticulous screening process was then undertaken to refine the dataset. Book reviews, book chapters, editorial materials, letters, and retracted publications were excluded from the analysis, following standard bibliometric practices (Aria & Cuccurullo, 2017). This screening process resulted in a final dataset of 2125 research articles and review articles. A PRISMA flow diagram (Figure 1) illustrate the identification, screening, and inclusion process. These documents spanned various WoS categories, predominantly including 'Education', 'Computer Science', 'Social Sciences', and 'Linguistics', reflecting the interdisciplinary nature of BLHE research. This refined dataset formed the basis for subsequent bibliometric analysis, providing a comprehensive overview of the field's development, key trends, and influential works in blended learning within higher education of more than two decades. The use of such a dataset for bibliometric analysis has been well-established in educational research (Chen, Zou & Xie, 2020).

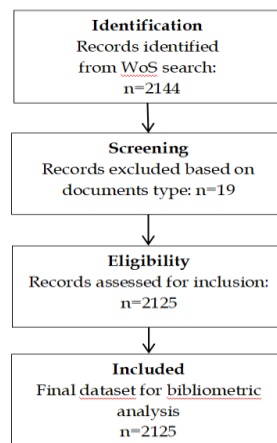


Figure 1: PRISMA flow diagram of study selection for bibliometric analysis of BLHE research

2.2 Descriptive Analysis

Prior to the in-depth bibliometric analysis, a comprehensive descriptive analysis of the dataset was conducted. This preliminary analysis aimed to provide an overview of publication trends and identify key contributors to the field of BLHE. The analysis began with an examination of the yearly publication trends from 2001 to 2024. This temporal analysis allowed for tracing the evolution of research interest in blended learning over time, identifying periods of rapid growth or potential plateaus in scholarly output. To visualize this trend, SPSS software was used to generate a bar graph depicting the number of publications per year.

The WoS website provided data on the number of publications for each journal, author, and institution. For journals and conference proceedings, we selected the top 5 for in-depth analysis, while for authors and institutions, we examined the top 10. These rankings offer insights into the key contributors and platforms driving research in this field. The analysis of the most productive journals and conference proceedings has revealed which publications have been most influential in disseminating research on BLHE. Similarly, identifying the most prolific authors has provided an understanding of the key thought leaders and researchers shaping the field. The examination of the most productive institutions highlighted the academic centers that have been at the forefront of blended learning research and implementation in higher education settings.

2.3 CiteSpace Analysis

While the descriptive analysis based on Web of Science (WoS) data has provided a valuable initial overview of the research field of BLHE, it has limitations in fully capturing the intellectual structure and emerging trends of this rapidly evolving domain (Zupic & Čater, 2015). The basic statistics on publication counts, top journals conference proceedings, authors, and institutions have offered a general picture but couldn't provide an exhaustive account of the field's development of the past more than two decades or identify the most recent directions for future research (Chen, 2006). Traditional literature reviews in the field of blended learning have often relied on researchers' prior knowledge and subjective (Halverson et al., 2014). This approach, while valuable, risks overlooking crucial information or emerging trends, particularly given the interdisciplinary nature and rapid technological advancements characteristic of blended learning research. The complex interplay between education, technology, and pedagogy in blended learning has made it challenging for individual researchers.

To move beyond the limitations of basic descriptive statistics and gain deeper insights into the intellectual structure and evolution of BLHE research, CiteSpace, an information visualization analysis software designed to present the structure and distribution of scientific knowledge through visualization (Chen, 2006; Kim, Zhu & Chen, 2016; Hou, Yang & Chen, 2020) has been employed for the bibliometric analysis. This approach allows us to examine the structures and characteristics of the existing knowledge regarding BLHE in a more systematic and data-driven manner (Chen, 2018). A key feature of CiteSpace is its ability to select a particular field based on a time sequence and link both together, enabling the deduction of developmental trends and changes within the area of BLHE (Chen et al., 2009). In our study, the bibliographic data files collected from WoS were in the field-tagged Institute for Scientific Information Export Format. We selected the 'full record and cited references' as the content, allowing CiteSpace to easily identify the files.

Once the files were loaded into CiteSpace, the following procedural operations were performed: time slicing, thresholding, modeling, merging, and mapping (Chen, 2004). To capture the longitudinal evolution of blended learning research in high education, we set the time span to 2001-2024. For the annual publication trend analysis, we used a one-year time slice to provide fine-grained temporal resolution. For both the document co-citation analysis and co-occurring terms analysis, we adopted a three-year time slice, which is commonly recommended for identifying stable intellectual structures within a developing research field. In constructing the co-citation network, we selected the top 50 most-cited references per slice, ensuring that the network retained the most influential scholarly works. Thresholding was performed using CiteSpace's default g-index scaling factor ($k=25$), which balances network density and interpretability. For term-based analysis, we enabled the Look Back Years (LBY) parameter to include all previous years, allowing cumulative detection of emerging concepts. No network pruning algorithms (e.g., Pathfinder or Pruning Sliced Networks) were applied, in order to preserve the full structural connections among nodes and avoid the removal of potentially meaning but low-frequency links. These operations allowed for a comprehensive analysis of the blended learning literature. We conducted two separate visualizing analyses of the data:

- Document Co-citation Analysis: This analysis helped identify important documents in blended learning research. A co-cited reference was called a node, and when several nodes were strongly related to one another, they formed a cluster. This analysis revealed the intellectual structure and key influencers in the field of BLHE;
- Keyword Co-occurrence Analysis: The purpose of this analysis was to identify the most-discussed areas in research on BLHE. Keyword Co-occurrence identifies terms that frequently appear together across publications, indicating their thematic relatedness within the field. This helped in understanding the main themes and trends in the field over time.

3. Results

Publication years, journals and conference proceedings, productive authors, and institutions on BLHE. Figure 2 indicated the annual publications on BLHE research. In the web of Science core collection, this research field experienced a slow start from 2001 to 2006, with fewer than 20 publications per year. A noticeable increase began in 2007, with 22 publications, marking the beginning of more significant interest in the topic. Rapid growth was observed from 2010 onwards, with publications more than doubling from 67 in 2012 to 138 in 2015. The field reached its peak in terms of publications in 2018 and 2019, with 196 and 194 papers respectively. Interestingly, there was a slight dip in 2020 to 159 papers, possibly due to the disruptions caused by the COVID-19 pandemic. However, the field quickly rebounded in 2021 with 194 publications, suggesting a renewed interest in blended learning strategies as institutions adapted to new educational paradigms. The most recent years have shown a gradual decline in the number of publications, with 162 in 2022, 140 in 2023, and 101 in the partial year of 2024. This trend could indicate a maturation of the field or a shift in research focus within higher education.

