



E-Book-Supported Problem-Based Learning: Synthesizing Evidence on Critical Thinking Development in Elementary Education

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Abstract: This study aims to explore the integration of e-book-based problem-based learning (PBL) to develop students' critical thinking through a Systematic Literature Review (SLR). The study employed an SLR method consisting of eight stages: defining the review objectives, developing the review protocol, collecting data, screening studies, appraising study quality, extracting data, synthesizing the findings, and writing the review. A total of 54 articles were identified from Google Scholar, Open Knowledge Maps, Scimago, and SINTA, of which 15 met the inclusion criteria. The selected articles were indexed in Scopus and SINTA. The data were analyzed using Qualitative Data Analysis (QDA). The findings indicate that e-book-based PBL can enhance students' critical thinking through the integration of the eight stages of PBL into e-book content, classroom-based implementation, and two-stage trials. However, several challenges were identified, particularly regarding teachers' technological competence and students' digital literacy. Therefore, although e-book-based PBL demonstrates strong pedagogical potential, its effectiveness depends on adequate digital readiness and well-designed instructional support. Further empirical research is needed to strengthen the evidence regarding its implementation and effectiveness.

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Introduction

Low learning outcomes have become a major problem in the Indonesian education system, where its literacy frequently ranks in the low category in PISA (Suliyansyah, 2022). The decline is commonly caused by the education system itself. It is argued that the major issue affecting students' literacy stems from teachers who still lack sufficient teaching skills, particularly in elementary school settings (Rosmalinda et al., 2021). It is a serious concern, given that children begin developing their thinking abilities in elementary school (Santos et al., 2025). As an initial stage, several elementary schools in Indonesia are still largely guiding students to memorize information rather than encouraging them to think critically (Sarwanto et al., 2021). It indicates that pedagogical issues are a fundamental problem underlying low learning outcomes and students' cognitive development in elementary schools.

The current issue contrasts with the phenomenon of 21st-century learning, which frames the learning process not merely as knowledge transformation but as the development of a range of skills. It is an educational paradigm that emphasizes students' higher-order thinking skills through student-centered learning (Huda & Lubis, 2019). Among these skills, critical thinking is crucial, helping students acquire knowledge by rationally and reflectively deciding what they need to do and learn (Suratmi & Sopandi, 2022). It is noted that developing students' critical thinking skills in elementary schools is essential for familiarizing them with more challenging problems and training their problem-solving skills



from the initial stage of their learning (Achmad & Utami, 2023). It is important for elementary school teachers to foster students' critical thinking not only to meet the demands of 21st-century learning but also to optimize students' development from an early age.

Many innovative teaching strategies have been developed by scholars to overcome the current problem. One strategy to enhance students' critical thinking skills is problem-based learning (PBL), which stimulates critical thinking through problem-solving (Nalma & Siga, 2025; Pimdeet et al., 2024). Students are introduced to a problem in which they are expected to interpret, analyze, evaluate, and draw a conclusion from the information to solve it (Agnesa & Rahmadana, 2022). It indicates that PBL provides learning activities that require higher-order thinking skills and directly develop students' thinking and intellectual skills (Susilawati & Supriyatno, 2023). Teachers can facilitate meaningful learning by applying authentic problems related to students' daily lives (Nurlaily et al., 2019). By integrating real-world problems, teachers can encourage students to actively participate in the classroom to develop their thinking skills, particularly critical thinking.

However, combining learning media is also crucial in implementing problem-based learning in the classrooms. It is noted that learning media create a more engaging learning environment, thereby optimizing the implementation of the learning strategy (Pratiwi et al., 2024). Learning media assist teachers in delivering learning material and packaging it in an interesting way, based on the implemented learning strategy, to reduce students' boredom (Novitasari et al., 2023). It facilitates students' understanding, engagement, and the creation of an interactive learning environment aligned with the learning strategies applied in the classroom (Triyanto et al., 2022). An appropriate learning medium effectively supports the learning strategy in developing students' cognition by framing learning as an interesting activity.

