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Developing Critical Thinking in Digital Learning Environments: Challenges and Opportunities

Trias Istina Rokhmah[1], Darsono[1], Sucipto[1], Arina Restian[1], Ichsan Anshory AM[1]
[1]Universitas Muhammadiyah, Malang, Indonesia

ABSTRACT
Purpose – This study aims to map existing research on critical thinking in digital learning environments by identifying reported challenges, opportunities, and pedagogical strategies.
Methods – A scoping review was conducted following the framework of Arksey and O'Malley (2005). A systematic search of the Scopus database was performed using the keywords critical thinking, digital learning, online learning, and blended learning. After automated filtering, title screening, abstract screening, and full-text review, 20 peer-reviewed open-access journal articles published between 2020 and 2025 were included. Data were extracted and synthesized in relation to three research questions addressing challenges, opportunities, and pedagogical strategies.
Findings – The review identified recurring challenges, including superficial integration of higher-order thinking, limited learner self-regulation, technological and institutional constraints, and assessment limitations. At the same time, digital learning environments offer opportunities through flexible access, authentic learning tasks, collaborative interaction, and metacognitive support. Pedagogical strategies such as inquiry-based, project-based, case-based, and flipped learning were consistently associated with positive critical thinking outcomes when supported by instructional alignment and scaffolding.
Research Implications – The findings emphasize the central role of pedagogical design in fostering critical thinking through digital learning. As a scoping review, this study maps trends rather than evaluating intervention effectiveness and is limited to open-access Scopus-indexed articles.

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Corresponding Author:

Trias Istina Rokhmah
Magister Pedagogy, Universitas Muhammadiyah, Malang, Indonesia
Batu City, Indonesia
Email: triasistina@webmail.umm.ac.id

Introduction

The digital revolution has profoundly reshaped contemporary educational practices by expanding access to learning resources and enabling diverse forms of interaction beyond traditional classroom boundaries. The integration of digital technologies into education has led to the emergence of various digital learning environments—such as online, blended, and mobile learning—which have become defining features of 21st-century education (Bond et al., 2021; Dhawan, 2020). While these environments offer increased flexibility, accessibility, and learner-centered opportunities, they also introduce new pedagogical and cognitive demands that challenge conventional approaches to teaching and learning.

Within digital learning environments, critical thinking has emerged as a core competence. Learners are increasingly required to evaluate the credibility of information, manage information overload, and engage in reflective and independent learning processes (Facione, 2015). Consequently, teachers are expected to design instructional activities and assessment practices that promote higher-order thinking rather than passive knowledge consumption. However, empirical findings on the role of digital learning in supporting critical thinking development remain mixed and context-dependent. Some studies suggest that digital learning environments enhance student engagement, creativity, and collaborative problem-solving (Redecker & Punie, 2017), whereas others highlight challenges such as distraction, superficial learning, and cognitive overload that may inhibit deeper reasoning and reflection (Kirschner & De Bruyckere, 2017).

Conceptually, critical thinking in this review is understood as a multidimensional construct encompassing analysis, evaluation, inference, reflection, and reasoned decision-making. These dimensions are particularly salient in digital learning environments, where learners must actively regulate their learning while processing large volumes of information. Accordingly, this review draws on self-regulated learning and cognitive load theory as complementary conceptual lenses. Self-regulated learning emphasizes learners' capacity to plan, monitor, and evaluate their learning in technology-mediated contexts, whereas cognitive load theory provides insight into how instructional design and technological complexity may either support or constrain learners' cognitive processing and critical engagement.

Despite the growing body of research on critical thinking in digital learning environments, the literature remains fragmented across educational levels, disciplinary domains, and modes of digital delivery. Many studies focus on specific technologies, instructional models, or learning contexts, making it difficult to identify recurring challenges and systematic opportunities reported across studies. As a result, educators and researchers lack a comprehensive synthesis of the conditions under which digital

learning environments consistently hinder or support the development of critical thinking.

To address this gap, the present study adopts a scoping review approach to systematically map existing research on the development of critical thinking in digital learning environments. Specifically, the review aims to identify (1) the challenges most frequently reported in relation to developing critical thinking and (2) the opportunities afforded by digital learning environments that support higher-order thinking. Within this framework, pedagogical strategies, instructional designs, and assessment practices are examined as integral components of the opportunities reported in the literature rather than as a separate analytical strand. By synthesizing peer-reviewed studies published between 2020 and 2024, this scoping review seeks to provide an integrative overview of how digital learning environments shape critical thinking development and to highlight patterns that can inform future research and educational practice.

