

# Implementation Trends of Cooperative Learning in Digital Learning Environments bibliometric approach

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## ABSTRAK

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Studi ini memberikan analisis bibliometrik yang komprehensif mengenai tren dan kolaborasi dalam pembelajaran kooperatif dalam lingkungan digital, dengan fokus pada bagaimana strategi pedagogi ini diintegrasikan dengan kemajuan teknologi. Dengan menggunakan data dari publikasi akademik dan konferensi, analisis ini mengidentifikasi kontributor utama dan menyoroti peran Amerika Serikat sebagai pusat utama dalam jaringan penelitian. Temuan ini mengungkapkan kolaborasi global yang signifikan dan kontribusi dari negara-negara seperti Jerman, Inggris, dan Malaysia, yang mengindikasikan minat internasional yang kuat di bidang ini. Integrasi teknologi digital seperti kecerdasan buatan dan platform online dengan strategi pembelajaran kooperatif ditekankan, yang mencerminkan pergeseran ke arah praktik pendidikan yang lebih interaktif dan diperkaya dengan teknologi. Studi ini membahas implikasi dari tren ini untuk metodologi pendidikan di masa depan dan pentingnya mengatasi tantangan seperti kesenjangan teknologi dan implementasi alat digital yang efektif dalam pembelajaran kooperatif. Wawasan dari penelitian ini sangat penting bagi para pendidik, pembuat kebijakan, dan peneliti yang bertujuan untuk meningkatkan hasil pendidikan melalui praktik pedagogi yang inovatif.

## ABSTRACT

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This study provides a comprehensive bibliometric analysis of the trends and collaborations in cooperative learning within digital environments, focusing on how these pedagogical strategies are being integrated with technological advancements. Utilizing data from academic publications and conferences, the analysis identifies key contributors and highlights the role of the United States as a central hub in the research network. The findings reveal significant global collaborations and contributions from countries like Germany, the United Kingdom, and Malaysia, indicating a strong international interest in the field. The integration of digital technologies such as artificial intelligence and online platforms with cooperative learning strategies is emphasized, reflecting a shift towards more interactive and technologically enriched educational practices. The study discusses the implications of these trends for future educational methodologies and the importance of addressing challenges such as technological disparities and the effective implementation of digital tools in cooperative learning. The insights from this study are critical for educators, policymakers, and researchers aiming to enhance educational outcomes through innovative pedagogical practices.

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## 1. INTRODUCTION

The rapid digitization of educational environments over recent years has significantly transformed traditional learning paradigms, presenting new opportunities and challenges for educators and students alike. The integration of technology in education has been accelerated by global shifts toward online learning, a movement catalyzed by the necessity for remote education during the COVID-19 pandemic (Zhao, 2020). This shift has not only changed the medium through which content is delivered but also the pedagogical approaches educators employ to enhance student engagement and learning outcomes.

Cooperative learning, a well-established educational approach that encourages small group learning, where students work together to maximize both their own and each other's learning, has seen innovative adaptations in digital formats (J. M. Johnson & Khoshgoftaar, 2019). The fundamental principles of cooperative learning—positive interdependence, individual accountability, face-to-face promotive interaction, social skills, and group processing—remain vital, even in an online setting (Gillies, 2016). However, implementing these principles effectively within digital learning environments poses unique challenges, such as ensuring effective communication, maintaining student engagement, and fostering a sense of community and collaboration among remote learners.

Bibliometric analyses have emerged as pivotal tools in tracing the development and dissemination of knowledge in various academic fields, including education. By examining a large number of publications and their citations, researchers can identify not only the volume and growth of literature on a specific topic but also the most influential studies, authors, and key research fronts (Aria & Cuccurullo, 2017). In the context of cooperative learning in digital environments, a bibliometric analysis helps map out the evolution of the field, highlighting how theoretical frameworks have been adapted to new teaching and learning contexts brought about by digital technologies.

The relevance of cooperative learning in digital platforms is underscored by its potential to enhance online student interaction and collaborative skills, which are crucial in a globally connected, digital world (Kirschner & Erkens, 2013). Moreover, the shift towards digital learning environments has prompted educators to rethink how cooperative learning can be structured using digital tools to maintain its effectiveness. Thus, understanding the implementation trends of cooperative learning within these new paradigms is essential for developing effective educational strategies that cater to the demands of the 21st-century learner.