In a problem-based learning context, an e-book is one of the learning media that has been widely integrated to present problems and stimulate students' cognition. E-book delivers learning materials by incorporating features such as audio-visual content, images, graphics, and interactive learning activities, allowing students to understand the problem and process information more easily (Ardika & Sukmana, 2024; Kusumatuty et al., 2018). It is perceived as a digital learning resource that involves students in actively solving problems using the scientific method (Damayanti & Yohandri, 2022). It is added that e-book-based problem-based learning has advanced the learning process in elementary school settings, where it transforms the conventional learning into modern learning that attractively boosts students' cognitive levels (Dewi, 2025). Therefore, e-book-based problem-based learning is considered a promising medium for fostering students' thinking development.

Many studies have explored the use of e-book-based problem-based learning to improve students' critical thinking. Studies highlight that integrating an e-book into problem-based learning effectively improves students' critical thinking in junior high school (Putranti, 2024; Wahyuni & Rosana, 2025). The development of e-book-based problem-based learning has successfully increased students' critical thinking skills in elementary school, particularly in science (Semara et al., 2024). It is noted that the developed e-book-based problem-based learning has high feasibility and a large effect size on students' critical thinking skills (Putri & Wiarta, 2024). These studies have reported that e-book-based learning is essential for developing students' critical thinking in both junior high and elementary schools.

Despite its essential impact, there remains limited research that systematically reviews and synthesizes existing findings, particularly in the elementary school context. It indicates the need to provide a comprehensive understanding of how e-book-based problem-based



learning contributes to students' critical thinking development across studies. A systematic literature review is needed to synthesize existing research and identify implementation patterns, including their effectiveness and challenges. Therefore, the current study aims to systematically synthesize existing research on e-book-based problem-based learning to improve students' critical thinking skills in elementary schools.

Research Method

The current study was designed as a systematic literature review by adapting the model proposed by Mesgari et al., (2015). It consisted of eight stages: review objective, review protocol, data collection, screening, quality appraisal, data extraction, data synthesis, and review writing. As an initial step, the researcher identified the current phenomenon of integrating e-book-based problem-based learning to develop students' critical thinking skills in elementary schools. The researchers began formulating the research objectives based on the observed phenomenon. There were three research objectives formulated in the current study: 1) identifying the implementation pattern, 2) exploring the effectiveness of e-book-based problem-based learning in improving students' critical thinking skills, and 3) identifying the challenges during the implementation. Those objectives were used as the foundation for the next stage.

The researcher began to create the key terms for the data collection by combining the Boolean "AND" and "OR". The key terms were: ("e-book, and e-module, or digital book"), ("problem-based learning" or "PBL"), ("critical thinking skills", or "critical thinking abilities"), ("elementary school", and "elementary education" or "primary education"). In addition, the inclusion and exclusion criteria were arranged for the screening stage. The inclusion and exclusion criteria were adapted from Kerimbayev et al., (2025), as presented in Table 1.

Table 1. The Inclusion and Exclusion Criteria

	Inclusion Criteria	Exclusion Criteria
Source	Published articles indexed in SCOPUS, SINTA, and WOS	Thesis, dissertation, or proceeding articles
	Field study articles	Book's reviews, or library research articles
	Peer-reviewed articles	Non-peer-reviewed articles
Publication Year	The articles were published between 2016 - 2026	The articles were published before 2016
Research Scope	Concerning the integration of e-book-based problem-based learning in increasing students' critical thinking in elementary schools	Focusing on the integration of e-book with other innovative models in all educational levels
	Addressing the implementation including the challenges and effectiveness in implementing e-book-based problem-based learning in elementary schools	Focusing on the product development that combines e-book and problem-based learning without providing further evaluation

Table 1 shows that three dimensions were used to determine the inclusion and exclusion criteria. The source covered the published articles that were reduced based on their journal indexing. The articles were intended for publication in journals indexed by SCOPUS, SINTA, and WOS to ensure their reliability and validity. Meanwhile, data from theses, dissertations, or proceeding articles were excluded. The data should be obtained from field study articles and through a peer-review process to ensure that the data were valid and



reliable. In contrast, the non-peer-reviewed articles, book reviews, and library research were deleted from the metadata. The publication year covered articles published between 2016 and 2026, whereas articles published before 2016 were not selected as sources. In addition, the research scope focused on integrating e-book-based problem-based learning to improve students' critical thinking, with the articles addressing not only implementation patterns but also the product's challenges and effectiveness. In contrast, the study excluded articles that focused solely on product development, without further investigation into the implementation and evaluation of e-book-based problem-based learning. These criteria were used for the data collection and screening process to answer the research questions.

