Blended learning in higher education: A bibliometric analysis based on Scopus and WoS data (2015–2024)

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Abstract: This study aims to map the intellectual structure, research evolution, and emerging topics of blended learning in higher education. Drawing on bibliometric techniques, the analysis covers 950 publications indexed in Scopus and Web of Science from 2015 to 2024. VOSviewer and CiteSpace were employed to examine publication trends, co-authorship patterns, keyword clusters, journal co-citation networks, and thematic evolution. The findings reveal a notable surge in research output after 2020, driven largely by the COVID-19 pandemic. The United States, China, and Spain emerge as the most productive countries, while journals such as Computers & Education and the British Journal of Educational Technology demonstrate the strongest citation impact. Keyword and cluster analyses highlight five dominant research themes: emergency remote teaching, technology-enhanced learning, course design frameworks, learner attitudes, and technology-driven motivation. The study concludes that blended learning has evolved from model construction to a deeper focus on learner experience and technological integration. Practical implications include the need for stronger international collaboration, more robust theoretical frameworks, and inclusive pedagogical strategies to enhance long-term sustainability in post-pandemic higher education.

Keywords: Bibliometric Analysis, Blended learning, Co-citation analysis, Higher education, Knowledge mapping, Research hotspots, Thematic evolution.

1. Introduction

With the rapid advancement of Information and Communication Technology (ICT), higher education is facing increasing pressure to transition from traditional classroom-based instruction to more flexible learning models [1]. In this context, blended learning has emerged as a response to bridge the gap between face-to-face teaching and online learning [2, 3].

The rise of blended learning in higher education is driven by two major factors. First, there is a growing global demand for flexible learning. As student populations become more diverse, including lifelong learners who balance study and work, higher education institutions are being compelled to adopt more adaptive teaching approaches to accommodate learners' varied temporal and spatial needs [4]. Second, the maturity and widespread availability of educational technologies now enable the integration of synchronous and asynchronous activities in course design, providing multiple learning pathways for students [5].

In addition, policy support and socio-environmental factors have further promoted the adoption of blended learning. During the COVID-19 pandemic, higher education institutions around the world were

forced to transition to online and blended teaching models to ensure instructional continuity [6]. This "Great Online Transition" not only demonstrated the potential of blended learning but also encouraged institutions to integrate the experiences gained during the pandemic into long-term teaching strategies [7].

Blended learning is generally defined as "the organic integration of traditional classroom instruction and online learning experiences." As an innovative learning model, it aims to optimize instructional objectives and enhance the learning experience [8]. By combining the interactive benefits of face-to-face instruction with the flexibility of online learning, blended learning provides students and educators with diverse instructional approaches and resource allocations [1]. This model is considered the "new normal" in modern education and has been widely adopted across higher education institutions globally [9]. Numerous practical cases, Blended Learning Universe [10]; Cambridge Assessment [11] and Waterloo University [12] academic studies, Dziuban et al. [13]; Castro-Rodríguez et al. [14] and Imran et al. [15] have demonstrated the positive impact of blended learning on higher education. Its advantages, including flexibility, engagement, and resource optimization, have not only improved learning outcomes but also contributed to educational equity and crisis response [16].

However, blended learning also presents challenges for higher education institutions. One of the most common barriers is the lack of ICT skills and technological infrastructure among teachers, students, and institutions [5].

To fully realize the potential of blended learning in higher education, a more comprehensive understanding of existing research is necessary. In this regard, the present study aims to conduct a bibliometric analysis to examine the current landscape of research on blended learning in higher education from a broad and data-driven perspective.

2. Literature Review
2.1. The Application of Blended Learning in Higher Education
Research on blended learning in higher education has expanded rapidly in recent years, with numerous systematic reviews examining its implementation, effectiveness, and challenges. Early reviews, such as Anthony Jr et al. [1], Vallée et al. [17], and Jowsey et al. [18] highlighted improved learning outcomes in medical and nursing education, whereas McCarthy and Palmer [19] synthesized conceptual clarity, pedagogical design, and institutional implementation as core components of blended learning adoption [19].

Bibliometric studies have provided broader quantitative insights into the field. Castro-Rodríguez et al. [14] analyzed publications across Scopus and Web of Science (WoS) and identified increasing interdisciplinary applications and learner-centered outcomes Castro-Rodríguez et al. [14]. Tonbuloğlu and Tonbuloğlu [20] mapped long-term trends from 1965 to 2022, although their reliance on a single database limited the generalizability of their findings [20]. Collectively, these studies show a growing research interest but reveal a lack of targeted bibliometric work focusing solely on higher education and integrating multiple databases.

Recent literature published between 2024 and 2025 reflects an evolution toward post-pandemic pedagogical transformation. Shlomo and Rosenberg-Kima [21] emphasized differentiated learner preferences among synchronous, asynchronous, and face-to-face modes, suggesting the need for more adaptable hybrid designs Shlomo and Rosenberg-Kima [21]. Akgunduz and Kinik Topalsan [22] that academics' digital competencies and institutional technological support significantly shape effective blended learning implementation Akgunduz and Kinik Topalsan [22]. Ali and Georgiou [23] further proposed a process-oriented institutional adoption framework stressing leadership alignment and organizational readiness [23].

More comprehensive analyses have emerged in 2025. Panday et al. [24], using 1,673 WoS-indexed publications, mapped thematic evolution and international research distribution, but their study did not focus specifically on higher education or integrate multiple databases [24]. Complementing this, Gudoniene et al. [25] conducted a systematic review of hybrid learning in higher education,

synthesizing pedagogical frameworks, technological integration, assessment practices, and student engagement. They argued that hybrid and blended models represent a long-term transformation beyond pandemic-driven shifts [25].

Together, recent bibliometric and systematic reviews emphasize the need for integrated, higher-education-specific analyses. The present study responds to this gap by examining blended learning through combined Scopus and WoS data from 2015 to 2024, offering a more comprehensive mapping of research development and thematic evolution in the field.

2.2. Advantages and Challenges of Blended Learning in Higher Education

As a pedagogical approach that combines online and offline teaching, blended learning offers several advantages for higher education. First, it significantly enhances students' academic performance and engagement. Ashraf et al. [5] found that blended learning improves class efficiency and interactivity by enabling students to preview and review content via digital resources [5]. Similarly, Sosa Díaz et al. [26] noted that blended learning promotes a shift from passive knowledge reception to active learning, fostering students' critical thinking and autonomy [26].

Blended learning also plays a key role in promoting educational equity. Lambert emphasized that open educational resources (e.g., MOOCs) and multilingual support expand access to quality education for learners from disadvantaged socioeconomic backgrounds or remote regions [27]. This helps ensure that more learners can benefit from equitable learning opportunities.

However, despite its benefits, the implementation of blended learning in higher education faces multiple challenges. One major issue is inadequate technological infrastructure, particularly in under-resourced areas, where stable internet and modern teaching equipment are lacking [5]. Additionally, disparities in the digital competencies of students and teachers create barriers to effective implementation.

Another challenge is the high demand for pedagogical planning and instructional design. Sosa Díaz et al. [26] pointed out that the success of blended learning depends on the seamless integration of online and face-to-face components, which requires instructors to align teaching goals and learning activities coherently. Moreover, evaluating student performance in blended environments remains complex and requires the development of new assessment tools and indicators [26].

Finally, the sustainable development of blended learning hinges on effective resource allocation and supportive institutional policies. Fresen [28] suggested that universities need to revise policy frameworks and resource distribution mechanisms to ensure long-term quality and viability [28].

2.3. Review of Blended Learning Research in Higher Education

Several systematic reviews have explored the application, challenges, and outcomes of blended learning in higher education. Anthony et al. conducted a meta-analysis and systematic review examining the adoption and use of blended learning Anthony Jr et al. [1]. Vallée et al. [17] and Jowsey et al. [18] focused on medical and nursing education, respectively, and reported significant improvements in learning outcomes under blended models. McCarthy and Palmer [19] proposed a three-dimensional model: conceptual clarity, framework design, and institutional implementation based on a systematic review of blended learning in higher education [19].

Some studies have also conducted bibliometric analyses on the subject. Castro-Rodríguez et al. [14] used bibliometric and content analysis, 508 blended learning publications from 2006 to 2020 across Scopus and WoS [14]. They concluded that blended learning is applied in a wide range of scientific and professional fields, with positive effects on learner motivation, outcomes, and autonomy. Tonbuloğlu and Tonbuloğlu [20] analyzed blended learning literature from 1965 to 2022 based on Scopus data, identifying major interdisciplinary clusters related to online learning, educational technologies, pedagogy, and student engagement. While their study covered a longer historical span, it was limited to a single database [20].

In sum, systematic reviews tend to focus on specific implementation strategies and outcomes, whereas bibliometric studies offer a macro-level, quantitative view of research trends. Despite the growing number of such studies, few have focused specifically on the development of blended learning in higher education over the past decade using both Scopus and WoS databases. This highlights a significant gap that the present study aims to address.

Recent studies published in 2024–2025 further highlight the evolving directions of blended learning research in higher education. Shlomo and Rosenberg-Kima [21] identified a growing differentiation in students' preferences across synchronous, asynchronous, and face-to-face modalities, underscoring the need for more flexible hybrid learning structures. Shlomo and Rosenberg-Kima [21]. Akgunduz and Kinik Topalsan [22] examined academics' digital competencies and found that institutional technology support plays a crucial role in the effective adoption of blended learning models [22]. In parallel, Ali and Georgiou [23] proposed a process-oriented institutional adoption model, emphasizing leadership commitment, policy alignment, and organizational capacity as essential drivers of sustainable blended learning integration [23].