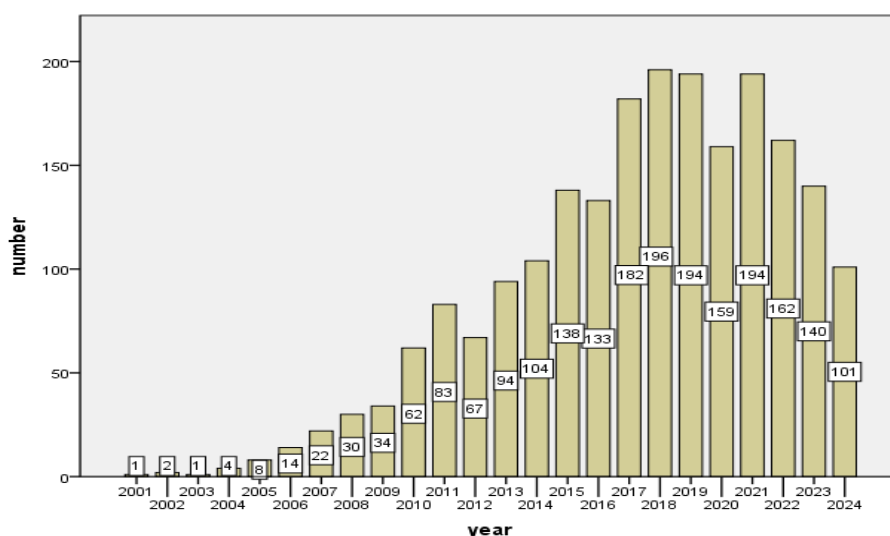


Figure 2: Annual publications on BLHE. The diagram reveals the publication number for each year and the general trend

Examining 2,125 articles and reviews revealed a diverse landscape of publication venues, encompassing both traditional journals and conference proceedings. Notably, conference proceedings dominated the upper echelons of this bibliometric analysis. At the forefront, *Edulearn Proceedings* stood out with an impressive 177 papers, closely followed by *Inted Proceedings* and *Iceri Proceedings*, contributing 138 and 87 publications respectively. Occupying the fourth position, *Lecture Notes in Computer Science*, a book series frequently utilized for conference proceedings, accounted for 63 publications. *Education and Information Technologies* emerged as the first traditional journal on the list, securing the fifth rank with 60 papers. Subsequently, another conference proceeding, *Proceedings of the European Conference on E-Learning*, claimed the sixth spot with 49 publications. Further down the list, two more journals make their appearance: *Higher Education Research Development* and *Procedia Social and Behavioral Sciences*, contributing 40 and 36 papers respectively. Rounding out the top ten were *Elearning and Software for Education*, a hybrid publication featuring both journal articles and conference proceedings, and the journal *Sustainability*, both tied at 34 publications each. A systematic summary of the top 10 most productive journals and conference proceedings in BLHE research is provided in Table 1.

Table 1: Top 10 most fruitful journals and conference proceedings for BLHE research

Ranking	Journals	The number of published papers
1	<i>Edulearn Proceedings</i>	177
2	<i>Inted Proceedings</i>	138
3	<i>Iceri Proceedings</i>	87
4	<i>Lecture Notes in Computer Science</i>	63
5	<i>Education And Information Technologies</i>	60
6	<i>Proceedings On the European Conference of E Learning</i>	49
7	<i>Higher Education Research Development</i>	40
8	<i>Procedia Social and Behavioral Sciences</i>	36
9	<i>Elearning And Software for Education</i>	34
10	<i>Sustainability</i>	34

Sources: Authors' analysis based on Web of Science Core Collection data (May, 2024)

Table 2 presented the top 10 most productive authors for BLHE research. The table ranked authors based on in this field. Jesús Sergio Artal-Sevil led the list with 19 publications, followed by Chang Zhu with 14 publications. Denise Jackson and Enrique Romero shared the third position, each with 10 publications. The remaining authors in the top 10 had between 7 and 9 publications each, with Yang Harrison Hao rounding out the list at 10th place with 7 published papers.

Table 2: Top 10 most productive authors for BLHE research

Ranking	Authors	The number of published papers
1	Artal-Sevil, Jesús Sergio	19
2	Zhu, Chang	14
3	Jackson, Denise	10
4	Romero, Enrique	10
5	Han, Feifei	9
6	Graham, Charles R.	9
7	Simonova, Ivana	9
8	Manuel Artacho, J.	9
9	Castro, Manuel	8
10	Yang, Harrison Hao	7

Sources: Authors' analysis based on Web of Science Core Collection data (May, 2024)

Turning to institutional productivity (Table 3), we noticed a landscape dominated by university systems rather than individual institutions. Griffith University topped the list with 29 published papers. Deakin University, Instituto Politécnico do Porto, and University of Zaragoza were tied for second place, each with 23 publications. The list included universities from various countries, including Australia, Portugal, Spain, Belgium, and China. Interestingly, the Ministry of Education and Science of Ukraine appeared in the 9th position with 16 publications, indicating significant governmental involvement in this research area. The number of published papers for these institutions ranged from 29 to 16, with the University of Granada completing the top 10 with 16 publications.

Table 3: Top 10 most productive institutions for BLHE research

Ranking	Institutions	The number of published papers
1	Griffith University	29
2	Deakin University	23
3	Instituto Politécnico do Porto	23
4	University of Zaragoza	23
5	Vrije Universiteit Brussel	18
6	Central China Normal University	17
7	Universidad Nacional de Educación a Distancia (UNED)	17
8	Hong Kong Polytechnic University	16
9	Ministry of Education and Science of Ukraine	16
10	University of Granada	16

Sources: Authors' analysis based on Web of Science Core Collection data (May, 2024)

Document co-citation analysis. The document co-citation analysis of 2125 publications on BLHE, spanning from 2001 to 2024, revealed a comprehensive picture of the field's intellectual structure. Using CiteSpace, we generated a visualization of the co-citation network, which comprised 674 nodes representing cited publications and 2801 links indicating co-citation relationships, as shown in Figure 3. The network was constructed by selecting the top 50 most-cited papers per 3-year time slice, allowing for a more granular view of the field's evolution over time. The resulting visualization presented a dense and intricate network structure with node sizes reflecting citation frequency and a color spectrum from cool to warm tones representing the temporal progression of publications. The modularity Q score of 0.8165 indicated a well-structured network with clearly defined communities, while the mean silhouette value of 0.3607 suggested reasonable clarity in the cluster divisions.

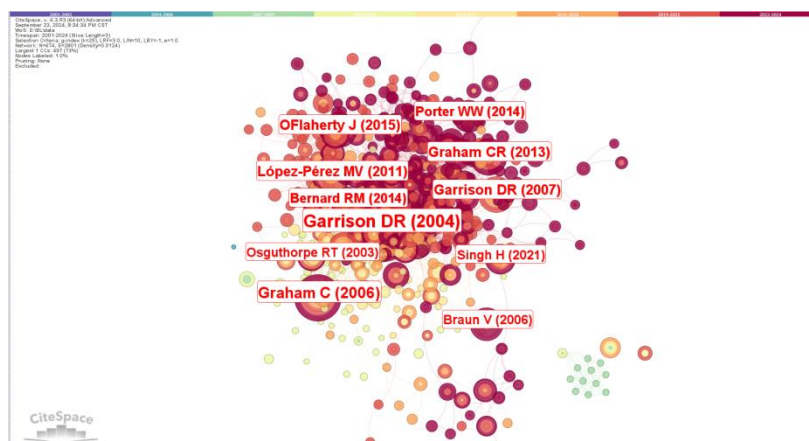


Figure 3: Crucial documents in BLHE study (2001-2024). Node size indicates citation frequency. High-frequency and central nodes such as Garrison (2004), Graham (2006) occupy prominent positions in the network

The diagram of document co-citations revealed the top 5 most cited articles among the 2125 publications collected from the WoS. The co-citation analysis identified the most frequently cited publications within the

BLHE dataset. Table 4 presents the top 5 cited works among the 2,125 articles and reviews. Citation counts ranged from 75 to 241.

