AI'S ROLE IN COLLABORATIVE LEARNING SETTINGS IN HIGHER EDUCATION – A SYSTEMATIC REVIEW

DOI
https://doi.org/10.18690/um.fov.4.2025.21

ISBN
978-961-286-998-4

HENNA PERNU, SANNA PAANANEN, SATU AKSOVAARA, MINNA SILVENNOINEN

Jamk University of Applied Sciences, School of Professional Teacher Education, Jyväskylä, Finland
henna.pernu@jamk.fi, sanna.paananen@jamk.fi, satu.aksovaara@jamk.fi, minna.silvennoinen@jamk.fi

There is increasing demand for teamwork and collaboration proficiencies, which require recalibration of workforce capabilities. As artificial intelligence reshapes societal and professional demands, higher education must adapt by equipping students with essential skills for evolving workplace needs. This systematic review aims to map the perspectives explored and the observed effects of using AI in collaborative learning among higher education students. The reviewed 34 studies primarily explored how AI enhances collaborative learning, targeting group performance, collaboration, knowledge building, and social interactions. Findings showed that integrating AI into collaborative learning situations can promote both collaborative and individual learning in various higher education contexts. This review provides an overview of AI's role in collaborative learning settings, highlights current development, and identifies gaps for further research. It also serves as a source for educators, policymakers, and researchers interested in leveraging AI to foster enriching educational experiences.

Keywords:
artificial intelligence,
collaborative learning,
higher education,
student,
knowledge building

University of Maribor Press

1 Introduction

Artificial intelligence (AI) has emerged as a powerful and rapidly advancing technology impacting our society (Vinothkumar & Karunamurthy, 2023), and in higher education (HE), it enhances human capabilities and opens new opportunities for teaching and learning (Popenici & Kerr, 2017). AI is commonly described as the capacity of computing systems to learn, adapt, and perform tasks that typically require human intelligence (Duan et al., 2019). In educational contexts, AI is further understood as the simulation of human-like cognitive processes such as data synthesis, adaptation, and error correction (Popenici & Kerr, 2017). As AI reshapes industries, professionals must acquire new competencies. There is a growing demand for higher-order cognitive skills as routine tasks are automated, necessitating a recalibration of the workforce's capabilities. The increasing complexity of tasks requires a diverse set of skills, such as problem-solving skills, and multidisciplinary knowledge (Katsamakas et al., 2024). This shift underlines the growing importance of 'human skills and competencies'—such as creativity, critical thinking, and emotional intelligence, and the ability to work and communicate effectively in teams is more critical than ever (Huang & Rust, 2018; Bae & Bozkurt, 2024).

While digital transformation presents both challenges and opportunities for HE (Rasul et al., 2024; Ritter et al., 2024), it is crucial that educational systems not only respond to these changes but also proactively equip students with the skills demanded by modern workplaces (Rêgo et al., 2024; Yang, 2023). Therefore, learning should shift from individual mastery to collaborative knowledge building that fosters essential skills like problem-solving and communication (Atchley et al., 2024; D'Mello et al., 2024). While AI reshapes the modern workplace, HE institutions (HEIs) must ensure students develop AI-complementary skills, those that support effective interaction with AI, informed decision-making, and navigation of complex social dynamics in professional settings (Katsamakas et al., 2024; Ritter et al., 2024; Poláková et al., 2023; Korteling et al., 2021). For HEIs to thrive in today's world, it is highly relevant to engage students in collaborative learning activities (Atchley et al., 2024).

Collaborative learning is grounded in social constructivism, which asserts that knowledge is constructed through collaborative interaction and shared understanding among individuals (Barkley et al., 2014; Dillenbourg, 1999), and it may include sharing knowledge, assisting peers, and resolving viewpoints (Webb & Mastergeorge, 2003). Collaborative learning has been an integral part of HE for many decades. It was initiated by educators in the 1960s and 1970s with the aim of transforming the structure of authority within education (Yang, 2023). In HE, collaborative learning enhances student motivation, engagement, and academic success (Joseph et al., 2024; La Rocca, 2014; Loes, 2022; Webb & Mastergeorge, 2003) and it is also known to foster critical 21st-century workplace skills (Atchley et al., 2024).

The increased opportunities of AI in learning have led to its adoption in monitoring, assisting, and supporting collaborative situations (Järvelä et al., 2023; Atchley et al., 2024). Innovative digital practices are needed as HE increasingly faces situations where instructors cannot be present and there is a lack of in-person interactions (e.g., Otto et al. 2024). Recent research indicates that in the HE context, AI-based tools may effectively support collaboration by assisting both educators and students (Atchley et al., 2024). For example, generative AI tools can also support collaborative learning experiences through inquiry-based learning, critical thinking, and group communication, providing personalized experiences while fostering essential social and cognitive skills (Bae & Bozkurt, 2024).

