Digital Collaborative Learning in Higher Education: A Systematic Review

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Abstract
With the rapid development of digitization and informatization, digital course resources and online learning platforms are rapidly increasing, and the phenomenon of superficial learning is increasingly attracting widespread attention. Although digital courses have abundant resources, they reduce the interaction and exploration process of knowledge between teachers and students, as well as between students and themselves. Exploring effective stragies for online discussions and interactions is of great significance in promoting the efficiency and quality of digital collaborative learning. This article aims to review effective strategies for promoting meaningful online discussions and interactions in a digital collaborative learning environment. In addition, this article also proposes future directions for higher education to enhance the interactivity of collaborative learning. Therefore, this article fills the limited gap in the systematic evaluation of digital collaborative learning. This article adopts the preferred reporting item (PRISMA) of systematic evaluation and meta-analysis to review current research, and uses two core journal databases, Scopus and Web of Science. Through a systematic search of "digital collaborative learning" or "online collaborative learning" or "online interactive learning" or "online collaborative learning" or "remote collaborative education" and "higher education" or "professional education" or "academic education" or "adult education", a total of 15 articles were found. Based on this, we explored the main problems and effective strategies to promote interaction in digital collaborative learning, and put forward some targeted suggestions at the end of the research, which should be the focus of future research. The main outcome emphasizes four effective strategies for promoting meaningful online discussions and interactions in a digital collaborative learning environment: positive promotion, positive feedback, reflection, and technical support. Despite its limitations, this systematic review can make a certain contribution to digital collaborative learning, benefiting practitioners in related fields and paving the way for future research.
Keywords: Systematic Review, Digital Tools, Collaborative Learning, Higher Education

Introduction

Digital learning and online learning have become a new trend in the field of education around the world, which is due to the huge impact of digital technology on education. The worldwide prevalence of COVID-19 has also accelerated this historical process, and made digital learning more important and universal. It is regarded as one of the important teaching forms faced by both learners and educators in the field of education. Digital teaching tools and platforms are constantly emerging, and how to strengthen collaboration and improve learning efficiency and interest in the digital teaching environment is attracting more and more attention and attention from peers.

Collaboration ability is often described as a typical skill of the 21st century, and its value is constantly increasing with the proliferation of digital tools and their associated culture of engagement (Sobko, 2020). Collaboration emphasizes the interaction and influence between a range of human and non-human participants, including teachers, students, education, technology, and the internet. People's interest in digital collaborative learning practices is increasing day by day, and the academic community exploring this phenomenon is no exception. In fact, people generally believe that collaboration is necessary and beneficial, and is a necessary component of work, life, and learning, especially in today's digital age.

Although there has been an increase in research trends related to online learning, many fields have shown strong interest in studying the impact and nature of collaboration in digital environments, with some exploring how people can learn together with the assistance of computers under the banner of "computer-supported collaborative learning" (Stahl, 2006; Armstrong, 2010; Chen, 2018, et al.). There are also some studies that focus on the nature of cross group collaboration (Oliveira et al., 2011)as well as evaluating and encouraging collaboration in online courses (Swan et al., 2013). Most studies focus on revealing people's perceptions of the quality of online course experiences, with very little direct observation of collaborative learning. As Dillenburg said, "Bringing learners together does not guarantee an effective collaborative learning experience.". There is a blank space in research on how to effectively promote interactive communication and co construction of knowledge systems among members of online learning, in order to achieve the best learning outcomes and achieve established goals. Therefore, the goal of this study is not to focus on digital technology, but to explore how teachers, students, and digital technology play important mediating roles in collaborative learning processes. As Latour said, our goal is to open the "black box" of collaborative learning and explore the most effective strategies for promoting meaningful online discussions and interactions in the context of digital collaborative learning.

RQ: What are the most effective strategies for facilitating meaningful online discussions and interactions in digital collaborative learning environments?