Table 4: The top 10 most cited publications in BLHE research

Ranking	Citation count	Author(year)	Publication name	Journal or press	H-Index
1	241	Garrison and Kanuka (2004)	Blended learning: Uncovering its transformative potential in higher education	The Internet and Higher Education	41/32
2	116	Graham (2006)	The Handbook of Blended Learning: Global Perspectives, Local Designs	San Francisco: Pfeiffer Publishing	74
3	76	Garrison and Vaughan (2007)	Blended Learning in Higher Education: Framework, Principles, and Guidelines.	San Francisco: Jossey-Bass.	41/9
4	75	López-Pérez et al. (2011)	Blended Learning in Higher Education: Students' Perceptions and Their Relation to Outcomes	Computers & Education	23
5	75	Graham et al. (2013)	A framework for institutional adoption and implementation of blended learning in higher education	The Internet and Higher Education	74

Sources: Authors' analysis based on Web of Science Core Collection data (May, 2024)

The most cited work, Garrison and Kanuka's (2004) *'Blended learning: Uncovering its transformative potential in higher education'* (241 citations), stood as a cornerstone in the field. Its high citation count reflected its seminal role in introducing the Community of Inquiry (Col) framework to blended learning contexts. This was followed by Graham (2006), *'The Handbook of Blended Learning: Global Perspectives, Local Designs'*, with 116 citations. While building on the theoretical foundations laid by Garrison and Kanuka (2004), Graham's work (2006) expanded the scope to include diverse global perspectives and implementation strategies. The next three works, all with similar citation counts (75-76), represented a diversification of research approaches in the field. Garrison and Vaughan's (2007) *'Blended Learning in Higher Education: Framework, Principles, and Guidelines'* (76 citations) further developed the Col framework, providing more detailed guidance for practitioners. López-Pérez et al.'s (2011) *'Blended Learning in Higher Education: Students' Perceptions and Their Relation to Outcomes'* (75 citations) marked a crucial turn towards empirical validation. Graham et al.'s (2013) *'A framework for institutional adoption and implementation of blended learning in higher education'* (75 citations) represented another significant shift, focusing on the institutional level of blended learning adoption.

Co-occurring terms analysis. Keyword co-occurrence analysis is a powerful tool for identifying research areas and dominant topics within a field (Chen et al., 2016). This method leverages the principle that keywords in academic papers serve as concise summaries of the work's subject matter. When two or more keywords frequently appear together across multiple publications, it suggests a strong thematic relationship between these terms. In our analysis of blended learning literature, we examined keywords that co-occurred in at least two separate publications. We employed a three-year slice length and set the Look Back Years (LBY) parameter to all years to ensure a comprehensive view of the field's evolution. The network of related keywords is shown in Figure 4. This approach allowed for the identification of research hotspots, as terms with high frequency often indicated areas of intense scholarly interest. The results of our analysis revealed that the top five most frequently occurring terms were blended learning, higher education, students, (online) learning, and flipped classroom. These keywords provided insight into the central themes and preoccupations of blended learning research during the studied period. Additionally, all terms that appeared more than 30 times in the analyzed literature were listed in Table 5, providing a more comprehensive view of the field's vocabulary and research foci.

In Table 5, keyword frequency (count) and betweenness centrality (central) jointly characterize the prominence and structural positioning of terms within the BLHE co-occurring network. Frequency reflects the absolute

occurrence of a keyword in the dataset, with blended learning (955), higher education (827), students (170), online (157), online learning (134), and flipped classroom (113) forming the core high-frequency terms that dominate the lexical composition of the field.

Betweenness centrality provides an additional topological indicator of each keyword's bridging function in the network. CiteSpace calculates centrality based on the extent to which a node lies on the shortest paths between other nodes, identifying terms that connect otherwise weakly linked thematic areas. Several keywords exhibit notable centrality values, including blended learning (0.26), higher education (0.13), collaborative learning (0.06), performance (0.05), technology (0.04), hybrid learning (0.04), achievement (0.04), and satisfaction (0.04). These nodes serve as structural intermediaries within the network and thus occupy more central positions in the overall knowledge structure.

Conversely, some terms appear with relatively high frequency but low centrality (e.g., education, learning analytics, distance education), indicating that they function as localized or domain-specific descriptors rather than cross-cutting connectors. The combined distribution of frequency and centrality therefore delineates both the dominant lexical patterns and the topological architecture of the BLHE keyword network.

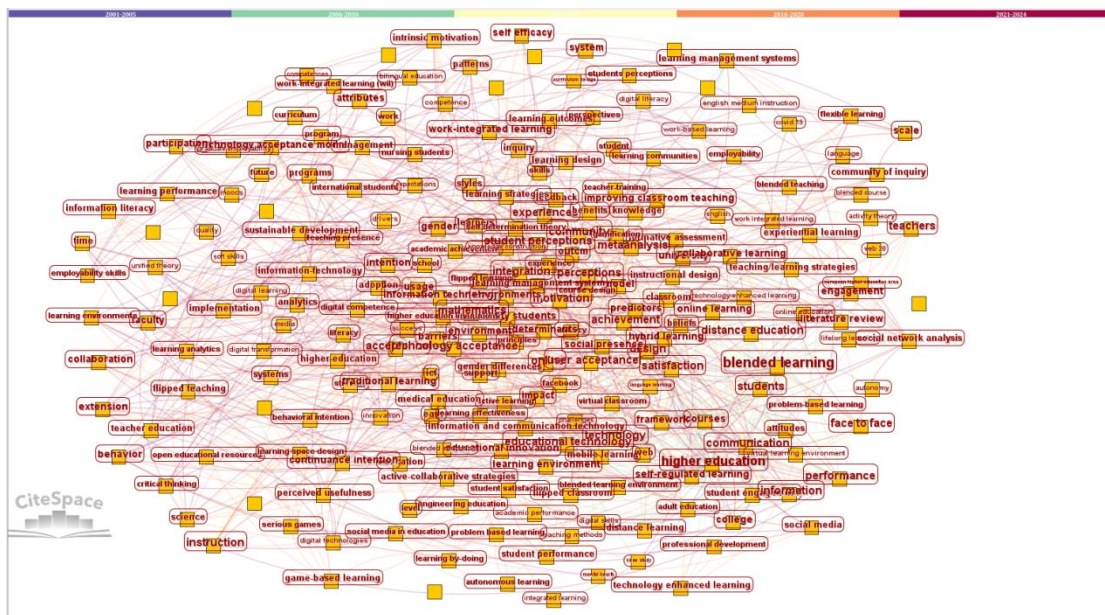


Figure 4: Keyword co-occurrence network. The keyword co-occurrence network diagram revealed the most popular keywords in BLHE research

Table 5: Co-occurring terms with high frequency

count	central	keyword	count	central	keyword	count	central	keyword
955	0.26	blended learning	74	0.02	design	43	0.02	outcome
827	0.13	higher education	74	0.04	satisfaction	43	0.03	teachers
170	0.03	students	74	0.04	work-integrated learning	41	0.00	learning analytics
157	0.04	online	65	0.04	hybrid learning	40	0.04	distance education
134	0.01	online learning	57	0.03	motivation	37	0.02	flipped learning
113	0.02	flipped classroom	57	0.04	achievement	37	0.02	distance learning
107	0.03	perceptions	55	0.02	engagement	35	0.03	acceptance

count	central	keyword	count	central	keyword	count	central	keyword
105	0.05	performance	55	0.02	university	34	0.01	adoption
92	0.04	technology	46	0.01	student engagement	34	0.03	instruction
89	0.01	education	46	0.01	classroom	33	0.00	challenges
79	0.01	impact	46	0.04	experiences	32	0.01	knowledge
78	0.03	model	45	0.06	collaborative learning	31	0.03	framework

Cluster interpretations. We utilized CiteSpace to conduct a cluster analysis based on keyword co-occurrences in the field of BLHE. The analysis, using a 3-year time slice, yielded a total of 674 nodes in the co-citation network, and 11 distinct clusters, providing a comprehensive overview of the research landscape in this field. Figure 5 illustrated these clusters, with warmer colors indicating more recent research topics and cooler colors representing older research themes. Table 6 presented the important clusters of keywords in BLHE research, including cluster size, silhouette value, and key terms associated with each cluster. The 11 clusters were named *blended learning*, *collaborative learning*, *continuance intention*, *self-regulated learning*, *curriculum design*, *work-integrated learning*, *teaching/ learning strategies*, *hybrid learning*, *game-based learning*, *learning communities*, *community of inquiry*.