Integrating AI into collaborative learning offers great potential but also raises concerns about bias, accuracy, ethics, and long-term educational impact (Monteith et al., 2024; Adeshola & Adepoju, 2024). To mitigate these challenges, AI should function as an assistive rather than a directive tool, fostering collaborative problem-solving and supporting rather than replacing human intellectual engagement (Atchley et al., 2024; Rêgo et al., 2024). In the systematic review, Chu et al. (2022) recognized that AI research in HE primarily focuses on student learning behaviour, as well as the accuracy and sensitivity of AI tools, with limited emphasis on AI's role in fostering higher-order thinking and collaboration. Due to the swift emergence of AI in HE, a literature review is needed to synthesize existing research and provide an evidence-based foundation for understanding its potential in supporting collaboration and collaborative learning. A systematic assessment of the current state of research aims to highlight impacts, identify gaps, and raise relevant research questions. It also aims to offer knowledge to support, for example, educators and education designers in making informed decisions about integrating AI tools in collaborative learning settings in HE. This systematic review will address the following research questions:

- RQ1: What thematic categories can be identified in research on the use of artificial intelligence in the context of collaborative learning among higher education students?
- RQ2: What effects of students' use of artificial intelligence on collaborative learning are identified in research conducted in higher education settings?

2 Method

2.1 Search strategy and identification of relevant publications

This study adopted the PRISMA framework for tracking and reporting the selection of studies (Moher et al., 2009). We specifically included research articles that discussed collaborative learning and the use of AI applications by students in HE. We conducted two searches. The initial search was conducted by both authors on February 3, 2024, and the filtering process resulted in a reduced set of records for further screening. Following this, the backward snowballing method (Wohlin, 2014) was applied in alphabetical order of the included records by the second author using the same inclusion and exclusion criteria. The second search was conducted on October 30, 2024, to update the review with the latest articles. The overall search and screening process is summarized in Figure 1.

The selection process for relevant articles was conducted similarly after both searches as follows. To ensure a sufficient level of interrater reliability during the screening process, we implemented a multi-step procedure. Before the abstract screening began, we conducted a calibration phase in which both authors independently screened a shared sample of abstracts (n = 26) to align the inclusion and exclusion criteria into practice. Discrepancies were discussed jointly to reach a common understanding and refine the screening guidelines. After this calibration, the remaining abstracts were divided evenly between the two primary authors, with each screening being approximately half. During this phase, any potentially unclear or borderline cases were flagged and discussed collaboratively. If consensus could not be reached between the two, a fourth author acted as an adjudicator and made the final inclusion decision. This process helped to ensure consistency in decision-making and minimize the risk of bias or misinterpretation.

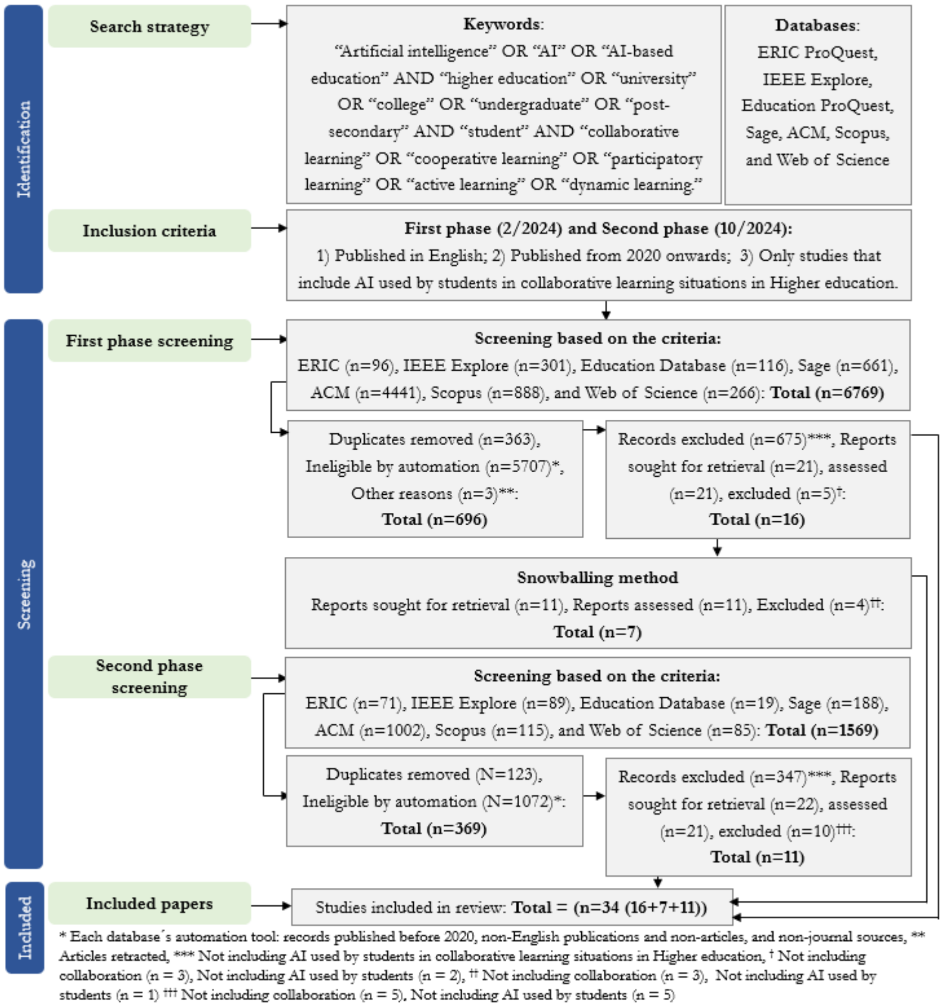

Figure 1: Flowchart of the selection process

2.3 Analysis

The analysis of the included articles followed a systematic and collaborative methodology, in line with PRISMA guidelines. Initially, the 34 records that met the inclusion criteria were independently reviewed by the first and second authors.

