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A Systematic Literature Review of Interactive E-Modules Integrating Collaboration and Local Wisdom to Foster Students' Problem-Solving Skills and Character

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Abstract

Although interactive e-modules in mathematics education have attracted growing scholarly interest, limited research has addressed the integration of collaboration and local wisdom to simultaneously enhance students' problem-solving skills and character development. This study systematically reviews prior empirical research on interactive e-modules to examine their distribution across educational levels, evaluate their impact on cognitive and character-related outcomes, and identify existing gaps and future directions. Adopting a Systematic Literature Review (SLR) approach guided by the PRISMA framework, 15 peer-reviewed studies published between 2020 and 2025 were analyzed, sourced from Google Scholar and Scopus databases. Descriptive and thematic analyses reveal that most studies focused on junior high school contexts and employed pedagogical models such as Problem-Based Learning (PBL), STEAM, Realistic Mathematics Education (RME), and Ethnomathematics, all of which demonstrated effectiveness in enhancing mathematical problem-solving abilities. However, integration of Social Emotional Learning (SEL) and local wisdom—such as the *Tri Hita Karana* philosophy—was relatively rare, despite their potential to cultivate values like

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empathy, responsibility, and environmental awareness. The findings contribute to the theoretical advancement of constructivist and sociocultural learning paradigms by underscoring the value of culturally and emotionally responsive digital content. The study concludes that interactive e-modules designed with collaborative and local cultural elements are instrumental in promoting holistic learning that supports both academic and character development. It recommends cross-sector collaboration among educators, families, and policymakers to design and implement contextually grounded e-modules. This review also identifies avenues for future research, including multi-level educational implementation, family involvement, and the integration of emotional learning in digital instructional design.

Keywords: Interactive E-Modules; Problem-Solving Skills; Character Education; Local Wisdom; Collaborative Learning

INTRODUCTION

Education in the 21st century requires students to master a range of higher-order thinking skills critical, creative, communicative, and collaborative alongside strong character formation to face increasingly complex global challenges. According to Trilling and Fadel (2009), these competencies are the foundation of 21st-century learning that emphasizes not only knowledge acquisition but also the ability to apply it in real-world contexts. Among these essential skills, problem-solving occupies a crucial position because it reflects students' ability to think logically, analyze situations, and make reasoned decisions (OECD, 2019). Problem-solving skills are also closely related to students' numeracy competence the ability to apply mathematical reasoning in everyday life situations. Numeracy supports students' cognitive development, logical thinking, and competitiveness in an era dominated by technology and globalization.

However, both international and national assessments consistently reveal that Indonesian students' problem-solving and numeracy abilities remain low. The PISA 2022 results show that Indonesian students' average mathematics score (379) is far below the OECD average (472), indicating weaknesses in applying mathematical concepts to real-life problems (OECD, 2023). Similarly, national assessments (Kemendikbud, 2023) report that only 46.67% of elementary, 40.63% of junior high, and 41.14% of senior high school students demonstrate numeracy competence above the minimum level. This finding highlights the urgent need for innovative learning strategies that not only enhance students' problem-

solving skills but also build moral and character values, especially in light of the growing number of student moral degradation cases, such as bullying and intolerance (Kompas, 2024).

In responding to these challenges, teachers play a vital role as facilitators who guide students in developing cognitive and affective competencies simultaneously. Innovative learning designs especially through digital and interactive media are increasingly needed to improve learning effectiveness. One promising approach is the development and use of interactive e-modules, which allow flexibility, interactivity, and contextual learning. Several studies have demonstrated their potential effectiveness. For instance, Juniantari (2022) found that problem-based learning (PBL) e-modules significantly improve students' mathematical problem-solving skills. The interactive e-modules integrate contextual problems, self-assessment features, and direct feedback mechanisms that encourage active learning. Similarly, Paramita et al. (2024) revealed that e-modules integrating ethnomathematics enhance students' problem-solving abilities by linking mathematics with local cultural contexts. Cahyaningrum (2025) further demonstrated that PBL-based e-modules oriented toward social emotional learning (SEL) and the Tri Hita Karana philosophy not only improve mathematical performance but also foster students' noble character.