The largest cluster (#0) is labeled ‘blended learning,’ representing the core concept of the field. This cluster's high silhouette value (0.903) indicates its coherence and distinctiveness. Key terms within this cluster, such as ‘higher education,’ ‘flipped classroom,’ ‘online learning,’ and ‘student engagement,’ suggest a focus on innovative pedagogical approaches within tertiary education settings. Blended learning, as the central concept, has been extensively studied in higher education contexts (Garrison & Kanuka, 2004). Closely related to this foundational cluster are ‘hybrid learning’ (#7) and ‘collaborative learning’ (#1). The hybrid learning cluster, with terms like ‘digital competence,’ ‘distance learning,’ and ‘learning technologies,’ reflects the evolving nature of blended learning as it incorporates more sophisticated digital elements. The collaborative learning cluster (#1), encompassing terms such as ‘web 2.0,’ ‘English for academic purposes,’ and ‘bilingual education,’ accentuates the value of interactive and participatory methodologies in blended environments. The prominence of this cluster signifies a paradigm shift from conventional, instructor-centric approaches towards more learner-oriented, dynamic models. The inclusion of language-specific terms (English for academic/specific purposes, bilingual education) in the collaborative learning cluster suggests that blended learning is being actively explored in language education contexts. This may be due to the unique advantages blended approaches offer for language learning, such as opportunities for authentic communication, access to diverse language resources, and the ability to practice language skills both synchronously and asynchronously (Ahmad, 2021).

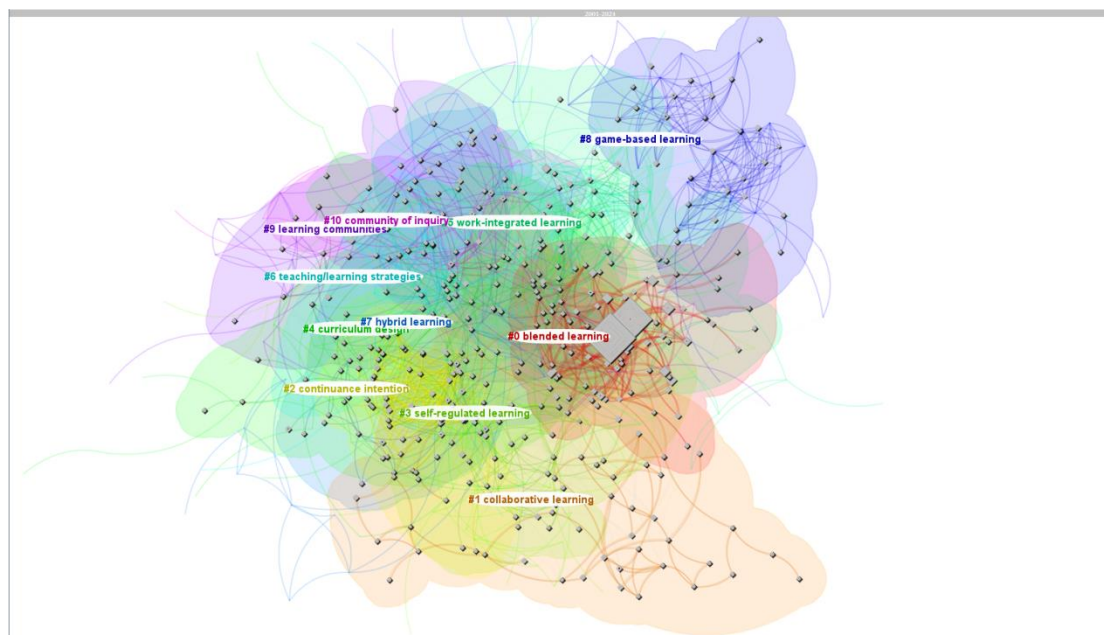


Figure 5: Cluster view of keyword co-occurrence for BLHE research

Several clusters focus on the theoretical underpinnings and learning processes in blended environments. These include ‘self-regulated learning’ (#3), ‘community of inquiry’ (#10), and ‘learning communities’ (#9). The self-regulated learning cluster (#3), with terms like ‘mixed methods,’ ‘learning strategies,’ and ‘social network analysis,’ highlights the importance of learner autonomy and metacognition in blended contexts. The community of inquiry framework (cluster #10), with its emphasis on teaching presence, social presence, and cognitive presence, has been particularly influential in blended learning research (Garrison, Anderson & Archer, 1999). Its appearance as a distinct cluster underscores its significance in understanding the dynamics of blended learning environments. The inclusion of terms like ‘deep learning’ and ‘synchronous teaching model’ within this cluster suggests ongoing research into how to foster meaningful, collaborative learning experiences in blended settings. The learning communities cluster (#9), featuring terms such as ‘technology-enhanced learning,’ ‘undergraduate education,’ and ‘reflective practice,’ reflects the growing recognition of social learning theories in blended education. This cluster emphasizes the importance of creating supportive, interactive learning environments that extend beyond the traditional classroom (Wenger, 1998). The inclusion of ‘digital immigrants’ and ‘digital natives’ in this cluster suggests that researchers are considering generational differences in technology use and learning preferences when designing blended learning communities.

Table 6: Important clusters of keywords in BLHE research

cluster ID	size	silhouette	cluster names (LLR)	LSI primary	LSI secondary	LLR
0	51	0.903	blended learning	blended learning; collaborative learning; teaching evaluations; instructional change; online education	online learning; student satisfaction; learning strategy; physical education; virtual learning	blended learning (133.65, 1.0E-4); higher education (68.21, 1.0E-4); flipped classroom (38.68, 1.0E-4); online learning (35.66, 1.0E-4); student engagement (17.75, 1.0E-4)
1	49	0.789	collaborative learning	blended learning; collaborative learning; continuous assessment; adaptive tests; technology quality	formative assessment; learning report; formative feedback; teaching bpm; distance learning education	collaborative learning (24.22, 1.0E-4); web 2.0 (23.61, 1.0E-4); English for academic purposes (23.36, 1.0E-4); English for specific purposes (18.68, 1.0E-4); bilingual education (18.68, 1.0E-4)