Relevant information from each article, including article details such as title, authors, publication year, country of origin, study design, journal ranking level, publication venue, and impact factor, was recorded in a structured Excel file to facilitate analysis and ensure consistency. A data-driven inductive content analysis method was employed to analyze the data extracted from the results of the selected articles. This approach followed the principles of qualitative content analysis as described by Elo and Kyngäs (2008), emphasizing systematic data reduction, category development, and transparent documentation of the analytical process. To systematically organize and interpret the data, key elements such as the original expression, condensed expression, keyword or phrase, subcategory, and main category were recorded in a structured Excel file. During the summarization process, the data collected was organized into initial subcategories, which were formed based on the observed recurring elements and similarities. These subcategories served as the basis for the creation of broader categories, which were built by combining thematically similar subcategories. The formation of categories was a critical step in the analysis, as it allowed for the structuring of the data and the presentation of key findings systematically and coherently. To facilitate this process, the main categories and subcategories were visually mapped on the MIRO board, enabling a clearer overview of the relationships between the key concepts and supporting the structured synthesis of the findings. The entire content analysis process was carried out in close collaboration among the research team, and each step of the process was carefully documented, ensuring transparency of the methods and the reproducibility of the research. The final categories are presented in the results section 3.1 of the article.

2.4 Quality appraisal

The quality of the articles included in the review was assessed using the Mixed Method Appraisal Tool (MMAT), which is a validated tool designed for the appraisal of empirical studies employing qualitative, quantitative, and mixed methods approaches. We used screening questions tailored to these research designs (Hong et al. 2018). The first and second authors conducted independent evaluations of the studies utilizing the MMAT scoring system. The final evaluations revealed that the studies included achieved scores ranging from 40% to 100% on the MMAT. Furthermore, the impact factors of the journals were screened. (See Table 1.)

Table 1: Quality assessment (MMAT score%, journal, IF)

MMAT Quality Score (%)	Studies	Total	Impact Factor (IF) [0,10]	Studies	Total
100	8	34	6-10	6	34
80	14		3-6	18	
60	10		1-3	8	
40	2		Unknown	2	

2.5 Included publications

A diverse range of research methodologies was employed across the identified studies. Specifically, four studies employed qualitative approaches. Among the quantitative studies, seven were randomized controlled trials, four were nonrandomized studies, and one utilized a descriptive quantitative approach. Additionally, 18 studies utilized mixed methods. Of these, eight combined qualitative and quantitative descriptive methods, while ten integrated qualitative approaches with non-randomized quantitative methods. Most of the studies (23) included in the review were published within the years 2023-2024. During the years 2020-2022, there were 10 studies published, and one article was published in 2025. The studies included in this research were collected from a range of 18 different countries. A significant portion of these studies originated from institutions in China (15), followed by the USA, Serbia, and Saudi Arabia, each with two studies. The remaining countries each contributed a single study.

3 Results

3.1 Thematic categories on the use of artificial intelligence in collaborative learning among higher education students (RQ1)

The analysis of the selected literature of 34 studies revealed five main thematic categories concerning the use of AI in collaborative learning among HE students. From these main categories, altogether 20 subcategories were identified (See Table 2).

Table 2: Thematic categories of the use of AI in collaborative learning situations

