Research Article

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The complex adaptive blended learning system: A systematic review

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Abstract

The complex adaptive blended learning system (CABLS) is an open system that optimizes the learning process by interacting in a non-linear and dynamic manner. This system consists of six subsystems: learner, teacher, technology, content, learning support, and institution. The purpose of this study was to systematically review studies conducted within the framework of the complex adaptive blended learning system between the years 2015 and 2023. Thus, selected studies regarding explicit inclusion and exclusion criteria, were analysed in terms of the year, type, subject areas, level of education, research methods, countries, and trends. The systematic review results identified 10 pieces of research studies that defined and described on CABLS. The studies were published mainly in 2022. Eight studies focused on education, two on health sciences, covering K-12 and higher education. Qualitative methods were prevalent, and research was global, with contributions from India, Indonesia, Malaysia, Pakistan, the UK, and the US, with the US leading in the number of studies. The results of this study may serve as a guide for future studies.

Keywords: Blended learning, Complex adaptive systems, Complex adaptive blended learning system, Systematic review, System-based perspective, System-based frameworks.

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INTRODUCTION AND BACKGROUND

Blended learning, which combines the traditional face-to-face classroom setting with online learning (BL), has gained significant attention in recent years, especially during the pandemic. BL provides unique opportunities for students to engage in real-world problem-solving, collaborate with others, develop creativity, communicate globally with technology, and become effective workers in the 21st century (Cummings, 2022). Although the benefits of BL are widely recognized, the process of implementing a blended learning course can present challenges (Evenhouse et al., 2017). Educators may face obstacles related to technology integration, curriculum design, and instructional strategies. In other words, with the advancement of technology, modern learning systems have become more complex and dynamic (Yeop et al., 2016).

Developing a conceptual framework for blended learning research will help to inform educational practitioner implementation of blended learning (Gulosino & Miron, 2017). Within this context, the Complex Adaptive Blended Learning System (CABLS) framework offers a comprehensive perspective on the intricate nature of blended learning.

This systematic review aims to address further contribute to the existing literature and serve as a foundation for future research in the complex adaptive blended learning system. Additionally, the distribution of the reviewed studies by various factors such as year, type, subject areas, level of education, research methods, and country can provide a holistic understanding of the field and highlight any patterns or trends that emerge. This study will further contribute to the existing blended learning literature and serve as a foundation for future research in the CABLS.

The Complex Adaptive Blended Learning System

The CABLS framework, which stands for Complex Adaptive Blended Learning Systems, provides a systems-based approach to understanding the non-linear relationships in blended learning environments (McGee & Poojary, 2020; Wang et al., 2015). Complex adaptive blended learning system is based on the principles of complex adaptive systems (CAS) theory. These systems are characterized by their complexity, self-organization, adaptability, dynamism, and coevolution. The CAS framework helps us understand the complexity of blended learning and how it can be effectively managed. It also reveals how blended learning can create new and innovative learning opportunities for students. CAS are described as living, open systems that exchange matter, energy, or information across boundaries to maintain their structure. The CAS framework helps us understand the complexity of blended learning and how it can be effectively managed. It also reveals how blended learning can create new and innovative learning opportunities for students. CAS are described as living, open systems that “exchange matter, energy, or information across boundaries to maintain their structure (Cleveland-Innes & Wilton, 2018). CAS as a lens through which blended learning may be more accurately viewed (Keiner, 2017). CAS are a powerful framework for exploring thresholds, resilience, and other related phenomena. CAS are systems of agents that interact with each other and their environment. Even simple agents with simple rules of behavior can produce complex, emergent behavior (Carmichael & Hadžikadić, 2019).

The CABLS framework is a holistic and systematic view of blended learning.It offers a comprehensive view of these six subsystems (teacher, learner, institution, learning support, technology, and content) that interact with each other in a blended learning environment (Figure 1). Rather than operating independently, these subsystems function as dynamic units. The CABLS framework assists stakeholders in gaining a better understanding of the various components of blended learning, resulting in increased effectiveness in the process.

Furthermore, this framework can guide blended learning research and promote the adoption of cohesive blended learning environments in educational institutions (Wang et al., 2015).