cluster ID	size	silhouette	cluster names (LLR)	LSI primary	LSI secondary	LLR
2	48	0.873	continuance intention	blended learning; mobile learning; technology adoption; mixed methods; new technologies	continuance intention; academic self-efficacy; intrinsic motivation; mandatory environments; success model	continuance intention (21.51, 1.0E-4); grounded theory (16.25, 1.0E-4); technology acceptance (16.25, 1.0E-4); utaut (15.3, 1.0E-4); technology acceptance model (12.53, 0.001)
3	47	0.759	self-regulated learning	blended learning; online learning; social capital; learning strategies; education	self-regulated learning; blended course designs; academic success; czech republic; self-reported measures	self-regulated learning (27.89, 1.0E-4); mixed methods (14.77, 0.001); learning strategies (13.85, 0.001); social network analysis (12.31, 0.001); critical thinking (10.37, 0.005)
4	47	0.731	curriculum design	blended learning: public health; educational modality; work-integrated learning; sustainability assessment	online learning; educational technology; hybrid learning; multi-criteria decision; decision making	curriculum design (14.38, 0.001); continuing professional development (14.38, 0.001); online and blended learning (14.38, 0.001); communities of practice (14.37, 0.001); professional development (12.18, 0.001)
5	41	0.854	work-integrated learning	work-integrated learning; scoping review; learning design; self-directed learning; study behaviors	blended learning; transparency assessment; research methods; descriptive review; work placements	work-integrated learning (100.14, 1.0E-4); blended learning (40, 1.0E-4); employability (30.82, 1.0E-4); online learning (17.18, 1.0E-4); work integrated learning (16.01, 1.0E-4)
6	31	0.866	teaching/learning strategies	blended learning; digital content; hybrid learning; management studies; student-generated media	learning strategies; pedagogical issues; improving classroom teaching; adult learning; digital content	teaching learning strategies (37.5, 1.0E-4); pedagogical issues (25.6, 1.0E-4); improving classroom teaching (20.84, 1.0E-4); distributed learning environments (20.33, 1.0E-4); lifelong learning (19.58, 1.0E-4)
7	29	0.86	hybrid learning	blended learning; online learning. social science; academic health; information technology	hybrid learning; engineering education; computer-aided design; linear auto-regression; data mining	hybrid learning (30.35, 1.0E-4); digital competence (24.71, 1.0E-4); distance learning (24.49, 1.0E-4); learning design (15.34, 1.0E-4); learning technologies (15.12, 0.001)
8	27	0.925	game-based learning	Blended learning; game-based learning; advanced classroom technology; interactive tools; traditional learning	Open educational resources; advanced classroom applications; learning space design; serious games; didactical innovations	Game-based learning (41.77, 1.0E-4); flipped learning (41.77, 1.0E-4); learning by-doing (36.33, 1.0E-4); serious games (36.53, 1.0E-4); learning space design (36.53, 1.0E-4)
9	24	0.834	learning communities	blended learning; reflective practice ; digital immigrants;	technology-enhanced learning ; undergraduate education ; gross anatomy	learning communities (15.39, 1.0E-4); technology-enhanced learning (13.42, 0.001); undergraduate education

cluster ID	size	silhouette	cluster names (LLR)	LSI primary	LSI secondary	LLR
				digital natives; digital storytelling	education: medical education; task-based language	(13.23, 0.001); community of practice (13.2, 0.001)
10	20	0.871	community of inquiry	blended learning ; learning style model ; learning level; deep learning: synchronous teaching model	teaching presence ; social presence; cognitive presence; blended learning contexts; inquiry framework	community of inquiry (25.79, 1.0E-4); teaching presence (25.09, 1.0E-4); social presence (17.17, 1.0E-4); cognitive presence (12.7, 0.001); adult education (9.84, 0.005)

Clusters related to technological aspects include ‘game-based learning’ (#8) and elements of ‘continuance intention’ (#2), which often deals with technology adoption. These clusters reflect the ongoing integration of innovative technologies in blended learning environments. Game-based learning's emergence as a distinct cluster (#8), with terms like ‘serious games,’ ‘learning by-doing,’ and ‘learning space design,’ suggests a growing interest in leveraging gamification and interactive technologies to enhance engagement and learning outcomes in blended settings (Tsay, Kofinas & Luo, 2018). The continuance intention cluster (#2), featuring terms such as ‘technology acceptance,’ ‘UTAUT’ (Unified Theory of Acceptance and Use of Technology), and ‘grounded theory,’ indicates researchers' interest in understanding factors that influence the sustained use of blended learning technologies. They are crucial for ensuring the long-term success and adoption of blended learning approaches (Bhattacharjee, 2001).

Clusters focused on design aspects include ‘curriculum design’ (#4), ‘work-integrated learning’ (#5), and elements of ‘teaching/learning strategies’ embedded in other clusters. These clusters highlight the importance of thoughtful design in blended learning implementations. The curriculum design cluster (#4), with terms like ‘continuing professional development,’ ‘communities of practice,’ and ‘multi-criteria decision,’ underscores the need for intentional and pedagogically sound approaches to blended learning. The work-integrated learning cluster (#5), featuring terms such as ‘employability,’ ‘scoping review,’ and ‘self-directed learning,’ suggests a trend towards aligning blended learning with professional and vocational education (Wuxue, 2023).

While not appearing as a distinct cluster, assessment and evaluation themes are present within several clusters, particularly in ‘collaborative learning’ (#1) and ‘curriculum design’ (#4). Terms like ‘continuous assessment,’ ‘formative feedback,’ and ‘adaptive tests’ within these clusters reflect the ongoing challenges and innovations in assessing student learning in blended environments (Gikandi, Morrow & Davis, 2011). The presence of ‘adaptive tests’ in the curriculum design cluster points to an interest in using technology to create more personalized assessment experiences. Adaptive testing, which adjusts the difficulty or content of questions based on a student's performance, could be particularly powerful in blended learning environments (Barla et al., 2010) where data on student performance can be collected and analyzed in real-time.

To provide a consolidated view of the thematic structure identified in the cluster analysis, Table 7 provides an overview of the 11 keyword clusters, including representative terms, cluster size, dominant periods, and example studies drawn from the dataset. This table complements the preceding description by presenting the major clusters in a comparable format, enabling a clearer overview of their relative scope and temporal distribution.

Table 7: Summary of major keywords clusters in BLHE research

cluster ID	size	cluster names (LLR)	Dominate period*	Representative keywords	Example studies
0	51	blended learning	2004-2008	Higher education; online education; instructional change; flipped classroom	Garrison & Kanuka (2004); Graham (2006)

cluster ID	size	cluster names (LLR)	Dominate period*	Representative keywords	Example studies
1	49	collaborative learning	2012-2020	collaborative learning; continuous assessment; adaptive tests	Szeto & Cheng (2016); Ahmad (2021)
2	48	continuance intention	2013-2024	technology adoption; mixed methods; new technologies;	Bhattacharjee (2001)
3	47	self-regulated learning	2015-2024	self-regulated learning; learning strategies; social capital	Garrison & Kanuka (2004)
4	47	curriculum design	2010-2020	educational modality; sustainability assessment; curriculum design	Graham et al. (2013)
5	41	work-integrated learning	2014-2024	work-integrated learning; learning design; study behaviors	Wuxue (2023)
6	31	teaching/learning strategies	2011-2020	digital content; management studies; digital content; student-generated media	Halverson & Graham (2019); Garrison & Kanuka (2004)
7	29	hybrid learning	2015-2023	online learning; social science; academic health	Garrison & Kanuka (2004)
8	27	game-based learning	2016-2023	interactive tools; advanced classroom technology; traditional learning	Tsay et al. (2018); Moreno-Ger et al. (2008)
9	24	learning communities	2008-2018	reflective practice ; digital natives; digital storytelling; digital immigrants	Wenger (1998)
10	20	community of inquiry	2004-2015	learning style model ; learning level; deep learning; synchronous teaching model	Garrison et al. (1999)

As shown in Table 7, the identified clusters collectively outline the thematic breadth and chronological development of BLHE research over the past two decades.

