Multidisciplinary Reviews

REVIEW ARTICLE
Published Online: February 13, 2026
https://doi.org/10.31893/multirev.2026440

Exploring the landscape of digital learning materials in education: A PRISMA-based review

Pham Thi Huong[a] | **Nguyen Thi Phuong Nhung**[b] ✉ | **Tran Thi Kim Ngan**[c]

[a]Center for Digital Learning, Cyber School, Vinh University, Nghe An, Vietnam.
[b]Department of Primary Education, Vinh University, Nghe An, Vietnam.
[c]School of Agriculture and Natural Resources, Vinh University, Nghe An, Vietnam.

Abstract In recent years, digital learning materials have increasingly replaced and complemented traditional resources, and they are gradually being standardized to ensure higher levels of accuracy and diversity. Digital educational resources have become an indispensable component of modern education, offering numerous advantages over traditional materials. They allow learners to access content anytime and anywhere, and they can vividly illustrate mechanisms, processes, and natural phenomena that conventional resources often fail to convey effectively. However, the growing integration of digital materials in education also presents significant challenges that require further consideration. Despite growing research interest, comprehensive overviews remain limited. This study aims to address this gap by systematically analysing recent research trends, influential publications, thematic focuses, and future directions in digital learning materials. A systematic review was conducted via the PRISMA framework, with Scopus selected as the primary database for rigorous quality control. The inclusion criteria included peer-reviewed journal articles in English published from 2017 onwards containing “digital learning material” or “digital teaching material” in the title, abstract, or keywords. From an initial pool of 404 articles, 45 met the final selection criteria. The data were cleaned, coded, and analysed via VOSviewer for keyword co-occurrence and network mapping. The findings reveal significant growth in publications, especially after 2020, driven by the global shift toward online learning. Sixteen thematic clusters were identified, with collaborative learning and mathematics serving as key connectors. Fifteen categories of challenges emerged, including limited generalizability and small sample sizes. Five major research directions were proposed: spanning methodology, contextualization, technology integration, teacher training, and assessment. This study provides the first systematic, PRISMA-based synthesis of digital learning materials research, offering a holistic framework to guide future scholarly and practical advancements in the field.

Keywords: e-learning resources, digital pedagogy, instructional design, educational innovation, systematic synthesis

1. Introduction

Digital learning materials play a crucial role in transmitting information in general and in education in particular, especially in recent years, due to the application of advancements in science and technology to teaching and learning. Compared with other traditional learning materials such as books, newspapers, and printed materials, digital learning materials have several outstanding advantages. These advantages have been demonstrated to be successful in numerous research projects aimed at enhancing the quality of education (Dewi et al., 2020; Evawati & Susilowati, 2023; Mondragón-Estrada et al., 2023; Safitri, 2023).

However, digital learning materials also face numerous difficulties and challenges, such as a shortage of digital learning resources (Alwafi, 2023), a lack of funding for developing digital learning materials (Alwafi, 2023), existing digital materials being monotonous and unengaging for students (Mondragón-Estrada et al., 2023; Safitri, 2023), the limited ability of teachers to create digital learning materials (Dewi et al., 2020), the tools and time required to evaluate the quality of learning materials (Evawati & Susilowati, 2023), and so on.

To address the difficulties and challenges posed by digital learning materials, many scholars worldwide have conducted various experiments. For example, Alwafi (2023) studied students' deep learning on the basis of self-created digital learning materials, Afifah (2023) researched the creation and development of multimodal digital teaching materials, and Uda et al. (2022) explored the design and development of problem-based digital learning materials. However, most previous studies have focused on specific aspects of the digital learning material issue, with very few publications providing an overall perspective on digital learning materials in education. For example, Bong and Chen (2024) conducted a comprehensive study on teachers' digital competence, Ali et al. (2022) synthesized student learning models in online environments, and Rabiu et al. (2023) compiled approaches to designing materials for blended learning. The general overview of learning materials has not been extensively and comprehensively studied, leaving a gap that needs to be filled. Filling this gap is important because it allows for a more holistic understanding of digital learning materials and their impact on education.

 Received: September 17, 2025 | Accepted: October 22, 2025

For that reason, this study aims to bridge the current research gap with a comprehensive analysis of digital educational materials. The authors focus on addressing the following research questions:

- RQ1: What are the general research trends in digital learning materials in recent years?
- RQ2: Which publications on digital learning materials have had the most significant impact? How do scholars recognize the influence of these publications?
- RQ3: What are the prominent research topics surrounding digital learning materials?
- RQ4: What are the typical difficulties and challenges encountered in research on digital learning materials?
- RQ5: What research directions are proposed for the future?

2. Methodology

In this study, a comprehensive and structured approach was adopted to search, select, and evaluate articles via content analysis and synthesis methods. The research model employed in this study was the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework. The PRISMA model is widely recognized and recommended for conducting systematic reviews and rigorous research. It provides standardized procedures that guide scholars in conducting their studies and is widely utilized in reputable journals and the academic community at large.

2.1. Sample and data collection

Currently, various data sources are available for storing and retrieving relevant articles across multiple disciplines. Examples of popular data sources include Google Scholar, Scopus, Web of Science, ERIC, and ARXIV. Among these options, Scopus and Web of Science stand out as widely utilized data sources because the articles indexed in these databases undergo thorough evaluation and quality control. On the other hand, Google Scholar, ERIC, and ARXIV, while offering free access, include a vast array of unreviewed documents, which can pose challenges in terms of data management and filtering, particularly for novice researchers. Given these considerations, the authors of this study opted to utilize Scopus as the primary data source for their research.

2.2. Search criteria

To conduct a comprehensive search for articles pertaining to the current research topic, the following inclusion and exclusion criteria were established:

Inclusion criteria:

- The article must include the keywords "digital learning material*" or "digital teaching material*" in the title, abstract, or keywords.
- The article must have been published within recent years. The year 2017 was selected because it marked the beginning of the widespread application of information technology.
- The article should demonstrate a sound structure and content.
- The article must be written in English.
- The articles must be published in reputable journals.

Exclusion criteria:

- The article does not contain the keywords "digital learning material*" or "digital teaching material*" in the title, abstract, or keywords.
- The article was published prior to 2017.
- The article lacks a well-organized structure and adequate content.
- The article was not written in English.
- The articles are not published in journals.

2.3. Eligibility assessment

To ensure the accuracy and reliability of the search results, a two-step evaluation process was implemented. In the first step, the authors utilized Scopus's automatic filtering tools to screen the articles. In the second step, the remaining results were independently assessed by two researchers who were not affiliated with the author. The filtered results from both researchers' evaluations were then compared. If their assessments aligned, the article was included. However, in cases where discrepancies arose, the author exercised judgement to determine whether the article should be included or excluded, considering careful consideration of the various reviews.

2.4. Data coding and analysis

Following the filtering process, the selected articles were stored in a CSV file for subsequent analysis. The variables of interest included in the analysis included the title, abstract, keywords, year of publication, citations, research direction,

limitations, and future research directions. Before proceeding to the analysis stage, the data underwent a meticulous cleaning process to ensure accuracy and consistency. This cleaning process involved the following steps:

• The spelling errors are corrected to increase the accuracy of the data.

• The acronyms and their corresponding full words are consolidated to avoid duplication and maintain consistency across the entire dataset.

Once the data had been processed and cleaned according to the aforementioned steps, the VosViewer tool was employed for analysis. VosViewer is a recognized analytics tool in the field that facilitates the exploration and visualization of significant patterns, relationships, and trends within datasets.