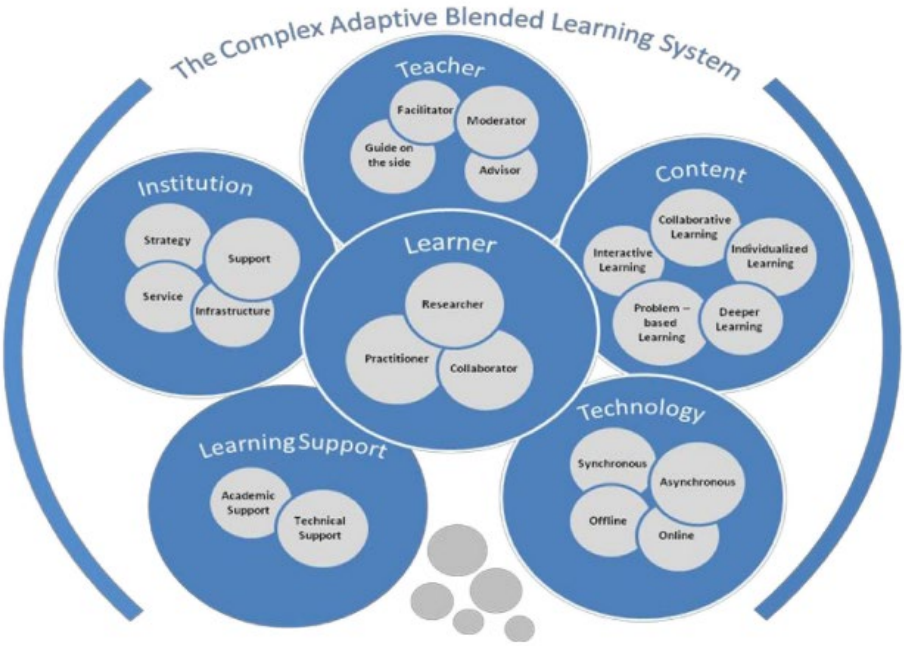


Figure 1. *The Complex Adaptive Blended Learning System (Wang et al., 2015)*

The learner's experience evolves from passive to active learning through interaction with various systems. In the context of blended learning, the role of the teacher shifts from being a lecturer to that of a facilitator. Blended learning offers dynamic and engaging content that continuously engages the learner, the teacher, and technology. Research has demonstrated that technological advancements inject fresh vitality into blended learning, catering to the requirements of both educators and students. Support structures for learning develop to meet the learner's needs, encompassing both academic and technological assistance. This extends beyond the individual course level to encompass the institution as a whole, highlighting the necessity for comprehensive support, which may include the development of strategies, plans, and policies (Wang et al., 2015).

In short, Blended learning in the CABLS framework involves the co-evolution of the learner, teacher, content, technology, learning support, and institution. Learners become active participants, teachers acquire new identities, content becomes rich and engaging, technology undergoes dynamic changes, learning support is foregrounded, and institutions provide support at an institutional level. The interdependency and dynamic interaction between these subsystems distinguish the CABLS framework from existing blended learning models.Therefore, CABLS framework is useful for understanding the complexity of blended learning and the interactions among the different elements of the system. It can be used by educators to design and implement effective blended learning programs (Kelly & Denson, 2017).

METHOD

Research Design

This paper utilized a systematic review methodology to provide a comprehensive overview of research on complex adaptive blended learning systems. A systematic review is a rigorous

and transparent method of reviewing existing research to address specific questions (Gough, Oliver & Thomas, 2017). It can also summarize the current evidence in a field and enhance the accuracy of conclusions by determining the consistency and generalizability of findings across studies (Juhl & Lund, 2018). Based on the objective of this study, the following questions were formulated:

1. What is the overall bibliometric landscape in the context being studied?
   a. What is the distribution of the reviewed studies by year?
   b. What is the distribution of the reviewed studies by type?
   c. What is the distribution of the reviewed studies by subject areas?
   d. What is the distribution of the reviewed studies by level of education?
   e. What is the distribution of the research methods applied in the reviewed studies?
   f. What is the distribution of the reviewed studies by country?
2. What are the trends related to the Complex Adaptive Blended Learning System (CABLS) in the context being studied?