Methods

This study employed a scoping review approach based on the framework proposed by Arksey and O'Malley (2005) to systematically map research related to the development of critical thinking in digital learning environments. A scoping review was selected because the purpose of this study was not to evaluate intervention effectiveness but to identify research trends, challenges, opportunities, and pedagogical strategies reported across empirical studies addressing critical thinking within online, blended, and digital learning contexts.

The literature search was conducted using the Scopus database, which provides extensive coverage of peer-reviewed journals in education and educational technology. The search was performed using the keywords critical thinking AND ("digital learning" OR "online learning" OR "blended learning") AND education. This initial search yielded 213 documents. Automatic filtering was then applied within Scopus to refine the results according to predefined inclusion criteria: publication years between 2020and 2024, journal articles only, English-language publications, and journal source type. After this filtering process, 129 articles remained.

Subsequently, a title screening process was conducted by reviewing article titles only. Studies were excluded if they were not situated in an educational context, focused primarily on technical, medical, or business domains, or mentioned critical thinking only peripherally. Articles were retained if their titles indicated a focus on digital, online, or blended learning environments and explicitly addressed critical thinking, higher-order thinking skills, or reasoning. This stage resulted in 85 articles.

The next stage involved abstract screening, in which abstracts were examined to assess relevance to the research questions. Abstracts were evaluated based on whether

the study was conducted in a digital learning environment, whether critical thinking was a primary outcome or focus, and whether the study reported challenges, opportunities, or pedagogical implications related to critical thinking development. Articles were excluded if they presented only general opinions, focused on digital tools without addressing critical thinking processes, or were not aligned with the research questions. After this stage, 38 articles were retained.

From these 38 articles, only open-access studies were selected for full-text review to ensure transparency and replicability of the analysis. A total of 30 open-access articles were reviewed in full. During the full-text screening, studies were assessed for explicit relevance to at least one of the three research questions and for providing sufficient methodological and contextual detail related to critical thinking in digital learning environments. Following this process, 20 articles met all inclusion criteria and were included in the final review.

Data extraction was conducted using a structured charting table to systematically record key information from each included study. Extracted data included authors and year of publication, educational context, type of digital learning environment, research method, reported challenges related to critical thinking development, opportunities afforded by digital learning environments, and pedagogical strategies associated with supporting critical thinking. The extracted data were then synthesized using a descriptive and thematic mapping approach, allowing patterns and recurring themes across the three research questions to be identified and summarized.

Result

Following the full-text screening process, 20 articles were included in the final scoping review. These studies were published between 2020 and 2025 and represented a range of educational contexts, including elementary education, secondary education, undergraduate and postgraduate higher education, as well as informal and professional learning settings. The reviewed studies employed diverse digital learning environments, such as online learning platforms, blended learning models, flipped classrooms, MOOCs, virtual reality media, and interactive multimedia systems. A summary of the characteristics of the included studies is presented in Table 1.

The results are organized according to the three research questions: reported challenges (RQ1), opportunities (RQ2), and pedagogical strategies (RQ3) related to the development of critical thinking in digital learning environments.