Main categories and frequency	Subcategories and frequency	References
Collaborative learning (28)	Group performance (8)	Hayashi (2020); Kumar (2021); Long, et al. (2024); Zheng, et al. (2022); (2023a); (2023b); (2023c); (2024)
	Collaboration (7)	Hayashi (2020); Ilic et al. (2021); Järvelä et al. (2023); Kuleto et al. (2021); Ouyang et al. (2023); Tegos et al. (2021); Van Horn (2024)
	Collaborative knowledge building (6)	Chen et al. (2023); Saadati et al. (2023); Zheng et al. (2023a); (2023b); (2023c); (2024)
	Social interaction (5)	Li X. et al. (2024); Ouyang et al. (2024); Zheng et al. (2021); (2022); (2023a)
	Socially shared regulation (2)	Zheng et al. (2023a); (2023c)
Learner characteristics (26)	Cognition (9)	Li T. et al. (2024); Li X. et al. (2024); Kong et al. (2025); Kumar (2021); Peng et al. (2022); Zheng et al. (2021); (2023a); (2023c); (2024)
	Engagement (6)	Kumar (2021); Ouyang et al., (2024); Peng et al. (2022), Ramos & Condotta (2024); Van Horn (2024); Xie et al. (2021)
	Metacognition (4)	Li T. et al. (2024); Malik (2024); Ouyang et al. (2023); Van Horn (2024)
	Reflection (3)	Chen et al. (2023); Lin et al. (2024); Ouyang et al. (2024)
	Self-efficacy (3)	Kong et al. (2025); Kumar (2021); Van Horn (2024)
	Demographics (1)	Joseph et al. (2024)
Learning process (19)	Learning performance (8)	Ilic et al. (2021); Kong et al. (2025); Kuleto et al. (2021); Kumar (2021); Peng et al. (2022); Ramos & Condotta (2024); Tegos et al. (2021); Li T. et al. (2024)
	Feedback (5)	Kumar (2021); Olga et al. (2023); Ouyang et al. (2023); Saadati et al. (2023); Van Horn (2024)
	Pedagogical support (3)	Chen et al. (2023); Ouyang et al. (2024); Ramos et al. (2024)
	Self-directed learning (3)	Järvelä et al. (2023); Richter et al. (2024); Van Horn (2024)
Use of AI tools in collaboration (12)	Skills and knowledge (5)	Almulla (2024); Ilieva et al. (2023); Richter et al. (2024); Tzirides et al. (2024); Ilic et al. (2021)
	Emotional response (4)	Ilieva et al. (2023); Li X. et al. (2024); Rosenberg-Kima et al. (2020); Peng et al. (2022)

Main categories and frequency	Subcategories and frequency	References
	Perception and attitude (3)	Joseph et al. (2024); Long et al. (2024); Tegos et al. (2021)
Learning outcomes (8)	Competency (5)	Li X. et al. (2024); Lin et al. (2024); Long et al. (2024); Qureshi (2023); Ouyang et al. (2024)
	Knowledge integration (3)	Hayashi (2020); Zheng et al. (2021); (2022)

3.2 Effects of students' use of AI on collaborative learning identified in research conducted in HE settings

To address the second research question, a more detailed overview of the studies previously summarised in the table is presented within each thematic category.

Collaborative learning: A synthesis of the reviewed studies highlights that the use of AI in collaborative learning situations can affect *group performance* (Hayashi, 2020; Zheng et al., 2021; 2023a; 2024) by enhancing teamwork skills (Kumar, 2021; Long et al., 2024; Zheng et al., 2023b) and teamwork competencies (Long et al., 2024). Furthermore, AI integration fosters *collaboration* among students (Järvelä et al., 2023; Tegos et al., 2021; Van Horn, 2024; Zheng et al., 2022), for example, by positively influencing mutual learning and knowledge exchange (Van Horn, 2024), as well as in fostering students' regulation-oriented feedback (Ouyang et al., 2024) and improving coordination (Hyashi, 2020). The synthesis also indicates that AI can facilitate collaborative learning environments for HE institutions (Ilic et al., 2021; Kuleto et al., 2021). Moreover, results showed that AI-based systems can enhance *collaborative knowledge building* (Zheng et al., 2023a; 2023b; 2024) through AI-generated feedback (Zheng et al., 2023c), support for constructing arguments (Chen et al., 2023), and by encouraging co-construction of knowledge and problem-solving (Saadati et al., 2023). According to the studies reviewed, AI tools support *social interaction* through enhanced social engagement (Zheng et al., 2023a), foster interactive relationships (Zheng et al., 2021; 2022), facilitate information sharing (Li X. et al., 2024), and improve peer interactions (Ouyang et al., 2024). Additionally, the use of AI-based tools in collaborative learning situations enhances *social shared regulation* among learners (Zheng et al., 2023a; 2023c).

Learner characteristics: The synthesis of reviewed studies indicates that AI can enhance cognition by promoting engagement (Zheng et al., 2024), deeper cognitive thinking (Peng et al., 2022), and cognitive presence (Kong et al., 2025). While AI-supported collaboration has been associated with reduced cognitive load in some cases (Li et al., 2024), other studies have found no significant impact (Kumar, 2021; Zheng et al., 2021, 2023a, 2023c). Furthermore, AI-supported learning was found to enhance student *engagement* in some studies (Ouyang et al., 2024; Peng et al., 2022; Ramos & Condotta, 2024; Van Horn, 2024; Xie et al., 2021). However, Kumar et al. (2021) found no significant influence on students' perception of learning. Moreover, studies also identified impacts on *metacognition*, as the use of AI tools in learning environments enhanced students' understanding by supporting reflective and critical thinking (Li T. et al., 2024). AI-supported learning was also found to enhance metacognitive skills and the development of metacognition (Malik, 2024; Van Horn, 2024), as well as increase metacognitive engagement (Ouyang et al., 2023). Studies also showed that AI tools use positively influenced students' *reflection*, as AI-assisted learning facilitated idea refinement, reflective thinking, and self-awareness through collaborative argumentation, structured observation, real-time feedback, and behaviour adjustment (Chen et al., 2023; Lin et al., 2024; Ouyang et al., 2024). While many studies reported positive outcomes, the effects on students' self-efficacy were mixed. Increased confidence was observed primarily in the specific skills targeted by the learning activities (Van Horn, 2024), but no significant effects were found on motivational beliefs or creative self-efficacy (Kumar, 2021), nor was there evidence of increased motivation (Kong et al., 2025). Moreover, Joseph et al. (2024) found that *demographic* factors such as gender, field of study, specialization, and place had no effect on AI tool use, digital literacy competence, or participation in AI-assisted learning.