The article selection process adhered to the PRISMA guidelines, as depicted in Figure 1. Initially, a total of 404 articles were identified in the Scopus database through keyword searches. After applying automatic filters on the basis of publication year, journal, and language (English), 296 articles were excluded. Among the remaining 108 articles, 23 were eliminated because of their lack of relevance to the research topic, despite the presence of search keywords in the title, abstract, or keywords. Among the remaining 85 articles, 32 did not provide full access to their content. Consequently, out of the total of 53 full articles collected by the author, 8 were excluded because their quality was relatively lower than the standards set for an article. Therefore, for the analysis in this study, a final set of 45 articles was utilized.

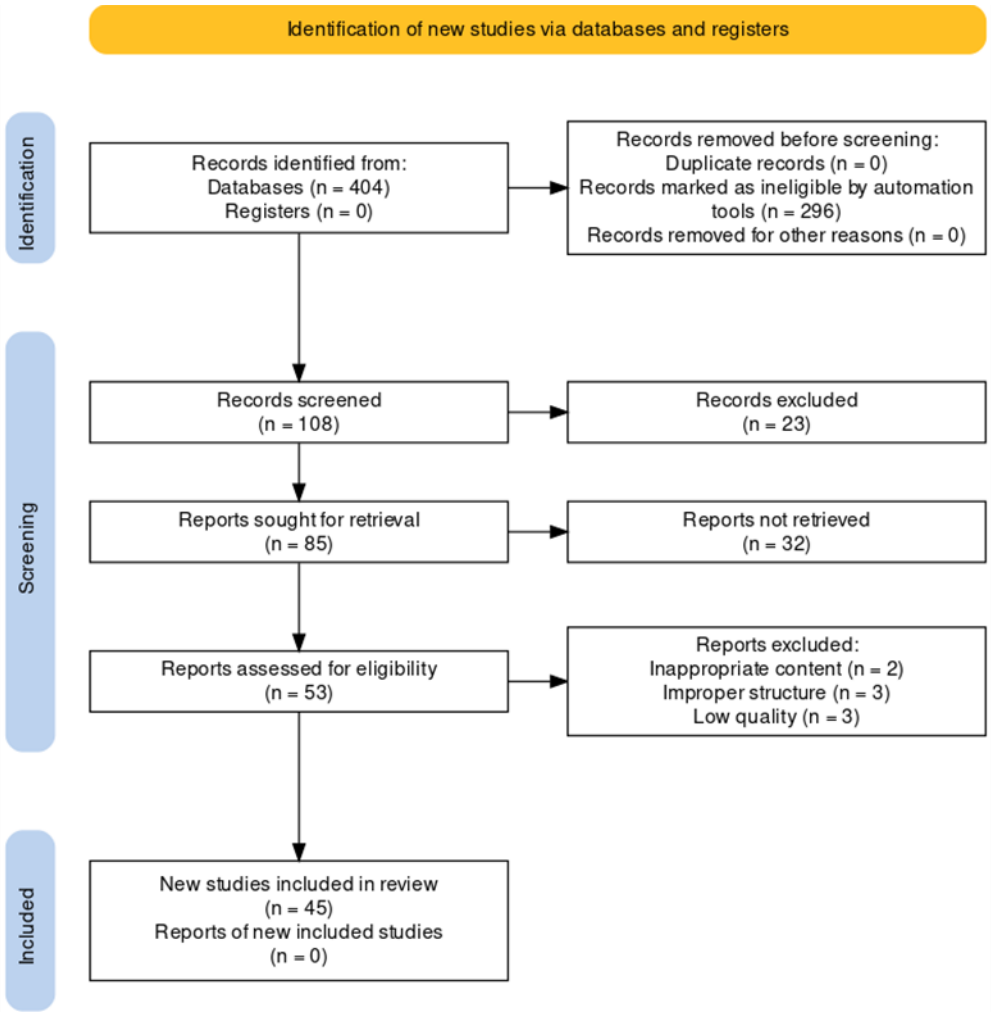

Figure 1 The PRISMA flowchart depicting the article selection process.

3. Results and Discussion

RQ1: What are the general research trends in digital learning materials in recent years?

In recent years, the research trends surrounding digital learning materials have exhibited intriguing patterns and fluctuations (see Figure 2). An analysis of the available data revealed the following general trends. Between 2017 and 2018, there was a consistent number of publications, with an average of three per year, indicating a steady level of interest in the topic. However, in 2019, there was a significant decrease in the number of publications, with only one recorded. This sudden

decline could be attributed to various factors, such as a shift in research focus or a temporary reduction in funding for digital learning materials research.

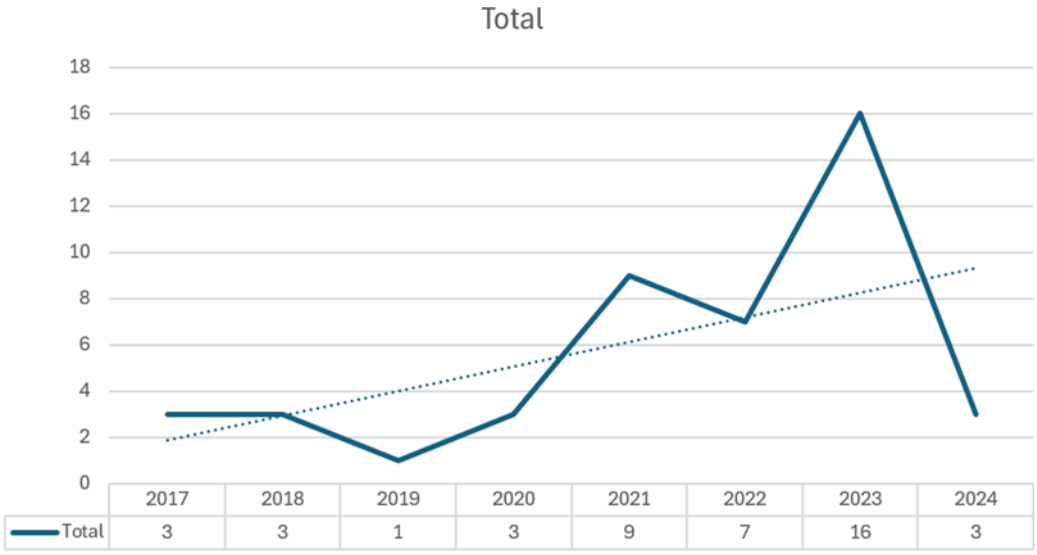

Figure 2 Publication trends in digital teaching and learning materials in recent years. *Source:* Scopus Database.

The trend shifted once again in 2020, with another increase of three publications. This suggests a renewed interest in the field, likely driven by advances in technology and the growing recognition of the importance of digital resources in education. The subsequent year, 2021, experienced a notable surge in the number of publications, totaling nine. This substantial growth indicates a renewed emphasis on exploring digital learning materials, potentially driven by the need for online and remote learning solutions during the global pandemic.

The upwards trajectory continued in 2022, with a relatively high number of publications at seven, indicating sustained research activity in this domain. However, in 2023, there was a significant spike in the number of publications, reaching 16. This increase can be attributed to several factors, including enhanced funding opportunities, technological advancements, and the growing recognition of the benefits associated with digital learning materials. For 2024, the available data include only three articles collected in the first quarter. Although this number is equivalent to the number of publications from 2017 and 2018, it is important to note that it represents a limited time frame. It is reasonable to predict that research related to digital learning materials may continue to increase throughout the remaining quarters of 2024.