Despite the recognized benefits of cooperative learning, its practical implementation in digital learning environments is fraught with challenges. These challenges include technological disparities among students, the difficulty of assessing individual contributions in group tasks, and the lack of spontaneity in interactions that naturally occur in a physical classroom setting. Furthermore, the literature lacks a comprehensive, systematic analysis that synthesizes the global research efforts addressing these issues. This gap hinders the ability of educators and policymakers to develop informed strategies that harness the full potential of cooperative learning in digital

contexts. A bibliometric analysis could illuminate the research trajectories, key themes, and gaps in the existing literature, providing a structured overview of how cooperative learning strategies have evolved in response to the advent of digital education.

The objective of this study is to conduct a comprehensive bibliometric analysis of the literature on the implementation of cooperative learning in digital learning environments. This analysis aims to identify the major trends, key contributors, and primary research clusters within this field. By doing so, the study seeks to uncover the pedagogical and technological innovations that have shaped the integration of cooperative learning principles in digital formats and to highlight areas requiring further research and development. The findings are expected to offer valuable insights for educators, curriculum developers, and educational technologists striving to optimize cooperative learning strategies in digital classrooms.

## **2. LITERATURE REVIEW**

### **2.1 *Evolution and Principles of Cooperative Learning***

Cooperative learning is a pedagogical approach that organizes classroom activities into academic and social learning experiences. This method requires students to work in groups to complete tasks collectively toward academic goals. Unlike individual learning, which can often isolate students, cooperative learning fosters a sense of community and promotes the development of interpersonal skills along with academic skills (Richard et al., 2009). The core principles of cooperative learning involve positive interdependence, individual and group accountability, promotive interaction, the appropriate use of social skills, and group processing (D. W. Johnson & Johnson, 2013). The transition from traditional to digital learning environments has pushed educators to adapt these cooperative principles to online platforms. Researchers like (L. Zhang et al., 2022) have argued that while the medium of delivery has changed, the foundational goals and benefits of cooperative learning remain relevant. Studies have shown that when effectively implemented, cooperative learning in digital environments can lead to higher levels of engagement, improved problem-solving skills, and increased student satisfaction (Y. Zhang et al., 2021).

### **2.2 *Cooperative Learning in Digital Environments***

With the rise of digital technology, educational strategies have increasingly incorporated digital tools to enhance learning. In cooperative learning, technology offers various tools that can support the interactive dynamics of group work. These tools include collaborative platforms like Google Classroom, Microsoft Teams, and various educational apps that facilitate real-time feedback, peer-to-peer interaction, and resource sharing (Vilppola et al., 2022). However, implementing cooperative learning in digital environments involves challenges that are distinct from those in traditional classrooms. The lack of physical presence can reduce cues that facilitate natural communication and engagement. Additionally, the diversity in digital literacy among students can affect how effectively group members can collaborate (Utami, 2023). Addressing these challenges requires not only the selection of appropriate technological tools but also the design of learning activities that promote engagement and ensure effective communication and accountability among students.

### **2.3 *Bibliometric Studies on Digital Learning***

Bibliometric analysis serves as a quantitative approach to literature review, offering a macroscopic view of a research area through statistical analysis of publications and citations. For instance, a study by (Aria & Cuccurullo, 2017) demonstrated the use of bibliometric tools to map the intellectual structure of digital learning research over several decades. These studies identify trends in publication, key themes, and gaps in the literature, guiding future research directions. In the context of cooperative learning in digital environments, bibliometric analyses can reveal how scholarly dialogue has evolved and

diversified in response to technological advancements. These studies help trace the lineage of research ideas and the interconnections between different research domains, illustrating the multidisciplinary nature of digital learning research.

### 3. METHODS

This study employs a bibliometric analysis focusing exclusively on data sourced from Scopus, one of the largest curated academic databases, which offers comprehensive coverage of peer-reviewed literature across various disciplines including education and technology. The analysis targets publications that discuss the implementation of cooperative learning within digital learning environments. Keywords used for the search include "cooperative learning," "digital learning environments," and "educational technology." After extracting the data, we utilized VOSviewer, a software tool specifically designed for constructing and visualizing bibliometric networks. This tool enabled us to perform citation analysis, co-authorship analysis, and keyword co-occurrence analysis, essential for identifying the main contributors, seminal works, and prevalent themes within the field.