Learning process: AI in collaborative learning demonstrated a positive impact on *learning performance* by enhancing learning retention and academic performance, as well as supporting dynamic problem-based learning activities (Kong et al., 2025; Kumar, 2021; Li, T. et al., 2024; Peng et al., 2022; Ramos et al., 2024). In addition, AI was found to support the development of customized learning skills and enhance personalized learning (Ilic et al., 2021; Kuleto et al., 2021). The importance of real-time *feedback* provided by AI was detected in several studies (e.g. Chen et al., 2023; Li X. et al., 2024; Ouyang et al., 2024; Van Horn, 2024; Zheng et al., 2022), for example, in fostering problem-solving approaches (Ouyang et al., 2024). Despite occasional confusion caused by AI-generated feedback (Ouyang et al., 2023), students generally viewed it positively (Kumar, 2021; Ouyang et al., 2024). A combination of peer and AI feedback was considered the most effective (Olga et al., 2023). AI tools have also been successfully utilized as *pedagogical support* for monitoring and managing the learning process (Chen et al., 2023), and they have proven effective in enabling more active teaching by supporting instructional planning (Ramos et al., 2024). Furthermore, AI-driven learning was found to reduce the need for extensive instructor feedback and support (Ouyang et al., 2024). Finally, AI-enhanced learning was found to support *self-directed learning*, contributing to more personalized education and fostering responsible decision-making through experimental and ethical practices (Van Horn, 2024; Richter et al., 2024). It also improved self-regulation by providing real-time adaptive feedback in human-AI collaboration (Järvelä et al., 2023).

Use of AI tools in collaboration: According to the synthesis of the reviewed studies, the use of AI in interactive and collaborative learning settings supports students' AI-related *skills and knowledge* by enhancing their perception of its ease of use and benefits, while also fostering skill development (Almulla, 2024; Ilic et al., 2021). Combining AI with human intelligence was found to improve AI literacy and boost students' confidence in using AI technologies (Joseph et al., 2024; Tzirides et al., 2024). Additionally, Richter et al. (2024) emphasize the importance of collaborative and experimental learning methods for ethical and practical use of AI. Students' *emotional responses* to AI in learning were generally positive (Ilieva et al., 2023; Li X. et al., 2024; Peng et al., 2022) as were their *perceptions and attitudes* towards AI integration (Long et al., 2024; Rosenberg-Kima et al., 2020; Tegos et al., 2021).

Learning outcomes: AI integration in collaborative learning has been shown to foster understanding and *competency* development, e.g., by providing essential support for structuring inquiry-based tasks, enhancing collaborative academic writing by improving writing quality, fostering reflective thinking and active participation in discussions, and enhancing problem-solving behaviours and learning outcomes, although final performance improvements may vary (Long et al., 2024; Li et al., 2024; Lin et al., 2024; Qureshi, 2023; Ouyang et al., 2023). Furthermore, AI was found to promote deeper knowledge processing by fostering both knowledge convergence and elaboration through real-time feedback and automated interaction classification, thereby contributing to *knowledge integration* (Zheng et al., 2022; Hayashi, 2020).

4 Discussion and conclusions

The quality and credibility of the analysed studies appeared relatively high, with the majority demonstrating strong methodological quality. As a response to the **first research question**, the analysis of the selected studies revealed five main categories and 20 subcategories. In addressing **the second research question**, the findings suggest that AI integration in collaborative learning holds potential to support both group and individual learning. Most reported effects were positive, including enhanced teamwork skills, improved group performance, and strengthened collaboration and knowledge building (e.g., Hayashi, 2020; Kumar, 2021; Tegos et al., 2021; Saadati et al., 2023). In summary, AI was found in supporting learning by providing adaptive and real-time feedback, enhancing engagement, assisting in the development of metacognitive skills, and facilitating the management of cognitive load (e.g., Chen et al., 2023; Li et al., 2024; Malik, 2024; Van Horn, 2024; Zheng et al., 2023a, 2023c). **The limitations of this review** include its focus on peer-reviewed journal articles and English-language publications, which may have restricted the diversity of perspectives and limited the international scope of the findings.

Future research should examine AI's long-term impact on teaching and learning, particularly as a collaborative and self-directed learning companion, while expanding to diverse educational settings across academic levels, disciplines, and cultural contexts. Although most reviewed studies focused on the benefits of AI, critical perspectives were limited. As AI tools use expands, concerns about bias, inaccuracy, and ethics emerge (Adeshola & Adepoju, 2024; Monteith et al., 2024), highlighting the need to examine the ethical and responsible use of AI in collaborative learning, in order to evaluate potential drawbacks.