More recently, Panday et al. [24] conducted a thorough bibliometric study of blended learning research based on 1,673 documents indexed in the Web of Science from 2018 to 2023 [24]. Their analysis mapped annual publication and citation trends, leading authors and countries, and thematic evolution using VOSviewer and related tools. While their study provides a broad overview of blended learning across educational levels, it does not focus specifically on higher education, nor does it combine multiple databases. This reinforces the need for more targeted bibliometric work that concentrates on blended learning in university settings and integrates complementary data sources.

Complementing bibliometric approaches, Gudoniene et al. [25] offered a systematic literature review of hybrid teaching and learning in higher education, synthesizing pedagogical frameworks, technological integration, faculty support, student engagement, assessment practices, and learning outcomes [25]. Their review highlights hybrid and blended models as part of a long-term transformation of university teaching rather than a temporary response to the pandemic. Taken together with the bibliometric work of Panday et al. [24], these recent studies underscore the value of combining quantitative mapping with qualitative synthesis. The present study extends this line of inquiry by concentrating specifically on higher education and by integrating data from both Scopus and Web of Science over the period 2015–2024.

3. Research Objectives and Questions

This study aims to conduct a bibliometric analysis of research on blended learning in higher education, with the goal of uncovering overall research trends. By doing so, it seeks to explore the development trajectory, emerging topics, intellectual resources, and potential future directions within this field. Unlike previous bibliometric studies on blended learning [14, 20], this research focuses exclusively on higher education and integrates data from both the Web of Science (WoS) and Scopus databases, covering the period from 2015 to 2024.

Considering the significant expansion of blended learning in higher education, especially after 2020, when the model rapidly gained traction in response to the COVID-19 pandemic, a bibliometric investigation based on both the quantity and quality of scholarly output during this period is timely and warranted. Such research is vital for identifying gaps in the literature, contributing to the existing body of knowledge, and guiding future academic inquiries.

In this context, the present study is guided by the following four core research questions, which aim to illuminate the development patterns and structural characteristics of the field through bibliometric methods:

1. What are the temporal, geographical, authorial, and journal-based distribution patterns of research on blended learning in higher education?

2. Which countries, journals, authors, and institutions are the most influential (i.e., most cited) in the field of blended learning in higher education?
3. What are the key research themes revealed through keyword co-occurrence and clustering analysis, and how have these themes evolved over the past decade?

(4) Which articles and journals are most frequently cited in the field, and what kind of intellectual structure and interconnections do they form?

4. Research Methodology and Data Sources

4.1. Research Methodology

This study adopts bibliometric analysis techniques to explore research trends, structural patterns, and the knowledge base of blended learning in higher education. Bibliometrics is a quantitative approach used to review and investigate the intellectual development of a specific research field [29]. Through various metrics, such as publication volume, citation frequency, and co-authorship networks, it enables researchers to quantitatively assess the influence and evolution of scholarly output [30, 31].

In contrast to traditional narrative reviews, bibliometric analysis offers the advantage of covering large datasets sourced from academic databases such as Scopus and Web of Science. Moreover, it incorporates visual analytic tools like VOSviewer and CiteSpace, which facilitate intuitive representations of the field's intellectual and thematic structures [32]. These data-driven approaches reduce subjectivity and enhance the reliability and replicability of the findings, making bibliometric methods widely applicable in scholarly trend analysis [33]. Accordingly, this study employs bibliometric techniques in combination with visualization tools to fulfill its research objectives.

Following the bibliometric research process outlined by Zupic and Čater [34], this study proceeded through the following four stages:
1. Research design and tool selection;
2. Data acquisition and filtering;
3. Bibliometric analysis and visualization modeling;
4. Interpretation of results and identification of research trends.

To identify research networks and define the most frequently used keywords, as well as the most cited authors, institutions, and countries in the field of blended learning in higher education, this study uses both CiteSpace and VOSviewer for knowledge mapping. CiteSpace relies on set theory-based normalization for measuring the similarity between knowledge units and is effective for illustrating the temporal progression of a research domain [35]. VOSviewer, by contrast, employs probability-based normalization and supports various visualization modes, making it a powerful tool for co-occurrence and citation analysis [36]. The primary functions and types of visualizations associated with these two tools in the present study are summarized in Table 1.

Table 1.
Functions and visualization types of CiteSpace and VOSviewer.

Tool	Primary Function	Visualization Type
CiteSpace	Temporal Evolution Analysis, Co-citation Network, Burst Keyword Detection	Timeline View, Burst Detection View
VOSviewer	Keyword Co-occurrence, Author/Institution Collaboration, Density Mapping Analysis	Network Visualization, Overlay Visualization, Density Visualization

In the data analysis process, this study employed bibliometric methods in conjunction with visualization tools CiteSpace and VOSviewer to generate a multidimensional perspective. By conducting a bibliometric analysis of blended learning in higher education over the past decade, this study maps the current state and structural framework of the field, identifies emerging research frontiers, and traces the evolutionary pathways of thematic development.

4.2. Data Sources

On January 3, 2025, a topic search was conducted in both the Web of Science (WoS) and Scopus databases to retrieve publications on blended learning in higher education from January 2015 to December 2024. This ten-year time frame was selected to capture the period of rapid growth in blended learning, especially before and after the COVID-19 pandemic, thereby enabling a more comprehensive analysis of its developmental trajectory and shifting research priorities.

Unlike previous studies that often relied on a single database, this study integrates data from both WoS and Scopus due to their broad coverage and well-established international reputation [37]. Prior research has demonstrated a high level of correlation between these two databases in terms of academic output (e.g., publication volume) and scholarly impact (e.g., citation counts), with reported coefficients of determination around $R^2 \approx 0.99$. This suggests that both databases offer stable and reliable data, making them highly suitable for bibliometric analysis [38, 39].

The data collection process was carried out using advanced search functions, incorporating logical operators and specific keywords. The detailed filtering criteria used to retrieve the final dataset are presented in Table 2.

Table 2.
Search Strategy and Filtering Criteria Used in the Study

Topic	((("blended learn" OR "blended teach" OR "hybrid learn*" OR "hybrid teach*"OR "HyFlex learn"OR "HyFlex teach*" OR "blended edu*" OR "hybrid edu*" OR "HyFlex edu*")AND("higher edu*" OR "Universit*" OR "College*"))
Documents Type	Article
Time Span	2015-2024
Language	English

A total of 1,535 records were initially retrieved (687 from WoS and 848 from Scopus). After manual screening to exclude irrelevant documents, those unrelated to blended learning or higher education, and to remove duplicates, a final dataset of 950 documents was retained for analysis.

5. Results

The dataset used in this study consists of 950 publications, originating from 102 countries, produced by 3,099 authors affiliated with 1,462 institutions, and published across 547 academic journals. These publications collectively cite 31,366 references from 15,009 different sources.

5.1. Annual Distribution of Publications

Figure 1 presents the annual distribution of publications on blended learning in higher education from 2015 to 2024. Overall, the number of publications in this field has shown a clear upward trend. Notably, since 2020, the volume of research output has increased significantly, with more than 200 publications consistently recorded in both 2023 and 2024. This suggests a growing scholarly interest in blended learning, which has become a prominent topic in educational research.

The surge in publication activity can be attributed to two major factors: the rapid advancement of educational technologies that support blended learning and the large-scale shift to online and hybrid instruction driven by the COVID-19 pandemic [6, 7].
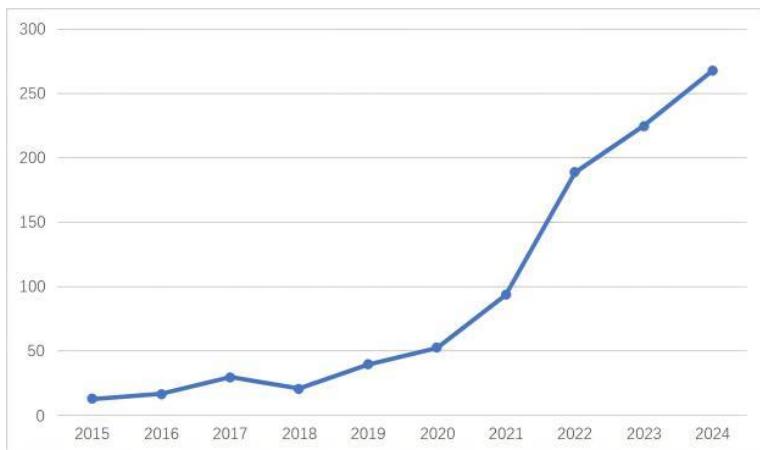
Figure 1.
Annual Growth Trend of Publications on Blended Learning in Higher Education.

5.2. Publications by Country

The distribution of publications by country was examined, with all countries that contributed at least one publication included in the analysis. The top five countries in terms of publication volume are shown in Table 3.

The United States ranks first with 169 publications, accumulating 1,032 citations, which results in an average of 6.11 citations per paper. China follows with 155 publications and 636 citations. Spain (64 publications), Indonesia (46), and Malaysia (45) rank third to fifth, respectively.