The integration of local wisdom particularly the Tri Hita Karana concept provides a strong theoretical foundation for developing students' character and harmonious relationships in spiritual, social, and ecological dimensions (Selamet et al., 2025; Suharta & Parwati, 2022; Suryawan et al., 2022). Learning based on local culture allows students to construct knowledge through contextual experiences (Ardana, Ariawan, & Yudana, 2023; Dewi et al., 2020). Nevertheless, most existing studies emphasize teacher–student interaction in e-module development, while the role of parental involvement as an essential component in students' emotional stability, motivation, and character development is often overlooked. In fact, numerous studies have highlighted that family support through communication, expectations, and participation in learning significantly affects students' academic achievement and moral growth (Ardana, Ariawan, & Sugandini, 2023).

This indicates a research gap: despite the proven effectiveness of interactive e-modules in improving problem-solving and character development, studies rarely explore models that integrate collaboration among teachers, parents, and students, combined with local wisdom-based content. Therefore, there is a need for further investigation into how

collaborative, locally grounded e-modules can comprehensively foster both cognitive and character development.

Accordingly, this study aims to conduct a Systematic Literature Review (SLR) to identify, analyze, and synthesize previous research on the use of interactive e-modules to enhance problem-solving and character-building skills. Specifically, this review focuses on: describing the distribution of interactive e-modules based on educational levels, analyzing their contributions to improving students' problem-solving abilities and character, and identifying research gaps and future directions in the development of interactive e-modules integrating collaboration and local wisdom.

METHODS

This study was conducted using a *Systematic Literature Review* (SLR) approach that follows the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework (Sugiyono, 2024). PRISMA consists of four main stages that serve as a reference in the literature review process: Identification, Screening, Eligibility, and Inclusion. Each stage is designed to ensure that the studies used in the review are truly relevant, valid, and in accorandce with the research objectives.