We have found through literature review that there has been extensive research on the benefits of collaboration for learners and educators. For example, Hiltz (S.R, 1993)and Johnson argue that "collaborative learning means that knowledge is not directly taught by teachers to students, but gradually formed through active practice such as communication and interaction among students in the process of understanding concepts and applying skills." (D.W, 1981) In collaborative learning groups, the interaction between students is mainly through communication and cooperation among peers, through learning motivation and dedication to achieving good team results. This viewpoint demonstrates the importance of necessary interaction among students, believing that close collaboration among students

determines whether educational goals can be achieved. Johnson emphasized that collaborative learning is not just about randomly arranging students into small groups, but rather requires the establishment of good collaborative relationships among students in a reasonable manner to achieve goals (Johnson, 1991). Bruffe believes that collaborative learning can enable students to change their habitual student-centered learning habits and adapt to group learning as a strategy (Bruffe, 1999). Knowledge is not a product of individual cognition, but is constructed through collaborative efforts within social groups. That's also why we frequently see terms like "collaborative learning" and "collaboration" in digital media. Moreover, we can add without hesitation that the importance of collaborative ability is determined rather than questioned.

Previous studies have analyzed the advantages of digital learning in higher education from multiple perspectives, such as flexibility, convenience, diversity of materials, and breaking through time and space limitations, as well as the problems in digital learning, such as (1) chaotic collaborative processes and low interactivity; (2) Lack of knowledge reserves, insufficient discussion and communication; (3) The learning content is dull and the learning form is single; (4) The evaluation method is too single and so on.A systematic literature review is a rigorous process that categorizes, selects, and critically evaluates past research to answer research questions. Researchers conducting systematic literature reviews determine protocols or guidelines before conducting the review process. The systematic literature review process is very transparent. This is because the recognition process in SLR is carried out through several databases, which other researchers can replicate. SLR includes a very strict search strategy that enables scholars to find answers to specific questions. Each review process performed, such as the keywords used and article selection, will receive detailed explanations so that others can replicate the query. Some studies attempt to systematically review strategies for collaborative learng, however, their focus is not on the problems and challenges in digital collaborative learning.

This systematic literature review focuses on a key research question: What is the most effective strategy to promote meaningful online discussions and interactions in a digital collaborative learning environment? This study aims to fill this gap by carefully reviewing similar studies in the past, in order to better understand the current challenges and future improvement directions of digital collaborative learning.This study provides important contributions to knowledge systems related to digital collaborative learning. Through this study, stakeholders or stakeholders such as course developers and educators can now understand the key and difficult points of integrating relevant technologies into traditional classrooms in the context of digital learning, which can further promote the development of digital collaborative learning methods. In addition, this study enables interested parties to stay informed of the latest research trends and provides them with opportunities to strategically plan adaptation to the needs and abilities of learners, as well as adaptation related to their respective national education systems. In addition, current research emphasizes key areas that future researchers should focus on.

Methodology
This section discusses the issues and challenges related to collaborative learning used by retrieval learning institutions for digital collaborative learners. The system review process is guided by PRISMA (preferred reporting item for system review and meta-analysis). The research on this system was conducted through the process of identifying and searching for articles related to digital collaborative learning practices in higher education institutions,

using two databases: Scopus and WOS. Then, the process of this system continues, including several stages of identification, screening, qualification, and exclusion.

The Review Protocol (PRISMA)

PRISMA (the preferred reporting item for systematic review and meta-analysis) was used as guidance throughout the entire process of preparing this systematic review paper. PRISMA is commonly used in the field of education (Yunus, 2022). PRISMA provides three benefits: (1) it presents clear research questions for systematic research; (2) Established exclusion and inclusion criteria; (3) Enable researchers to access vast scientific literature databases. PRISMA provides researchers with an opportunity to rigorously search for the difficulties and challenges faced in the process of digital collaborative learning. This method can be used to determine the collaborative learning practices used by learning institutions in digital teaching.