It is noteworthy that although Malaysia has fewer publications, it demonstrates a relatively high research impact, with an average of 4.93 citations per article, indicating the quality and influence of its contributions in the field.

Table 3.
Annual Distribution of Publications on Blended Learning in Higher Education.

Rank	Country	Publication	Citations	Average Citation/Publication
1	USA	169	1032	6.11
2	China	155	636	4.10
3	Spain	64	311	4.86
4	Indonesia	46	67	1.46
5	Malaysia	45	222	4.93

To further illustrate the collaborative relationships among countries, a country co-authorship network was constructed using VOSviewer, with the minimum publication threshold set to five. Figure 2 displays the resulting network: the node size represents the number of publications, the thickness of the links indicates the strength of collaboration between countries, and the colors distinguish different clusters of international cooperation.

As shown in the figure, the United States and China occupy central positions in the network with the highest publication volumes. However, their collaborative ties with other countries appear relatively dispersed, suggesting a concentration of domestic research efforts rather than extensive international cooperation.

Of particular interest is the fact that Spain is positioned on the left side of the map, forming a closely connected cluster with Portugal and several Latin American countries, reflecting strong linguistic and regional-cultural affinities. On the right side of the map, another prominent cluster includes Malaysia, the Philippines, and other developing countries, showing notable collaborative links with China.

Meanwhile, the United Kingdom, the Netherlands, and other European countries are situated between multiple clusters, indicating their role as bridging nodes in the global collaboration network.

Overall, the network exhibits a multi-core and regionally clustered structure, reflecting a diverse pattern of international collaboration. However, the field of blended learning in higher education still shows notable imbalances in global research cooperation. In particular, the breadth and intensity of collaboration among leading countries remain limited and could be further strengthened.
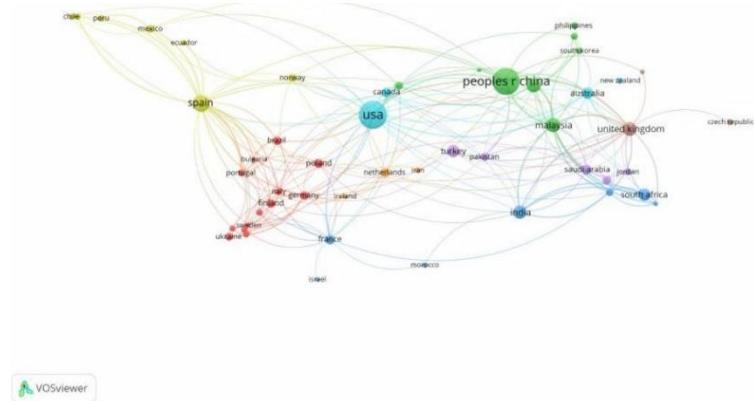

Figure 2.
Country Collaboration Network by VOSviewer.

5.3. Publications by Journal

The top 11 journals publishing research on blended learning in higher education over the past decade are listed in Table 4. Most of these journals, with a few exceptions, belong to the fields of higher education and educational technology. Two journals, Education Sciences and Applied Mathematics and Nonlinear Science, have published more than 20 articles each. However, their academic influence differs significantly.

According to citation analysis, the British Journal of Educational Technology exhibits the highest average citations per article, with 8 publications receiving a mean of 17.50 citations each. This highlights the journal's strong influence and recognition in the field of blended learning in higher education.

It is also worth noting the active contribution of interdisciplinary and technology-oriented journals such as Sustainability and IEEE Access. These journals demonstrate not only high publication activity but also strong citation performance, reflecting the increasing integration of blended learning with themes such as sustainable development and intelligent technologies.

In summary, the research on blended learning has expanded beyond traditional education journals into fields such as educational technology, information science, and interdisciplinary domains. This trend illustrates the growing breadth and diversity of blended learning as a research topic within higher education studies.

Table 4.
Top 11 journals publishing research on blended learning in higher education.

Rank	Source	Publication	Citations	Average Citation/Publication
1	Education Science	27	248	9.19
2	Applied Mathematics and Nonlinear Science	22	0	0
3	Sustainability	19	145	7.63
4	BMC Medical Education	17	75	4.41
5	International Journal of Emerging Technologies in Learning	15	161	10.73
6	Frontiers in Education	11	21	1,90
7	Journal of Higher Education Theory and Practice	11	0	0
8	Education and Information Technologies	10	73	7.30
9	International Journal of Environmental Research and Public Health	10	58	5.80
10	British Journal of Education Technology	8	140	17.50
11	IEEE Access	8	99	12.38

5.4. Publications by Author

An analysis of the co-authorship network provides insights into the representative scholars and core research forces within the field. The 950 articles in the dataset were authored by a total of 3,099 individuals. Using VOSviewer, a co-authorship overlay visualization was generated based on authors with more than three publications. The overlay visualization incorporates a time dimension, where blue nodes indicate earlier activity and yellow nodes represent more recent activity. The resulting network is presented in Figure 3.

The visualization reveals a prominent cluster of Finnish scholars, including Jonna Juntunen, Heli-Maria Kuivila, Kristina Mikkonen, and Sari Pramila-Savukoski, concentrated near the center of the map. Their nodes appear in lighter colors, indicating sustained research activity in the past two years. This group represents a highly productive author cluster within the field of blended learning in higher education.

In addition, a local collaboration cluster composed of Chinese scholars Zhu Hui and Jia Shiwei is visible on the map. Their nodes appear in yellow, suggesting increased activity between 2022 and 2024, and indicating their potential as emerging contributors in this research area.

However, from a broader perspective, the overall structure of the author network remains relatively dispersed, with weakly connected collaboration patterns. No dominant global research communities or leading international collaboration teams have yet emerged in this domain.
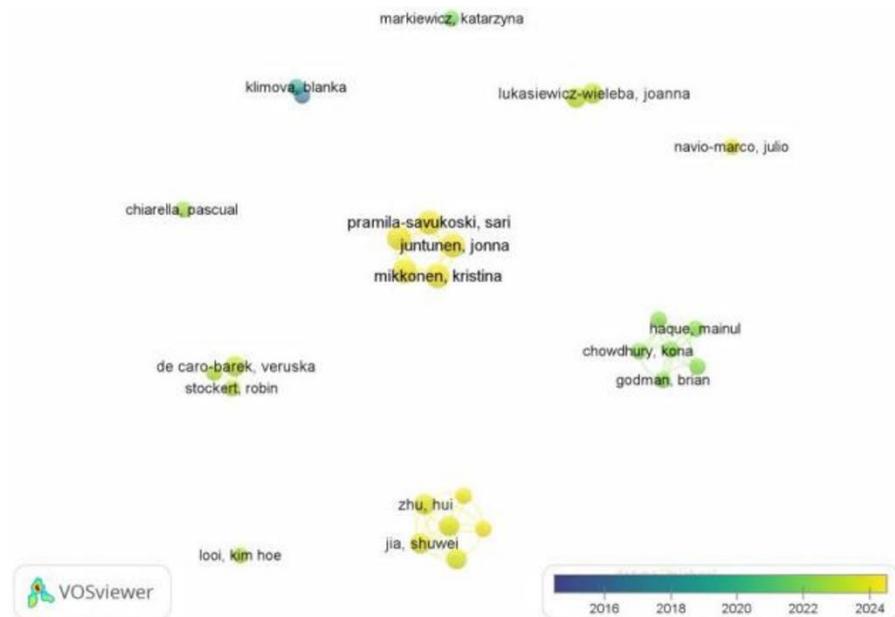
Figure 3.
Author Co-authorship Network Visualization by VOSviewer.

An analysis of publication authors helps identify the representative scholars and core contributors in this research field. According to Price's Law [40], the minimum number of publications to be considered a core author in a field can be calculated as m = 0.749 × √nmax = 1.498, where nmax denotes the highest number of publications by a single author in the dataset. Based on this principle, authors with more than two publications were classified as core authors.

In total, 171 core authors were identified, contributing 388 articles, which account for 40.8% of the total publication volume. This figure falls short of Price's 50% threshold, indicating that the field of blended learning in higher education has not yet developed a mature and stable core author group.

Table 5 lists the most prolific authors with more than four publications in this field. Each of these five scholars has published five articles, with an average citation count of eight citations per author. Notably, all five authors belong to the same research team, primarily affiliated with institutions in Finland, focusing on health and nursing education. This suggests that the team has maintained consistent scholarly output in the specialized application of blended learning models within professional education contexts.

Although their citation counts are currently modest, likely due to the recency of their publications, most of which were released within the last three years, their future academic impact may continue to grow.

These findings further indicate that regional, project-based research teams remain the primary driving force behind prolific scholarly output in this domain, while globally integrated academic networks and high-impact individual scholars have yet to fully emerge.

Table 5.
Most Productive Authors in the Field of Blended Learning in Higher Education.

Rank	Author	Documents	Citations	Average Citation/Publication
1	Juntun,Jonna	5	8	1.60
2	Kuivila,Heli-maria	5	8	1.60
3	Mikkone,Kristina	5	8	1.60
4	Pramila-savukoski,Sari	5	8	1.60
5	Tormanen,Tiina	5	8	1.60

5.5. Publications by Institution

Table 6 presents the top five institutions with the highest number of publications in the field of blended learning in higher education. The State University of Malang leads by a substantial margin with 60 publications. However, none of its publications have been cited thus far, which may suggest that its research has not yet gained visibility in the international academic community or that its output is primarily published in regional or non-indexed journals.