Table 1. Characteristics of Included Studies

No	Author (Year)	Educational Context	Digital Environment	Method	RQ1 Challenges	RQ2 Opportunities	RQ3 Strategies
1	Suwardika et al. (2024)	Elementary School	Flipped Classroom	Mixed-Methods Study	Learner context variability; limited technology access; assessment and measurement constraints.	Flexible access; active learning affordances; digital integration supporting critical thinking.	Flipped classroom with pre-class independent learning (WBA, modules) and in-class discussion, presentation, and real-world application.
2	Goodsett (2020)	Higher Education	Online Information Literacy Learning Objects (Olos)	Quantitative Content Analysis	Inconsistent integration of critical thinking strategies; underemphasis on higher-order skills; resource and design constraints; limited interaction in asynchronous OLOs; risk of superficial engagement.	OLOs support problem structuring and critical thinking practice; reflection and authentic tasks effective online; explicit CT integration enhances learning and retention.	Real-world tasks, practice and repetition, feedback, MCQs; recommended strategies include learner-generated questions, ill-structured problems, concept mapping, and reflection.
3	Yang et al. (2024)	Higher Education	Online Flipped Classroom	Quasi-Experimental Study	Cognitive demands; pedagogical design complexity; institutional and contextual constraints.	Enhanced cognitive presence; metacognitive development; active and collaborative learning; authentic case-based learning.	Case-Based Learning–driven online flipped classroom with active learning and continuous assessment.
4	Widiastuti et al. (2022)	Higher Education	Blended & Online Learning	Mixed-Methods Study	Ineffectiveness of conventional teaching; need for strong pedagogical orchestration.	Increased critical thinking, motivation, engagement, and 21st-century skills.	CINTA model (communicating, inquiring, networking, teaching, applying) with structured inquiry and collaborative digital pedagogy.
5	Manousou (2025)	Postgraduate	Distance Learning	Qualitative Study	Exam-oriented culture; insufficient	Asynchronous learning flexibility;	Dialogic tasks, reflective assignments,

No	Author (Year)	Educational Context	Digital Environment	Method	RQ1 Challenges	RQ2 Opportunities	RQ3 Strategies
					scaffolding; assessment and synthesis difficulties; AI misuse risks.	reflective digital materials; access to scholarly literature; AI as learning scaffold.	literature evaluation, content creation, formative feedback, and AI literacy instruction.
6	Kusumandari et al. (2025)	Elementary Students	Interactive Multimedia	Mixed-Methods Study	Initial learner dependency; digital divide; short intervention duration.	Interactive multimedia; self-paced learning; learner autonomy.	Multimedia-supported problem-based learning with self-regulated learning scaffolding and constructivist design.
7	Kurniawan et al. (2024)	Undergraduate	Digital Project-Based Blended Learning (Dpbbl) Menggunakan Platform Digital (Canva)	Mixed-Methods Study	Difficulties in generative and creative thinking; limited procedural scaffolding; uneven learning gains; lack of adaptive digital feedback.	Collaborative project work; flexible blended learning; interactive multimedia; real-world contextual tasks.	Digital project-based blended learning, collaborative learning, constructivist pedagogy, and formative project-based assessment.
8	Dumitru et al. (2023)	Undergraduate	Blended Learning	Experimental Study	Limited time for disposition development; reliance on self-report measures; baseline variation.	Access to digital resources; authentic cases; metacognitive engagement; multimedia and collaboration.	Inquiry-based learning, digital case/project-based learning, metacognitive scaffolding, and explicit CT instruction.
9	Khadka et al. (2025)	Higher Education	E-Learning	Qualitative Phenomenological Study	Underutilization of digital features; limited pedagogical variation; instructor digital competence gaps; reliance on self-report data; cognitive load in self-directed learning.	Flexible LMS access; synchronous–asynchronous modes; intercultural collaboration; enhanced digital literacy.	Collaborative learning, peer assessment, project-based and case-based tasks, inquiry-oriented activities, reflective presentations, and tutor scaffolding.

No	Author (Year)	Educational Context	Digital Environment	Method	RQ1 Challenges	RQ2 Opportunities	RQ3 Strategies
10	Attipoe (2024)	Undergraduate	Blended Learning	Quasi-Experimental Study	Technology access limitations; time constraints; infrastructural challenges.	Learning flexibility; collaboration; real-world project engagement.	Project-based learning, collaborative activities, digital tools, and formative feedback.
11	Maryani et al. (2022)	Undergraduate	E-Learning	Design And Development Research (Addie Model)	Low literacy levels; dominance of lower-order thinking; technological difficulties.	Metacognitive development; simulations; flexible learning environments.	Metacognitive problem-based learning, reflective activities, and mind mapping.
12	Lijun & Yoshida (2023)	Undergraduate	E-Learning	Sequential Analysis Study	Critical thinking stagnation at lower-order levels; agreement-oriented discussion limiting cognitive depth.	Online discussions enable reflection, peer exchange, and reverse cognitive transitions.	Inquiry-based online discussion and altruistic peer interaction supporting self-regulation and higher-order CT.
13	Solovyeva et al. (2023)	Higher Education	Hybrid Learning	Quasi-Experimental Study	Low–moderate initial CT levels; limited improvement without structured intervention; teacher readiness challenges.	Hybrid learning flexibility; reflective spaces; LMS-supported self-regulated learning.	Structured hybrid courses with explicit CT instruction, reflective tools, and inquiry-based activities.
14	Bektesh i et al. (2023)	Undergraduate	Online Learning	Qualitative Study	Low digital readiness; negative learner attitudes; reduced engagement; technical and pedagogical barriers.	Access to diverse digital resources; self-paced exploration; reduced social pressure for questioning.	Online inquiry-based learning, exploration-focused activities, project-based learning, and scaffolded facilitation.
15	Yulian (2021)	Undergraduate	Flipped Classroom	Quasi-Experimental Study	Passive online learning; lack of preparatory scaffolding; limited exploration time.	Asynchronous video preparation; self-paced learning; digital feedback and learner autonomy.	Flipped classroom pedagogy with scaffolded inquiry-based reading and feedback-rich instruction.