Resources

The study relied on two main databases (WoS and Scopus) and two supporting databases (Science Direct and Mendeley). WoS is regarded as a robust database comprising about 33,000 journal articles and covering more than 256 disciplines including the subjects related to environmental studies, interdisciplinary social sciences, social issues, as well as development and planning.Over 100 years of comprehensive backfile and citation data established by Clarivate Analytics have been included in the World of Science (WoS) database. These data were also ranked by Clarivate Analytics into three different measures (citations, papers, and citations per paper). The second database used in this systematic literature review was Scopus, which consists of 22,800 journals from 5000 publishers all over the world. Scopus is regarded as one of the largest abstract and citation databases including peer-reviewed literature. It covers a wide range of subject areas such as environmental sciences, social science, as well as agriculture and biological sciences.

Systematic Searching Strategies

There are three main stages in the systematic searching strategies, namely identification, screening, and eligibility (Figure 1).
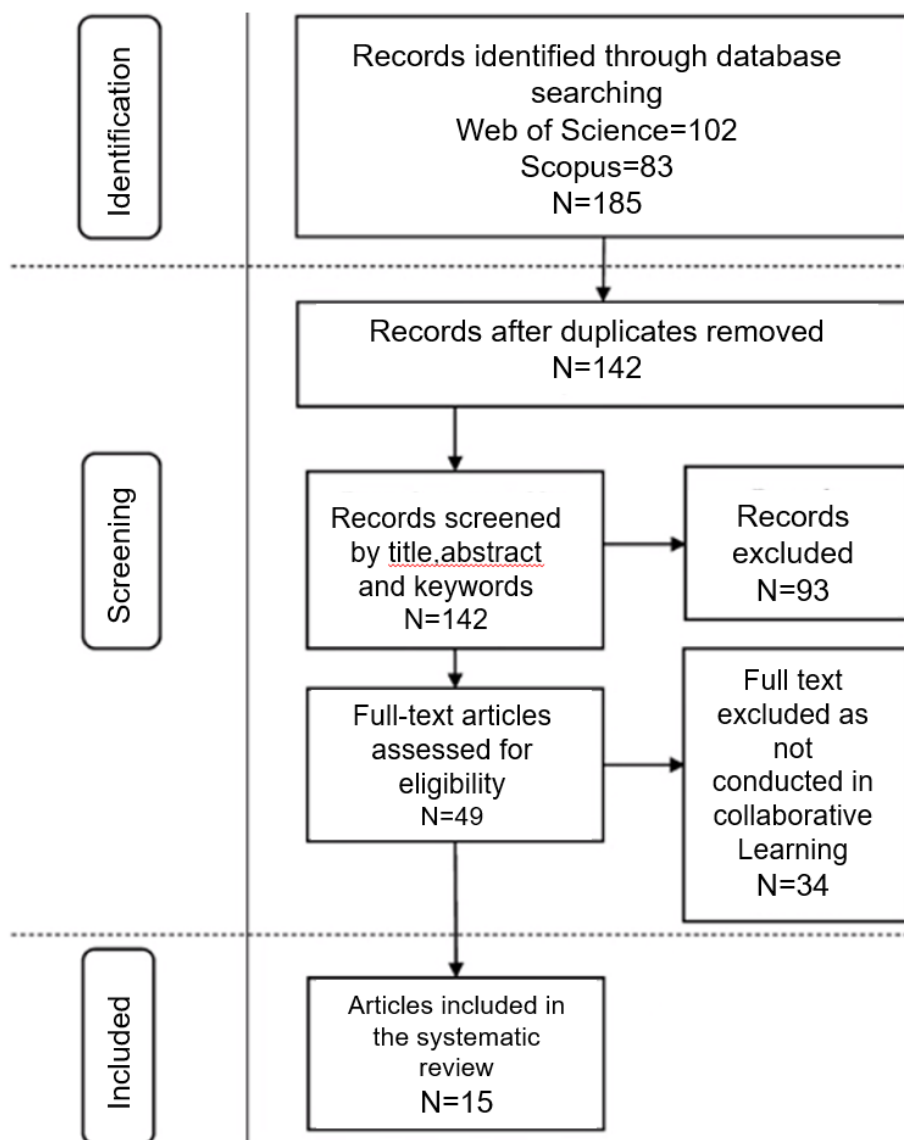
Figure 1. Flow diagram of the study.