4. Discussion and Implications for Future Studies

The bibliometric analysis of BLHE research from 2001 to 2024 revealed a field that has undergone significant evolution, characterized by the development of robust theoretical frameworks, methodological diversification, and an increasing focus on practical applications. This study addressed three key research questions, providing insights into the intellectual structure, global diffusion, and critical research features of BLHE.

The document co-citation analysis revealed a clear progression in the intellectual structure of blended learning research of the past more than two decades. The field's foundation was laid by Garrison and Kanuka's (2004) seminal work, which introduced the Community of Inquiry (CoI) framework to blended learning contexts. The CoI framework offered an integrated conceptual lens for understanding learning in blended environments

through the interaction of cognitive, social, and teaching presence, addressing an urgent theoretical need during the field's formative stage. The Col framework's dominance in blended learning research aligned with broader trends in educational theory that emphasized the social nature of learning. As Garrison and Arbaugh (2007) noted, the Col framework provided a valuable lens for understanding the complex interactions that occurred in blended learning environments (Garrison & Arbaugh, 2007). However, as Rourke and Kanuka (2009) pointed out, there was a need for more research on how the Col framework translated into measurable learning outcomes, suggesting a potential area for future investigation (Rourke & Kanuka, 2009). The progression of highly cited works demonstrated a clear evolution in the field's focus. Graham's (2006) *The Handbook of Blended Learning: Global Perspectives, Local Designs* marked a shift towards contextual considerations in blended learning design. This work bridged the gap between theoretical frameworks and practical implementation, a theme that became increasingly prominent in later works. The emphasis on global perspectives and local designs resonated with calls from researchers like Uzuner (2009) for more cross-cultural studies in online and blended learning environments. Subsequent highly cited works by Garrison and Vaughan (2007), López-Pérez et al. (2011), and Graham, Woodfield and Harrison (2013) demonstrated a progression from theoretical foundations to empirical validation and institutional adoption strategies. This evolution mirrored the typical development pattern of maturing fields of study, as described by Kuhn (1962), in his work on the structure of scientific revolutions.

Methodologically, these works demonstrated a clear evolution in research approaches. Garrison and Kanuka (2004) as well as Graham (2006) primarily employed theoretical and conceptual analyses, laying the groundwork for the field. Garrison and Vaughan (2007) introduced more practical, design-based research approaches, bridging theory and practice. López-Pérez et al. (2011) marked a shift towards empirical, quantitative methods, using statistical analyses to correlate student perceptions with learning outcomes. This methodological diversity reflected the field's maturation and the growing recognition of the need for multiple research approaches to fully understand the complexities of blended learning.

Theoretically, while the Col framework dominates, particularly in the earlier works, there's a notable trend towards theoretical pluralism. None of these highly cited works adhered exclusively to a single learning theory. Instead, they drew from various constructivist and social learning principles, reflecting the inherently hybrid nature of blended learning. This theoretical eclecticism suggested that the field recognized the need for flexible, adaptable frameworks to accommodate the diverse contexts in which blended learning was implemented.

Thematically, all five works emphasized the transformative potential of blended learning in higher education, but approached this potential from different angles. Garrison and Kanuka (2004) and Garrison and Vaughan (2007) focused on pedagogical transformation through the Col framework. Graham (2006) emphasized the importance of contextual adaptation and cultural sensitivity in blended learning design. López-Pérez et al. (2011) highlighted the potential for improved student outcomes, while Graham, Woodfield and Harrison (2013) addressed the broader institutional transformations necessary for successful blended learning adoption. The evolution of these themes over time reflected the field's growing sophistication. Early works focused on defining blended learning and establishing theoretical frameworks. Later works moved towards providing practical implementation guidelines, empirical evidence of effectiveness, and strategies for institutional adoption. This progression mirrored the typical development of a maturing field of study, moving from conceptual foundations to practical applications and empirical validation.

Interestingly, the balanced citation counts across the later works suggested that the field valued theoretical development, practical implementation, and empirical research equally. This balance indicated a holistic approach to understanding blended learning, recognizing that effective implementation required a combination of strong theoretical grounding, practical know-how, and evidence-based practice.

This analysis examined the implications of the observed publication trends for the global diffusion and adoption of blended learning practices in higher education. This trend aligned with broader patterns of educational technology adoption and the increasing digitalization of higher education (Zawacki-Richter & Latchem, 2018). The slight dip in publications in 2020, followed by a quick rebound in 2021, likely reflected the impact of the COVID-19 pandemic and subsequent renewed interest in blended learning strategies. This observation was consistent with findings from other educational technology research areas, where the pandemic acted as a catalyst for increased interest and adoption of online and blended learning approaches (Ferdig et al., 2020).

The geographic diversity of top institutions, spanning countries such as Australia, Portugal, Spain, and China, indicated that blended learning research is indeed a global endeavor. This diversity was crucial for developing a comprehensive understanding of blended learning, as it allowed for the exploration of cultural and contextual

factors that may influence the effectiveness of blended learning approaches (Tarhini, Hone & Liu, 2015). However, the dominance of English-language publications from Western institutions also pointed to potential gaps in the literature, particularly regarding blended learning implementation in other cultural contexts. This observation aligned with concerns raised by Zawacki-Richter and Latchem (2018) about the need for more diverse perspectives in educational technology research. The prominence of conference proceedings among the most productive outlets suggested a field that valued rapid dissemination of ideas and practices. This was congruent with observations by Halverson et al. (2014), who noted the importance of conferences in disseminating emerging educational technology research. The preference for conference proceedings may be particularly beneficial in a fast-evolving area like blended learning, where practitioners and researchers alike benefited from timely access to new insights and best practices. This aligned with observations by Martin et al., (2018), who noted the importance of conferences in disseminating emerging educational technology research.

The cluster analysis revealed a rich tapestry of research areas within blended learning, providing a nuanced picture of the field's current focus. The emergence of distinct clusters around foundational concepts, theoretical frameworks, technological integration, curriculum design, and assessment methods reflected the multifaceted nature of blended learning research. These clusters suggest that the transformative potential of blended learning lies in its ability to integrate the complementary strengths of face-to-face and online learning modalities. The largest cluster, labeled 'blended learning,' encompassed core concepts such as 'higher education,' 'flipped classroom,' and 'student engagement.' The prominence of the 'flipped classroom' within this cluster reflected a growing interest in pedagogical models that leveraged technology to restructure traditional learning environments. As Bergmann and Sams (2012) argued, the flipped classroom model represented a specific implementation of blended learning that aimed to enhance face-to-face interactions by shifting content delivery to online platforms. The presence of 'student engagement' in this cluster underscores the potential of blended learning to increase student participation and motivation. Research has shown that well-designed blended learning environments could lead to higher levels of student engagement compared to traditional face-to-face or fully online courses (Halverson & Graham, 2019). This engagement is often attributed to the flexibility and interactivity offered by blended approaches.