No	Author (Year)	Educational Context	Digital Environment	Method	RQ1 Challenges	RQ2 Opportunities	RQ3 Strategies
16	Al-Said et al. (2024)	Undergraduate	Virtual Reality Media	Quasi-Experimental Study	Potential cognitive overload; novelty effects; dependence on instructional design quality; teacher readiness constraints.	Immersive engagement; reduced cognitive load; increased learning intention and motivation.	Design-driven VR pedagogy, immersive video instruction, and experiential learning.
17	Zainil et al. (2024)	Elementary School	Digital Learning	Quasi-Experimental Study	Need for age-appropriate pedagogical design; learner self-regulation demands; teacher digital competence requirements.	Authentic problem-based learning; digital simulations; global connectivity; monitored independent learning.	STEM-oriented digital project-based learning, inquiry cycles, collaborative platforms, and reflective activities.
18	Pereles et al. (2024)	Postgraduate	Fully Online Learning Environment	Quasi-Experimental Study	Difficulty fostering dialogical critical thinking without scaffolding.	Digital metacognitive tools supporting self-regulated learning and CT.	Explicit metacognitive and self-regulated learning strategies.
19	Veng (2022)	Undergraduate	Online Learning Environment	Qualitative Descriptive Study	Technical constraints; limited instructional support; misaligned task design.	Multimodal interaction; gamification; real-time engagement supporting CT.	Discussion-based learning, questioning techniques, problem-based learning, scaffolding, and strong instructor presence.
20	Poce (2021)	Informal Higher Education	MOOC (Massive Open Online Course)	Qualitative Study	Difficulty reaching integration and resolution phases of CT; low critical evaluation; participation constraints.	MOOC forums, art-based discussion, and online writing supporting critical exploration and reflection.	Structured prompts, CT rubrics, sustained discussion, and solution-oriented tasks.

1. Reported Challenges in Developing Critical Thinking in Digital Learning Environments

Across the reviewed studies, several recurring challenges were identified in relation to developing critical thinking in digital learning environments. One of the most frequently

reported challenges was the limited and inconsistent integration of critical thinking strategies within digital learning designs, particularly in asynchronous environments such as online learning objects and MOOCs. Many studies noted that learning activities often remained focused on lower-order cognitive skills, while higher-order skills such as argument analysis, evaluation, and synthesis were underemphasized.

Another prominent challenge concerned pedagogical and instructional design constraints, including insufficient scaffolding, lack of structured inquiry, and weak alignment between learning tasks and critical thinking objectives. Several studies also highlighted contextual and participant-related factors, such as learners' varying levels of digital readiness, self-regulation skills, and prior knowledge, which influenced the effectiveness of digital learning for critical thinking development.

Technological and institutional constraints were also commonly reported. These included limited access to reliable technology and internet connectivity, insufficient institutional support, time constraints, and limited human resources. Additionally, some studies pointed to assessment-related challenges, such as reliance on self-reported measures, difficulty assessing dialogic and higher-order critical thinking, and short intervention durations. In immersive or innovative environments (e.g., virtual reality), risks of cognitive overload and novelty effects were also identified as potential barriers.

2. Opportunities Afforded by Digital Learning Environments for Supporting Critical Thinking

Despite the challenges, the reviewed studies consistently reported multiple opportunities offered by digital learning environments to support critical thinking development. A key opportunity identified was the flexibility of access, allowing learners to engage with content asynchronously, revisit materials, and learn at their own pace. This flexibility was found to support reflection, self-regulated learning, and deeper cognitive engagement.