In conclusion, as AI, particularly Generative AI, continues to reshape work and education, the importance of human skills, such as communication, collaboration, and problem-solving, is growing. In this context, AI also offers new opportunities to support collaborative learning. These developments call for HEIs to rethink their role and pedagogy (see also Popenici & Kerr, 2017). AI should be integrated in various ways into learning environments and competency development in diverse ways, while ensuring that students' AI literacy is strengthened and that they can apply it both ethically and effectively (Richter et al., 2024; Tzirides et al., 2024). Maximizing

AI's educational benefits requires collaboration among educators, policymakers, researchers, and developers, along with a deeper understanding of its role across learning environments to refine best practices for its integration, ensuring that it meaningfully supports both individual and collaborative learning.

Acknowledgments

The first and second authors contributed equally to this work.

References

(*) Indicates review articles included in the synthesis

Adeshola, I., & Adepoju, A. P. (2024). The opportunities and challenges of ChatGPT in education. Interactive Learning Environments, 32(10), 6159-6172.

Almulla, M. A. (2024). Investigating influencing factors of learning satisfaction in AI ChatGPT for research: University students' perspective. *Heliyon*, *10*(11). Scopus. https://doi.org/10.1016/j.heliyon.2024.e32220 *

Atchley, P., Pannell, H., Wofford, K. et al. Human and AI collaboration in the higher education environment: opportunities and concerns. Cogn. Research 9, 20 (2024). https://doi.org/10.1186/s41235-024-00547-9

Bae, H., & Bozkurt, A. (2024). The Untold Story of Training Students with Generative AI: Are We Preparing Students for True Learning or Just Personalization? Online Learning, 28(3).

Barkley, Elizabeth F., and K. Patricia Cross. (2014) Collaborative Learning Techniques: A Handbook for College Faculty, John Wiley & Sons, Incorporated.

Chen, W., Tan, J. S., Zhang, S., Pi, Z., & Lyu, Q. (2023). AppleTree system for effective computer-supported collaborative argumentation: An exploratory study. *Educational technology research and development*, *71*(5), 2103-2136.*

Chu, H. C., Hwang, G. H., Tu, Y. F., & Yang, K. H. (2022). Roles and research trends of artificial intelligence in higher education: A systematic review of the top 50 most-cited articles. Australasian Journal of Educational Technology, 38(3), 22-42.

Dillenbourg, P. (1999). What do you mean by collaborative learning?. *Collaborative-learning: Cognitive and computational approaches.*, 1-19.

D'Mello, S. K., Biddy, Q., Breideband, T., Bush, J., Chang, M., Cortez, A., ... & Whitehill, J. (2024). From learning optimization to learner flourishing: Reimagining AI in Education at the Institute for Student-AI Teaming (iSAT). AI Magazine, 45(1), 61-68.

Duan, Y., Edwards, J. S., & Dwivedi, Y. K. (2019). Artificial intelligence for decision making in the era of Big Data–evolution, challenges and research agenda. *International journal of information management*, *48*, 63-71.

Elo S. & Kyngäs H. (2008) The qualitative content analysis process. J Adv Nurs.Apr;62(1):107-15.

Feuerriegel, S., Hartmann, J., Janiesch, C., & Zschech, P. (2024). Generative ai. Business & Information Systems Engineering, 66(1), 111-126.

Hayashi, Y. (2020). Gaze awareness and metacognitive suggestions by a pedagogical conversational agent: an experimental investigation on interventions to support collaborative learning process and performance. International Journal of Computer-Supported Collaborative Learning, 15(4), 469-498. *

Hingle, A. (2025, January). How Technology Students Develop AI Literacy through Collaboration, Reflection, and Situated Learning. In Companion Proceedings of the 2025 ACM International Conference on Supporting Group Work (pp. 118-120).

Hong, Q. N., Pluye, P., Fàbregues, S., Bartlett, G., Boardman, F., Cargo, M., ... & Vedel, I. (2018). Mixed methods appraisal tool (MMAT), version 2018. *Registration of copyright*, *1148552*(10), 1-7.

Huang, M. H., & Rust, R. T. (2018). Artificial intelligence in service. Journal of service research, 21(2), 155-172.

Ilic, M. P., Păun, D., Popović Šević, N., Hadžić, A., & Jianu, A. (2021). Needs and performance analysis
for changes in higher education and implementation of artificial intelligence, machine learning, and extended reality. *Education Sciences*, *11*(10), 568. *

Ilieva, G., Yankova, T., Klisarova-Belcheva, S., Dimitrov, A., Bratkov, M., & Angelov, D. (2023). Effects of generative chatbots in higher education. *Information*, *14*(9), 492.*

Joseph, G. V., Athira, P., Thomas, M. A., Jose, D., Roy, T. V., & Prasad, M. (2024). Impact of Digital Literacy, Use of AI Tools and Peer Collaboration on AI Assisted Learning: Perceptions of the University Students. Digital Education Review, 45, 43-49. *

Järvelä, S., Nguyen, A., & Hadwin, A. (2023). Human and artificial intelligence collaboration for socially shared regulation in learning. *British Journal of Educational Technology*, *54*(5), 1057–1076. Education Database. *

Katsamakas, E., Pavlov, O. V., & Saklad, R. (2024). Artificial Intelligence and the Transformation of Higher Education Institutions: A Systems Approach. Sustainability, 16(14), 6118.