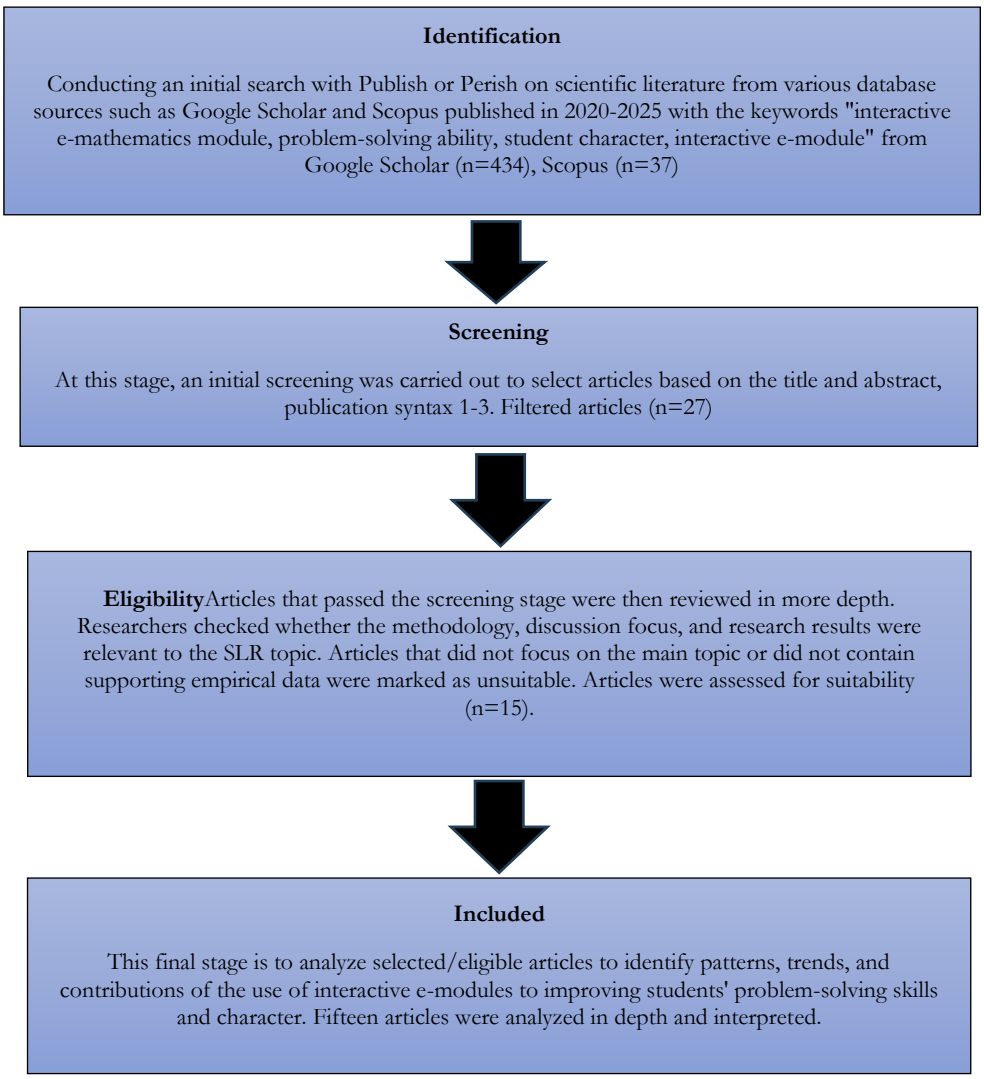


Figure 1. Prism Flowchart

Based on the initial search in publish or perish of scientific literature from various database sources such as Google Scholar and Scopus published in 2020-2025 using the keywords: interactive e-module mathematics, problem-solving skills, student character, interactive e-module.

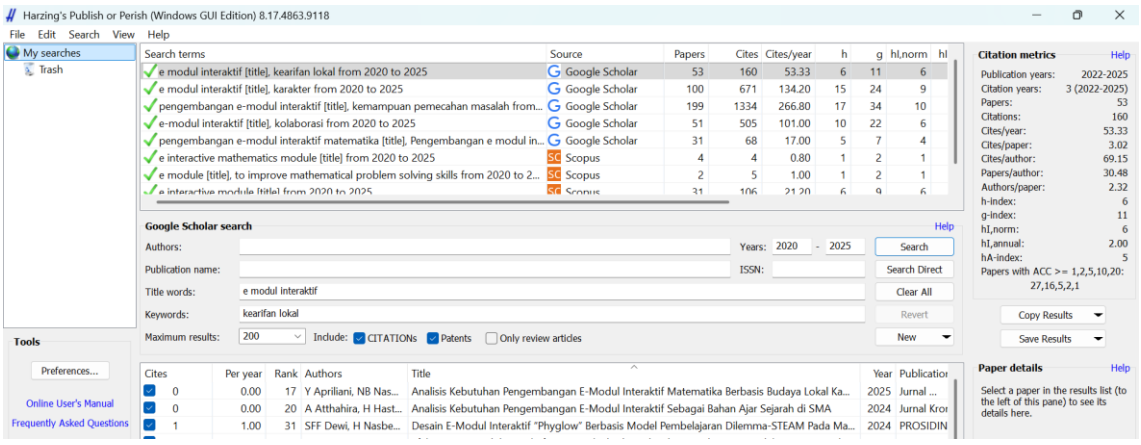


Figure 2. Initial search in publish or perish

RESULTS

After conducting a selection and feasibility test, 15 articles relevant to the keywords used were obtained. Next, the researchers reviewed the articles relevant to the SLR topic. The relevant article data was documented as shown in Table 1.