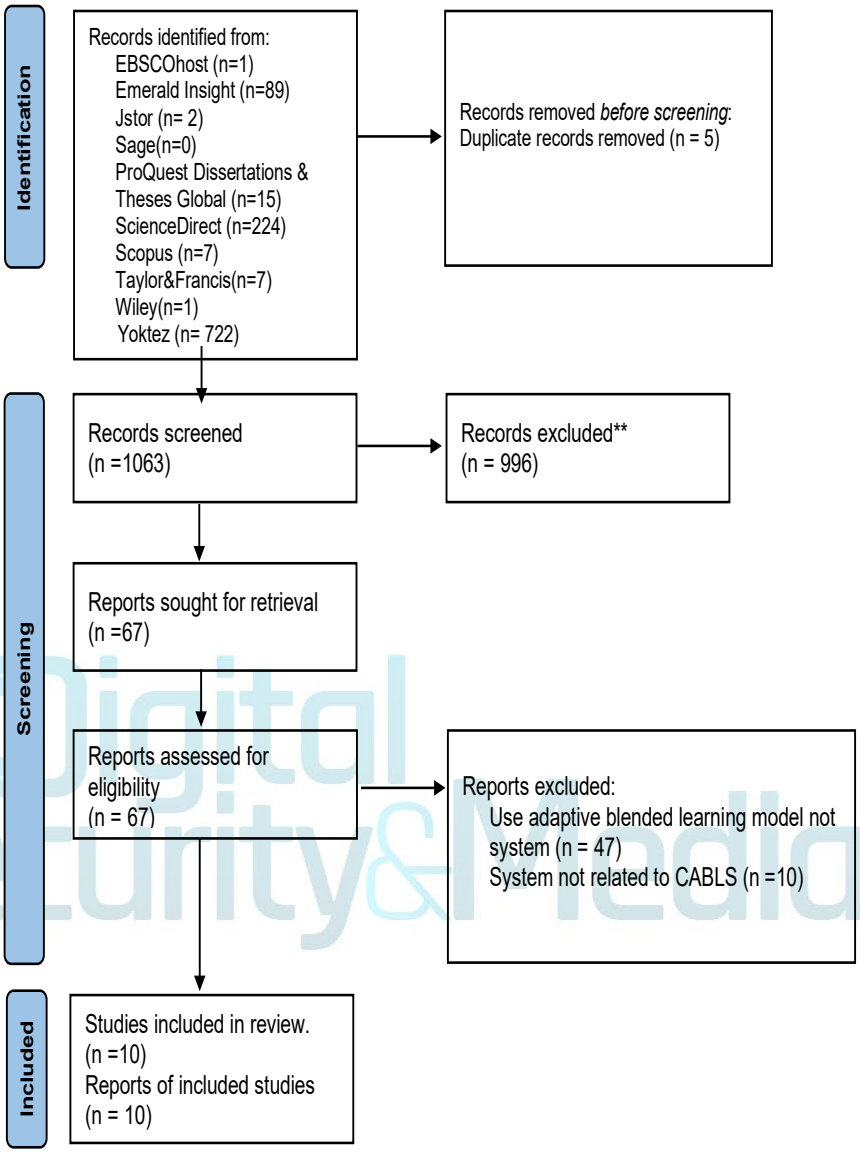
Sampling and Data Collection Techniques

The authors used a search string (see Table 1) and inclusion criteria to select the articles for their review. The research considered the period between 2015 and June 2023, starting from when CABLS was first introduced by Wang et al. They conducted searches in ten electronic scientific databases, namely EBSCOhost, Emerald Insight, JSTOR, ProQuest, Sage, Sciencedirect, Scopus, Taylor & Francis, Wiley Online Library, and YOKTEZ, through the Anadolu University Library. Only relevant studies in English and Turkish that pertained to CABLS were included in the review (Table 1). Consequently, the research's inclusion criteria are articles published between 2015 and 2023, peer-reviewed, written in English and Turkish, and accessible in full-text online.

Table 1. *Search Strategies for Databases*

Database	Search strategy
EBSCOhost	"blended learning" OR " Blended Learning System Frameworks" OR "Complex Adaptive Blended Learning System" OR "CABLS"
Emerald Insight	"blended learning" OR " Blended Learning System Frameworks" OR "Complex Adaptive Blended Learning System" OR "CABLS"
JSTOR	"Blended learning" OR "Blended Learning System Frameworks" OR "Complex Adaptive Blended Learning System" OR "CABLS"
ProQuest Dissertations and theses	"Complex Adaptive Blended Learning System" OR "CABLS"
SAGE	All "blended learning" AND "("blended learning" OR " Blended Learning System Frameworks" OR "Complex Adaptive Blended Learning System" OR "CABLS"
Sciencedirect	Title, abstract, keywords: ("blended learning" OR "Blended Learning System Frameworks" OR "Complex Adaptive Blended Learning System" OR "CABLS" OR "CABL")
Scopus	Başlık-özet- anahtar kelimeler "blended learning" AND "Complex Adaptive Blended Learning System" OR "Blended Learning System Frameworks" OR "CABLS"
Taylor&Francis	"Blended learning" AND "Complex Adaptive Blended Learning System" OR "Blended Learning System Frameworks" OR "CABLS"
Wiley Online Library	"Complex Adaptive Blended Learning System" OR "Blended Learning System Frameworks" OR "CABLS"
YOKTEZ dissertations and theses	"Blended learning" OR "Blended Learning System Frameworks" OR "Complex Adaptive Blended Learning System" OR "CABLS" OR "CABL"

After removing duplicate articles, 1063 articles were reviewed. Of these, 996 were excluded because they were not directly related to CABLS or were not primary research. The researchers then reviewed the full text of the remaining 67 articles and excluded 57 more that were not primary research or not related to the study topic. This left them with 10 studies that met their inclusion criteria and were therefore used in this analysis (see Figure 2).