Kong, X., Liu, Z., Chen, C., Liu, S., Xu, Z., & Tang, Q. (2025). Exploratory study of an AI-supported discussion representational tool for online collaborative learning in a Chinese university. *Internet and Higher Education*, *64*. Scopus. Available online 10 October 2024 *

Korteling, J. H., van de Boer-Visschedijk, G. C., Blankendaal, R. A., Boonekamp, R. C., & Eikelboom, A. R. (2021). Human-versus artificial intelligence. Frontiers in artificial intelligence, 4, 622364.

Kuleto, V., Ilić, M., Dumangiu, M., Ranković, M., Martins, O. M., Păun, D., & Mihoreanu, L. (2021). Exploring opportunities and challenges of artificial intelligence and machine learning in higher education institutions. Sustainability, 13(18), 10424.*

Kumar, J. A. (2021). Educational Chatbots for Project-Based Learning: Investigating Learning Outcomes for a Team-Based Design Course. *International Journal of Educational Technology in Higher Education*, *18*. ERIC. *

La Rocca, C. (2014). Collaborative learning in higher education. *Open Journal of Social Sciences*, *2*(02), 61.

Li, T., Ji, Y., & Zhan, Z. (2024). Expert or machine? Comparing the effect of pairing student teacher with in-service teacher and ChatGPT on their critical thinking, learning performance, and cognitive load in an integrated-STEM course. *Asia Pacific Journal of Education*, *44*(1), 45-60. *

Li, X., Jiang, S., Hu, Y., Feng, X., Chen, W., & Ouyang, F. (2024). Investigating the impact of structured knowledge feedback on collaborative academic writing. Education and Information Technologies, 1-29. *

Lin, C. J., Lee, H. Y., Wang, W. S., Huang, Y. M., & Wu, T. T. (2024). Enhancing reflective thinking in STEM education through experiential learning: The role of generative AI as a learning aid. Education and Information Technologies, 1-23. *

Loes, C. N. (2022). The Effect of Collaborative Learning on Academic Motivation. Teaching & Learning Inquiry, 10. https://doi.org/10.20343/teachlearninqu.10.4

Long, T., Zheng, Z., Shi, Y., Tong, M., & Liu, Z. (2024). Understanding how pre-service science teachers design inquiry-based activities in a knowledge integration (KI) based collaborative learning environment: a network analytic approach. Educational technology research and development, 1-32. *

Malik, U. (2024). Developing Student Metacognition Through Collaborative Work on the Quip Platform. *International Journal of Educational Reform*, 10567879241247557. *

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & The PRISMA Group. (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *PLoS Medicine, 6*(7), e1000097.

Monteith, S., Glenn, T., Geddes, J. R., Whybrow, P. C., Achtyes, E., & Bauer, M. (2024). Artificial intelligence and increasing misinformation. The British Journal of Psychiatry, 224(2), 33-35.

Olga, A., Saini, A., Zapata, G., Searsmith, D., Cope, B., Kalantzis, M., ... & Kastania, N. P. (2023). Generative AI: Implications and applications for education. arXiv preprint arXiv:2305.07605. *

Otto, S., Bertel, L. B., Lyngdorf, N. E. R., Markman, A. O., Andersen, T., & Ryberg, T. (2024). Emerging digital practices supporting student-centered learning environments in higher education: A review of literature and lessons learned from the COVID-19 pandemic. Education and Information Technologies, 29(2), 1673-1696.

Ouyang, F., Guo, M., Zhang, N., Bai, X., & Jiao, P. (2024). Comparing the effects of instructor manual feedback and ChatGPT intelligent feedback on collaborative programming in China's higher education. *IEEE Transactions on Learning Technologies*. *

Ouyang, F., Wu, M., Zheng, L., Zhang, L., & Jiao, P. (2023). Integration of artificial intelligence performance prediction and learning analytics to improve student learning in online engineering course. *International Journal of Educational Technology in Higher Education*, *20*(1), 4. *

Peng, Y., Li, Y., Su, Y., Chen, K., & Jiang, S. (2022). Effects of group awareness tools on students' engagement, performance, and perceptions in online collaborative writing: Intergroup information matters. *The Internet and Higher Education*, *53*, 100845. *

Poláková, M., Suleimanová, J. H., Madzík, P., Copuš, L., Molnárová, I., & Polednová, J. (2023). Soft skills and their importance in the labour market under the conditions of Industry 5.0. Heliyon, 9(8).

Popenici, S. A., & Kerr, S. (2017). Exploring the impact of artificial intelligence on teaching and learning in higher education. Research and practice in technology enhanced learning, 12(1), 22.