Data were collected through a literature search. The data were collected by searching for key terms on several websites, including Google Scholar, Open Knowledge, Scimago, Sinteristikdikti, and Clarivate. The data were further collected and checked for their indexed journals through Scimago, Sinteristikdikti, and Clarivate. The data were first randomly collected using the key terms and their indices, then filtered during the screening stage.

The collected data were filtered by the researcher, who screened them through a comprehensive reading. The data were also selected based on the inclusion and exclusion criteria. The data were comprehensively read from the abstracts to the contents, and were analysed systematically in the next stage. There were 54 articles exploring the integration of e-books and problem-based learning to improve students' critical thinking skills. After the selection and comparison to the inclusion and exclusion criteria, there were only 15 articles passing the screening process. The articles were checked for their quality appraisal. Quality appraisal was conducted to assess the methodological quality of the selected studies, ensuring that only reliable and valid research was included in the review. During the assessment, a rubric was provided to check the selected sources, as presented in Table 2.

Table 2. The Quality Appraisal Checklist

Articles	Clear Research Method	Adequate Research Samples or Subjects	Appropriate Data Analysis	Clear and Coherent Findings	Quality
Ardika and Sukmana, (2024)	√	√	√	√	Good
Arynata et al., (2025)	√	√	√	√	Good
Dewi et al., (2025)	√	√	√	√	Good
Liana et al., (2021)	√	√	√	√	Good
Lutfiani and Andriani (2025)	√	√	√	√	Good
Kristi &Andriani (2023)	√	√	√	√	Good
Pradipta et al., (2025)	√	√	√	√	Good
Puteri (2023)	√	√	√	√	Good
Putri and Wiarta (2024)	√	√	√	√	Good
Saputra and Sukmana (2024)	√	√	√	√	Good
Semara et al., (2024)	√	√	√	√	Good
Sholihah et al., (2022)	√	√	√	√	Good
Sung et al., 2019)	√	√	√	√	Good
Susanto et al., (2022)	√	√	√	√	Good
Usri and Fitria, (2023)	√	√	√	√	Good

Based on Table 2, the articles were assessed for their research methods to determine whether the data used were qualitative or quantitative. Adequate research samples or subjects



indicated the validity of the findings and their correlation with the data analysis. An appropriate data analysis strengthened the quality of the findings, enhancing their clarity and coherence. The data were considered coherent and clear if the findings answered the research questions and were presented with strong evidence. The assessment process indicated that all 15 articles had good quality.

Data were extracted to systematically collect information from the selected studies, covering authors, publication years, research designs, research objectives, research subjects or samples, data analysis, and findings. It organized the key information from the included articles, comparing and synthesizing it into the research findings. Data analysis was conducted at this stage, using Qualitative Data Analysis as proposed by Miles et al. (2014). It consisted of data condensation, data display, and conclusion drawing. Data condensation was the step of simplifying and synthesizing information from the selected articles, focusing on implementation patterns, challenges, and effectiveness of e-book-based problem-based learning. Data display was the step of presenting the data, in which they were presented in the form of a table and a description. Conclusion drawing is the final step in interpreting the current data, whether they answer the research questions or not.

Results and Discussion

The current study collected 54 articles, but only 15 were validated as high-quality based on the screening process. Those articles met the inclusion criteria; they mainly explored the integration of e-books and problem-based learning to improve students' critical thinking skills and were indexed in SCOPUS and SINTA. There were two articles indexed in Q3, two articles indexed in S3, two articles indexed in S4, and the rest of nine articles were indexed in S2. Those articles were categorized as good-quality articles, given their clarity in methods, findings, and data analysis, and adequate research samples or subjects. The collected data were analysed based on three dimensions, such as the implementation patterns, effectiveness, and challenges. Those were presented in Table 3.