Table 1. Selected Research

No	Source	Author, Year	Title	Level	Research Result
1	Google Scholar	(Islahiyah et al., 2021)	Development of E-Modules with Problem-Based Learning Models to Improve Students' Mathematical Problem-Solving Skills	SMA	The developed PBL-based e-module can improve mathematical problem-solving skills. This research still has limitations, namely its implementation in only one class. Suggestions for further research include implementing it on a broader scale.
2	Google Scholar	(Juniantari, 2022)	Development of Interactive E-Modules Based on Problem Based Learning (PBL) to Improve Problem-Solving Skills in Grade X Students	SMA	PBL-based interactive e-modules are effective in improving students' mathematical problem-solving abilities. The characteristics of the interactive e-modules developed are: (1) each opening of the material begins with a problem related to everyday life, (2) contains problems and activities that enable students to discover concepts independently, (3) contains practice questions that present problems, (4) contains a self-assessment activity section aimed at enabling students to recognize and assess their own abilities, and (5) contains practice questions and interactive evaluations where students immediately receive results and feedback.
3	Google scholar	(Sari et al., 2023)	Development of an E-Module of a Creative Problem Solving Model Based on HOTS Questions to Improve Mathematical Problem Solving Skills and Adversity Quotient	SMA	he HOTS-Based Creative Problem Solving Model e-module is effective for improving mathematical problem-solving skills and adversity quotient. Using this e-model, students can more easily understand linear programming material.
4	Google scholar	(Mustofa & Wahyuni, 2023)	Development of a STEAM-based electronic mathematics module to improve problem-	SMP	The product developed from this research is a STEAM-based e-module to improve the problem-solving skills of MTs students using the 4D method,

No	Source	Author, Year	Title	Level	Research Result
			solving skills in sets for MTs students		namely "Define, Design, Develop, and Disseminate".
5	Google scholar	Putri et al. (2023)	A Problem-Based Learning Mathematics E-Module Containing Local Cultural Knowledge to Improve Problem-Solving Skills	SMP	The development of a problem-based learning-based mathematics e-module containing local cultural knowledge is quite effective in facilitating students in improving their mathematical problem-solving skills. Suggestions for further research include the need to develop e-modules for other materials and variations of mathematical practice questions, the need to insert other features so that they can be more interactive and interesting, the need to add variations of other local cultural objects so that students can indirectly gain other insights while learning mathematics.
6	Google scholar	(Wilandari et al., 2024)	Augmented Reality-Assisted Mathematics E-Module through Problem-Based Learning to Improve Problem-Solving Skills	SMP	An AR-assisted Mathematics e-module with innovative video, audio, interactive quizzes, games, and AR content features can improve students' mathematical problem-solving skills. A limitation of this study is the use of a pre-experimental one-group pre-test post-test design, which may limit the generalizability of the results. Future research may consider more effective research designs.
7	Scopus	(Safitri et al., 2024)	E-Module Based on Realistic Mathematics Education (RME) on Number Material to Improve Problem Solving Ability	SD	The Realistic Mathematics Education (RME)-based e-module was effectively applied to the whole number material in mathematics. The implication of this research is that it can be an innovative alternative in mathematics learning, particularly in the number material.
8	Google Scholar	(Komariah & Purwasih, 2024)	The Development Of Contextual Approach E-Modules To Improve Students'mathematical Problem Solving Ability On Junior High School	SMP	The developed E-module can improve students' problem-solving abilities.
9	Google Scholar	(Paramita et al., 2024)	E-module containing ethnomathematics to improve mathematical	SMP	The developed e-module can improve students' problem-solving skills. The characteristics of this e-module include learning outcomes, learning