In contrast, the University of Malaya, although contributing only five articles, has accumulated 115 citations, resulting in an average of 23 citations per paper. This indicates a significantly higher academic impact, highlighting both the quality of its research and its global recognition.

Similarly, the University of Oslo (8 publications) and The Hong Kong Polytechnic University (7 publications) also exhibit relatively high average citation rates, demonstrating a combination of research productivity and scholarly influence.

Taken together, these findings suggest that while research activity in this field is concentrated within Asian institutions, there remains considerable room for improvement in terms of international visibility and high-impact scholarly output.

Table 6.
Most Frequently Cited Articles from WoS and Scopus (2015–2024).

Rank	Organization	Documents	Citations	Average Citation/Publication
1	State University of Malang	60	0	0
2	University of Oslo	8	36	4.50
3	The Hong Kong Polytechnic University	7	64	9.14
4	University of Malaya	5	115	23.00
5	University of Technology Mara	5	0	0

5.6. Keyword Co-occurrence Analysis

Keywords serve to distill the core themes of academic articles. By analyzing co-occurrence patterns among keywords, it is possible to uncover the key research hotspots within a given field. Drawing on prior literature that helps define the structure of research clusters, this study used VOSviewer to generate a keyword co-occurrence network based on the 950 articles included in the dataset. A total of 89 high-frequency keywords (occurrence ≥ 10) were visualized, producing five distinct thematic clusters that reveal the major areas of focus in blended learning research in higher education. As shown in Figure 4, the size of the nodes reflects keyword frequency, while node color represents cluster affiliation. Representative keywords such as COVID-19, students, education, online learning, and e-learning were among the most prominent.

The five identified clusters are summarized as follows:

Cluster 1 (Red): Emergency Teaching During COVID-19. This cluster centers on keywords such as COVID-19, distance learning, and mental health, reflecting research on the application and challenges of blended learning in higher education during the pandemic. Studies have acknowledged its flexibility and safety [41], while also highlighting issues such as technological barriers and social isolation [42, 43]. Scholars have called for institutional support and systemic development to ensure the long-term viability of blended learning in the post-pandemic era [44].

Cluster 2 (Blue): Technology-Enhanced Learning Outcomes. This group is driven by high-frequency terms such as artificial intelligence, big data, and educational computing, reflecting the role of technology in supporting personalized learning pathways. Blended learning enhances students' academic performance, competencies, and engagement by integrating diverse technological tools into online and offline learning environments [45-48]. However, researchers also caution against over-reliance on digital tools and emphasize the need to maintain balanced human interaction in the learning process [49].

Cluster 3 (Green): Course Design and Assessment Frameworks. This cluster includes keywords such as course design, problem-based learning, and questionnaire, emphasizing that course design is foundational to blended learning [50, 51]. Problem-based learning fosters integration between theory and practice [52] while questionnaires are commonly used to evaluate the effectiveness of blended models and identify pedagogical strengths and limitations [53].

Cluster 4 (Yellow): Learner Experience and Attitudes. This thematic group focuses on learner-centered terms such as student perception, self-directed learning, attitude, and experience. It reflects the evolving understanding of student agency in blended learning environments [54]. Student perceptions provide valuable insights into the actual effectiveness of online components [21, 55] while attitudes toward online learning are shaped by learning experiences, social interaction, and instructional design [56]. These variables are often captured through case-based research [57] to inform improvements in online pedagogy.

Cluster 5 (Purple): Technology and Motivation Mechanisms. This cluster explores the relationship between technological design and student motivation. As an innovative approach that integrates the advantages of e-learning, blended learning leverages platforms and interactive tools to enhance learner motivation and satisfaction [13, 22, 58, 59]. These motivational factors play a key role in shaping learning outcomes and skill acquisition [60]. Ultimately, the success of blended learning depends on striking a balance between usability and innovation in technological design to maximize its positive impact on learner motivation and satisfaction.
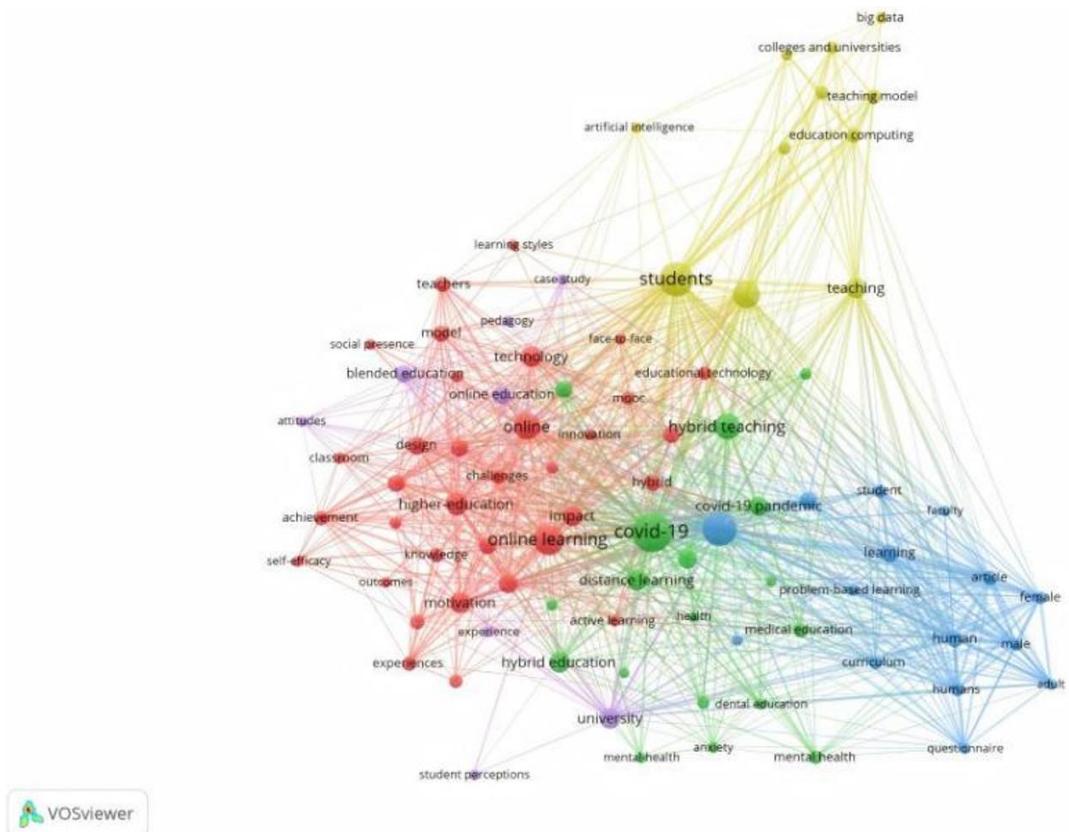
Figure 4.
Keyword Co-occurrence Network Map by VOSviewer.

5.7. Keyword Evolution Analysis

To examine the progression of research on blended learning in higher education, a Timeline View of the keyword co-occurrence network was generated using CiteSpace (see Figure 5). This visualization illustrates the temporal evolution of research hotspots over time and highlights the emergence and transition of major themes across different periods. Based on the clustering results, the literature can be grouped into seven major clusters, with each cluster corresponding to a specific research focus along the timeline. These clusters can be broadly categorized into three chronological phases.

Phase 1 (2015–2020): Foundational theories and pedagogical models. During this period, the research focus was primarily on the theoretical foundations and instructional design of blended learning. Frequently occurring keywords such as course design, curriculum, framework, and flipped classroom indicate that scholars were exploring how to effectively integrate blended learning into higher education curricula. Emphasis was placed on the development of theoretical models, pedagogical strategies, and practical implementation through case studies.

Phase 2 (2020–2022): Learner Experience and Psychological Factors. Driven by the global COVID-19 pandemic, blended learning became a dominant instructional mode in higher education. Accordingly, the research focus shifted toward student-centered experiences and psychological dimensions. Keywords such as satisfaction, motivation, engagement, and mental health appeared with high frequency, reflecting an intensified interest in understanding the effectiveness, challenges, and impact mechanisms of blended learning from the learners' perspective.

Phase 3 (2023–2024): Diversified models and integrated instructional design. In the most recent period, studies have increasingly emphasized the systematic integration and diversification of teaching models. Keywords such as teaching models and teaching modes suggest that current research focuses more on the organic blending of online and face-to-face instruction, as well as on the adaptability of course design to different educational contexts.

It is worth noting that technology-related keywords, including artificial intelligence, big data, education computing, and data mining, appear consistently across all three phases. This suggests that technological advancement has remained a central driving force in the development of blended learning throughout its evolution.