RQ2: Which publications on digital learning materials have had the most significant impact? How do scholars recognize the influence of these publications?

The impact of articles can be assessed through their citation counts. The research team delved deeper into this aspect by examining high-impact citations, general knowledge citations, and research method citations (see Table 1). With respect to the total number of citations, the study titled "The effects of digital learning material on students' mathematics learning in vocational education" authored by Zwart et al. (2017) demonstrated the highest performance, with 83 citations. However, it is important to note that this cumulative count spans from 2017, making direct comparison with other articles in the same table challenging. The article titled "Potential Barriers to the Implementation of Digital Game-Based Learning in the Classroom: Preservice Teachers' Views" by Kaimara et al. (2021) and the article titled "Changes in Teacher Burnout and Self-Efficacy During the COVID-19 Pandemic: Interrelations and e-Learning Variables Related to Change" by Weißenfels et al. (2022) garnered a total of 39 citations each.

In terms of citation impact, the article titled "Potential Barriers to the Implementation of Digital Game-Based Learning in the Classroom: Preservice Teachers' Views" authored by Kaimara et al. (2021) stands out as highly influential, receiving a total of four high-impact citations. Similarly, the publication titled "Understanding teacher design practices for digital inquiry-based science learning: the case of Go-Lab" by de Jong et al. (2021) is also recognized for its significant impact, garnering three influential citations. The remaining articles in the dataset either had only one high-impact citation or lacked information regarding high-influence citations. Notably, the influence index of citations is determined through a supervised machine learning model, which takes into account the context surrounding the cited article. This index was developed to assist researchers in understanding how an article has been utilized in related research, whether it has been used or expanded upon (Valenzuela et al., 2015).

Table 1 Top 10 influential publications.

No	Title (References)	Total	Highly Influential Citations	Background	Methods
1	Potential Barriers to the Implementation of Digital Game-Based Learning in the Classroom: Preservice Teachers' Views (Kaimara et al., 2021)	39	4	16 (41.03%)	2 (5.13%)
2	Understanding teacher design practices for digital inquiry–based science learning: the case of Go-Lab (de Jong et al., 2021)	30	3	8 (26.67%)	7 (23.33%)
3	The effects of digital learning material on students' mathematics learning in vocational education (Zwart et al., 2017)	83	N/A	18 (21.68%)	N/A
4	Changes in Teacher Burnout and Self-Efficacy During the COVID-19 Pandemic: Interrelations and e-Learning Variables Related to Change (Weißenfels et al., 2022)	39	1	13 (33.33%)	N/A
5	The art of note taking with mobile devices in medical education (Pyörälä et al., 2019)	18	1	9 (50%)	1 (5.56%)
6	Distance learning and assistance using smart glasses (Spitzer et al., 2018)	15	1	5 (33.33%)	N/A
7	Digital teaching materials and their relationship with the metacognitive skills of students in primary education (Nieto-Márquez et al., 2020)	24	N/A	10 (41.67%)	N/A
8	Impacts of aiot implementation course on the learning outcomes of senior high school students (Tsai et al., 2021)	15	N/A	8 (53.33%)	1 (6.67%)
9	The effect of digital learning material on students' social skills in social studies learning (Sariyatun et al., 2021)	19	1	8 (42.10%)	N/A
10	An investigation of the digital teaching book compared to traditional books in distance education of teacher education programs (Uygarer & Uzunboylu, 2017)	32	N/A	21 (65.62%)	N/A

Source: Scopus Database.

In terms of general influence, the article titled "An investigation of the digital teaching book compared to traditional books in distance education of teacher education programs", authored by Uygarer and Uzunboylu (2017), presented the highest level of influence, as it was cited in 65.62% of instances. This article contributes primarily to the general knowledge section. The article titled "Impacts of AIoT implementation course on the learning outcomes of senior high school students" by Tsai et al. (2021) and "The art of note-taking with mobile devices in medical education" by Pyörälä et al. (2019) recorded contributions of 53.33% and 50%, respectively. When considering the number of citations related to research methods, the results were relatively modest, with only four out of ten articles providing this information (source: Semantic Scholar). Among these, the article titled "Understanding teacher design practices for digital inquiry-based science learning: the case of Go-Lab" by Jong et al. (2021) held the highest proportion, with 23.33%. The remaining three articles had percentages ranging from 5% to 7% in terms of citation weight.

RQ3: What are the prominent research topics surrounding digital learning materials?

To address research question 3, the thematic structure of the field was established by analysing the occurrences of authors' keywords (Vinh et al., 2024) Figure 3 presents a network representation of keywords that appeared together in at least one article from 2017--2024. In this figure, nodes represent keywords, edges symbolize connections between keywords, and the distance between nodes and the thickness of edges indicate the frequency of cooccurring keywords.

The overall findings reveal that a total of 97 keywords were used, forming 240 links, and these keywords were categorized into 16 clusters, distinguished by different colours. This observation highlights the diverse range of topics within the field of digital learning materials. The accompanying image displays specific nodes that serve distinct functions, such as collaborative learning and mathematics. Notably, the keyword "collaborative learning" acts as a bridge between two prominent research networks, namely, "digital learning materials" and "digital teaching materials." This underscores the importance of collaborative learning in the advancement and implementation of digital teaching materials and methodologies. Additionally, "mathematics" plays a crucial role in connecting digital learning materials with domains such as learning analytics and digital education.

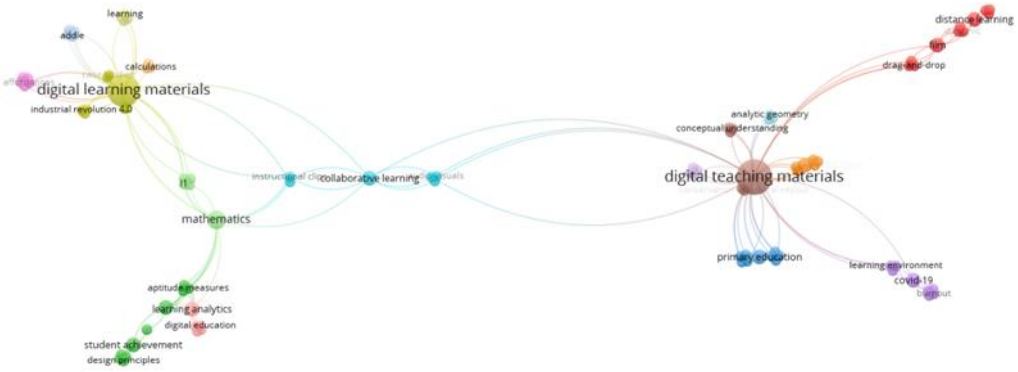

Figure 3 Network of keywords in the topic of digital teaching and learning materials. *Source:* Scopus Database.