Closely related lines of research further extend this pedagogical focus by examining how blended learning evolves through more nuanced integrations of technology and interaction. The emergence of 'hybrid learning' as a distinct cluster suggests a nuanced approach to integrating face-to-face and online learning, potentially incorporating more advanced technologies and pedagogies. Within this cluster, the emphasis on digital competence underscores the significance of cultivating students' technological prowess alongside domain-specific knowledge, thus equipping them for a digitally-driven workforce. Similarly, the cluster of 'collaborative learning' foregrounds the interactive and participatory dimensions of blended environments. The prominence of this cluster signifies a paradigm shift from conventional, instructor-centric approaches towards more learner-oriented, dynamic models. This transition resonates with constructivist learning theories and illustrated the capacity of blended environments to nurture meaningful interactions among peers and between students and instructors (Szeto & Cheng, 2016). However, the concentration of research on this particular model raised questions about whether other innovative blended learning approaches were being overlooked.

The clusters focused on theoretical frameworks and learning processes, including 'self-regulated learning,' 'community of inquiry,' and 'learning communities,' underscore the field's strong theoretical grounding. The emergence of self-regulated learning as a distinct cluster resonated with findings from Broadbent and Poon (2015), who highlighted the importance of self-regulation skills in online and blended learning environments. This focus suggested that successful blended learning required students to develop skills in managing their own learning processes, a crucial competency in increasingly flexible and personalized learning environments (Schunk & Zimmerman, 2011). This reflects a growing recognition that successful blended learning requires students to develop skills in managing their own learning processes (Garrison & Kanuka, 2004). The inclusion of 'social network analysis' in this cluster is intriguing, suggesting that researchers are exploring the social aspects of self-regulated learning in blended environments, perhaps examining how students' social connections influence their self-regulation strategies. The presence of 'critical thinking' in this cluster aligns with the idea that self-regulated learning could foster higher-order thinking skills. Blended learning environments, by their nature, often require students to navigate complex information landscapes, make decisions about their learning paths, and reflect on their progress – all activities that could promote critical thinking (Garrison & Kanuka, 2004).

However, the emphasis on self-regulated learning also raised important questions about equity and access in blended learning environments. Students with well-developed self-regulation skills may thrive in these settings, while those who struggled with self-regulation may be at a disadvantage. This concern echoed broader issues of

educational equity in digital learning environments, as highlighted by Broadbent and Poon (2015). Future research could explore interventions to support the development of self-regulation skills in blended learning contexts, particularly for students from diverse educational backgrounds.

The persistence of the Community of Inquiry (CoI) framework, nearly two decades after its introduction, speaks to its robustness and applicability in understanding the complex interactions that occur in blended learning environments. However, as Rourke and Kanuka (2009) pointed out, there was a need for more research on how the CoI framework translated into measurable learning outcomes. This gap suggests a potential area for future research that could bridge theoretical understanding with practical outcomes.

Clusters related to technological integration and innovation, such as ‘game-based learning’ and ‘continuance intention,’ reflect the ongoing integration of innovative technologies in blended learning environments. The game-based learning cluster, with terms like ‘serious games’ and ‘learning by-doing,’ aligns with findings from Dicheva et al. (2015), who identified positive effects of gamification on student engagement and motivation in various educational contexts, including blended learning. From a pedagogical perspective, game-based approaches in blended learning are often valued for their capacity to create immersive and motivating learning experiences that complement, rather than replace, traditional instructional methods. The integration of game-based learning can provide immediate feedback, allow learners to experiment and fail in low-risk environments, and incorporate elements of storytelling and problem-solving, all of which have been shown to support engagement and knowledge retention (Tsay, Kofinas & Luo, 2018). Moreover, the emphasis on learning by doing inherent in many game-based designs aligns closely with constructivist learning theories that underpin much of blended learning pedagogy (Moreno-Ger et al., 2008). However, the enthusiasm for game-based learning and other technological innovations in blended environments should be tempered with critical consideration of their long-term effectiveness and potential drawbacks, as it was stressed by Moreno-Ger et al. (2008) in his study.

The continuance intention cluster, featuring terms such as ‘technology acceptance’ and ‘UTAUT’ (Unified Theory of Acceptance and Use of Technology), indicates ongoing interest in understanding the factors that influence the adoption and sustained use of blended learning technologies. This research stream, building on the work of Venkatesh et al. (2003), is crucial for ensuring the long-term success and sustainability of blended learning initiatives. The focus on technology acceptance and continuance intention also highlights a potential blind spot in the field. While understanding the factors that influence adoption is important, there is a risk of technological determinism – the assumption that technological innovation alone can drive educational improvement.

Clusters focused on ‘curriculum design’ and ‘work-integrated learning’ highlight the importance of thoughtful design in blended learning implementations. The cluster of ‘curriculum design’ suggests a focus on designing blended learning experiences that are aligned with professional development needs and foster ongoing learning communities. The inclusion of ‘multi-criteria decision’ in this cluster is particularly interesting, as it suggests that researchers are exploring complex decision-making processes in curriculum design for blended learning. This could involve balancing various factors such as learning objectives, technological constraints, student preferences, and institutional resources when designing blended curricula.

The emergence of work-integrated learning as a distinct cluster suggests a trend towards aligning blended learning with professional and vocational education, reflecting broader trends in higher education towards more career-focused curricula (Bonk & Graham, 2012). This cluster highlights the potential of blended approaches to bridge the gap between academic learning and workplace requirements, potentially enhancing students’ employability and career readiness. The emphasis on ‘self-directed learning’ within this cluster aligns well with the demands of many modern workplaces, where employees are often expected to take initiative in their own learning and professional development. Blended learning approaches, by offering flexibility and promoting self-regulation, may be particularly well-suited to preparing students for these workplace expectations. While this trend is promising, it also raises questions about the broader purpose of higher education. There is a risk that an overemphasis on vocational skills could come at the expense of critical thinking, creativity, and other transferable skills that are crucial for long-term career success and civic engagement.

The cross-cutting theme of assessment, evident across multiple clusters, reflected the ongoing challenges and innovations in evaluating student learning in blended environments. Terms like ‘continuous assessment,’ ‘formative feedback,’ and ‘adaptive tests’ suggested that researchers have been exploring ways to leverage both online and face-to-face components of blended learning for more effective and diverse assessment strategies. This aligns with the findings of Gikandi, Morrow and Davis (2011), who highlighted the potential of online formative assessment in blended and online learning contexts. However, the integration of these assessment strategies with traditional evaluation methods remains a challenge, particularly in institutional contexts where

established assessment practices are deeply entrenched. Despite the rich insights provided by this analysis, several significant gaps and potential areas for future research emerge. Despite the rich insights provided by this analysis, several significant gaps and potential areas for future research emerge. For example, existing evidence suggests that the adoption and implementation of blended learning may differ substantially across regions such as East Asia, Africa, and Latin America, due to variations in technological infrastructure, institutional autonomy, pedagogical traditions, and cultural attitudes toward teacher–student interaction. Future research could explore how cultural factors influence the design, implementation, and effectiveness of blended learning approaches in different global contexts. Moreover, while the field has made significant progress in understanding the implementation of blended learning, there is still a critical need for more longitudinal studies that examine the long-term impacts on student outcomes and institutional transformation. Most of the highly cited works focus on short-term outcomes or implementation processes, leaving questions about the sustained effects of blended learning initiatives largely unanswered. This gap aligns with observations by Halverson and Graham (2019) about the need for more rigorous, long-term studies of blended learning effectiveness. Future research could adopt longitudinal cohort designs that track student learning trajectories across multiple semesters, or institutional case studies that examine how blended learning initiatives evolve over time within specific policy and organizational contexts. The analysis also reveals potential methodological gaps in the field. While there is a mix of theoretical, quantitative, and qualitative approaches represented in the highly cited works, there appears to be a lack of large-scale, mixed-methods studies that combine the depth of qualitative insights with the breadth of quantitative data. Future research could benefit from more integrated methodological approaches, as suggested by Creswell and Plano (2017), to provide a more comprehensive understanding of blended learning phenomena. As blended learning continues to evolve, the integration of emerging technologies such as artificial intelligence and virtual reality presents both opportunities and challenges. While these technologies have the potential to significantly reshape blended learning practices, their integration must be approached thoughtfully, with careful consideration of both pedagogical implications and ethical concerns.