In summary, research on blended learning in higher education has evolved from theoretical model construction to a more in-depth exploration of learner experience, demonstrating a multi-phase development pattern that is closely intertwined with technological innovation.
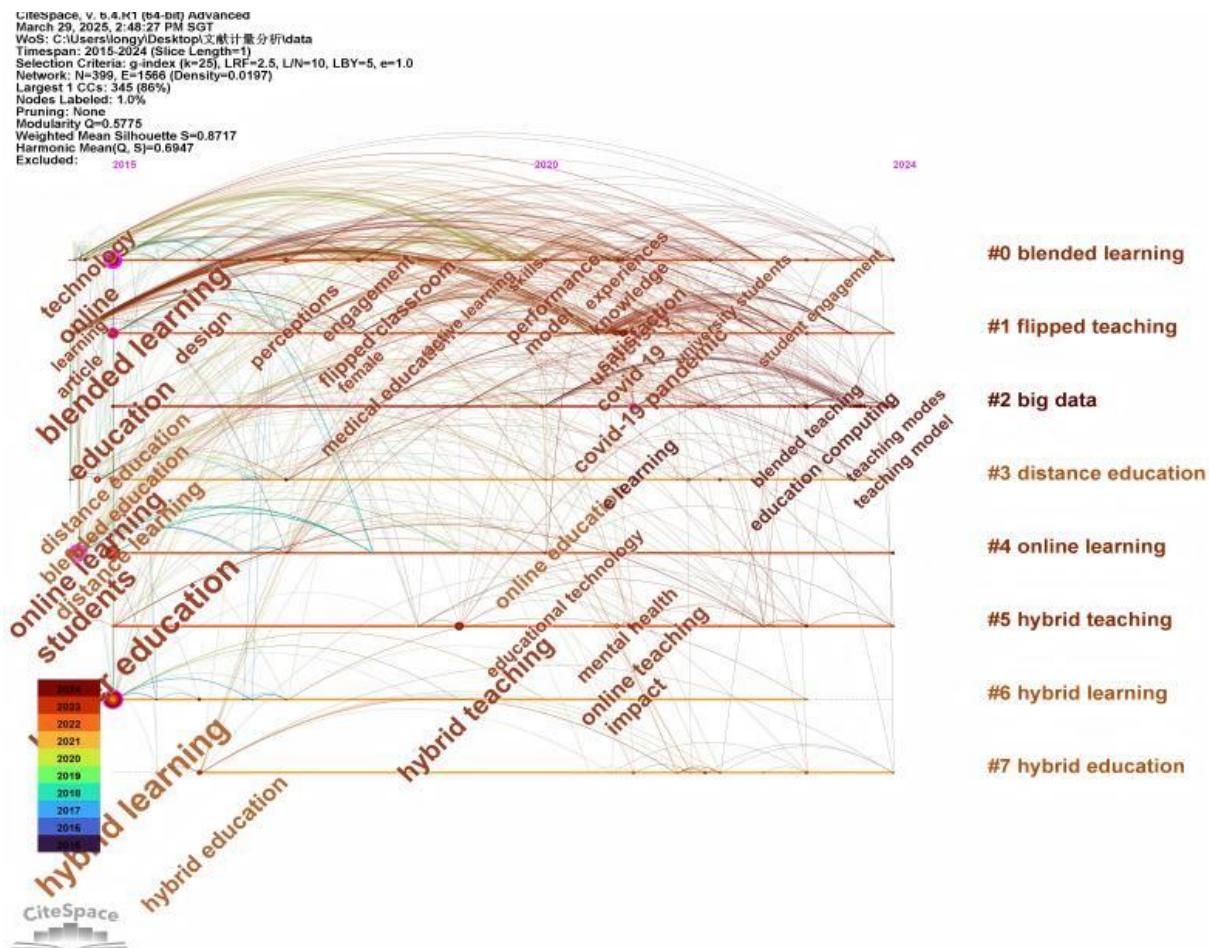
Figure 5.
Keyword Evolution Timeline Visualization by CiteSpace.

5.8. Burst Keyword Detection and Analysis

Burst keywords refer to terms that experience a sudden surge in frequency during a specific time period. These terms not only reflect shifting research hotspots over time but also provide insights into emerging and potentially future research trends. Figure 6 presents the top five identified burst keywords: blended learning, framework, distance learning, mental health, and COVID-19 pandemic.

The keyword "blended learning," the central theme of this study, showed the strongest burst intensity (4.04) during 2018–2019, indicating a critical period in which the concept of blended learning became widely recognized and conceptualized within higher education research.

The term "framework" received sustained attention between 2018 and 2021. Research during this period focused on developing adaptive and empirically grounded implementation models for blended learning, particularly in response to the challenges posed by the pandemic and rapid technological change (e.g., [61, 62]). These frameworks typically integrate pedagogical strategies with digital tools and are designed for practical validation and scalability.

"Distance learning" became a notable buzz term in 2020–2021, directly associated with the global shift to online education prompted by COVID-19. This transition forced higher education institutions to address issues related to platform development, resource adaptation, and learning quality assurance, thereby driving innovation in educational technologies and pedagogical models [63, 64].

The keyword "mental health" emerged as a significant research focus in 2021–2022, reflecting growing academic concern over the psychological impacts of remote learning during the pandemic. Studies highlighted issues such as stress, anxiety, and social isolation among students [65, 66].

Finally, "COVID-19 pandemic" has remained an active burst keyword since 2022, highlighting the continued interest in understanding the long-term effects of the pandemic on teaching, learning, assessment, and educational equity. This trend also reinforces the strategic importance of blended learning as a bridge between emergency remote instruction and sustainable educational models.

Top 5 Keywords with the Strongest Citation Bursts

Keywords	Year	Strength	Begin	End	2015 - 2024
blended learning	2015	4.04	2018	2019	
framework	2018	2.5	2018	2021	
distance learning	2015	3.44	2020	2021	
mental health	2021	3.32	2021	2022	
covid-19 pandemic	2021	2.8	2022	2024	

Figure 6.
Top 5 Keywords with the Strongest Citation Bursts.

5.9. Journal Co-Citation Analysis

The purpose of journal co-citation analysis is to identify the most frequently cited journals and the foundational literature within a specific research domain. In this study, the co-citation network was generated using VOSviewer, with the minimum citation threshold set at 50. As a result, 61 journals were included in the analysis. Each node in the network represents a cited journal, with node size corresponding to citation frequency, color indicating cluster membership, and edges representing the strength of co-citation relationships. The final co-citation map is displayed in Figure 7, which reveals three major clusters.

The Red Cluster mainly includes influential journals in the field of educational technology, such as Computers & Education, The Internet and Higher Education, and Teaching and Teacher Education. These journals focus on the integration of digital technologies and pedagogical strategies and serve as key theoretical and methodological foundations in blended learning research. Notably, Computers & Education stands out as the most frequently cited journal in the network, with 507 citations.

The Blue Cluster focuses on educational technologies and sustainability-related themes. Prominent journals in this cluster include Sustainability, Education and Information Technologies, and Educational Technology Research and Development. Although Sustainability primarily emphasizes sustainable development, it has increasingly published research on blended learning, educational equity, and access in recent years, reflecting its interdisciplinary expansion. It has received 349 citations, making it one of the most influential journals in this cluster.

The Green Cluster is centered on health sciences and clinical education, featuring journals such as BMC Medical Education, Nurse Education Today, Medical Education, and PLOS ONE. These journals emphasize the application of blended learning in professional and technical training, including remote instruction, clinical simulation, and personalized curriculum design. This cluster is characterized by a strong empirical orientation.

This co-citation network reveals that research on blended learning in higher education has formed a relatively well-defined knowledge structure. It combines theoretical support from educational technology with interdisciplinary, evidence-based contributions, demonstrating an integrated development of theory and practice within the field.
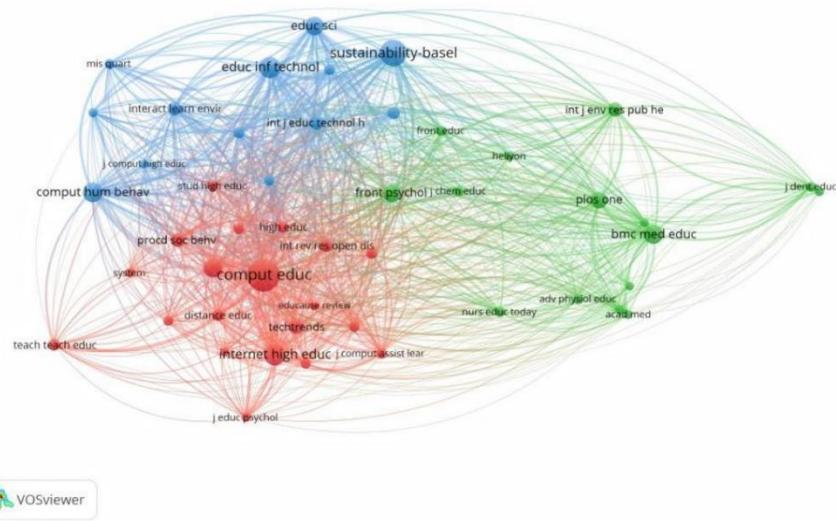
Figure 7.
Journal Co-citation Network by VOSviewer.

5.10. Reference Co-citation Analysis

A further analysis using VOSviewer was conducted to identify the top five most cited references in the field between 2015 and 2024. Table 7 presents the details of the top-cited studies in WoS and Scopus, including their authors, publication years, sources, and total number of citations. Among these studies, the most frequently cited is the design-based research by Bower [67] with 227 citations. This study proposed a framework for adaptive learning design, emphasizing the importance of instructors dynamically adjusting instructional strategies during the teaching process to meet students' changing cognitive and collaborative needs.