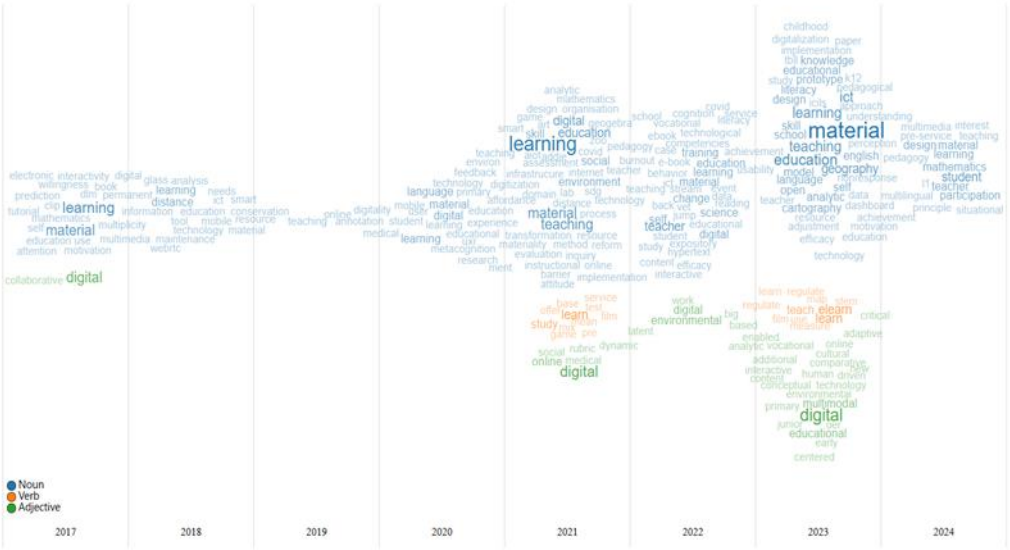

Figure 4 Evolution of keywords over time. *Source:* Scopus Database.

Figure 4 provides deep temporal insight into the evolving trends of digital teaching and learning materials from 2017--2024. The dominance of terms such as “learning,” “teaching,” “material,” and “digital” across all years suggests a sustained focus on digital education and pedagogical strategies. However, the increasing presence of context-specific terms, such as “cartography,” “multimodal,” and “environmental” in later years, indicates a shift toward interdisciplinary approaches and specialized applications in education. The term “digital” remains prevalent, reflecting the ongoing digital transformation in pedagogy.

The presence of action-oriented verbs, such as “learn,” “teach,” and “regulate,” highlights a methodological shift, potentially towards student-centered and adaptive learning frameworks. Additionally, adjectives such as “collaborative,” “analytic,” and “adaptive” suggest a growing interest in personalized and technology-enhanced learning environments. A key observation is the increased complexity and diversity of topics from 2020 onwards, coinciding with the global shift toward online education due to COVID-19. This highlights the pandemic’s role in accelerating digital learning innovations. The figure, therefore, not only captures linguistic trends but also reflects broader technological and pedagogical shifts in education research.

RQ4: What are the typical difficulties and challenges encountered in research on digital learning materials?

Research on digital learning materials has encountered significant limitations and challenges (see Table 2). One crucial issue is the limitation of generalizability, which hinders the application of research findings in broader contexts. Generalizing from specific target samples can be challenging, impeding the transferability of results. Another common problem is the small sample size. When the sample size is insufficient, drawing accurate and reliable conclusions becomes difficult due to inadequate data. A notable challenge lies in the lack of analytics. Insufficient detailed and insightful analysis limits our understanding of the impact and outcomes of digital learning materials. The long-term effectiveness of digital learning materials is also a concern. It is crucial not only to assess the short-term effectiveness but also to monitor and evaluate their long-term impact and sustainability.

Furthermore, there are additional important challenges in digital learning materials research, including a lack of knowledge, inadequate consideration of variables, insufficient comparative research, potential response bias or data accuracy issues, inadequate methods, and limited motivation.

Table 2 Limitations of prior research.

No	Limitations	Occurrences
1	Limited generalizability	15
2	Small sample size	14
3	Lack of analysis	13
4	Lack of long-term effect	11
5	Lack of knowledge	11
6	Lack of variables	9
7	Lack of cross-studies	6
8	Response bias or data accuracy	6
9	Lack of methods, motivations	6
10	Lack of tools	4
11	Lack of time	4
12	Lack of evaluation	3
13	Lack of resources	3
14	Lack of data	3
15	Lack of funding, design, policies, knowledge, teaching methods	5

Source: Scopus Database.

RQ5: What research directions are proposed for the future?

The data in Table 3 indicate several potential future research directions in the field of digital learning materials. First, in the realm of research methods and design, future research could focus on conducting long-term follow-up studies, employing a mixed methods approach, replicating studies under controlled conditions, exploring different teaching methods, and identifying subjective biases.

Second, regarding generalizability and contextual consideration, potential research directions include conducting comparative studies across diverse educational contexts, replicating studies across various cultures and genders, balancing samples across different levels of instruction and subjects, investigating the impact of external factors on students' self-awareness development, and conducting research in diverse communities.

Third, in the field of digital learning and technology, future research could involve investigating the effective utilization of digital learning materials, enhancing the design and usability of such materials, exploring the integration of new technologies in different contexts, fostering collaboration skills in digital environments, and investigating the integration of smart glasses in educational and professional settings.

Fourth, in the areas of teacher training and professional development, potential research directions include developing guidelines for instructors, refining methods to activate student engagement, enhancing the content of teacher training programs, providing long-term and sustainable professional development opportunities, promoting the customization of learning materials, and establishing best practices for reviewing open educational resources (OERs).

Finally, in terms of learning outcomes and assessment, future research could focus on analysing the impact and achievement of the learning process, evaluating the effectiveness of teaching modules, investigating the influence of collaborative efforts among teachers on the quality of teaching materials, and assessing the adaptability and creativity of digital teaching materials by integrating self-management measures and interventions within the learning materials themselves.

This review indicates that the effectiveness of digital learning materials (DLMs) depends less on the novelty of technology and more on how learning activities are structured to promote active, constructive, and interactive engagement. A recent second-order meta-analysis of technology-enhanced learning (TEL), synthesising multiple meta-analyses, found that substantial learning gains occur when digital tools are integrated into activity designs that incorporate scaffolds– such as prompts, feedback, and sequencing– whereas purely substitutional uses tend to yield smaller effects (Sailer et al., 2024).

Beyond design, teachers' pedagogical beliefs and orientations critically determine whether DLMs are implemented in student-centred ways. Empirical evidence suggests that student-centred beliefs are strongly correlated with constructivist technology practices, even under resource constraints, underscoring the importance of addressing teacher beliefs in professional development programmes (Bice et al., 2022; Ertmer et al., 2012). Large-scale surveys indicate that teachers generally value digital resources but report significant variation in self-efficacy and institutional support, implying that capacity building must accompany access (Alberola-Mulet et al., 2021).

Table 3 Future research directions on the topic of digital teaching and learning materials.