From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372: n71. doi 10.1136/bmj. n71

Figure 2. *Flow of the Systematic Review Process*

Data Analysis

The researchers coded and analyzed all articles in this study independently using content analysis, a method of textual analysis that enables data comparison, contrasting, and categorization (Fraenkel & Wallen, 2000). To analyze the data, the authors initially identified descriptive themes in the data and subsequently used content analysis to find out the trends related to the CABLS. Additionally, a Microsoft Excel form was created to record the analysis results.

Validity & Reliability

Several steps were taken to enhance the validity and reliability of the systematic review search, Firstly, the included studies were coded into pre-set categories. In the second phase, another

researcher independently recoded the same articles. The researchers only proceeded to the next phase when they reached a consensus. To ensure accurate recording of the analysis results, a Microsoft Excel form was used. The categories in the form were aligned with the research question codes of the reviewed studies. Finally, all researchers involved in the study article coding process contributed to enhancing the overall validity and reliability of the systematic review search.

Ethical Concerns

Since there are no participants in this review, no informed consent was needed for this study.

FINDINGS

Descriptive Findings

The distribution of studies referring to CABLS by years is shown in Figure 3. Notably, the year 2022 stands out with the highest number of published articles. This surge in publications can be attributed to the significant impact of the Covid-19 pandemic.

Figure 3. *Distribution of the Reviewed Studies by Year*

The distribution of the reviewed studies by type shows that there are 5 doctoral dissertations and 5 articles specifically focused on the complex adaptive blended learning system shown in Figure 4. This balanced representation of research types in the literature review indicates the importance and relevance of this learning approach in the educational context. It highlights the need for further exploration and investigation to better understand the potential benefits and challenges associated with the complex adaptive blended learning system.

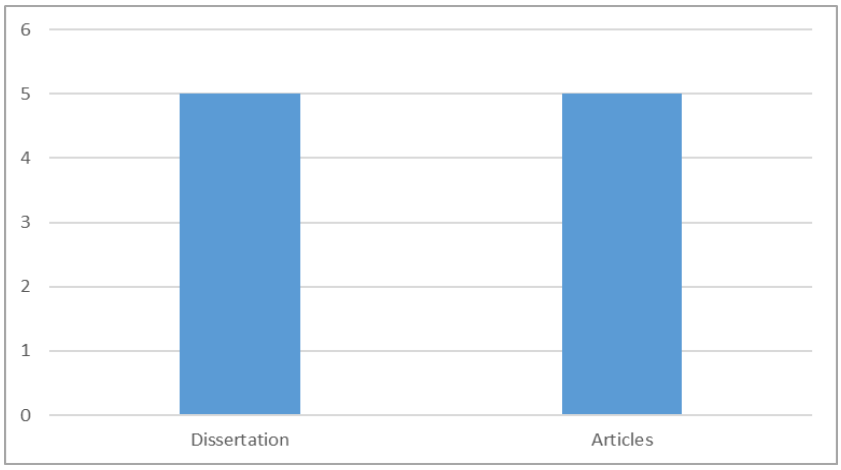


Figure 4. *Distribution of the Reviewed Studies by Type*

Two studies have been conducted on the complex adaptive blended learning system in the health sciences, while eight studies have focused on education. This indicates that the majority of research on this topic has been carried out in the field of education (Figure 5). Additionally, it is important to note that the existing research in the field of education suggests a strong emphasis on exploring the applications and effectiveness of the complex adaptive blended learning system. This indicates a growing interest in utilizing this approach in educational settings. Further research in the health sciences can provide valuable insights into the potential benefits and challenges of implementing this system in healthcare education and training.