No	Source	Author, Year	Title	Level	Research Result
			problem solving ability		objectives, concept maps, ethnomathematics, interaction, and discovery.
10	Scopus	(Suharmita et al., 2024)	Development of e-modul based on a problem based learning model to improve problem solving ability and appreciation of mathematics at SMP Dharma Pancasila Meand	SMP	The use of the developed E-Module can improve students' ability to solve mathematical problems and can increase students' appreciation of mathematics.
11	Google scholar	(Cahyaningrum et al., 2025)	Development of a Problem-Based Interactive E-Module with Social Emotional Learning in Tri Hita Karana to Enhance Mathematical Problem-Solving and Noble Character	SD	The results of the study indicate that interactive e-modules based on problem-based learning oriented to social emotional learning in Tri Hita Karana can improve students' mathematical problem-solving abilities and noble character. The results of the study showed that the pre-test and post-test scores for students of SDN 1 Baktisegara were 21.41 and 85.18, respectively, and for students of SDN 6 Panji were 45.14 and 86.00, respectively. The increase in noble character was also seen from the results of the character observation sheet analysis which showed positive changes from before and after the use of the e-module. In all stages of the trial until the implementation of noble character, which was initially in the "developing" category, became "cultured".
12	Google scholar	(Maeti et al., 2025)	Developing e-module-based PJBL oriented with STEM on SPLDV material to improve problem solving skills	SMP	The developed e-module effectively meets students' learning needs through a structured process involving initial research, prototyping, and product evaluation. The developed e-module can be an innovative solution for improving problem-solving skills. Future research is expected to expand on these findings by exploring broader implementation contexts, including emotional and motivational aspects of learning.
13	Google scholar	(Amalia et al., 2025)	Development of e-modules assisted by scientific calculators	SMA	The developed e-module was effective in improving students' mathematical problem-solving skills. Suggestions for

No	Source	Author, Year	Title	Level	Research Result
			with problem-based learning models to improve problem solving in exponential material.		further research include adding interactive features to the e-module.
14	Google Scholar	(Indrawati et al., 2025)	Development of E-Modules Based on Core Learning Models to Improve Problem-Solving Skills and Self-Efficacy	SMK	The developed e-module was effectively used in the teaching and learning process to improve students' problem-solving skills and self-efficacy. Several suggestions for further research are available, including expanding the study to include topics beyond circles and applying it to a broader range of research subjects.
15	Google Scholar	(Ulya, 2025)	Development of AI-Based Learning E-Module with Discovery Learning Approach to Improve Students' Mathematical Problem-Solving Ability	SMA	The developed e-module is designed to improve students' problem-solving skills in quadratic equations. This demonstrates that integrating AI technology and the Discovery Learning approach can enhance the mathematics learning process, particularly by enhancing students' cognitive engagement and problem-solving abilities.

Based on Table 1, a total of 15 studies were reviewed to examine the development and implementation of interactive e-modules in mathematics learning. The analysis results show that most studies were conducted at the junior high school (SMP) level (8 out of 15), followed by senior high school (SMA/SMK) (5 studies), and elementary school (SD) (2 studies). This indicates that research attention is concentrated on the middle school level, where students are transitioning from concrete to abstract thinking. Therefore, interactive e-modules are considered effective in facilitating students' understanding of mathematical concepts during this developmental stage.

Most e-modules were developed using the Problem-Based Learning (PBL) approach, as seen in studies by Ihwatul et al. (2021), Juniantari (2022), Suharmita et al. (2024), and Cahyaningrum (2025). The PBL model consistently showed a positive impact on improving mathematical problem-solving abilities. Other learning models used include Creative Problem Solving (CPS), STEAM, RME, Contextual Learning, and Discovery Learning, which all emphasize student-centered and inquiry-based learning.

From the technological perspective, several studies incorporated advanced features such as Augmented Reality (AR) (Wilandari et al., 2024) and Artificial Intelligence (AI) (Saryadi & Sulisworo, 2023), indicating a growing trend toward technology-enhanced mathematics learning. These innovations were found to increase interactivity and student engagement through multimedia elements such as videos, quizzes, and games.

Furthermore, only a few studies integrated local culture and character education values specifically Putri et al. (2023), Paramita et al. (2024), and Cahyaningrum (2025). These studies demonstrate that embedding cultural or character-based content can enhance students' moral values, empathy, and social awareness in addition to improving cognitive outcomes. However, this limited number shows that the integration of character education and local wisdom within e-modules remains underexplored.

Overall, all studies reported improvements in students' mathematical problem-solving abilities after using interactive e-modules. Nevertheless, most were limited in scope, conducted in single classes or schools, and focused primarily on cognitive aspects rather than emotional or collaborative learning. These limitations reveal opportunities for future research to develop e-modules that integrate collaboration between teachers, parents, and students, while also incorporating local cultural values to build both competence and character.