No	Category	Future directions
1	Research Methodology and Design	Conducting longitudinal studies (Alisaari et al., 2024; Mohr et al., 2021; Bratec Mrvar & Gašperič, 2023)
		Implementing mixed methods approaches (Kaimara et al., 2021; Lomos et al., 2023)
		Replicating studies under controlled conditions (Zwart et al., 2017)
		Exploring different modes of instruction (Bland et al., 2024)
		Addressing subjectivity bias (Vilppola et al., 2022)
2	Generalizability and Contextual Considerations	Conducting comparative research across different educational contexts (Śliwerski, 2023; Kaimara et al., 2021; Pyörälä et al., 2019)
		Replication in different cultures and balanced gender samples (Weißenfels et al., 2022)
		Exploring different teaching levels and subjects (Senden et al., 2023)
		Investigating the impact of external factors on metacognitive development in students (Nieto-Márquez et al., 2020)
		Conducting research in diverse populations (Markey et al., 2023)
3	Technology and Digital Learning	Investigating the use and design of digital learning materials (Berthelsen & Tannert, 2020; Sarsar et al., 2020; Şimşek & Yazıcı, 2021; Zhidkikh et al., 2023)
		Exploring emerging technologies and contexts (Pyörälä et al., 2019)
		Enhancing collaboration skills in digital environments (Pyörälä et al., 2019)
		Integrating smart glasses in educational and professional domains (Spitzer et al., 2018)
4	Teacher Training and Professional Development	Developing guidelines for tutors (Rahayu & Sapriati, 2018)
		Refining methods for activating students (Rahayu & Sapriati, 2018)
		Enhancing teacher education content (Alisaari et al., 2024)
		Providing sustained, longer-term professional development (Arispe et al., 2023)
		Encouraging customization and best practices in revising Open Educational Resources (OER) (Arispe et al., 2023)
5	Learning Outcomes and Assessment	Analysing learning impacts and gains (Mohseni et al., 2020; Nieto-Márquez et al., 2020)
		Assessing the effectiveness of teaching modules (Tsai et al., 2021)
		Investigating the impact of collaboration among teachers on instructional material quality (de Jong et al., 2021)
		Assessing adaptability and innovativeness of digital teaching materials (Bratec Mrvar & Gašperič, 2023; Tsai et al., 2021)
		Integrating self-regulated learning measures and interventions into digital learning materials (Nieto-Márquez et al., 2020; Zhidkikh et al., 2023)

Source: Scopus Database.

Learner self-regulation constitutes a second pillar linking DLMs to learning outcomes. Open-access syntheses and empirical research in online and blended environments consistently find that scaffolds for goal setting, monitoring, and feedback—especially – particularly when mediated by learning analytics or AI-based tools– enhance engagement and performance, provided they are pedagogically rather than technically oriented (An et al., 2021; Jin et al., 2023).

At the systemic level, the post-2020 acceleration of digitalisation revealed persistent gaps in pedagogical design capacity and quality standards. Studies of emergency remote teaching highlight that sustainable digital transformation in higher education requires institutional strategies that align technology with competence frameworks and quality assurance mechanisms, rather than ad hoc tool adoption (Mondragón-Estrada et al., 2023). Furthermore, evidence-synthesis efforts in health professions education show that curricular decisions should be based on cumulative systematic reviews rather than isolated interventions– an approach equally applicable to DLM selection in other fields (Tudor Car et al., 2019).

Integrating these strands, five design and implementation principles emerge for high-quality DLMs: (1) begin with targeted learning activities and cognitive processes rather than technological novelty; (2) embed scaffolding mechanisms such as prompting, timely feedback, and task sequencing; (3) include explicit self-regulation supports and, where appropriate, learning analytics or AI-driven features; (4) align tasks with authentic performance contexts and competence standards; and (5) foster teacher capability and shared reflective practice through professional learning that addresses beliefs and self-efficacy.

Together, these principles synthesise the most robust and verifiable evidence currently available and clarify why some DLM implementations produce consistent learning gains, while others do not.

4. Conclusion

Using 45 peer-reviewed articles that are indexed in Scopus, this study provides a comprehensive PRISMA-based synthesis of research on digital learning resources. After 2020, there was a notable increase in academic interest, according to the data, which was caused mostly by the global trend toward online and distant learning. Fifteen sets of restrictions emphasized the methodological and contextual intricacies that still pose challenges in this discipline, whereas sixteen theme clusters were discovered, with mathematics and collaborative learning emerging as crucial connectors. These results offer a thorough summary of the state of the art and validate the pivotal role that digital learning resources play in transforming modern pedagogy.

The study highlights significant implications for theory and practice in addition to combining the available data. The findings emphasize the necessity for educators and policymakers to make investments in the creation of technologically integrated, context-sensitive, and captivating digital learning materials. Researchers can enhance the conceptual and practical aspects of digital learning by using thematic maps as a useful framework to expand their investigation into new fields, including multimodality, adaptive technologies, and transdisciplinary applications.

However, there are certain restrictions on the review. It is possible that the emphasis on English-language journal articles and the use of Scopus as the only database prevented pertinent information from other sources, including books, conference proceedings, and non-English publications. These limitations imply that, despite their strength, the current findings should be regarded cautiously in terms of their generalizability.

Therefore, to capture a more comprehensive evidence base, future research should expand its scope by embracing various databases, publishing kinds, and languages. To evaluate the immediate and long-term effects of digital learning resources in various cultural and educational contexts, longitudinal and mixed-method techniques are also needed. Furthermore, the incorporation of cutting-edge technologies—such as augmented reality, artificial intelligence, and adaptive learning environments—offers encouraging opportunities for innovation. To guarantee the long-term and successful use of digital learning tools in practice, strengthening teacher preparation and professional development is equally important.

Acknowledgment

The authors received no specific funding or support from any individual or organization for this study. The data used in this research were obtained from the Scopus database. The authors would like to thank Elsevier for maintaining the Scopus dataset that made this analysis possible.

5. Declarations

5.1. Ethical considerations

Not applicable.

5.2. Use of artificial intelligence (AI)

The authors declare that the generative artificial intelligence (AI) tool ChatGPT was used exclusively for language editing and grammatical improvement. The use of AI did not influence the scientific content, study design, data analysis, data interpretation, results, or conclusions of the manuscript. Full responsibility for the content remains with the authors.

5.3. Conflict of interest

The authors declare that they have no conflicts of interest.

5.4. Funding

This research was not funded.

References

Afifah, R. N., Putri, A., Hartanti, A. N., Negari, S. I. T., Pratama, M. S. R., Zuaini, P. A. K., Al Madani, A. R., Muryanto, B. S., Muhammad, F., Astikasari, L., Indriyani, S., Kurniawati, I., Sunarto, Kusumaningrum, L., Budiharta, S., Flores, A. B., & Setyawan, A. D. (2023). Ecotourism development as a community-based conservation effort in Ayah Mangrove Forest, Kebumen, Central Java, Indonesia. *Asian Journal of Forestry, 7*(1), 37–44. https://doi.org/10.13057/asianjfor/r070106

Alberola-Mulet, I., Iglesias-Martínez, M. J., & Lozano-Cabezas, I. (2021). Teachers' beliefs about the role of digital educational resources in educational practice. *Education Sciences, 11*(5), 239. https://doi.org/10.3390/educsci11050239

Ali, W., Khan, M., & Ashraf, M. (2022). Adoption of digital learning tools in higher education during COVID-19: Students' perspectives. *Education and Information Technologies, 27*(5), 6597–6616. https://doi.org/10.1007/s10639-022-11017-5

Alisaari, J., Heikkola, L. M., & Harju-Autti, R. (2024). Teachers' beliefs and practices related to multilingual pedagogy: Implications for longitudinal research. *Teaching and Teacher Education, 137*, 104382. https://doi.org/10.1016/j.tate.2023.104382

Alwafi, N. A. (2023). Digital platforms and the improvement of learning outcomes: A systematic review. *Technologies, 11*(6), 140. https://doi.org/10.3390/technologies11060140

Al-Yahmadi, H. (2023). Impact of professional learning communities on teacher professional development in Oman. *MOJEM: Malaysian Online Journal of Educational Management, 11*(3), 48–62. https://mjs.um.edu.my/index.php/MOJEM/article/view/44985