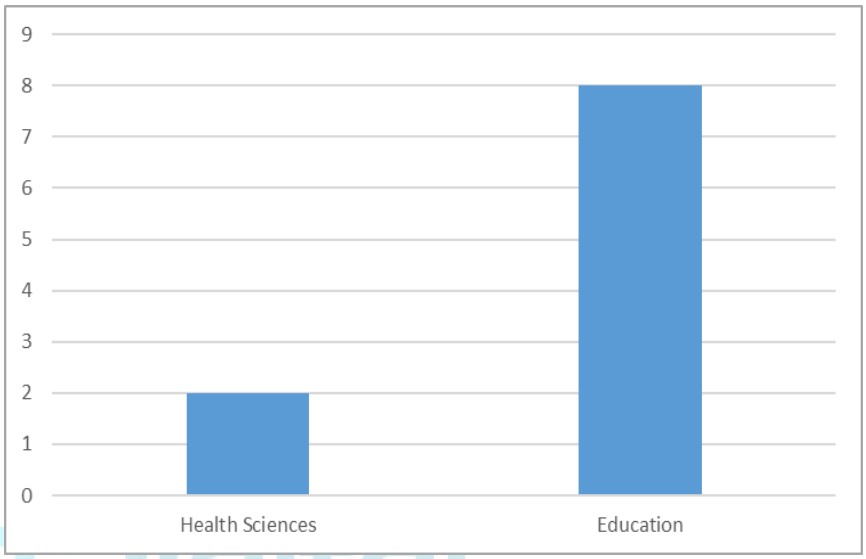


Figure 5. *Distribution of the Reviewed Studies by Subject Areas*

Based on the data from the CABLS, it can be observed that there are 4 studies focused on K-12 education and 6 studies focused on higher education. The distribution of these studies is relatively even, although there is a slightly higher number of studies conducted at the higher education level (Figure 6).

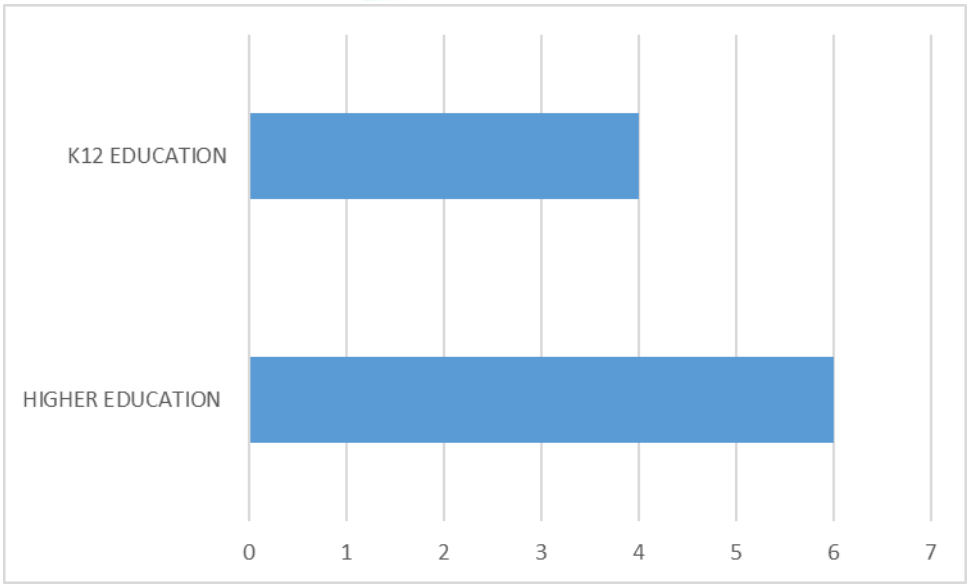


Figure 6. *Distribution of the Reviewed Studies by Level of Education*

Qualitative research is the primary research method used in the field of complex adaptive blended learning systems. This is because CABLS are complex in nature, making them challenging to study using quantitative methods. Qualitative research methods, such as

interviews, case studies, and focus groups, allow for a deeper understanding of the intricate interactions and dynamics that occur within CABLS (Figure 7).