DISCUSSION

Distribution of Interactive E-Modules by Educational Level

The analysis of the reviewed studies shows that research on interactive e-modules to improve mathematical problem-solving skills is most prevalent at the junior high school level, followed by senior high/vocational and elementary levels. This distribution suggests that researchers view the junior high level as a critical transition stage from concrete to abstract reasoning, where digital and interactive learning media can effectively enhance conceptual understanding.

This finding aligns with Piaget's cognitive development theory, which identifies early adolescence as the stage when students begin to think abstractly and logically. Therefore, the use of interactive e-modules during this stage supports students' ability to connect mathematical symbols with real-world problems.

However, the relatively limited studies at the elementary and vocational levels highlight a gap in research. Early numeracy at the elementary level is a crucial foundation for later mathematical competence (National Council of Teachers of Mathematics, 2020), and digital media can play a key role in fostering this development. Similarly, vocational education requires context-based problem-solving applications linked to future careers, which remains underexplored in current e-module research.

Theoretically, this implies that the development of interactive e-modules should be adapted to the learner's developmental stage, while practically, it suggests that future studies should design e-modules addressing early mathematical literacy and applied numeracy in vocational contexts.

Contribution of Interactive E-Modules to Problem-Solving Skills and Character Development

The reviewed literature consistently demonstrates that interactive e-modules contribute significantly to students' cognitive and affective growth.

a. Cognitive Contribution

In the cognitive domain, interactive e-modules have been proven to enhance students' mathematical problem-solving skills through structured and engaging learning processes. Juniantari (2022) showed that PBL-based e-modules guide students through contextual problem situations, self-assessment, and feedback loops that enhance metacognitive awareness. Similarly, Suharmita et al. (2024) and Amalia et al. (2025) found that e-modules designed with PBL frameworks encourage students to explore, hypothesize, and evaluate mathematical strategies independently.

The integration of Augmented Reality (AR) (Wilandari et al., 2024) and Artificial Intelligence (AI) (Ulya, 2025)further increases interactivity by visualizing abstract concepts and offering adaptive feedback, aligning with Mayer's (2021) multimedia learning theory which emphasizes the importance of dual coding (verbal + visual) for deeper understanding. These findings corroborate earlier studies such as Suardika et al. (2025), who found that technology-based learning media support students' problem-solving through multimodal engagement. Thus, from both theoretical and practical perspectives, interactive e-modules serve as effective scaffolds for cultivating higher-order thinking skills (HOTS) and mathematical reasoning.

b. Affective and Character Co ntribution

Beyond cognitive gains, several studies have highlighted the potential of e-modules to foster character development. Cahyaningrum (2025) showed that problem-based interactive e-modules incorporating Social Emotional Learning (SEL) and *Tri Hita Karana* values can significantly improve students' discipline, empathy, and responsibility.

Similarly, Putri et al. (2023) and Paramita et al. (2024) integrated local culture and ethnomathematics into e-modules, helping students perceive mathematics as relevant to their community and cultural heritage. This integration not only strengthens moral values but also promotes respect for diversity and environmental awareness.

These findings are consistent with Paolini (2020), who emphasized that SEL-based learning improves students' emotional regulation, empathy, and decision-making skills. Theoretically, this supports Vygotsky's sociocultural perspective that learning occurs most effectively within meaningful social and cultural contexts. In practical terms, integrating local values and SEL principles into e-modules helps bridge cognitive and affective learning, producing students who are both competent and compassionate key traits for 21st-century learners.

Identified Research Gaps and Future Directions

Although interactive e-modules have shown strong potential, several research gaps remain evident. First, most studies used small-scale trials (e.g., single-class or single-school implementations) such as those by Islahiyah et al. (2021) and Indrawati et al (2025). These limited contexts restrict the generalizability of the findings. Future research should employ broader samples and more rigorous experimental or mixed-method designs to validate effectiveness across diverse learning settings.