Identification

The first phase, which is identification, is a process that finds related terms, synonyms, and variations for the main keywords for the study, namely digital cooperative learning, strategies, and higher education. The purpose of this stage is to provide more alternatives for the identified database to search for more relevant articles to be included in the systematic review. This process relied on keywords used by previous studies, online thesaurus, and keywords suggested by Scopus. Furthermore, the keywords were developed according to the research question as recommended by. Boolean operator, phrase searching, and truncation were used by the authors on the database particularly Scopus and Web of Science to enrich the current keywords and produce the full search string. Keywords similar and related to digital cooperative learning were used as shown in Table 1. Both Scopus and Web of Science are considered the leading database in the systematic review, as they are comprehensive and have advanced search functions. Moreover, these two databases have a multidisciplinary focus and can control the

quality of the articles. A total of 185 articles were retrieved from the searching process through Scopus, Web of Science.

Table 1
The search string used for the systematic review process.

Database	Keyword Used
Scopus	TITLE-ABS-KEY (("Digital collaborative Learning*" OR "Online collaborative learning*" OR "Interactive online learning" OR "Computer-supported collaborative learning" OR "Virtual collaborative learning" OR "Internet-based collaborative learning" OR "Network collaborative learning") AND ("Higher Education" OR "Higher Learning" OR "Postsecondary" OR "Advanced education" OR "University education" OR "College education" OR "Academic education" OR "Professional education*"))
Web of Science	TS=(("Digital collaborative Learning*" OR "Online collaborative learning*" OR "Interactive online learning" OR "Computer-supported collaborative learning" OR "Virtual collaborative learning" OR "Internet-based collaborative learning" OR "Network collaborative learning") AND ("Higher Education" OR "Higher Learning" OR "Postsecondary" OR "Advanced education" OR "University education" OR "College education" OR "Academic education" OR "Professional education*"))

Screening

Duplicate papers in Scopus and WOS were thoroughly detected by the researchers. The remaining publications were scrutinized in-depth to see if they met the researchers' requirements. The criteria for articleselection were applied to all 185 articles, which was done automatically in the database with the sorting method. The criteria for selecting papers were based on the review's research question, as suggested. Since it is difficult for the authors to read all the articles, the authors have opted to adopt the advice, which states that writers should determine the time range of the articles before reviewing them.

The results of the search on the chosen database showed that there have been many studies done on cooperative learning since 2010. However, there were not many systematic reviews focused on the years after the year 2020. As a result, the period from 2020 to 2023 was chosen as one of the inclusion criteria. Only studies with empirical data that were published in a journal were included in the review to assure its quality. Furthermore, only items written in English were included to minimize misunderstandings. Moreover, only articles related to cooperative learning were selected for this review (Table 2). This method resulted in the removal of 43 duplicated articles and the exclusion of 93 articles that did not meet the inclusion criteria

Table 2
The search string used for the systematic review process.

Criterion	Eligibility	Exclusion
Timeline	Between 2020 to 2023	<2020
Literature type	Empirical	Conference proceedings, review articles, book chapters, reports
Language	English	Non-English
Scope	Related to cooperative learning and HE	Not related to cooperative learning and HE

Eligibility

As for the third stage known as eligibility, a total of 49 articles were prepared. On a more important note, the titles, abstracts, and main contents of all the articles were thoroughly examined at this stage to ensure that they met the inclusion criteria (Table 2) and were suitable for use in the current study to meet the research objectives. As a result, 34 articles were eliminated since they were not related to empirical data and digital cooperative learning context. Finally, 15 articles were ready to be examined.

Exclusion Criteria

Only articles that truly met the criterion were included after the three steps. They included quantitative, qualitative research, and mixed methods. Book, book series, chapters in book, systematic review articles, conference proceedings, non-English publications published before 2020, and non-ESL articles were all essential points for exclusion.All these factors were considered to generate high-quality data. Figure 1 illustrates the procedure followed.