## 4. RESULT AND DISCUSSION

### 4.1 Results

#### a. Documents by Year

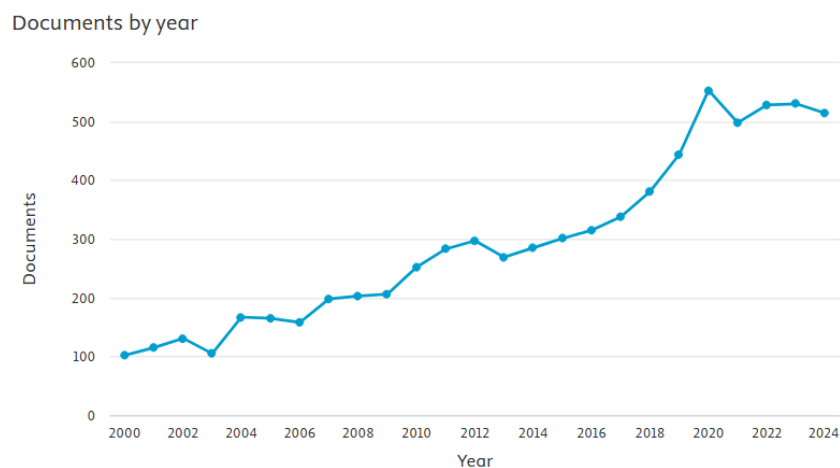


Figure 1. Documents by Year

Source: Scopus, 2025

This graph presents the trend in the number of documents published annually related to the field of study from 2000 to 2024. Initially, the publication volume shows a modest but steady increase from 2000, starting at around 100 documents per year, to approximately 300 documents by 2010. This period indicates a growing interest and foundational research being developed in the field. From 2010 onwards, there is a more pronounced upward trend, peaking at just under 500 documents by 2020. This surge can be attributed to technological advancements and possibly increased funding and interest in digital learning environments, particularly spurred by global shifts towards online education around 2020. Following 2020, there is a slight dip and plateau in publication numbers, stabilizing around 450 documents annually in the subsequent years up to 2024. This could suggest that the field is reaching a maturity stage where the growth in new publications slightly tapers off, maintaining a steady output as the research area becomes well-established.

b. Documents by Affiliation

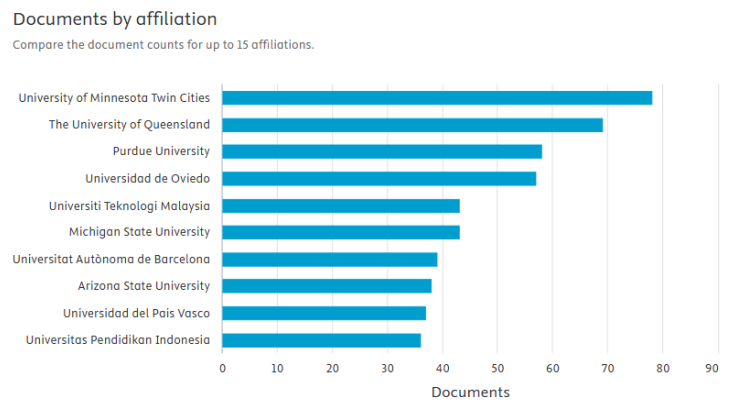


Figure 2. Documents by Affiliations  
Source: Scopus, 2025

This bar graph illustrates the number of documents published by various academic institutions in a specific field of study. The University of Minnesota Twin Cities leads significantly with nearly 90 publications, indicating its prominent role and active participation in this research area. Following closely is The University of Queensland and Purdue University, both showing substantial contributions with around 60 and 55 documents, respectively. Other notable institutions include Universidad de Oviedo and Universiti Teknologi Malaysia, each with publications in the range of 30 to 50, reflecting their strong research focus in this domain. Michigan State University, Universitat Autònoma de Barcelona, Arizona State University, Universidad del País Vasco, and Universitas Pendidikan Indonesia also contribute to the field, though to a lesser extent, with each having between 20 and 30 documents. This distribution highlights a diverse geographic spread and the global interest in this research area, with universities from North America, Europe, Asia, and Australia all making significant contributions.