Many studies highlighted the potential of digital environments to provide authentic and contextualized learning experiences, such as real-world problems, case-based learning, project-based tasks, and simulations. These affordances enabled learners to analyze complex situations, evaluate evidence, and apply knowledge in meaningful contexts. Digital platforms also facilitated collaborative and dialogic learning, including online discussions, peer feedback, and cross-cultural interaction, which were associated with higher levels of cognitive and metacognitive engagement.

Furthermore, digital tools were reported to support metacognitive development and self-regulated learning, particularly through reflective activities, feedback mechanisms, learning analytics, and metacognitive scaffolds. Interactive multimedia, gamification, and immersive environments were also identified as opportunities to

enhance learner engagement, motivation, and sustained participation in critical thinking activities.

3. Pedagogical Strategies Associated with Supporting Critical Thinking in Digital Learning Environments

The analysis revealed a range of pedagogical strategies consistently associated with supporting critical thinking in digital learning environments. Frequently reported strategies included the use of authentic real-world problems, practice and repetition, formative feedback, and structured questioning. However, studies emphasized that these strategies were most effective when deliberately designed to elicit higher-order thinking rather than surface-level engagement.

Several pedagogical models emerged prominently across the reviewed literature, including flipped classroom, project-based learning, case-based learning, inquiry-based learning, and problem-based learning, often implemented within blended or online formats. These approaches commonly combined asynchronous preparation with synchronous or interactive activities focused on analysis, discussion, and application.

More advanced strategies highlighted in the studies included learner-generated questioning, concept mapping and visual organization of ideas, reflection-based tasks, and metacognitive scaffolding to support self-regulation. Collaborative strategies such as peer assessment, group discussion, and presentation-based defense of ideas were also frequently associated with enhanced critical thinking outcomes. Overall, the findings indicate that explicit instructional alignment, sustained scaffolding, and active learner engagement are central to effective critical thinking pedagogy in digital learning environments.

Discussion

This scoping review mapped the current state of empirical research on the development of critical thinking within digital learning environments, with a focus on reported challenges, opportunities, and pedagogical strategies. Drawing on 20 studies across diverse educational contexts and digital modalities, the findings reveal that while digital learning environments offer substantial potential to foster higher-order thinking, their effectiveness remains highly contingent upon pedagogical design, learner readiness, and institutional support.

1. Challenges in Developing Critical Thinking in Digital Learning Environments

One of the most persistent challenges identified in this review is the superficial integration of critical thinking within digital learning designs. Although critical thinking is frequently articulated as a desired learning outcome, many digital learning activities remain focused on procedural engagement or lower-order cognitive processes. This finding aligns with longstanding concerns in the literature that technology use alone does

not guarantee deep cognitive engagement unless it is intentionally aligned with higher-order learning objectives (Anderson & Krathwohl, 2001; Bloom et al., 1964; Laurillard, 2012). As Clark & Goellnicht (1995) argued, it is pedagogical method—not media—that ultimately drives learning outcomes, a position further reinforced by more recent digital pedagogy research.

Another prominent challenge concerns learners' readiness and self-regulation capacities. Several studies reported that students struggle to engage in analysis, evaluation, and synthesis when they lack experience with self-directed learning, reflective practices, or inquiry-oriented tasks. This challenge is particularly evident in asynchronous and fully online environments, where limited interaction and insufficient scaffolding may constrain learners' progression beyond surface-level engagement. These findings are consistent with self-regulated learning theory, which emphasizes the importance of learners' abilities to plan, monitor, and evaluate their own learning processes in cognitively demanding tasks (Zimmerman, 2002).

Institutional and technological constraints further exacerbate these pedagogical challenges. Limited access to reliable digital infrastructure, time constraints, and insufficient teacher preparedness were frequently cited barriers. In addition, assessment-related issues—such as reliance on self-reported measures and the difficulty of capturing dialogic, integrative, and reflective dimensions of critical thinking—raise concerns about the validity and sustainability of reported learning gains. Prior research has similarly noted the limitations of traditional assessment tools in capturing the complex and socially constructed nature of critical thinking, particularly in online and collaborative learning environments (Facione, 2015; Garrison et al., 2001). Collectively, these findings suggest that challenges in developing critical thinking through digital learning are not merely technical, but systemic, encompassing pedagogical, contextual, and organizational dimensions.