Main Findings

Table 3
Summary of the selected studies.

Study	Data base	Aim	Samples	Findings
Ignacio, J., & Chen, H. C. (2020)	WOS Scopus	This study aimed to describe and evaluate, through focus group discussions, a virtual collaborative learning activity implemented to assist first year undergraduate nursing students to develop cognitive integration in a module consisting of pathophysiology, pharmacology, and nursing practice.	Fourteen first year undergraduate students and four faculty	With better planning directed at addressing the learners' needs and the faculty's capabilities and readiness for online learning pedagogies, and with a strong institutional support to help mitigate the identified constraints of virtual collaborative learning, students and faculty will benefit.
Naamati-Schneider, L., & Alt, D. (2023)	WOS Scopus	It aimed to investigate how students' flexible thinking within the learning process might shape their perceptions of the advantages derived from this instructional activity within the domain of online collaborative learning.	100 Israeli undergraduate students	This study mainly underscores the important role flexible thinking plays in motivating managers and medical professionals to embrace innovative technologies or methods for teamwork.
Khalifeh, G., Noroozi, O., Farrokhnia, M., & Talaee, E. (2020)	WOS Scopus	The purpose of this research was to study the perceived readiness of higher education students for computer-supported collaborative learning (CSCL).	326 higher education students	The male participants demonstrated more online learning aptitude compared to females. A statistically significant difference was found in the online learning aptitude of the respondents majoring in engineering and basic sciences with the rest of the participants.

Hernández-Sellés, N., Muñoz-Carril, P. C., & González-Sanmamed, M. (2020)	*WOS Scopus*	The purpose of this study is to understand the key elements that configure effective interaction in the implementation phase of CSCL and to analyze the different types of interactions that occur during collaborative learning processes.	106 learners	A factorial analysis of results prove that students identify three types of interaction to be necessary during the implementation phase of collaboration in order to reach knowledge convergence: cognitive, social and organizational interaction.
Frania, M., & Correia, F. L. D. S. (2022)	*WOS Scopus*	This research aims to diagnose and compare the level of interpersonal competences and attitude in the OCL model among students preparing for the profession of an educator, pedagogue or teacher in the autonomous region of Madeira and in Poland.	the surveyed students	The largest group of the surveyed students in both countries expressed a positive attitude towards implementing OCL in their courses of study and declared their willingness to be a member of a group that learns online together.
Nungu, L., Mukama, E., & Nsabayezu, E. (2023)	*WOS Scopus*	This study aims to investigate how online collaboration can support the learning of science, technology, engineering, and mathematics (STEM) in higher education.	88 postgraduate students	The study found moderate positive Spearman rho correlation coefficient, $r_s = 0.69$, $P < 0.01$ which explains that 69% of the total variance in the students' successful performance is explained by the two variables, i.e., social and cognitive presence.
Luo, H., Han, X., Chen, Y., & Nie, Y. (2022)	*WOS Scopus*	To investigate the impact of assigned leadership and its key characteristics in promoting team learning in the online context.	94 students	The results revealed significant differences between assigned leaders and group members in certain participating behaviors. However, the impact of assigned leadership on learning outcomes and perceptions was insubstantial.
Männistö, M., Mikkonen, K., Kuivila, H. M., Koskinen, C., Koivula, M., Sjögren, T., … & Kääriäinen, M. (2020)	*WOS Scopus*	The aim of this study was to describe and explore health and social care educators' perceptions of their current level of competence in digital collaborative learning and identify distinct educators' profiles.	Educators from 21 applied science universities and 8 vocational colleges	The vocational college educators rated their competence in fostering construction of knowledge in digital collaborative learning as significantly lower than higher education educators. There were also remarkable differences in competence in supporting students' individual collaborative learning.
Ngo, D., Nguyen, A., Dang, B., & Ngo, H. (2024).	*WOS*	This study aims to utilize AI facial recognition to inform the learning regulation behaviors in synchronous online collaborative learning environments.	36 university students	Findings accentuate fundamental added values of AI application in education, whilst indicating further interesting patterns about student self-regulation in the collaborative learning environment.
Muñoz-Carril, P. C., Hernández-Sellés, N., Fuentes-Abeledo, E. J., & González-Sanmamed, M. (2021).	*WOS*	The goal of this study was to identify factors affecting students' satisfaction and erception of impact on learning in CSCL.	701 students in a virtual university	Perceived ease of use and perceived usefulness positively and significantly influenced attitude, and attitude, together with perceived enjoyment, were determining factors in perceived impact on learning.
Sjølie, E., & Van Petegem	*WOS*	This paper explores the perceived sociability of a virtual learning environment after it was implemented	1,611 students	The results of this large-scale study suggest that the Norwegian version of the sociability scale can be used