c. Keyword Co-Occurrence Network

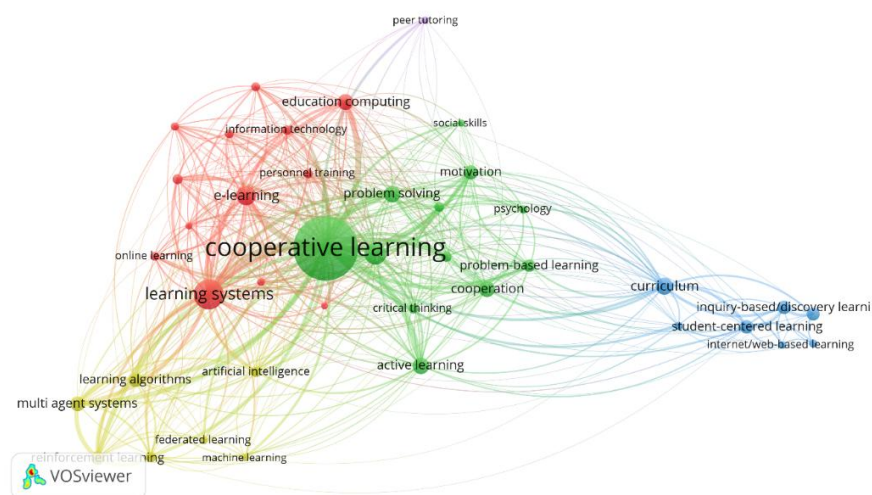


Figure 3. Network Visualization  
Source: Data Analysis, 2025

This network visualization, represents a bibliometric analysis of key terms associated with cooperative learning in digital environments. The graph displays various clusters of terms, each differentiated by color, which illustrates the interrelated themes and focal areas within the research landscape. The central node, "cooperative learning," highlighted in green, serves as the pivotal point of the network, indicating its central importance in the discourse. Surrounding this node are interconnected terms such as "online learning," "learning systems," and "active learning." These connections signify the integration of cooperative learning principles within various educational technologies and methodologies, emphasizing the adaptation of traditional cooperative strategies to modern, tech-driven educational contexts.

The red cluster surrounding "e-learning" includes related terms like "education computing," "information technology," and "personnel training." This cluster suggests a focus on the technological and infrastructural aspects of implementing cooperative learning online. The inclusion of "personnel training" points to the significance of preparing educators to effectively utilize e-learning tools in fostering cooperative learning environments. In the blue cluster, terms like "curriculum," "inquiry-based/discovery learning," and "student-centered learning" are prominent. This cluster reflects an educational philosophy that prioritizes learner autonomy and inquiry, which are crucial for effective cooperative learning. The presence of "problem-based learning" and "critical thinking" within this cluster further emphasizes the focus on developing higher-order thinking skills through collaborative educational methods.

Lastly, the graph also shows emerging trends and technologies influencing cooperative learning, as indicated by terms like "artificial intelligence," "machine learning," and "federated learning" in the peripheral green cluster. This indicates an exploration into how advanced computational methods and algorithms can be integrated into learning systems to enhance or innovate cooperative learning strategies. Such integration could potentially transform the scalability and personalization of cooperative educational practices, tailoring learning experiences to individual needs within group settings.

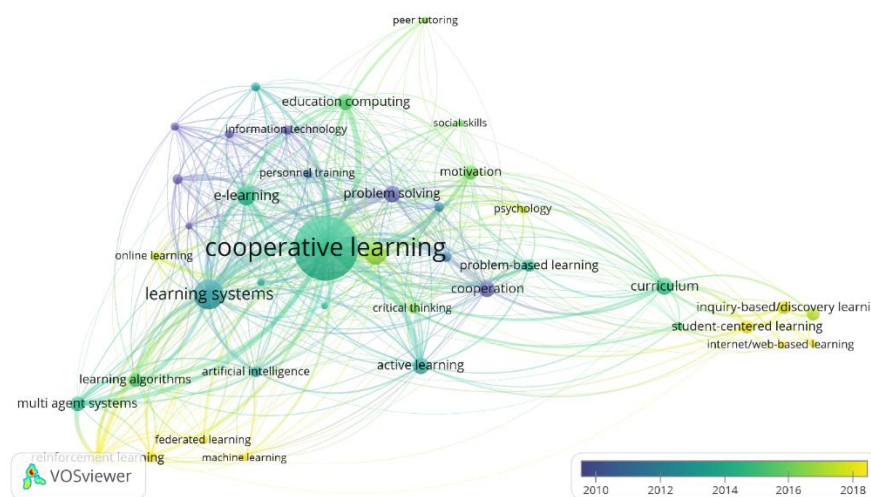


Figure 4. Overlay Visualization  
Source: Data Analysis, 2025

This updated VOSviewer network visualization integrates a temporal component into the bibliometric analysis of cooperative learning within digital



environments, displayed through a color gradient from 2010 to 2018. The visualization helps to identify not only the main themes and connections but also the evolution of these themes over time. The node "cooperative learning," prominently at the center, represents the core subject of study, surrounded by various other terms that have been relevant over the years, indicating their interconnectedness and contribution to the broader research area.