Next is the empirical study by Porter and Graham [68] on the institutional factors influencing faculty adoption of blended learning in higher education, and the work by Díaz et al. [69] exploring the integration of virtual reality technologies into blended teaching in higher education. These two studies received 114 and 110 citations, respectively.

Following them are two COVID-19-related studies, which examine the stress and behavioral changes caused by remote e-exams among medical students during the pandemic, and the experiences and reflections of university educators during the initial phase of emergency remote teaching.

These highly cited works reveal key aspects of the theoretical foundations, technological environment, and institutional support for blended learning, providing critical references in terms of research themes, conceptual frameworks, and methodological approaches.

Table 7.
Top 5 Most Cited Articles on Blended Learning in Higher Education.

Rank	Title	Author(s)	Year	Source	Citations
1	A framework for adaptive learning design in a web-conferencing environment	Bower [67]	2015	Learning design	227
2	Institutional drivers and barriers to faculty adoption of blended learning in higher education	Porter and Graham [68]	2016	British Journal of Educational Technology	114
3	Virtual world as a resource for hybrid education	Díaz et al. [69]	2020	International Journal of Emerging Technologies in Learning	110
4	Stress and behavioral changes with remote E-exams during the COVID-19 pandemic: A cross-sectional study among undergraduates of medical sciences	Elsalem et al. [70]	2020	Annals of Medicine and Surgery	98
5	COVID-19 Emergency eLearning and Beyond: Experiences and Perspectives of University Educators	Müller et al. [2]	2021	Education Sciences	96

To further identify the knowledge base and seminal literature in blended learning research within higher education, this study constructed a reference co-citation network using VOSviewer. As shown in Figure 8, the minimum citation threshold was set at 10, resulting in 53 highly cited references. These were grouped into three main clusters based on co-citation patterns, represented in blue, green, and red.

The blue cluster primarily focuses on the practical implementation and dissemination of blended learning in higher education. Most of the literature in this cluster was published after 2019, with an emphasis on instructional strategies, learning environment design, and the integration of educational technologies to improve learning outcomes. Representative works include [4, 71].

The green cluster centers on the theoretical foundations and conceptual frameworks of blended learning and includes earlier research that has served as the theoretical pillars of the field. Key references include [8, 72, 73]. These works have provided foundational insights into instructional design and research models in blended learning.

The red cluster consists of literature related to emergency remote teaching and online education in the context of the COVID-19 pandemic. Representative studies emphasize the transition to online instruction and learners' adaptation in response to crisis-driven changes [74, 75].

In terms of temporal distribution, the majority of highly co-cited references were published between 2019 and 2021, reflecting the significant impact of the pandemic on the research agenda in this field. In contrast, most pre-2010 co-cited works represent classical theoretical contributions, forming the conceptual backbone for the development of blended learning research.

In summary, the co-citation network reveals a clear trajectory in the evolution of blended learning in higher education, from theoretical construction to practical refinement, with the COVID-19 pandemic accelerating its transformation and diversification.
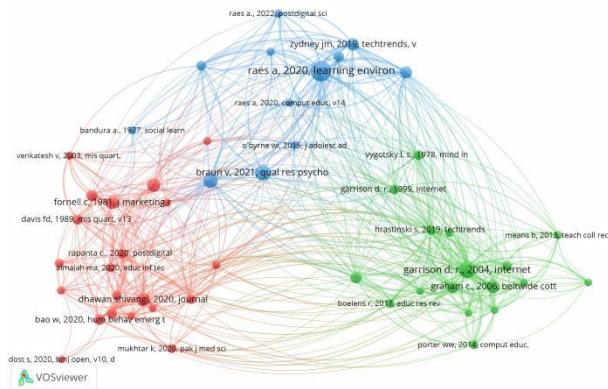
Figure 8.
Reference Co-citation Network by VOSviewer.

6. Discussion

Blended learning has become a central topic in the field of educational technology, combining the advantages of traditional face-to-face instruction and online learning. It emphasizes course design, technological integration, institutional policy, and the optimization of teaching outcomes. In the context of rapid advancements in information technology, blended learning has been widely adopted in higher education, making it a continually evolving research topic. This study adopts a bibliometric approach based on data from Scopus and Web of Science (WoS) to analyze more than a decade of related studies, reviewing the development trajectory of the field and examining key authors, productive countries and institutions, core journals, and keyword clusters.

With regard to research distribution, studies on blended learning in higher education show an overall upward trend, especially after the onset of the COVID-19 pandemic in 2020. This growth reflects the global higher education system's increasing attention to remote and blended teaching models. Geographically, the United States, China, and Spain dominate research output, followed by Indonesia and Malaysia, indicating regional disparities. Research publications are primarily concentrated in educational technology journals (e.g., Computers & Education) and medical education journals (e.g., BMC Medical Education).

In terms of research influence, the United States leads in both publication volume and citation impact. Journals such as the British Journal of Educational Technology and Computers & Education exhibit strong influence and have facilitated the interdisciplinary diffusion of knowledge. Some institutions with relatively fewer publications, such as the University of Malaya, still show high academic impact due to high average citation rates. Meanwhile, the high-productivity author group remains in an early phase of aggregation, with no stable global core research network established yet.

From the perspective of thematic evolution, the co-occurrence and keyword timeline analyses identified five major research themes: emergency teaching in response to COVID-19, technology-enabled learning enhancement, course design and evaluation frameworks, learner perception and attitude, and the relationship between technology and motivation. The research focus has gradually shifted from early model construction to a deeper emphasis on student experience, learning outcomes, and mental health, while also reflecting a growing integration of AI and big data technologies.

As far as the co-citation structure is concerned, journal co-citation analysis reveals three major knowledge clusters in the field: educational technology, online teaching, and medical education. These clusters together provide both theoretical foundations and practical applications. The reference co-citation analysis identifies three main research pathways: (1) early frameworks and theoretical models of blended learning; (2) the integration and application of educational technologies; and (3) empirical studies on emergency remote teaching during the pandemic. These different research streams form the

intellectual foundation of the field. Notably, many highly cited studies were published around the pandemic period, producing a surge of empirical insights. Seminal studies such as those by Elsalem et al. [70] on blended learning frameworks, Braun et al. [71] on psychological impacts, and Díaz et al. [69] on adaptive teaching design offer valuable theoretical and practical guidance.

By employing a bibliometric methodology, this study provides a comprehensive mapping of research dynamics and knowledge structures in blended learning within higher education over the past decade. The findings reveal a trend toward the co-development of technology, pedagogy, and policy, but also highlight several ongoing challenges, such as insufficient cross-institutional collaboration, weak theoretical modeling, and limited attention to marginalized student groups.

7. Conclusion

Blended learning, as a dynamic and interdisciplinary field, spans education, information technology, psychology, and management. The evolving nature of the COVID-19 pandemic and its long-term effects have created numerous research opportunities. Therefore, a bibliometric and scientometric mapping of this research landscape provides valuable insights for scholars in the field.

This study conducted a systematic bibliometric analysis of blended learning in higher education from 2015 to 2024, drawing on data from Scopus and WoS. It identifies major research trends, thematic evolutions, and structural patterns in the knowledge network. The key findings include:

(1) A sharp rise in publications since 2020, reflecting the rapid adoption of blended learning amid the pandemic;

(2) The United States, China, and Malaysia demonstrate prominent performance in research output and influence;

(3) Keyword clustering revealed five core themes, reflecting the field's diversity and breadth;

(4) Co-citation analysis of journals and references uncovered key theoretical foundations and core research works.

Despite these contributions, the study has certain limitations. First, it relies solely on WoS and Scopus, which may exclude relevant literature indexed in other databases. Second, the analysis does not fully explore inter-topic connections or the dynamic mechanisms of thematic evolution.

Future research could expand the scope of databases and adopt mixed-method approaches, combining quantitative bibliometrics with qualitative content analysis. Specific subfields, such as technology integration, learner experience, or pedagogical strategies, deserve more targeted investigation. Additionally, longitudinal analyses focusing on post-COVID-19 literature may yield deeper educational insights into the transformation of teaching and learning models.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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References

[1]   B. Anthony Jr et al., "Blended learning adoption and implementation in higher education: A theoretical and systematic review," *Technology, Knowledge and Learning*, vol. 27, pp. 531-578, 2022. https://doi.org/10.1007/s10758-020-09477-z

[2]   A. M. Müller, C. Goh, L. Z. Lim, and X. Gao, "Covid-19 emergency elearning and beyond: Experiences and perspectives of university educators," *Education Sciences*, vol. 11, no. 1, p. 19, 2021. https://doi.org/10.3390/educsci11010019

[3]   T. Yu, J. Dai, and C. Wang, "Adoption of blended learning: Chinese university students' perspectives," *Humanities and Social Sciences Communications*, vol. 10, p. 390, 2023. https://doi.org/10.1057/s41599-023-01904-7

[4]   A. Raes, L. Detienne, I. Windey, and F. Depaepe, "A systematic literature review on synchronous hybrid learning: Gaps identified," *Learning Environments Research*, vol. 23, pp. 269-290, 2020. https://doi.org/10.1007/s10984-019-09303-z

[5]   M. A. Ashraf, S. Mollah, S. Perveen, N. Shabnam, and L. Nahar, "Pedagogical applications, prospects, and challenges of blended learning in Chinese higher education: A systematic review," *Frontiers in Psychology*, vol. 12, p. 772322, 2022. https://doi.org/10.3389/fpsyg.2021.772322