Table 3. The Analysis Result

Dimensions	Findings	Sources
Implementation Patterns	Integrating problem-based learning stages in e-book	(Ardika & Sukmana, 2024; Kristi & Andriani, 2023)
	Using interactive multimedia features	
	Applying classroom-based implementation	(Dewi et al., 2025; Liana et al., 2021; Puteri, 2023)
	Two-stages classroom trials	(Lutfiani & Andriani, 2025; Saputra & Sukmana, 2024)
	Interactive learning activities	(Pradipta et al., 2025)
Effectiveness	Improving students' critical thinking skills	(Ardika & Sukmana, 2024; Dewi et al., 2025; Kristi & Andriani, 2023; Liana et al., 2021; Lutfiani & Andriani, 2025; Pradipta et al., 2025; Puteri, 2023; Putri & Wiarta, 2024; Saputra & Sukmana, 2024; Semara et al., 2024; Sholihah et al., 2022; Sung et al., 2019; Susanto et al., 2022; Usri & Fitria, 2023)
Challenges	Teachers' digital competence	(Semara et al., 2024)
	Students' Digital Literacy	(Arynata et al., 2025)



Based on the displayed data, a majority of studies examined the effectiveness of e-book-based problem-based learning in developing students' critical thinking skills. Ardik and Sukmana (2024) revealed that e-book-based problem-based learning successfully improved students' learning outcomes, as indicated by the post-test, which showed higher science scores. It is noted that students achieved scores above the passing grade and answered Higher-Order Thinking (HOTS) questions correctly. It showed that their critical or analytical skills were also improved during the implementation of e-book-based problem-based learning. This finding strengthened the evidence that e-book-based problem-based learning positively fostered students' 21st-century skills, including critical thinking, by providing interactive learning materials relevant to students' characteristics and needs (Dewi, 2025; Kristi & Andriani, 2023; Puteri, 2023). In practice, integrating e-books and problem-based learning improved students' critical thinking skills through independent learning (Pradipta et al., 2025; Putri & Wiarta, 2024). It was also noted that e-book-based problem-based learning was an effective learning medium for familiarizing students with critical thinking activities, with its effect categorized as medium, stimulating students to actively respond to the activities (Liana et al., 2021a; Lutfiani & Andriani, 2025; Saputra & Sukmana, 2024). E-book-based problem-based learning also supported constructivist theory by engaging students in the critical identification and investigation of the problem through interactive features and guided scaffolding (Semara et al., 2024; Sholihah et al., 2022). It directly influenced students' cognitive development by increasing students' interest and motivation (Sung et al., 2019; Susanto et al., 2022). Students were able to achieve higher levels of learning engagement, promoting their creativity, critical thinking, and collaboration, and providing meaningful experiences (Usri & Fitria, 2023). These findings indicated that integrating e-books and problem-based learning effectively increased students' critical thinking skills.

The reviewed studies discover several key patterns in implementing e-book-based problem-based learning. It was found that problem-based learning is incorporated into the e-book content. The e-book consisted of several activities, each reflecting problem orientation, problem identification, hypothesis formulation, data collection, data analysis, hypothesis testing, conclusion, and reflection or evaluation (Ardika & Sukmana, 2024; Kristi & Andriani, 2023). The activities were gradually presented in the e-book, in which students engaged in a systematic problem-solving process with the assistance of images, audio, video, and interactive games (Pradipta et al., 2025). In addition, the e-book-based problem-based learning was implemented through a classroom-based approach. The implementation was conducted in three phases: pre-activity, main activity, and post-activity (Dewi et al., 2025; Liana et al., 2021; Puteri, 2023). Pre-activity was the stage for introducing students to the problem and providing a space for them to identify the problem. The main activity was the phase in which students processed the information to solve the problem. Meanwhile, the post-activity phase was for students to conduct an evaluation and reflection. The e-book became a guide and learning resource for all phases. Additionally, studies highlighted that the e-book-based problem-based learning was implemented through two stages of classroom trials (Lutfiani & Andriani, 2025; Saputra & Sukmana, 2024). The trials were conducted twice through small-scale and large-scale groups. The implementation followed the problem-based learning phases, with classroom activities designed interactively using the e-book content. These studies pointed out that the implementation patterns followed the stages of problem-based learning and its function as interactive media.

Furthermore, the review identified challenges encountered during the implementation of e-book-based problem-based learning. It was revealed that the challenges related to



teachers' digital competence and students' digital literacy. It was found that teachers struggled to operate digital tools when using e-book features, leading to less effective integration (Semara et al., 2024). On the other hand, students' digital literacy was also perceived as a potential challenge, considering that not all students had adequate skills in navigating digital platforms. It caused them to have a lack of comprehension on multimodal contents (Arynata et al., 2025). These aspects were prone to distraction when e-book-based problem-based learning was implemented in classrooms. Therefore, both teachers' and students' digital readiness played a crucial role in the successful implementation of e-book-based problem-based learning.