, P. (2022)		in an interdisciplinary project-based course in a higher education institute in Norway due to the COVID-19 pandemic.		as a valid and reliable instrument to measure the perceived sociability of a virtual learning environment in the context of self-organized student project teams.
Sjølie, E., Espenes, T. C., & Buø, R. (2022)	WOS	We explored how the transition to online learning affected social interaction and how teams changed their practices to support and sustain social interaction in the online environment.	1611 graduate students	The findings show that the changed conditions of the learning environment influenced social interaction in negative ways, but also that team reflection seemed to enable the students to reverse some of the adverse effects and develop practices that supported both the cognitive and socio-emotional dimensions of social interaction.
Dashkina, A., Kobicheva, A., Lazovskaya, T., Tokareva, E., Tarkhov, D., & Guselnikova, I. (2022).	Scopus	The main goal of this research was to assess the effectiveness of the computer-supported collaborative learning for language learning purposes using the indicators of students' learning outcomes and the level of their engagement, as well as to determine the most effective benchmarks for teams' forming.	81 undergraduate	As the COVID-19 pandemic is an ever-changing situation, it is important to implement effective learning models that promote higher learning outcomes and students' engagement.
Zheng, L., Long, M., Chen, B., & Fan, Y. (2023)	Scopus	To cope with these challenges, this study proposes and evaluates a novel automated assessment and feedback approach that is based on knowledge graph and artificial intelligence technologies.	108 college students	The introduced automated assessment and feedback significantly promoted group performance, knowledge elaboration, and socially shared regulation of collaborative learning.
Jieun, L. E. E., & Osman, G. (2021)	Scopus	The purpose of this study was to compare the experiences and perceptions of UAE and Korean students in campus-based universities of online collaborative learning (OCL)	262 college students	As barriers to OCL, UAE students pointed out language, gender, and privacy as the major barriers while Korean students mentioned students' attitude and language.

Discussion

This study mainly explores the most effective strategies for promoting meaningful online discussions and interactions in a digital collaborative learning environment. When answering our research question, we found the following points:

(1) The importance of positive promotion. How to improve the quality and depth of interaction by proposing exploratory questions, providing timely feedback, and guiding discourse strategies. Emphasize the role of mediators or intermediaries in maintaining normal discussions, easing conflicts, and ensuring that all participants have a voice. In addition, the positive impact that students generate when cooperating with each other is not only an unexpected result of this cooperation, but also a behavior that promotes the development of the internet. This observation is consistent with Latour's explanation of networks and their actors: actors do not interact with each other or produce predetermined effects, but they are always embedded in a relational network, promoting unpredictable processes and outcomes. Educators and instructional designers must intentionally "combine" homework and tools to achieve collaborative learning and maintain student engagement, while also understanding that the network will inevitably work in unpredictable ways and have its own impact.

(2) The importance of positive feedback. Positive feedback helps to develop a supportive learning community in an online environment. When learners receive supportive and constructive feedback from peers and counselors, they cultivate a sense of trust and collaboration. When learners' ideas and viewpoints are affirmed and validated, they are more likely to openly express themselves in online discussions and take intellectual risks. This confidence can lead to more meaningful interaction, as learners are willing to participate in

deeper discussions and share their unique insights. In addition, positive feedback helps cultivate social cohesion and connectivity among learners in online collaborative learning environments.