[6]   C. González, D. Ponce, and V. Fernández, "Teachers' experiences of teaching online during COVID-19: Implications for postpandemic professional development," *Educational Technology Research and Development*, vol. 71, pp. 55-78, 2023. https://doi.org/10.1007/s11423-023-10200-9

[7]   S. K. Howard and J. Tondeur, "Higher education teachers' digital competencies for a blended future," *Educational Technology Research and Development*, vol. 71, pp. 1-6, 2023. https://doi.org/10.1007/s11423-023-10211-6

[8]   D. R. Garrison and H. Kanuka, "Blended learning: Uncovering its transformative potential in higher education," *The Internet and Higher Education*, vol. 7, no. 2, pp. 95-105, 2004. https://doi.org/10.1016/j.iheduc.2004.02.001

[9]   C. R. Graham, W. Woodfield, and J. B. Harrison, "A framework for institutional adoption and implementation of blended learning in higher education," *The Internet and Higher Education*, vol. 18, pp. 4-14, 2013. https://doi.org/10.1016/j.iheduc.2012.09.003

[10]   Blended Learning Universe, "Blended learning universe (BLU)," 2022. https://www.blendedlearning.org. [Accessed May 1, 2022]

[11]   Cambridge Assessment, "Shaping up education models for the future in the UAE," 2020. https://www.cambridgeassessment.org.uk/news/shaping-up-education-models-for-the-future-in-the-uae/. [Accessed Jun. 10, 2022]

[12]   Waterloo University, "Some examples of blended courses," 2020. https://uwaterloo.ca/. [Accessed Apr. 1, 2022]

[13]   C. Dziuban, C. R. Graham, P. D. Moskal, A. Norberg, and N. Sicilia, "Blended learning: The new normal and emerging technologies," *International Journal of Educational Technology in Higher Education*, vol. 15, p. 3, 2018. https://doi.org/10.1186/s41239-017-0087-5

[14]   M. M. Castro-Rodríguez, D. Marín-Suelves, S. López-Gómez, and J. Rodríguez-Rodríguez, "Mapping of scientific production on blended learning in higher education," *Education Sciences*, vol. 11, no. 9, p. 494, 2021. https://doi.org/10.3390/educsci11090494

[15]   R. Imran, A. Fatima, I. E. Salem, and K. Allil, "Teaching and learning delivery modes in higher education: Looking back to move forward post-COVID-19 era," *The International Journal of Management Education*, vol. 21, no. 2, p. 100805, 2023. https://doi.org/10.1016/j.ijme.2023.100805

[16]   Z. Almahasees, K. Mohsen, and M. O. Amin, "Faculty's and students' perceptions of online learning during COVID-19," *Frontiers in Education*, vol. 6, p. 638470, 2021. https://doi.org/10.3389/feduc.2021.638470

[17]   A. Vallée, J. Blacher, A. Cariou, and E. Sorbets, "Blended learning compared to traditional learning in medical education: Systematic review and meta-analysis," *Journal of Medical Internet Research*, vol. 22, no. 8, p. e16504, 2020. https://doi.org/10.2196/16504

[18]   T. Jowsey, G. Foster, P. Cooper-Ioelu, and S. Jacobs, "Blended learning via distance in pre-registration nursing education: A scoping review," *Nurse Education in Practice*, vol. 44, p. 102775, 2020. https://doi.org/10.1016/j.nepr.2020.102775

[19]   S. McCarthy and E. Palmer, "Defining an effective approach to blended learning in higher education: A systematic review," *Australasian Journal of Educational Technology*, vol. 39, no. 2, pp. 98–114, 2023. https://doi.org/10.14742/ajet.8489

[20]   B. Tonbuloğlu and İ. Tonbuloğlu, "Trends and patterns in blended learning research (1965–2022)," *Education and Information Technologies*, vol. 28, pp. 13987-14018, 2023. https://doi.org/10.1007/s10639-023-11754-0

[21]   A. Shlomo and R. B. Rosenberg-Kima, "F2F, zoom, or asynchronous learning? Higher education students' preferences and perceived benefits and pitfalls," *International Journal of Science Education*, vol. 47, no. 8, pp. 1002-1027, 2025. https://doi.org/10.1080/09500693.2024.2355673

[22]   D. Akgunduz and A. Kinik Topalsan, "Examining technology use and competence of higher education academics during the COVID-19 pandemic," *Higher Learning Research Communications*, vol. 14, no. 1, p. 3, 2024. https://doi.org/10.18870/hlrc.v14i1.1421

[23]   R. Ali and H. Georgiou, "A process for institutional adoption and diffusion of blended learning in higher education," *Higher Education Policy*, vol. 38, pp. 523-544, 2025. https://doi.org/10.1057/s41307-024-00359-y

[24]   A. Panday, T. Ray, A. Jalandharachari, and G. Gopinath, "Insights into blended learning research: A thorough bibliometric study," *Discover Education*, vol. 4, p. 50, 2025. https://doi.org/10.1007/s44217-025-00439-0

[25]   D. Gudoniene *et al.*, "Hybrid teaching and learning in higher education: A systematic literature review," *Sustainability*, vol. 17, no. 2, p. 756, 2025. https://doi.org/10.3390/su17020756

[26] M. J. Sosa Díaz, J. Guerra Antequera, and M. Cerezo Pizarro, "Flipped classroom in the context of higher education: Learning, satisfaction and interaction," *Education Sciences*, vol. 11, no. 8, p. 416, 2021. https://doi.org/10.3390/educsci11080416

[27] S. R. Lambert, "Do MOOCs contribute to student equity and social inclusion? A systematic review 2014–18," *Computers & Education*, vol. 145, p. 103693, 2020. https://doi.org/10.1016/j.compedu.2019.103693

[28] J. W. Fresen, "Embracing distance education in a blended learning model: Challenges and prospects," *Exploring Dual and Mixed Mode Provision of Distance Education*, pp. 108-124, 2020.

[29] P. Mayr and A. Scharnhorst, "Scientometrics and information retrieval: weak-links revitalized," *Scientometrics*, vol. 102, pp. 2193-2199, 2015. https://doi.org/10.1007/s11192-014-1484-3

[30] M. Bordons and M. Ángeles Zulueta, "Evaluation of scientific activity through bibliometric indicators," *Revista Española de Cardiología*, vol. 52, no. 10, pp. 790-800, 1999. https://doi.org/10.1016/S0300-8932(99)75008-6

[31] G. Abramo, C. A. D'Angelo, and F. Viel, "The field-standardized average impact of national research systems compared to world average: The case of Italy," *Scientometrics*, vol. 88, no. 2, pp. 599-615, 2011. https://doi.org/10.1007/s11192-011-0406-x

[32] O. Öztürk, R. Kocaman, and D. K. Kanbach, "How to design bibliometric research: An overview and a framework proposal," *Review of Managerial Science*, vol. 18, pp. 3333-3361, 2024. https://doi.org/10.1007/s11846-024-00738-0

[33] A. Diem and S. C. Wolter, "The use of bibliometrics to measure research performance in education sciences," *Research in Higher Education*, vol. 54, pp. 86-114, 2013. https://doi.org/10.1007/s11162-012-9264-5

[34] I. Zupic and T. Čater, "Bibliometric methods in management and organization," *Organizational Research Methods*, vol. 18, no. 3, pp. 429-472, 2015. https://doi.org/10.1177/1094428114562629

[35] C. Chen, "CiteSpace II: Detecting and visualizing emerging trends and transient patterns in scientific literature," *Journal of the American Society for Information Science and Technology*, vol. 57, no. 3, pp. 359-377, 2006. https://doi.org/10.1002/asi.20317

[36] N. Van Eck and L. Waltman, "Software survey: VOSviewer, a computer program for bibliometric mapping," *Scientometrics*, vol. 84, no. 2, pp. 523-538, 2010. https://doi.org/10.1007/s11192-009-0146-3

[37] V. Hernández-González, N. Sans-Rosell, M. C. Jové-Deltell, and J. Reverter-Masía, "Comparison between Web of Science and Scopus: A bibliometric study of anatomy and morphology journals," *International Journal of Morphology*, vol. 34, no. 4, pp. 1369–1377, 2016. https://doi.org/10.4067/S0717-95022016000400032

[38] É. Archambault, D. Campbell, Y. Gingras, and V. Larivière, "Comparing bibliometric statistics obtained from the Web of Science and Scopus," *Journal of the American Society for Information Science and Technology*, vol. 60, no. 7, pp. 1320-1326, 2009. https://doi.org/10.1002/asi.21062

[39] R. Pranckutė, "Web of Science (WoS) and Scopus: The titans of bibliographic information in today's academic world," *Publications*, vol. 9, no. 1, p. 12, 2021. https://doi.org/10.3390/publications9010012

[40] D. J. de Solla Price, *Little science, big science*. New York, USA: Columbia Univ. Press, 1963.

[41] M. W. Romaniuk and J. Łukasiewicz-Wieleba, "Hybrid education in higher education on the example of students' experiences in post-pandemic reality," *International Journal of Electronics and Telecommunications*, vol. 68, no. 3, pp. 497–504, 2022. https://doi.org/10.24425/ijet.2022.141266

[42] K. Markiewicz, B. L. Kaczmarek, and Z. B. Gaś, "The impact of personality traits and study mode on mental health and stimulant use among university students during COVID-19 pandemic," *Acta Neuropsychol.*, vol. 21, no. 4, pp. 373–386, 2023.