Overall, the findings suggest that digital learning environments tend to be less effective in supporting critical thinking when technology is adopted as an end in itself rather than as a means to support pedagogy. Several studies show that when digital learning relies heavily on self-paced and asynchronous activities without sufficient guidance, interaction, or feedback, students often focus on completing tasks rather than engaging in deeper thinking processes. In such cases, critical thinking is mentioned in learning objectives, but it is not consistently embedded in learning activities or assessment practices. This mismatch makes it difficult for students to understand what is actually expected of them. Moreover, complex digital platforms and densely packed learning materials may unintentionally increase cognitive load, especially for learners who are not yet accustomed to self-regulated learning. As a result, instead of encouraging analysis and reflection, digital learning may lead to fragmented attention and surface-level engagement. These findings indicate that the main issue lies not in the use of digital

technology itself, but in how learning activities are designed, scaffolded, and aligned with learners' cognitive readiness.

2. Opportunities Afforded by Digital Learning Environments

Despite these challenges, the reviewed studies consistently demonstrate that digital learning environments offer significant opportunities to support critical thinking development when used strategically. A key affordance identified is temporal and spatial flexibility, which allows learners to revisit content, engage in reflection, and regulate their learning processes autonomously. This flexibility aligns closely with theories of self-regulated and metacognitive learning, which emphasize time for reflection and iterative knowledge construction as essential conditions for higher-order thinking (Flavell, 1979; Zimmerman, 2002).

Digital environments also enable authentic and contextualized learning experiences, such as case-based learning, project-based tasks, problem-based learning, and simulations. These approaches were consistently associated with higher levels of analysis, evaluation, and application—core components of critical thinking. From a theoretical perspective, this finding is consistent with situated cognition and authentic learning theories, which argue that knowledge is most effectively developed through engagement with meaningful, real-world problems (Herrington et al., 2010; Lave & Wenger, 1991).

Furthermore, digital platforms facilitate collaborative and dialogic learning by enabling online discussions, peer feedback, and cross-cultural interaction. Such dialogic processes support the social construction of knowledge and encourage learners to articulate, defend, and revise their ideas through interaction with others. This resonates strongly with socio-constructivist perspectives, particularly Vygotskiĭ et al. (1987) emphasis on social interaction in cognitive development and the Community of Inquiry framework, which highlights cognitive presence as emerging through sustained discourse and reflection (Garrison et al., 2001).

Another important opportunity lies in the capacity of digital tools to scaffold metacognitive awareness through feedback systems, reflective prompts, and learning analytics. Several studies demonstrated that when digital environments explicitly support planning, monitoring, and evaluation, learners are better able to engage in sustained critical inquiry. These findings suggest that digital learning environments can function not only as content delivery systems, but also as cognitive and metacognitive scaffolds that support higher-order thinking.

The reviewed studies suggest that digital learning environments are more likely to support critical thinking when they provide learners with sufficient space to think, interact, and reflect, rather than simply consume content. Digital environments that allow learners to control the pace of learning—such as revisiting materials, pausing instructional videos,

or engaging in asynchronous discussions—appear to create conditions that are more conducive to reflection and deeper cognitive processing. Moreover, critical thinking tends to emerge more consistently when digital learning tasks are grounded in authentic, real-world problems that require learners to analyze information, weigh alternatives, and justify decisions. Collaborative features, including online discussions and peer feedback, further strengthen this process by exposing learners to diverse perspectives and encouraging them to articulate and defend their reasoning. Importantly, these opportunities become meaningful only when supported by clear guidance and purposeful task design. In this sense, digital learning works best not because of its technological sophistication, but because it enables pedagogical conditions—such as reflection, dialogue, and authenticity—that are essential for critical thinking development.

3. Pedagogical Strategies Supporting Critical Thinking

The review further indicates that the effectiveness of digital learning environments in promoting critical thinking is strongly mediated by pedagogical strategies rather than technological features alone. Across studies, pedagogical approaches such as flipped classrooms, inquiry-based learning, project-based learning, and case-based learning were most consistently associated with positive critical thinking outcomes. These strategies share a common emphasis on active engagement, problem-solving, and reflective learning, which are widely recognized as foundational elements of critical thinking development (Halpern, 2014).