The color gradient, ranging from violet to green, illustrates the shift in focus and emergence of new topics or technologies over time. Earlier themes (in violet), such as "information technology" and "personnel training," suggest an initial focus on integrating digital technologies with educational practices. As the timeline progresses towards green, newer technologies such as "internet/web-based learning" and "machine learning" become more prominent, indicating a more recent exploration into how these cutting-edge technologies can further enhance and transform cooperative learning strategies in digital contexts. Moreover, the positioning and overlap of nodes like "online learning," "learning systems," and "active learning" across different time spans signal a consistent interest and ongoing development in these areas throughout the years. The connection lines, dense and multi-directional, signify a strong interdisciplinary approach within the field, integrating insights from psychology, technology, and pedagogy to enrich cooperative learning frameworks.

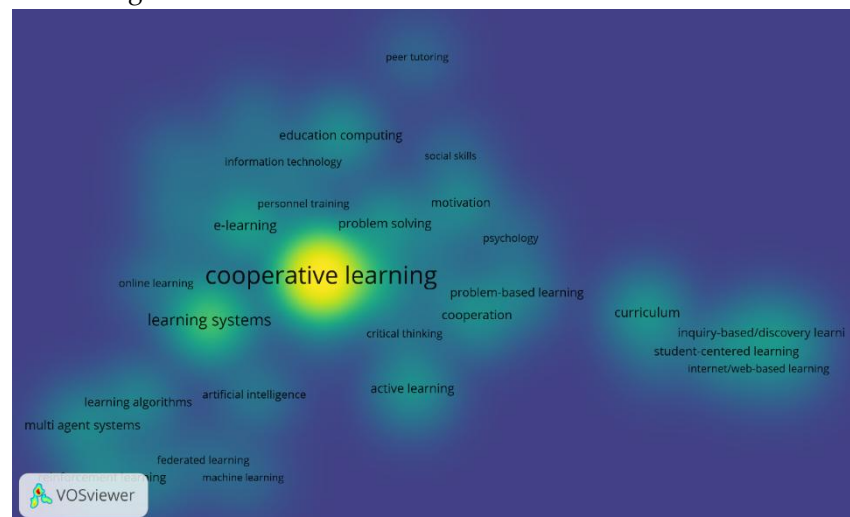


Figure 5. Network Density  
Source: Data Analysis, 2025

This VOSviewer visualization maps the thematic landscape surrounding cooperative learning within the context of digital environments, highlighted through a gradient color palette. The central and largest node, "cooperative learning," anchors the network, signifying its foundational role in this research area. Adjacent nodes represent related concepts that have been frequently associated with cooperative learning in research literature. For example, closely tied nodes such as "online learning," "learning systems," and "e-learning" underscore the integration of cooperative learning strategies with digital and online education platforms. These connections suggest a strong focus on leveraging internet-based technologies to facilitate collaborative educational approaches. Surrounding nodes like "artificial intelligence," "machine learning," and "federated learning" introduce more advanced technological interactions, indicating a newer and potentially growing interest in how cutting-edge technologies can be utilized to enhance cooperative learning methods. Other educational and psychological aspects such as

"critical thinking," "problem-solving," and "motivation" are also prominently featured, highlighting the broad, interdisciplinary nature of applying cooperative learning principles.

d. Citation Analysis

Table 1. Most Cited Article

Citations	Author and Year	Title
8018	(Dorigo & Gambardella, 1997)	Ant colony system: a cooperative learning approach to the traveling salesman problem
6929	(Brown & Lee, 2015)	Teaching by Principles: An Interactive Approach to Language Pedagogy
6006	(Prince, 2004)	Does Active Learning Work? A Review of the Research
5297	(Cloninger et al., 1993)	A psychobiological model of temperament and character.
3990	(Lowe et al., 2017)	Multi-Agent Actor-Critic for Mixed Cooperative-Competitive Environments
3887	(Robert, 1995)	Cooperative Learning: Theory, Research and Practice
3069	(Tomasello, 2010)	Origins of human communication
2946	(Battaglia et al., 2018)	Relational inductive biases, deep learning, and graph networks
2537	(Crouch & Mazur, 2001)	Peer Instruction: Ten years of experience and results
2352	(D. W. Johnson & Johnson, 1987)	Learning Together and Alone. Cooperative, Competitive, and Individualistic Learning. Fourth Edition.