An, Z., Li, S., Gan, Z., & Li, H. (2021). Technology-assisted self-regulated English language learning: Associations with English language self-efficacy, English enjoyment, and learning outcomes. *Frontiers in Psychology, 11*, 558466. https://doi.org/10.3389/fpsyg.2020.558466

Arispe, K., Hoye, A., & Palmer, K. (2023). The impact of open educational resource professional development for teachers in secondary education. *Open Praxis, 15*(4), 303–313. https://doi.org/10.55982/openpraxis.15.4.593

Barr, S., & Askell-Williams, H. (2020). Changes in teachers' epistemic cognition about self-regulated learning as they engaged in a researcher-facilitated professional learning community. *Asia-Pacific Journal of Teacher Education, 48*(2), 187–212. https://doi.org/10.1080/1359866X.2019.1599098

Berthelsen, U. D., & Tannert, M. (2020). Utilizing the affordances of digital learning materials. *L1-Educational Studies in Language and Literature, 20*, 1–23. https://doi.org/10.17239/l1esll-2020.20.02.03

Bice, H., Hodges, C., & Moore, S. (2022). Teachers' beliefs and practices of technology integration at a one-to-one school: A mixed-methods study. *Education and Information Technologies, 27*(5), 6621–6645. https://doi.org/10.1007/s10639-021-10853-5

Bland, T., Guo, M., & Dousay, T. A. (2024). Multimedia design for learner interest and achievement: A visual guide to pharmacology. *BMC Medical Education, 24*(1), 113. https://doi.org/10.1186/s12909-024-05077-y

Bong, W. K., & Chen, W. (2024). Integration of technology-enhanced learning in higher education: A systematic review. *Education and Information Technologies, 29*(2), 2015–2034. https://doi.org/10.1007/s10639-023-12014-2

Botha, C., & Nel, C. (2022). Purposeful collaboration through professional learning communities: Teacher educators' challenges. *International Journal of Learning, Teaching and Educational Research, 21*(6), 210–225. https://doi.org/10.26803/ijlter.21.6.13

Bratec Mrvar, R., & Gašperič, P. (2023). Traditional and modern cartographic materials for geography teaching: From Blaž Kocen to the present. *Acta Geographica Slovenica, 63*(2), 73–89. https://doi.org/10.3986/AGS.11625

Brennan, A., & Gorman, A. (2023). Leading transformative professional learning for inclusion across the teacher education continuum: Lessons from online and on-site learning communities. *Professional Development in Education, 49*(6), 1117–1130. https://doi.org/10.1080/19415257.2023.2238717

Brodie, K. (2021). Teacher agency in professional learning communities. *Professional Development in Education, 47*(4), 560–573. https://doi.org/10.1080/19415257.2019.1689523

Chen, L. (2020). A historical review of professional learning communities in China (1949–2019): Some implications for collaborative teacher professional development. *Asia Pacific Journal of Education, 40*(3), 373–385. https://doi.org/10.1080/02188791.2020.1717439

Chen, L. (2022). Facilitating teacher learning in professional learning communities through action research: A qualitative case study in China. *Teaching and Teacher Education, 119*, 103875. https://doi.org/10.1016/j.tate.2022.103875

Chen, L., & Zhang, J. (2022). Exploring the role and practice of teacher leaders in professional learning communities in China: A case study of a Shanghai secondary school. *Educational Studies, 50*(5), 1034–1052. https://doi.org/10.1080/03055698.2022.2026297

Dahl, K. K. B. (2019). Professional development lost in translation? 'Organising themes' in Danish teacher education and how it influences student-teachers' stories in professional learning communities. *Research in Comparative and International Education, 14*(3), 357–375. https://doi.org/10.1177/1745499919865141

de Jong, L., Wilderjans, T., Meirink, J., Schenke, W., Sligte, H., & Admiraal, W. (2021). Teachers' perceptions of their schools changing toward professional learning communities. *Journal of Professional Capital and Community, 6*(4), 336–353. https://doi.org/10.1108/JPCC-07-2020-0051

Dewi, K. A. I. D., Suarsana, I. M., & Juniantari, M. (2020). Pengaruh e-learning berbasis rumah belajar terhadap kemampuan berpikir kritis matematika siswa. *Wahana Matematika dan Sains: Jurnal Matematika, Sains, dan Pembelajarannya, 14*(1), 65–77. https://doi.org/10.23887/wms.v14i1.23986

Elfarargy, H., Irby, B. J., Singer, E. A., Lara-Alecio, R., Tong, F., & Pugliese, E. (2022). Teachers' perceptions of instructional coaches' practices in professional learning communities. *SAGE Open, 12*(3), 21582440221116103. https://doi.org/10.1177/21582440221116103

Ertmer, P. A., Ottenbreit-Leftwich, A., Sadik, O., Sendurur, E., & Sendurur, P. (2012). Teacher beliefs and technology integration practices: A critical relationship. *Computers & Education, 59*(2), 423–435. https://doi.org/10.1016/j.compedu.2012.02.001

Evawati, D., & Susilowati. (2023). Optimization of nutrition science learning through educational technology at PGRI Adi Buana University Surabaya. *Jurnal Iqra': Kajian Ilmu Pendidikan, 8*(1), 385–401. https://doi.org/10.25217/JI.V8I1.2734

Feldman, J. (2020). The role of professional learning communities to support teacher development: A social practice theory perspective. *South African Journal of Education, 40*(1), 1–8. https://doi.org/10.15700/saje.v40n1a1668

Grimm, F. (2024). Teacher leadership for teaching improvement in professional learning communities. *Professional Development in Education, 50*(6), 1135–1147. https://doi.org/10.1080/19415257.2023.2264286

Gunning, A. M., Marrero, M. E., Hillman, P. C., & Brandon, L. T. (2020). How K–12 teachers of science experience a vertically articulated professional learning community. *Journal of Science Teacher Education, 31*(6), 705–718. https://doi.org/10.1080/1046560X.2020.1758419

Ismail, S., Abdullah, Z., Komariah, A., Kurniatun, T., Kurniady, D., Sunaengsih, C., & Sanjaya, A. (2020). Influence of the professional learning community of Malay language teachers at the transformation school in Selangor. *International Journal of Innovation, Creativity and Change, 12*(6), 236–254. https://www.ijicc.net/images/vol12/iss6/12623_Ismail_2020_E_R.pdf

Jin, S. H., Kim, M., Lee, S., & Rha, I. (2023). Supporting students' self-regulated learning in online learning using artificial-intelligence applications: Learner perceptions and design implications. *International Journal of Educational Technology in Higher Education, 20*(1), Article 57. https://doi.org/10.1186/s41239-023-00406-5

Jong, M. S. Y., Tsai, C. C., & Wong, Y. M. (2021). Supporting self-regulated learning with technology: A review of recent literature. *Educational Technology Research and Development, 69*(1), 45–69. https://doi.org/10.1007/s11423-020-09850-2

Kaimara, P., Fokides, E., & Deliyannis, I. (2021). Augmented reality games in education: A case study in primary school. *Education and Information Technologies, 26*(3), 3457–3476. https://doi.org/10.1007/s10639-020-10435-9

Keijzer, H. D., Jacobs, G., Swet, J. V., & Veugelers, W. (2020). Identifying coaching approaches that enable teachers' moral learning in professional learning communities. *International Journal of Mentoring and Coaching in Education, 9*(4), 375–392. https://doi.org/10.1108/IJMCE-11-2019-0104