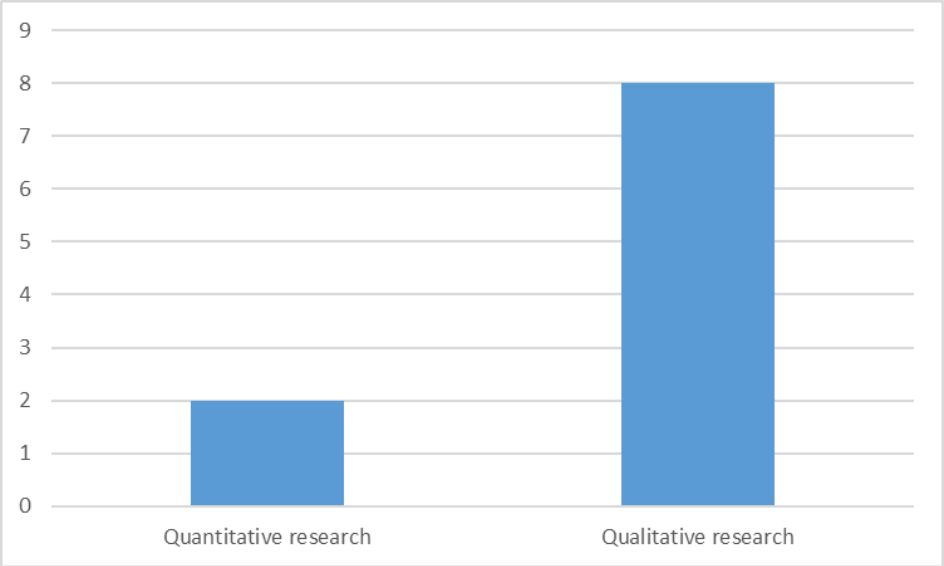


Figure 7. *Distribution of the Research Methods Applied in the Reviewed Studies*

The distribution of the reviewed studies among six countries is as follows: India, Indonesia, Malaysia, Pakistan, the United Kingdom, and the United States. There are five studies conducted in the United States, while one study has been conducted in each of the other five countries. The study is a doctoral thesis conducted in the UK with a primary focus on Nigerian higher education. Data is shown in Figure 8.

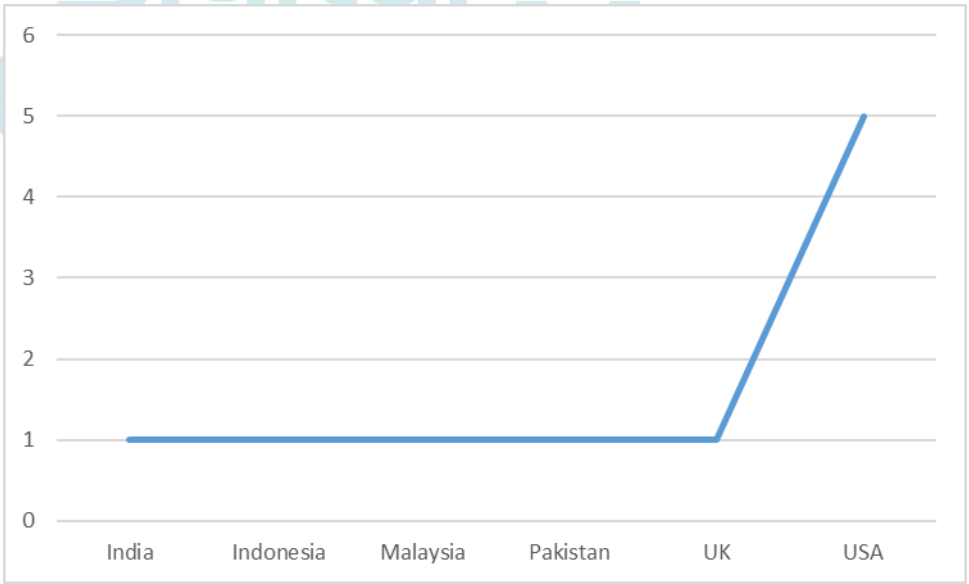


Figure 8. *Distribution of the Reviewed Studies by Country*

Analysis of the Trends

This section presents emerging research trends identified through content analysis. The systematic review on the CABLS identifies several trends: Blended learning accelerated by the pandemic, hybrid models and student perceptions, integration of ICT in education, blended learning in higher education, student satisfaction and high-order thinking, teacher perspectives and professional development, frameworks and models in blended learning research, content analysis and research gaps, teacher motivation and pedagogical goals, and understanding relationships within CABLS.

The COVID-19 pandemic has accelerated the adoption of blended learning in education. Researchers are investigating the use of the CABLS frameworks to develop guidelines for creating effective blended curricula, particularly in fields like medical education (Rafi et al., 2022). Keiner (2017) explores how hybrid instructional models based on the CABLS influence student experiences and outcomes, noting that teacher expectations and attitudes play a significant role in shaping student perceptions. The integration of Information and Communication Technology (ICT) and student-centered learning approaches within the CABLS framework is seen to enhance teaching and learning, especially in STEM subjects (Giwa, 2022).

Blended learning is increasingly important in higher education due to its flexibility and efficiency. However, there is a need for common frameworks and metrics to assess the maturity and success of blended learning programs (Duarte, 2016). Some studies are examining the impact of CABLS on student satisfaction and their ability to develop high order thinking skills. These studies often cluster students based on their experiences and examine different levels of contentment (Sudrajat et al., 2019).