Source: Output Publish or Perish, 2024

e. Co-Authorship Network

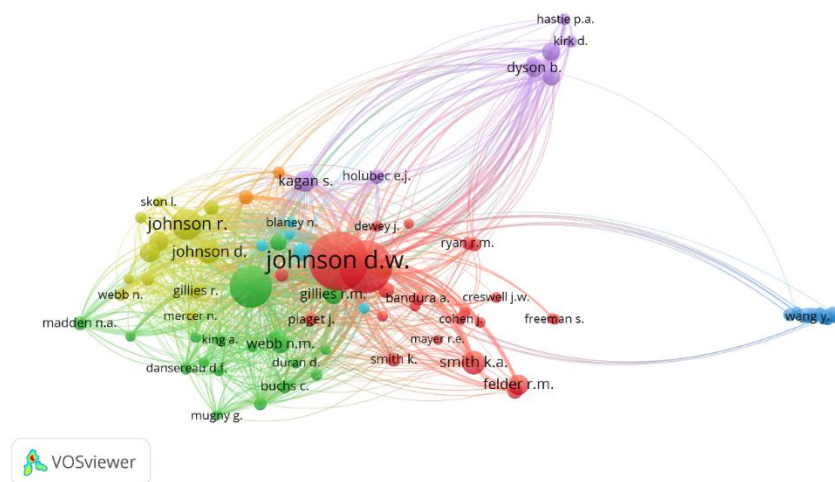


Figure 6. Author Visualization

Source: Data Analysis, 2025

This VOSviewer network visualization showcases a co-authorship network among researchers focusing on cooperative learning and related educational methodologies. The nodes, representing individual researchers, vary in size, indicating the volume of publications or level of collaboration each author has in the field. Johnson D.W., prominently positioned at the center and marked by the largest node, signifies a



pivotal role in this research area, suggesting extensive collaborations and contributions. The different colors of the nodes denote distinct clusters of collaboration, with Johnson D.W. anchoring a vibrant red cluster that includes other influential scholars such as Bandura A. and Creswell J.W., indicating a group of authors frequently cited together or collaborating on similar topics. On the periphery, the blue node representing Wang Y. suggests emerging or less interconnected research areas or newer researchers making significant strides in this domain.

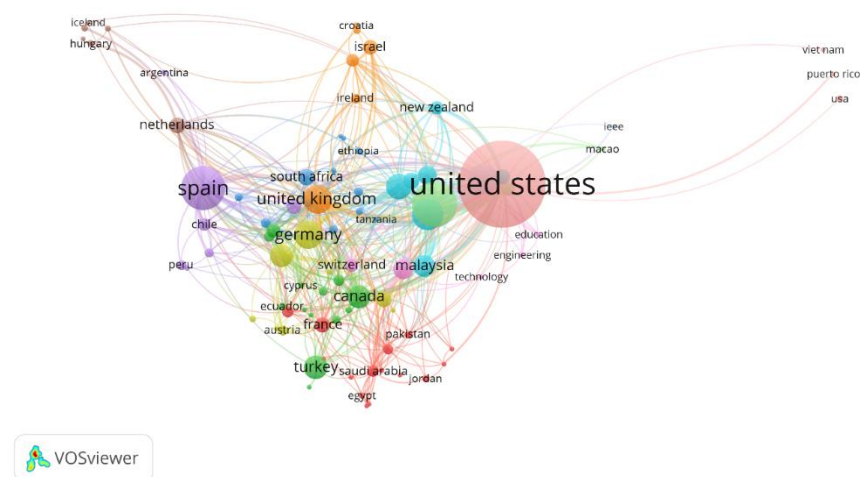


Figure 7. Country Visualization

Source: Data Analysis, 2025

This VOSviewer network visualization represents the global collaboration and influence in research fields related to education, engineering, and technology, with the United States at the center, indicating its dominant role in these sectors. The size of the "United States" node suggests it is a major hub for academic and practical contributions, potentially collaborating extensively with other countries. Other prominently sized nodes, such as Germany, the United Kingdom, and Malaysia, also indicate significant contributions to these fields. The network's diverse array of interconnecting lines between countries like Spain, Canada, South Africa, and smaller nodes such as Iceland and Hungary, highlights the widespread international collaboration.