Discussion

The current findings reviewed in this study demonstrate that e-book-based problem-based learning (PBL) effectively enhanced students' critical thinking skills, aligning with constructivist theory. It was argued that students' active involvement constructed knowledge through experience and interaction (Fahira & Nurkhamidah, 2024; Santosa et al., 2024). The integration of PBL stages into e-book content allowed students to conduct investigations, evaluations, and reflections, facilitating meaningful knowledge construction. It supported the implementation of student-centred learning to enhance students' self-efficacy and directed learning (Alvarez-Huerta et al., 2022; Panadero et al., 2017). The interactive multimedia features within the e-book provided rich learning stimulus, encouraged students' active engagement (Amirudin & Setuju, 2018). In addition, the structural activities and scaffolding fostered students' Higher-Order Thinking skills (HOTS) (Tirtayasa et al., 2022). The findings supported the cognitive theory of multimedia learning, showing that students easily comprehended information when it was presented in text, images, audio, and video (Menno & Prodjosantoso, 2025).

The findings on implementation patterns strengthened both instructional design and pedagogical theories. The implementation of e-book-based problem-based learning supported the adoption of innovative teaching strategies in elementary education, with the product implemented across all eight stages (Jaya et al., 2025; Sarwanto et al., 2021). Based on a pedagogical perspective, the implementation of pre-, main-, and post-activities reflected principles of instructional design theory, particularly systematic learning sequences that support goal-oriented instruction (Williyanto et al., 2022). Conducting two-stage classroom trials was crucial to ensuring the evaluation was carried out coherently, thereby strengthening the learning process itself. These implementation patterns demonstrated that the e-book-based problem-based learning was pedagogically grounded and systematically designed to provide an iterative process for developing students' cognition and ensuring its sustainability in classroom practice.

Furthermore, the identified challenges were interpreted through the lens of the TPACK (Technological Pedagogical Content Knowledge) framework, in which teachers' digital competence and students' digital literacy became obstacles to implementing e-book-based problem-based learning. Without sufficient TPACK, students did not optimally perceive the potential of technological means (Wijaya et al., 2023; Zaim et al., 2025). It supported previous studies on the need for digital training for teachers to enhance their pedagogical skills in the classroom, given that teachers play a pivotal role in selecting and implementing appropriate learning models or media (Paschal & Gougou, 2022). It also implicated students' digital literacy as a fundamental element in technological integration (Merta et al., 2023).



The current study has shown that e-book-based problem-based learning was beneficial for students' critical thinking skills, considering that previous investigations have successfully demonstrated its effectiveness by outlining implementation patterns and challenges. Further investigation was suggested to enhance the theoretical and empirical significance in the elementary context, as the current study was limited to a systematic literature review (SLR) design. As such, it relied solely on secondary data from previously published studies, which may be subject to publication bias and variations in research quality, context, and methodology. In addition, the findings were constrained by the selection criteria, databases, and time range of the reviewed articles, potentially excluding other relevant studies. Therefore, future research was recommended to conduct empirical studies, such as experimental or quasi-experimental designs, to provide more comprehensive and context-specific evidence regarding the implementation and effectiveness of e-book-based problem-based learning in elementary education.

Conclusion

In conclusion, this study demonstrates that e-book-based problem-based learning is an effective approach to enhancing students' critical thinking skills in elementary education. The integration of interactive e-books with structured problem-based learning stages fosters active engagement, independent learning, and meaningful knowledge construction, ultimately supporting the development of 21st-century skills. The identified implementation patterns highlight the importance of systematic instructional design and classroom-based application in achieving optimal learning outcomes. However, challenges related to teachers' digital competence and students' digital literacy remain significant factors influencing its success. Therefore, while e-book-based problem-based learning offers strong pedagogical potential, its effectiveness depends on adequate digital readiness and well-designed instructional support, suggesting the need for continuous improvement and further empirical research in this area.

Recommendation

It is recommended that teachers integrate e-book-based problem-based learning (PBL) with appropriate digital and instructional support to foster students' critical thinking. Teachers should also strengthen their technological competence, while students need to develop adequate digital literacy to optimize the use of e-book-based PBL. Future research should conduct empirical studies with diverse educational contexts to further examine its effectiveness and implementation challenges.

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