Research is also exploring the perspectives of teachers experienced in blended learning within the CABLS framework. These studies highlight the importance of professional development and technology coaching to help teachers effectively utilize blended learning (Cummings, 2022). Various frameworks and models, including CABLS and Community of Inquiry (COI), are used to understand the components and interactions within blended learning environments (Mathur & Shukla, 2022). Content analysis is employed to systematically review existing literature on blended learning, identifying gaps in current practices and emphasizing less explored aspects (Yeop et al., 2016).

Furthermore, studies emphasize the significance of teacher motivations and clear pedagogical goals when implementing blended learning. These factors influence the choice of online resources and the transformation of teaching methods (Arfanakis, 2022). Researchers are also conducting interviews with stakeholders to gain insights into the complex relationships within the CABLS framework and promote collaborative approaches to blended learning in higher education (Mcgee & Poojary, 2019).

In summary, researchers are exploring the use of the CABLS in various educational contexts to enhance teaching and learning outcomes. This exploration focuses on technology integration, teacher perspectives, student satisfaction, and the development of high order thinking skills. The need for clear guidelines, frameworks, and professional development to effectively implement blended learning is also emphasized.

DISCUSSION AND CONCLUSION

The research paper presents findings of a systematic review on complex adaptive blended learning system (CABLS) and discusses gaps in current research. The review revealed a need for exploring all six subsystems of CABLS. Analyzing the distribution of studies related to the CABLS provides valuable insights into the evolving research landscape in this field. The systematic review results identified ten research studies that defined and described the theory. The significant increase in the number of published articles in 2022 indicates the growing importance of the CABLS. This surge in publications can be attributed to the global impact of the Covid-19 pandemic, which compelled educators and institutions to quickly adapt to blended learning environments. The balanced representation of research types, with an equal number of dissertations and articles, highlights the multifaceted nature of the CABLS and its relevance in various educational contexts. This balance underscores the need for further investigation into the potential benefits and challenges associated with complex adaptive blended learning systems. The study's findings also highlight gaps in current studies and practices, such as the absence of discussion on all six subsystems, the importance of considering subsystem

relationships, and the exploration of significant interactions between subsystems. Potential areas for future research include investigating the effects of subsystem interactions and addressing the shortcomings in blended learning practices (Yeop et al., 2016).

The distribution of studies across fields reveals a notable concentration of research in the education domain, with eight studies focusing on education compared to two in the health sciences. This emphasizes the significance of additional research and development in this area. Within the education sector, the distribution of studies is also noteworthy, with four studies focused on K-12 education and six on higher education. This suggests that the CABLS are being examined and applied at different educational levels, highlighting their versatility and adaptability in diverse learning environments. Additionally, the prevalence of qualitative research methods in studying the CABLS can be attributed to the complex and dynamic nature of these systems. Furthermore, the reviewed studies span across six countries, including India, Indonesia, Malaysia, Pakistan, the United Kingdom, and the United States, indicating a global interest in the CABLS in blended learning environments. While the United States has conducted the highest number of studies, the inclusion of research from different countries suggests the universal applicability of the CABLS concepts and the need for cross-cultural insights to inform their implementation.

Regarding the analysis of CABLS trends, researchers investigate the use of the CABLS in various educational settings to enhance teaching and learning outcomes. They explore aspects such as technology integration, teacher perspectives, student satisfaction, and the development of higher-order thinking skills. Additionally, the importance of clear guidelines, frameworks, and professional development for successful blended learning implementation is emphasized.

In conclusion, this study highlights the importance of continued research on the complex adaptive blended learning systems to achieve effective and adaptable education. The findings provide a foundation for future research and emphasize the need to address the identified gaps in current studies and practices. The global interest in CABLS, as demonstrated by the distribution of studies across six countries, indicates the universal applicability of CABLS concepts and the necessity of cross-cultural insights to inform their implementation. The study also underscores the significance of CABLS in the education domain, with potential implications for improving teaching and learning outcomes. Clear guidelines, frameworks, and professional development are identified as crucial factors for the successful implementation of blended learning. Overall, this study contributes to the understanding of the CABLS and calls for further research to enhance educational practices and outcomes.

Limitations & Recommendations

The limitations of the analysis include a focus solely on published articles and dissertations from ten electronic scientific databases, potentially excluding relevant research presented in other forms such as conference papers or unpublished studies. The study also only examined studies related to Complex Adaptive Blended Learning Systems (CABLS), which may have limited the scope and excluded other related research within the broader field of blended learning. Additionally, the analysis did not consider the quality or impact of the included studies, which could have influenced the overall findings. Furthermore, the distribution of studies across countries may not be representative of the global landscape of CABLS research, as it relied on the availability of published literature from specific countries.