(3) The importance of reflection. When participants reflect, they have the opportunity to evaluate the effectiveness and reliability of shared information, analyze arguments, and determine biases or hypotheses. The development of critical thinking has improved the quality of online discussions. Through reflection, participants can gain a better understanding of their ideas, assumptions, and learning strategies in online discussions. This metacognitive awareness enables participants to monitor their understanding, identify areas for improvement, and adjust their communication or learning methods. In addition, through reflective discussions, participants can evaluate different ideas and challenge their own hypotheses. This kind of reflection promotes a more open approach, allowing participants to appreciate different perspectives and engage in mutually respectful dialogue that encompasses multiple perspectives.

(4) The importance of technical support. Technical support can help solve any technical issues that participants may encounter during online discussions. This may include connectivity, audio or video conferencing tools, file uploads, or any other technical malfunctions. Timely and effective technical support can ensure that participants can quickly overcome these issues, minimize interference, and maximize participation in discussions. Technical support can help integrate and utilize multimedia and collaborative methods to enhance online discussions. This may include features such as video conferencing, screen sharing, collaborative document editing, polling, or group meeting rooms.

Based on the above discussion, we also propose future directions for higher education to enhance the interactivity of collaborative learning, such as artificial intelligence, AR, and VR technologies. They have the potential to transform online discussions into immersive interactive experiences. Virtual meeting spaces or classrooms can be created where participants can interact with avatars, manipulate virtual objects, and collaborate in a more realistic and engaging manner. Thus improving learner engagement, promoting simulation, and creating unforgettable learning experiences. In addition, specialized social learning platforms can be designed to create a sense of community and promote meaningful interaction. These platforms can include functions such as user profiles, forums, interest based groups, direct messaging, and content sharing. By providing participants with a centralized space for connection, collaboration, and resource sharing, social learning platforms encourage continuous participation and establish relationships beyond individual discussion, creating an inclusive and open digital citizen community.

Conclusions

To conclude, this study has reviewed papers related to digital collaborative learning. This article aims to review effective strategies for promoting meaningful online discussions and interactions in a digital collaborative learning environment. Therefore, this article fills the limited gap in the systematic evaluation of digital collaborative learning. By using two major databases, WOS and Scopus, 15 articles were included based on inclusion and exclusion criteria. The main outcome emphasizes four effective strategies for promoting meaningful online discussions and interactions in a digital collaborative learning environment: positive promotion, positive feedback, reflection, and technical support. By implementing these strategies, educators can create a dynamic and engaging digital collaborative learning environment, promoting meaningful online discussions and interactions. Importantly, in the

future, these strategies can be adjusted and improved based on specific situations, participant needs, and constantly evolving technologies to ensure continuous improvement and a positive learning experience. In addition, this article also proposes future directions for higher education to enhance the interactivity of collaborative learning, such as the application of artificial intelligence, AR, and VR technologies. They have the potential to transform online discussions into immersive interactive experiences, thereby increasing learner engagement and knowledge co construction, sharing, and innovation.

There are certain limitations to this study, as most studies focus mainly on undergraduate students in universities and colleges. Therefore, this review does not mention that education level is a trend. This limitation undoubtedly opens up new opportunities for future research, especially in selecting different levels of digital collaborative learning research. Secondly, this review is based on high impact journals such as WOS and Scopus. Therefore, if other databases such as Google Scholar and Dimension.ai were used for this review, the results may be slightly different. In addition, some of the articles analyzed in this review do not involve the interaction between teachers, students, and situations. Further analysis and exploration in this area can be considered in the future.

Despite its limitations, this systematic review can make a certain contribution to digital collaborative learning, benefiting practitioners in related fields and paving the way for future research. The implementation of digital collaborative learning not only overcomes the shortcomings of traditional education systems, but also provides a more promising teaching environment in face-to-face teaching environments. In addition, the review also fills the knowledge gap of digital collaborative learning supporting digital civil society, which is of great significance for achieving the sustainable development goals of higher education.

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