Notably, the findings underscore the importance of explicit instructional alignment. Digital learning environments that clearly align learning objectives, learning activities, and assessment methods with critical thinking outcomes demonstrate stronger and more consistent effects. This supports the principle of constructive alignment, which posits that meaningful learning occurs when teaching and assessment are coherently designed to support intended learning outcomes (Biggs & Tang, 2011).

Advanced pedagogical strategies—such as learner-generated questioning, concept mapping, reflective writing, and peer assessment—were also frequently associated with enhanced critical thinking. These strategies promote metacognitive engagement and require learners to actively organize, evaluate, and justify their thinking. Importantly, the role of instructors remains central across digital contexts. Teacher facilitation, timely feedback, and pedagogical orchestration were repeatedly identified as enabling conditions for effective critical thinking development. Rather than diminishing the instructor's role, digital learning environments appear to reposition educators as learning designers and facilitators of cognitive engagement (Laurillard, 2012).

The findings of this review indicate that pedagogical strategies in digital learning environments succeed in fostering critical thinking when they are implemented as coherent learning processes rather than isolated instructional techniques. Strategies such

as flipped classrooms, inquiry-based learning, and project-based learning tend to be effective because they position learners as active participants who must prepare, question, analyze, and justify their ideas across multiple stages of learning. In contrast, similar strategies often fail to support critical thinking when they are reduced to procedural routines—for example, when flipped classrooms consist only of watching videos without meaningful in-class or online discussion, or when project-based tasks emphasize product completion over reasoning processes. Moreover, the success of these strategies is closely tied to the presence of sustained scaffolding and instructor facilitation. Without clear guidance, timely feedback, and explicit connections to critical thinking objectives, learners may focus on task completion rather than cognitive engagement. These findings suggest that pedagogical strategies do not work simply because they are labeled as "active" or "innovative," but because they are thoughtfully designed to make learners' thinking visible, challenged, and continuously refined.

4. Implications for Research and Practice

Taken together, the findings suggest that developing critical thinking in digital learning environments requires a holistic approach that integrates pedagogical design, learner support, and institutional readiness. For practice, educators should move beyond tool-centered adoption and prioritize pedagogical strategies that explicitly scaffold cognitive and metacognitive processes. For research, the review highlights a need for more longitudinal and mixed-methods studies that examine how critical thinking develops over time, how it is sustained beyond short-term interventions, and how contextual factors shape learning outcomes across diverse learner populations.

Finally, this scoping review shifts the discourse from whether digital learning can support critical thinking to how, under what conditions, and for whom such support is most effective. Addressing this question requires continued theoretical grounding, rigorous methodological approaches, and intentional pedagogical design that places critical thinking at the core of digital learning innovation.

Conclusion

This scoping review examined empirical studies on the development of critical thinking within digital learning environments across diverse educational contexts. Drawing on 20 peer-reviewed articles, the review provides a comprehensive overview of the challenges, opportunities, and pedagogical strategies associated with fostering critical thinking through online, blended, and digitally mediated learning.

The findings indicate that while digital learning environments offer considerable potential to support higher-order thinking, this potential is not automatically realized through technology adoption alone. Persistent challenges—such as superficial integration of critical thinking, limited learner self-regulation, inadequate pedagogical scaffolding, and assessment constraints—continue to hinder the effective development of critical

thinking skills. These challenges highlight that critical thinking in digital contexts is shaped by systemic interactions among pedagogy, learners, instructors, and institutional conditions.

At the same time, the review demonstrates that digital learning environments can meaningfully support critical thinking when intentionally designed. Affordances such as flexibility, authentic learning tasks, collaborative interaction, and metacognitive scaffolding enable learners to engage in analysis, evaluation, and reflective inquiry. Importantly, pedagogical strategies, including inquiry-based, project-based, case-based, and flipped learning models, emerged as central mechanisms for activating critical thinking processes in digital settings.

Overall, this scoping review underscores that the effectiveness of digital learning environments in fostering critical thinking depends less on technological sophistication and more on pedagogical intentionality, instructional alignment, and sustained learner support. Rather than replacing pedagogy, digital technologies amplify its impact when critical thinking is explicitly embedded within learning design and instructional practice. For future research, this review highlights the need for more longitudinal and mixed-methods studies that examine how critical thinking develops over time and across different learner populations.

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