Khun-Inkeeree, H., Kasa, M. D., Sofian, F. N. R. M., & Yakob, W. R. W. (2023). Understanding new approaches to professional learning community practice and secondary school teacher motivation. *International Journal of Evaluation and Research in Education, 12*(2), 882–892. https://doi.org/10.11591/ijere.v12i2.23644

Klatt, M., Beddoes, Z., & Starck, J. (2023). 'For once I felt useful': A self-study of a physical education teacher navigating school culture through professional learning communities during induction. *Studying Teacher Education, 19*(2), 169–185. https://doi.org/10.1080/17425964.2022.2119553

Kloser, M., Edelman, A., Floyd, C., Martínez, J. F., Stecher, B., Srinivasan, J., & Lavin, E. (2021). Interrogating practice or show and tell?: Using a digital portfolio to anchor a professional learning community of science teachers. *Journal of Science Teacher Education, 32*(2), 210–241. https://doi.org/10.1080/1046560X.2020.1808267

Liu, S., & Yin, H. (2024). Opening the black box: How professional learning communities, collective teacher efficacy, and cognitive activation affect students' mathematics achievement in schools. *Teaching and Teacher Education, 139*, Article 104443. https://doi.org/10.1016/j.tate.2023.104443

Liu, S., Lu, J., & Yin, H. (2022). Can professional learning communities promote teacher innovation? A multilevel moderated mediation analysis. *Teaching and Teacher Education, 109*, Article 103571. https://doi.org/10.1016/j.tate.2021.103571

Lomos, C., Luyten, J. W., & Tieck, S. (2023). Implementing ICT in classroom practice: What else matters besides the ICT infrastructure? *Large-scale Assessments in Education, 11*, Article 1. https://doi.org/10.1186/s40536-022-00144-6

Luyten, H., & Bazo, M. (2019). Transformational leadership, professional learning communities, teacher learning and learner-centred teaching practices: Evidence on their interrelations in Mozambican primary education. *Studies in Educational Evaluation, 60*, 14–31. https://doi.org/10.1016/j.stueduc.2018.11.002

Markey, K., Graham, M. M., Tuohy, D., McCarthy, J., O'Donnell, C., Hennessy, T., & Fahy, A. (2023). Navigating learning and teaching in expanding culturally diverse higher education settings. *Higher Education Pedagogies, 8*(1), 2165527. https://doi.org/10.1080/23752696.2023.2165527

McPherson, H., & Asghar, A. (2023). Professional learning communities: The journey from 'do we HAVE to go there' to 'teachers getting together and being colleagues'. *Professional Development in Education*. Advance online publication. https://doi.org/10.1080/19415257.2023.2212682

Mesa, J. C., & Pringle, R. M. (2019). Change from within: Middle school science teachers leading professional learning communities. *Middle School Journal, 50*(5), 5–14. https://doi.org/10.1080/00940771.2019.1674767

Mo, Y., Appel, M., Kim, J. W., & Lee, M. (2021). Pre-service teachers' international study experiences or in-service teachers' professional learning communities: What comes into play in Finnish teachers' self-efficacy in multicultural classrooms? *Teachers and Teaching, 27*(7), 602–624. https://doi.org/10.1080/13540602.2021.1983535

Mohr, S., Schmitz, A., & Zawacki-Richter, O. (2021). Developing digital competence: A longitudinal study of pre-service teachers. *Computers & Education, 166*, 104149. https://doi.org/10.1016/j.compedu.2021.104149

Mohseni, F., Seifoori, Z., & Ahangari, S. (2020). The impact of metacognitive strategy training and critical thinking awareness-raising on reading comprehension. *Cogent Education, 7*(1), 1720946. https://doi.org/10.1080/2331186X.2020.1720946

Mondragón-Estrada, E., Kirschning, I., Nolazco-Flores, J. A., & Camacho-Zuñiga, C. (2023). Fostering digital transformation in education: Technology-enhanced learning from professors' experiences in emergency remote teaching. *Frontiers in Education, 8*, Article 1250461. https://doi.org/10.3389/feduc.2023.1250461

Msimanga, A., Woolway, J., & Lelliott, A. (2019). Continuous collaborative reflection sessions in a professional learning community: The development of Grade 8 natural sciences teachers' reflective practice. *African Journal of Research in Mathematics, Science and Technology Education, 23*(1), 1–13. https://doi.org/10.1080/18117295.2018.1555985

Nguyen, G. T. C., & Thai, D. T. (2023). Integrated teaching in primary schools: A systematic review of current practices, barriers, and future developments. *International Journal of Evaluation and Research in Education, 12*(4), 2053–2062. https://doi.org/10.11591/ijere.v12i4.26087

Nguyen-The Vinh, Phung, T.-N., & Do-Dinh Cuong. (2024). *A bibliometric and thematic analysis of systematic reviews of artificial intelligence in education* (pp. 337–351). In P. T. Nghia, V. D. Thai & N. T. Thuy (Eds.), *Advances in Information and Communication Technology* (Lecture Notes in Networks and Systems, Vol. 337–351). Springer Nature Switzerland AG. https://doi.org/10.1007/978-3-031-50818-9_37

Nieto-Márquez, N. L., Baldominos, A., & Pérez-Nieto, M. Á. (2020). Digital teaching materials and their relationship with the metacognitive skills of students in primary education. *Education Sciences, 10*(4), 113. https://doi.org/10.3390/educsci10040113

Ninković, S., Florić, O. K., & Đorđić, D. (2022). The effect of teacher trust in colleagues on collective teacher efficacy: Examining the mediating role of the characteristics of professional learning communities. *Teaching and Teacher Education, 119*, Article 103877. https://doi.org/10.1016/j.tate.2022.103877

Pyörälä, E., Hietala, M., Väisänen, M., & Heikkilä, T. (2019). Digital education in health professions: The need for an overarching evidence-synthesis approach. *Journal of Medical Internet Research, 21*(2), e12912. https://doi.org/10.2196/12912

Rabiu, H., Musa, A., & Hassan, M. (2023). Technology-enhanced learning in teacher education: Opportunities and challenges. *International Journal of Emerging Technologies in Learning, 18*(9), 45–59. https://doi.org/10.3991/ijet.v18i09.34127

Rahayu, U., & Sapriati, A. (2018). Open educational resources based online tutorial model for developing critical thinking of higher distance education students. *Turkish Online Journal of Distance Education, 19*(4), 163–175. https://doi.org/10.17718/tojde.471914

Safitri, E. (2023). A comprehensive review of the guided inquiry learning model in education. *Journal of Digital Learning and Distance Education, 2*(7), 622–626. https://doi.org/10.56778/Jdlde.v2i7.268

Sailer, M., Maier, R., Berger, S., Kastorff, T., & Stegmann, K. (2024). Learning activities in technology-enhanced learning: A systematic review of meta-analyses and a second-order meta-analysis in higher education. *Learning and Individual Differences, 112*, 102446. https://doi.org/10.1016/j.lindif.2024.102446

Sariyatun, S., Suryani, N., Sutimin, L. A., Abidin, N. F., & Akmal, A. (2021). The effect of digital learning material on students' social skills in social studies learning. *International Journal of Instruction, 14*(3), 417–432. https://doi.org/10.29333/iji.2021.14324a