Recommendations for future research include incorporating a wider range of sources, such as conference proceedings and unpublished studies, to ensure a more comprehensive analysis of the research landscape in the field of the CABLS. To provide a more global perspective, future studies could aim to include a broader range of countries and regions, ensuring representation from diverse cultural and educational contexts. Cross-cultural insights and

collaboration among researchers from different countries can contribute to a better understanding of CABLS. Addressing these gaps can advance the field of blended learning and maximize the potential of CABLS for improving learning outcomes.

Statement of Researchers

Researchers' contribution rate statement: The contribution rates of the authors in the study are equal.

Conflict statement:

First Author declares that he/she has no conflict of interest.
Second Author declares that he/she has no conflict of interest.
Third Author declares that he/she has no conflict of interest.

REFERENCES

Arfanakis, A. K. (2022). *Variations in perspectives of blendedn learning in a predominantly face-to-face clasroom: the lived experience of high school science teachers*. Unpublished doctoral dissertation. University of Massachusetts Lowell.

Carmichael, T., Hadžikadić, M. (2019). The fundamentals of complex adaptive systems. In Carmichael, T., Collins, A., Hadžikadić, M. (Eds) *Complex adaptive systems. understanding complex systems.* Springer, Cham. https://doi.org/10.1007/978-3-030-20309-2_1

Cleveland-Innes, M.,&Wilton, D. (2018).*Guide to blended learning*. Commonwealth of Learning.

Cummings, S. (2022). *Elementary teacher perceptions of blended learning in the digital classroom.* Unpublished doctoral dissertation.Walden University.

Duarte, A. (2016). *Blended learning: Institutional frameworks for adoption and implementation*. Unpublished doctoral dissertation. University of the Incarnate World.

Evenhouse, D., Patel, N., Gerschutz, M., Stites, N. A., Rhoads, J. F., & Berger, E. (2018). Perspectives on pedagogical change: Instructor and student experiences of a newly implemented undergraduate engineering dynamics curriculum. *European Journal of Engineering Education, 43*(5), 664-678.

Fraenkel, R. J.,& Wallen, E. N. (2000). *How to design and evaluate research in education* (4th ed.). McGraw-Hill.

Giwa, K. A. (2022). *Investigating the use of information communication technology (ICT) for pedagogic change in mathematics and science (physics and chemistry) teaching/learning in Nigerian higher education institutions (HEIs).* Unpublished *doctoral dissertation*. University of Liverpool.

Gough, D., Oliver, S., & Thomas, J. (2017). *An introduction to systematic reviews* (2nd ed.). Sage.

Gulosino, C., & Miron, G. (2017). Growth and performance of fully online and blended K-12 public schools. *Education Policy Analysis Archives, 25* (124). https://doi.org/10.14507/epaa.25.2859

Juhl, C., & Lund, H. (2018). Do we really need another systematic review? *British Journal of Sports Medicine (BJSM)*, *52*(22), 1408-9. http://dx.doi.org/10.1136/bjsports-2018-099832

Kelly, D., & Denson, C. (2017). STEM teacher efficacy in flipped classrooms. *Journal of STEM Education: Innovations & Research*, *18*(4), 43-50.

Keiner, J. F. (2017). *Pedagogy and process: a case study of writing in a hybrid learning model.* Unpublished doctoral dissertation. Indiana University of Pennsylvania, School of Graduate Studies and Research Department.

Mathur, B., & Shukla, N. M. (2021). Blended learning understanding its frameworks and models. *Cosmos An International Journal of Art & Higher Education, 10*(2), 115-121.

Mcgee, E., & Poojary, P. (2020). Exploring blended learning relationship in higher education using a systems- based framework. *Turkish Online Journal of Distance Education-TOJDE 21(4)*, 2-13.

Rafi A, Anwar MI, Younas A and Manzoor S. Paradigm shift in medical education due to the COVID-19 pandemic: guidelines for developing a blended learning curriculum in medical education [version 2; peer review: 2 approved]. *F1000Research* 2022, 11:37 (https://doi.org/10.12688/f1000research.74779.2)

Sudrajat, D., Danar, D. R., Rahaningsih, N., Dikananda, A. R., & Kurnia, D. A. (2019). Clustering student's satisfaction in complex adaptive blended learning with the six value system using the k-means algorithm. *Universal Journal of Educational Research, 7*(9),1990-1995.

Wang, Y., Han, X., & Yang, J. (2015). Revisiting the blended learning literature: using a complex adaptive systems framework. *Educational Technology & Society, 18*(2), 380-393.

Yeop, M. A., Wong, K. T., & Noh, N. M. (2016). Blended learning in selected journals: a content analysis. *International Journal of Instructional Technology and Distance Learning, 13*(10), 47-58.