[43] J. Bidarra, V. Rocio, N. Sousa, and J. Coutinho-Rodrigues, "Problems and prospects of hybrid learning in higher education," *Open Learning: The Journal of Open, Distance and e-Learning*, vol. 40, no. 3, pp. 304-323, 2025. https://doi.org/10.1080/02680513.2024.2404036

[44] S. David, L. D. Manea, F. O. Virlanuta, N. Bărbuță-Mişu, and I. A. Şorcaru, "Higher education institution beyond the COVID-19 pandemic—Evidence from Romania," *Education Sciences*, vol. 12, no. 10, p. 693, 2022. https://doi.org/10.3390/educsci12100693

[45] Z. Huang, "IoT-inspired teaching for legal education: AI-based learning based on decision tree algorithm," *Soft Computing*, vol. 28, pp. 1609-1631, 2024. https://doi.org/10.1007/s00500-023-09451-8

[46] W. Zhang, "Exploring the diverse practices of artificial intelligence in blended music teaching in colleges and university," *Applied Mathematics and Nonlinear Sciences*, vol. 9, no. 1, pp. 497–504, 2024. https://doi.org/10.2478/amns-2024-1501

[47] T. He, "Construction of evaluation system for English translation teaching in colleges and universities under cross-cultural perspective," *Applied Mathematics and Nonlinear Sciences*, vol. 9, no. 1, pp. 497–504, 2024. https://doi.org/10.2478/amns-2024-0653

[48] J. Tian, "The application of blended teaching model in practical teaching in the context of big data," *Applied Mathematics and Nonlinear Sciences*, vol. 9, no. 1, 2024. https://doi.org/10.2478/amns-2024-1180

[49] F. Yang, P. Liu, P. Duan, and D. Zhang, "Evaluating blended teaching models in medical colleges: Preferences and influential factors for teachers and students," *Advances in Medical Education and Practice*, vol. 15, pp. 1195-1203, 2024. https://doi.org/10.2147/AMEP.S487408

[50]   Z. Liu, S. Wang, Y. Lin, M. Zhou, P. Jing, and Z. Zhong, "Design and application of the blended teaching mode in the curriculum of pharmacokinetics," *Indian Journal of Pharmaceutical Education and Research*, vol. 57, no. 4, pp. 1183-1191, 2023. https://doi.org/10.5530/ijper.57.4.141

[51]   L. Chen, "Integrating deep learning-based educational technologies in biotechnology training: An effectiveness evaluation from a hybrid education perspective," *Journal of Commercial Biotechnology*, vol. 29, no. 3, pp. 416–426, 2024.

[52]   M. Kubrusly, B. O. A. de Aquino, T. S. Simonian, M. do Nascimento Oliveira, and H. A. L. Rocha, "Self-efficacy of medical students in a hybrid curriculum course (traditional and problem-based learning) and associated factors," *BMC Medical Education*, vol. 24, no. 1, p. 9, 2024. https://doi.org/10.1186/s12909-023-05016-3

[53]   P. van Oort, J. Maaskant, M. L. Luttik, and A. Eskes, "Impact of a patient and family participation education program on hospital nurses' attitudes and competencies: A controlled before-after study," *PEC Innovation*, vol. 4, p. 100249, 2024. https://doi.org/10.1016/j.pecinn.2023.100249

[54]   M. Hartnett, C. Brown, D. Forbes, D. Gedera, and A. Datt, "Enhanced or diminished attitudes: University students' agency," *Computers & Education*, vol. 198, p. 104773, 2023. https://doi.org/10.1016/j.compedu.2023.104773

[55]   C. R. Barnhart, L. Li, and J. Thompson, "Learning whiplash: Chinese College EFL learners' perceptions of sudden online learning," *E-Learning and Digital Media*, vol. 19, no. 3, pp. 240-257, 2022. https://doi.org/10.1177/20427530211022922

[56]   E. Kalmar *et al.*, "The COVID-19 paradox of online collaborative education: When you cannot physically meet, you need more social interactions," *Heliyon*, vol. 8, no. 1, p. e08823, 2022. https://doi.org/10.1016/j.heliyon.2022.e08823

[57]   S. Taimur, M. Onuki, and H. Mursaleen, "Exploring the transformative potential of design thinking pedagogy in hybrid setting: A case study of field exercise course, Japan," *Asia Pacific Education Review*, vol. 23, pp. 571-593, 2022. https://doi.org/10.1007/s12564-022-09776-3

[58]   S. F. H. Zaidi, A. Kulakli, V. Osmanaj, and S. A. H. Zaidi, "Students' perceived M-Learning quality: An evaluation and directions to improve the quality for H-Learning," *Education Sciences*, vol. 13, no. 6, p. 578, 2023. https://doi.org/10.3390/educsci13060578

[59]   H. U. Rahiman and R. Kodikal, "Revolutionizing education: Artificial intelligence empowered learning in higher education," *Cogent Education*, vol. 11, no. 1, p. 2293431, 2024. https://doi.org/10.1080/2331186X.2023.2293431

[60]   A. Ramirez-Arellano, E. Acosta-Gonzaga, J. Bory-Reyes, and L. M. Hernández-Simón, "Factors affecting student learning performance: A causal model in higher blended education," *Journal of Computer Assisted Learning*, vol. 34, no. 6, pp. 807-815, 2018. https://doi.org/10.1111/jcal.12289

[61]   H. Y. Al-Sholi, O. R. Shadid, K. A. Alshare, and M. Lane, "An agile educational framework: A response for the covid-19 pandemic," *Cogent Education*, vol. 8, no. 1, p. 1980939, 2021. https://doi.org/10.1080/2331186X.2021.1980939

[62]   A. Kumar *et al.*, "Blended learning tools and practices: A comprehensive analysis," *Ieee Access*, vol. 9, pp. 85151-85197, 2021. https://doi.org/10.1109/ACCESS.2021.3085844

[63]   P. Huang and H. C. Lucas, "Early exploration of MOOCs in the US higher education: An absorptive capacity perspective," *ACM Transactions on Management Information Systems*, vol. 12, no. 3, pp. 1-28, 2021. https://doi.org/10.1145/3456295

[64]   I. V. Liashenko and L. V. Hnapovska, "ESP online course as a means of enhancing graduate students' employability opportunities — Case of Sumy State University," *Journal of Teaching English for Specific and Academic Purposes*, vol. 8, no. 3, pp. 215–230, 2020. https://doi.org/10.22190/JTESAP2003215L

[65]   K. Sabella, "Factors that hinder or facilitate the continuous pursuit of education, training, and employment among young adults with serious mental health conditions," *Psychiatric Rehabilitation Journal*, vol. 44, no. 4, pp. 373–380, 2021. https://doi.org/10.1037/prj0000470

[66]   S. N. Sato *et al.*, "Cultural differences between university students in online learning quality and psychological profile during COVID-19," *Journal of Risk and Financial Management*, vol. 15, no. 12, p. 555, 2022. https://doi.org/10.3390/jrfm15120555

[67]   M. Bower, *A framework for adaptive learning design in a web-conferencing environment. In Learning design*. New York, USA: Routledge, 2015.

[68]   W. W. Porter and C. R. Graham, "Institutional drivers and barriers to faculty adoption of blended learning in higher education," *British Journal of Educational Technology*, vol. 47, no. 4, pp. 748-762, 2016. https://doi.org/10.1111/bjet.12269

[69]   J. Díaz, C. Saldaña, and C. Avila, "Virtual world as a resource for hybrid education," *International Journal of Emerging Technologies in Learning (iJET)*, vol. 15, no. 15, pp. 94-109, 2020. https://doi.org/10.3991/ijet.v15i15.13025

[70]   L. Elsalem, N. Al-Azzam, A. A. Jum'ah, N. Obeidat, A. M. Sindiani, and K. A. Kheirallah, "Stress and behavioral changes with remote E-exams during the Covid-19 pandemic: A cross-sectional study among undergraduates of medical sciences," *Annals of Medicine and Surgery*, vol. 60, pp. 271-279, 2020. https://doi.org/10.1016/j.amsu.2020.10.058

[71]   V. Braun, V. Clarke, N. Hayfield, and G. Terry, *Thematic analysis. In Qualitative research in psychology*. London, UK: SAGE Publications, 2021.

[72]   D. R. Garrison, T. Anderson, and W. Archer, "Critical inquiry in a text-based environment: Computer conferencing in higher education," *The Internet and Higher Education*, vol. 2, no. 2-3, pp. 87-105, 1999. https://doi.org/10.1016/S1096-7516(00)00016-6

[73]   L. S. Vygotsky, *Mind in society: The development of higher psychological processes.* Cambridge, MA, USA: Harvard University Press, 1978.

[74]   W. Bao, "COVID-19 and online teaching in higher education: A case study of Peking University," *Human Behavior and Emerging Technologies*, vol. 2, no. 2, pp. 113-115, 2020. https://doi.org/10.1002/hbe2.191

[75]   S. Dhawan, "Online learning: A panacea in the time of COVID-19 crisis," *Journal of Educational Technology Systems*, vol. 49, no. 1, pp. 5-22, 2020. https://doi.org/10.1177/0047239520934018