Second, while many studies focus on cognitive outcomes, fewer explore affective, motivational, or socio-emotional dimensions. Yet, these aspects are critical to holistic learning. Integrating Social Emotional Learning (SEL) frameworks as suggested by CASEL (Widiastuti, 2022) into e-module design could ensure that learning outcomes encompass emotional intelligence and interpersonal skills.

Third, there is a notable lack of parental involvement in existing e-module research. Despite the crucial role of families in supporting home-based learning (Ardana, Ariawan, &

Sugandini, 2023), few e-modules are designed to facilitate collaboration among teachers, parents, and students. Future research should develop e-modules that enable parents to participate as learning partners, providing emotional and motivational support.

Finally, the integration of local wisdom, such as the *Tri Hita Karana* philosophy, remains underdeveloped. This Balinese concept emphasizes harmony between humans and God (*Parhyangan*), among humans (*Pawongan*), and with nature (*Palemahan*) (Ardana, Ariawan, & Sugandini, 2023). Incorporating such philosophies into e-module design could simultaneously strengthen students' academic and character development.

Theoretically, filling these gaps will expand the conceptual framework of digital pedagogy to include cultural and emotional dimensions. Practically, it will enable the creation of more holistic and human-centered interactive learning models.

Implications and Limitations

This review reinforces constructivist learning theories by showing that interactive e-modules facilitate active knowledge construction through engagement, exploration, and reflection. It also supports sociocultural theory by illustrating how learning enriched with local wisdom and SEL values produces more meaningful educational outcomes.

Practically, e-modules should be developed as collaborative learning tools that connect schools, families, and local communities. Teachers can use these modules not only to deliver mathematics content but also to foster moral and emotional growth. Integration of cultural elements ensures relevance and contextualization of mathematics in students' daily lives.

This SLR was limited to studies published between 2020–2025 and analyzed using English and Indonesian sources indexed in Scopus and Google Scholar. Some potentially relevant unpublished or non-indexed works might not have been included. Additionally, the interpretation of findings depends on the completeness and quality of reporting in the reviewed studies.

CONCLUSION

This study systematically reviewed fifteen empirical articles published between 2020 and 2025 that examined the use of interactive e-modules in mathematics learning to enhance students' problem-solving skills and character development. The review revealed that

interactive e-modules consistently improve mathematical problem-solving abilities through structured, student-centered, and technology-supported learning approaches, particularly those based on Problem-Based Learning (PBL), STEAM, Realistic Mathematics Education (RME), and Ethnomathematics. Beyond cognitive gains, several studies demonstrated that integrating Social Emotional Learning (SEL) principles and local wisdom especially the Tri Hita Karana philosophy fosters students' responsibility, empathy, and social awareness. These findings affirm that interactive e-modules function not only as digital instructional tools but also as holistic educational instruments that simultaneously strengthen cognitive, affective, and cultural dimensions when thoughtfully designed.

Scientifically, this review provides three key contributions. Theoretically, it extends the constructivist and sociocultural perspectives by demonstrating that meaningful digital learning occurs when cognitive, emotional, and cultural components are integrated within a unified pedagogical framework. Methodologically, the study underscores the value of applying a PRISMA-based Systematic Literature Review (SLR) as a rigorous and transparent approach for mapping the effectiveness of technology-enhanced learning innovations. Practically, the review offers a framework for developing interactive e-modules that are contextual, collaborative, and value-oriented, aligning with the competencies required in 21st-century education critical thinking, creativity, collaboration, communication, and character.

Based on the identified research gaps, future studies should focus on expanding the implementation of interactive e-modules across different educational levels and contexts to increase generalizability, designing e-modules that promote collaboration among teachers, parents, and students as co-participants in learning, and deepening the integration of local wisdom such as Tri Hita Karana and Social Emotional Learning (SEL) principles to ensure a balanced development of intellectual, emotional, and moral capacities. Therefore, interactive e-modules should be viewed not merely as digital innovations but as transformative pedagogical tools capable of cultivating intelligent, ethical, and adaptive learners who are prepared to thrive in the dynamic landscape of 21st-century education.

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