Qureshi, B. (2023). Exploring the use of chatgpt as a tool for learning and assessment in undergraduate computer science curriculum: Opportunities and challenges. *arXiv preprint arXiv:2304.11214*. *

Ramos, B., & Condotta, R. (2024). Enhancing Learning and Collaboration in a Unit Operations Course: Using AI as a Catalyst to Create Engaging Problem-Based Learning Scenarios. *Journal of Chemical Education*, *101*(8), 3246-3254. *

Rasul, T., Nair, S., Kalendra, D., Balaji, M. S., de Oliveira Santini, F., Ladeira, W. J., ... & Hossain, M. U. (2024). Enhancing academic integrity among students in GenAI Era: A holistic framework. The International Journal of Management Education, 22(3), 101041.

Rêgo, B. S., Lourenço, D., Moreira, F., & Pereira, C. S. (2024). Digital transformation, skills and education: A systematic literature review. Industry and higher education, 38(4), 336-349.

Richter, S., Giroux, M., Piven, I., Sima, H., & Dodd, P. (n.d.). A Constructivist Approach to Integrating AI in Marketing Education: Bridging Theory and Practice. *Journal of Marketing Education*, *0*(0), 02734753241288876. *

Ritter, B. A., Gopalkrishnan, S. S., & Sockbeson, C. E. S. (2024). The Next Generation of Pedagogy: Reflections from EdTech Leaders. Journal of Management Education, 48(4), 610-633.

Rosenberg-Kima, R. B., Koren, Y., & Gordon, G. (2020). Robot-supported collaborative learning (RSCL): Social robots as teaching assistants for higher education small group facilitation. Frontiers in Robotics and AI, 6, 148.*

Saadati, Z., Zeki, C. P., & Vatankhah Barenji, R. (2023). On the development of blockchain-based learning management system as a metacognitive tool to support self-regulation learning in online higher education. Interactive Learning Environments, 31(5), 3148-3171.*

Tegos, S., Mavridis, A., & Demetriadis, S. (2021). Agent-supported peer collaboration in MOOCs. *Frontiers in Artificial Intelligence*, *4*, 710856. *

Tzirides, A. O. O., Zapata, G., Kastania, N. P., Saini, A. K., Castro, V., Ismael, S. A., ... &

Kalantzis, M. (2024). Combining human and artificial intelligence for enhanced AI literacy in higher education. Computers and Education Open, 6, 100184. *

Van Horn, K. R. (2024). ChatGPT in English Language Learning: Exploring Perceptions and Promoting Autonomy in a University EFL Context. *TESL-EJ*, *28*(1). Scopus. *

Vinothkumar, J., & Karunamurthy, A. (2023). Recent Advancements in Artificial Intelligence Technology: Trends and Implications. Quing: International Journal of Multidisciplinary Scientific Research and Development, 2(1), 1–11.

Webb, N. M., & Mastergeorge, A. (2003). Promoting effective helping behavior in peerdirected groups.
International Journal of Educational Research, 39(1–2), 73–97.

Wohlin, C. (2014). Guidelines for snowballing in systematic literature studies and a replication in software engineering. Proceedings of the 18th International Conference on Evaluation and Assessment in Software Engineering (EASE '14), 1–10.

Xie, T., Liu, R., Chen, Y., & Liu, G. (2021). MOCA: A motivational online conversational agent for improving student engagement in collaborative learning. IEEE Transactions on Learning Technologies, 14(5), 653-664.*

Yang, X. (2023). A Historical Review of Collaborative Learning and Cooperative Learning. TechTrends
67, 718–728.

Zheng, L., Zhong, L., Niu, J., Long, M., & Zhao, J. (2021). Effects of Personalized Intervention on Collaborative Knowledge Building, Group Performance, Socially Shared Metacognitive Regulation, and Cognitive Load in Computer-Supported Collaborative Learning. *Educational Technology & Society*, *24*(3), 174–193. *

Zheng, L., Niu, J., & Zhong, L. (2022). Effects of a learning analytics-based real-time feedback approach on knowledge elaboration, knowledge convergence, interactive relationships and group performance in CSCL. British Journal of Educational Technology, 53(1), 130-149. *

Zheng, L., Niu, J., Long, M., & Fan, Y. (2023a). An automatic knowledge graph construction approach to promoting collaborative knowledge building, group performance, social interaction and socially shared regulation in CSCL. British Journal of Educational Technology, 54(3), 686-711. *

Zheng, L., Fan, Y., Chen, B., Huang, Z., & Long, M. (2023b). An AI-enabled feedback-feedforward approach to promoting online collaborative learning. *Education and Information Technologies*. Scopus. *

Zheng, L., Long, M., Niu, J., & Zhong, L. (2023c). An automated group learning engagement analysis and feedback approach to promoting collaborative knowledge building, group performance, and socially shared regulation in CSCL. International Journal of Computer-Supported Collaborative Learning, 18(1), 101-133. *

Zheng, L., Fan, Y., Gao, L., Huang, Z., Chen, B., & Long, M. (2024). Using AI-empowered assessments and personalized recommendations to promote online collaborative learning performance. *Journal of Research on Technology in Education*. Scopus. *