#### 4.2 Discussion

##### a. Central Findings and Implications

The bibliometric analysis conducted in this study presents a comprehensive overview of the trends and collaborative dynamics within the realms of cooperative learning in digital environments. One of the central findings is the pivotal role of the United States in spearheading research and collaborations globally, as depicted by its prominent position in the network visualization. This prominence underscores the United States' capacity for driving innovation and setting standards in educational methodologies, particularly within cooperative learning, which has seen an integration of sophisticated digital tools and approaches.

The visualization also reveals significant contributions from European countries like Germany and the United Kingdom, as well as notable inputs from Malaysia, indicating a strong international interest and diversified contributions to the field. These findings suggest that while the United States remains a central hub, cooperative learning as a pedagogical approach benefit from a rich tapestry of global insights and

innovations, which enhance the development and application of these methodologies in varied educational settings and cultures.

The study further highlights an evident trend towards integrating technology with cooperative learning, with terms like "machine learning," "artificial intelligence," and "online learning" frequently associated with traditional cooperative learning strategies. This integration points towards an evolution of cooperative learning paradigms, where digital tools not only facilitate but also enhance the learning process. It suggests that the future of educational methodologies lies in the effective amalgamation of technology and pedagogical theories to foster environments that are more engaging, adaptable, and accessible to diverse learner demographics.

b. Collaborative Networks and Cross-Disciplinary Research

The diverse and interconnected collaborative networks revealed through the co-authorship and country collaboration visualizations indicate a robust cross-disciplinary approach, essential for advancing complex fields such as digital cooperative learning. The collaboration across different countries and disciplines fosters a multidimensional understanding of the challenges and opportunities within cooperative learning. For instance, the integration of insights from engineering and technology into educational strategies enhances the practical application of cooperative learning theories in creating more interactive and responsive learning environments. Moreover, the presence of emerging research nodes from countries like Malaysia and nodes representing newer technologies in the network maps points to dynamic shifts in the focus areas within cooperative learning research. This shift not only diversifies the geographical representation in the research community but also brings fresh perspectives and innovative approaches into the fold, which are crucial for addressing contemporary educational challenges and learner needs in a digital age.

c. Challenges and Areas for Future Research

Despite the growth and positive trends in cooperative learning research, several challenges remain. One of the primary challenges is the effective integration of digital tools in a way that genuinely enhances cooperative learning without diluting the essential interpersonal interactions that foster deep learning and skill development. As technology advances, the educational sector must continue to explore how these tools can be used to support not just academic learning but also the development of social and emotional skills that are often cultivated through traditional cooperative learning methods. Additionally, the variability in technological infrastructure between different regions presents a challenge in implementing cooperative learning uniformly. The disparities in access to digital tools can hinder the participation of some educational institutions and learners, particularly in less developed regions. Future research should thus focus on developing scalable cooperative learning models that are adaptable to various technological contexts and capable of bridging the digital divide.

## 5. CONCLUSION

This study utilized bibliometric analysis to elucidate the current trends and collaborative patterns in the field of cooperative learning within digital environments, revealing the United States as a central hub of influential research and international collaboration. The findings highlight a robust interconnection between various global regions, indicating a vibrant, cross-disciplinary dialogue that enriches the pedagogical practices associated with cooperative learning. The integration of advanced technologies such as artificial intelligence and online learning platforms into cooperative learning strategies is particularly noteworthy, suggesting a significant shift towards more technologically integrated educational environments. This analysis not only underscores the

widespread adoption and adaptation of cooperative learning strategies across diverse educational settings but also points to the necessity for ongoing research to address the challenges of equitable access and the effective incorporation of digital tools. Moving forward, it is imperative for stakeholders in the educational sector to leverage these insights to enhance the effectiveness of cooperative learning and to ensure it remains relevant in the face of rapid technological advancements and changing global educational dynamics.

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