Sarsar, F., Kale, Ö. A., Andic-Çakir, Ö., Gueorguiev, T., Evstatiev, B., Georgieva, T., Kadirova, S., Mihailov, N., & Rózewski, P. (2020). Multicultural investigation of the students' acceptance of using digital learning materials in laboratory classes. *Computer Applications in Engineering Education, 28*(6), 1476–1492. https://doi.org/10.1002/cae.22322

Schaap, H., Louws, M., Meirink, J., Oolbekkink-Marchand, H., Van der Want, A., Zuiker, I., Zwart, R., & Meijer, P. (2019). Tensions experienced by teachers when participating in a professional learning community. *Professional Development in Education, 45*(5), 814–831. https://doi.org/10.1080/19415257.2018.1547781

Senden, B., Nilsen, T., & Teig, N. (2023). The validity of student ratings of teaching quality: Factorial structure and comparability across grades and subjects. *Studies in Educational Evaluation, 78*, 101274. https://doi.org/10.1016/j.stueduc.2023.101274

Shauly, A., & Avargil, S. (2025). Teachers' practices during emergency remote teaching: An investigation of the needs for support and the role of professional learning communities. *Chemistry Teacher International, 7*(1), 63–74. https://doi.org/10.1515/cti-2022-0048

Shdaifat, S. A. K. (2020). The future role of vocational education teachers in the professional learning communities in public schools from the perspective of principals and academic supervisors in Jordan. *International Journal of Higher Education, 9*(5), 322–337. https://doi.org/10.5430/ijhe.v9n5p322

Şimşek, M., & Yazıcı, N. (2021). Examining the digital learning material preparation competencies of pre-service mathematics teachers. *Participatory Educational Research, 8*(3), 323–343. https://doi.org/10.17275/per.21.68.8.3

Śliwerski, B. (2023). Problems of conducting comparative research in education. *Studia z Teorii Wychowania, 14*(3[44]), 41–65. https://doi.org/10.5604/01.3001.0053.9195

Spitzer, M., Nanic, I., & Ebner, M. (2018). Distance learning and assistance using smart glasses. *Education Sciences, 8*(1), Article 21. https://doi.org/10.3390/educsci8010021

Tahir, L. M., & Musah, M. B. (2020). Implementing professional learning community in rural Malaysian primary schools: Exploring teacher feedback. *International Journal of Management in Education, 14*(4), 422–451. https://doi.org/10.1504/ijmie.2020.10028176

Tai, M. K., & Omar, A. K. (2023). Relationship between professional learning community and teacher attitudes toward change. *International Journal of Management in Education, 17*(1), 1–18. https://doi.org/10.1504/ijmie.2023.127778

Tam, A. C. F. (2023). Transforming preschool language teachers' beliefs of implementing play-based learning in a professional learning community. *International Journal of Early Years Education, 31*(1), 46–62. https://doi.org/10.1080/09669760.2022.2065247

To, K. H., Yin, H., Tam, W. W. Y., & Keung, C. P. C. (2023). Principal leadership practices, professional learning communities, and teacher commitment in Hong Kong kindergartens: A multilevel SEM analysis. *Educational Management Administration & Leadership, 51*(4), 889–911. https://doi.org/10.1177/17411432211015227

Tsai, C.-C., Chai, C. S., & Kong, S. C. (2021). The role of teachers' beliefs in integrating technology into teaching: Advances and future directions. *Computers & Education, 168*, 104222. https://doi.org/10.1016/j.compedu.2021.104222

Tudor Car, L., Kyaw, B. M., Dunleavy, G., Smart, N. A., Semwal, M., Rotgans, J. I., & Car, J. (2019). Digital problem-based learning in health professions: Systematic review and meta-analysis. *Journal of Medical Internet Research, 21*(2), e12945. https://doi.org/10.2196/12945

Uda, S. K., Suryanto, A., & Mahendra, R. (2022). Digital learning media development in vocational education: Case study in Indonesia. *Journal of Technical Education and Training, 14*(4), 123–136. https://doi.org/10.30880/jtet.2022.14.04.011

Uygarer, R., & Uzunboylu, H. (2017). An investigation of the digital teaching book compared to traditional books in distance education of teacher education programs. *EURASIA Journal of Mathematics, Science and Technology Education, 13*(8), 5365–5377. https://doi.org/10.12973/eurasia.2017.00827a

Valenzuela, M., Ha, V., & Etzioni, O. (2015). Identifying meaningful citations. *Proceedings of the AAAI Conference on Artificial Intelligence, 29*(1), 338–344. https://doi.org/10.1609/aaai.v29i1.9345

Vilppola, J., Lämsä, J., Vähäsantanen, K., & Hämäläinen, R. (2022). Teacher trainees' experiences of the components of ICT competencies and key factors in ICT competence development in work-based vocational teacher training in Finland. *International Journal for Research in Vocational Education and Training, 9*(2), 146–166. https://doi.org/10.13152/ijrvet.9.2.1

Weißenfels, M., Drexler, M., & Seidel, T. (2022). Teachers' perspectives on digital learning materials: Design principles for fostering student engagement. *Computers & Education, 178*, 104399. https://doi.org/10.1016/j.compedu.2021.104399

Yin, H., To, K. H., Keung, C. P. C., & Tam, W. W. Y. (2019). Professional learning communities count: Examining the relationship between faculty trust and teacher professional learning in Hong Kong kindergartens. *Teaching and Teacher Education, 82*, 153–163. https://doi.org/10.1016/j.tate.2019.03.019

Yu, T.-K., & Chao, C.-M. (2023). Encouraging teacher participation in professional learning communities: Exploring the facilitating or restricting factors that influence collaborative activities. *Education and Information Technologies, 28*(5), 5779–5804. https://doi.org/10.1007/s10639-022-11376-y

Zhang, J., & Sun, Y. (2020). Investigating the effects of professional learning communities on teacher commitment in China. *Educational Studies, 46*(6), 773–777. https://doi.org/10.1080/03055698.2019.1651695

Zhang, J., & Yuan, R. (2020). How can professional learning communities influence teachers' job satisfaction? A mixed-method study in China. *Teachers and Teaching, 26*(3–4), 229–247. https://doi.org/10.1080/13540602.2020.1806049

Zhang, J., Huang, Q., & Xu, J. (2022). The relationships among transformational leadership, professional learning communities and teachers' job satisfaction in China: What do the principals think? *Sustainability, 14*(4), 2362. https://doi.org/10.3390/su14042362

Zhidkikh, D., Saarela, M., & Kärkkäinen, T. (2023). Measuring self-regulated learning in a junior high school mathematics classroom: Combining aptitude and event measures in digital learning materials. *Journal of Computer Assisted Learning, 39*(6), 1834–1851. https://doi.org/10.1111/jcal.12842

Zhou, W., Nakatsubo, F., Wu, J., & Liu, K. (2022). Digital ethnography of an online professional learning community based on WeChat for Chinese early childhood teachers. *Computers & Education, 191*, 104617. https://doi.org/10.1016/j.compedu.2022.104617

Zulu, F.-Q. B., & Mukeredzi, T. G. (2021). A case study of two teacher learning communities in KwaZulu-Natal, South Africa. *South African Journal of Education, 41*(3), 1–9. https://doi.org/10.15700/saje.v41n3a1877

Zwart, R. C., Wubbels, T., Bolhuis, S., & Bergen, T. (2017). Teacher learning through collaboration and teacher self-regulation. *Educational Research and Evaluation, 23*(3–4), 99–124. https://doi.org/10.1080/13803611.2017.1358701