Implications for future studies. Based on the discussion, two critical issues that deserve more consideration in future studies on BLHE. Future research should focus on exploring how cultural factors influence the design, implementation, and effectiveness of blended learning approaches in diverse global contexts. The current literature is dominated by Western perspectives, leaving a significant gap in our understanding of how blended learning can be effectively adapted and implemented in non-Western educational systems. This line of inquiry is crucial as higher education becomes increasingly globalized. As Shadiev et al. (2024) points out, there is a pressing need for more cross-cultural studies in online and blended learning environments. Such research could investigate how different cultural values, learning styles, and educational traditions impact the acceptance and effectiveness of blended learning models. For instance, studies could explore how the Community of Inquiry (CoI) framework, which has been primarily developed and tested in Western contexts, translates to educational settings in Asia, Africa, or the Middle East. This research could build on the work of Garrison and Arbaugh (2007) but extend it to diverse cultural contexts, potentially leading to refinements or adaptations of the framework. Moreover, as Nistor, Göğüş and Lerche (2013) demonstrated in their cross-cultural examination of educational technology acceptance, factors influencing technology adoption can vary significantly across cultures. Future studies could extend this work to blended learning specifically, examining how cultural factors impact not just technology acceptance, but also engagement with different aspects of blended learning, such as online discussions, collaborative projects, or flipped classroom approaches.

There is a critical need for more longitudinal studies that examine the long-term impacts of blended learning on student outcomes, skill development, and institutional transformation. As Versteijlen and Wals (2023) observed, much of the existing research focuses on short-term outcomes or implementation processes, leaving questions about the sustained effects of blended learning initiatives largely unanswered. Future research should aim to track cohorts of students through blended learning programs and into their early career stages, examining not only academic outcomes but also the development of lifelong learning skills, digital literacy, and career readiness. Such studies could build on the work of Ingkavara et al. (2022) on self-regulated learning in online environments, extending it to long-term outcomes in blended learning contexts. Additionally, research should investigate the institutional factors that contribute to the sustainability of blended learning initiatives over time. This could involve examining how institutions successfully embed blended learning into their long-term strategic plans, adapt to evolving technologies, and maintain faculty engagement and development. The framework for institutional adoption proposed by Graham, Woodfield and Harrison (2013) could serve as a starting point for such investigations, but with a focus on long-term sustainability rather than initial adoption. Furthermore, as the educational technology landscape continues to evolve rapidly, longitudinal studies could explore how institutions successfully integrate emerging technologies like artificial intelligence and virtual reality into their

blended learning models over time. This research could build on the work of Zawacki-Richter et al. (2019) on AI in higher education (Zawacki-Richter et al., 2019), but with a specific focus on its long-term integration and impact in blended learning environments. By addressing these two critical areas, future research can contribute to a more comprehensive and nuanced understanding of BLHE, informing both policy and practice in an increasingly diverse and technology-driven educational landscape.

5. Conclusion

Blended learning has emerged as a significant area of research in higher education over the past two decades. This study aimed to systematically review the literature on BLHE using bibliometric tools, specifically CiteSpace. Our analysis of 2,125 publications from the Web of Science Core Collection spanning from 2001 to 2024 provides a comprehensive overview of the field's evolution, intellectual structure, and emerging trends. The descriptive analysis indicates a sustained growth of blended learning research in higher education over the past two decades, reflecting increasing and continuing scholarly interest in BLHE. Our findings highlight the dominance of conference proceedings in disseminating blended learning research, with Edlearn Proceedings, Inted Proceedings, and Iceri Proceedings leading in publication output. This trend underscores the field's dynamic nature and the need for rapid knowledge exchange, as noted by Martin, Sun and Westine (2020) in their recent review of educational technology research dissemination. And the Community of Inquiry framework remains the most influential theoretical foundation shaping the field. Overall, the evolution of influential publications and the cluster analysis indicate that BLHE has matured into a thematically diverse field, encompassing a wide range of pedagogical and technological perspectives. The prominence of self-regulated learning and technology acceptance models in these clusters resonated with recent findings by Junaštková (2024) on the importance of learner autonomy and technology integration in successful blended learning implementations. At the same time, this finding raises important implications for equity and access, as disparities in digital literacy, learning support, and technological resources may shape students' capacity to benefit from BLHE.

Our analysis also revealed several gaps and potential areas for future research. Firstly, there is a pressing need for more diverse cultural perspectives on blended learning, particularly from non-Western contexts. As Serradell-Lopez, Lara-Navarra and Casado-Lumbreras (2012) argued, understanding the cultural dimensions of blended learning is crucial for its effective global implementation. Secondly, longitudinal studies examining the long-term impacts of blended learning on student outcomes and institutional transformation are scarce (Ashraf et al., 2021). Future research should address this gap to provide insights into the sustained effects of blended learning initiatives. Furthermore, the integration of emerging technologies such as artificial intelligence and virtual reality in blended learning environments presents both opportunities and challenges that warrant further investigation (Zawacki-Richter et al., 2019). Additionally, as blended learning continues to evolve, research on innovative assessment strategies that leverage both online and face-to-face components will be crucial (Buhl-Wiggers, Kjærgaard & Munk, 2023). While this study aimed to provide a comprehensive review of blended learning research in higher education, it has some limitations. The analysis was limited to publications in the Web of Science Core Collection, potentially excluding relevant studies from other databases. Additionally, the rapid pace of technological advancements and the recent impact of the COVID-19 pandemic may not be fully reflected in the analyzed literature due to publication time lags.

Despite these limitations, this bibliometric review provides a comprehensive synthesis of global research on BLHE and clarifies the field's intellectual structure and developmental trajectory. It provides researchers, educators, and policymakers with insights into the field's intellectual structure, emerging trends, and future directions. As blended learning continues to play a crucial role in shaping the future of higher education, addressing the identified research gaps and embracing new challenges will be essential for developing more effective, inclusive, and transformative learning experiences. The findings of this review have significant implications for both theory and practice in blended learning. They highlight the need for more integrated theoretical frameworks that can account for the complex interplay of pedagogical, technological, and institutional factors in blended learning environments. Practically, they underscore the importance of thoughtful design, ongoing assessment, and institutional support in successful blended learning implementations. For educators, it highlights the importance of designing blended learning environments that explicitly support students' self-regulation, engagement, and assessment literacy. For institutional leaders, the results underscore the need for sustained professional development, digital infrastructure investment, and coherent institutional strategies to support blended learning implementation. At the policy level, the findings point to the importance of addressing equity and access by ensuring that digital resources and support mechanisms are available to diverse student populations. Together, these insights contribute to a more informed understanding of how

blended learning can be effectively and inclusively implemented as higher education systems continue to adapt to digital transformation.

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