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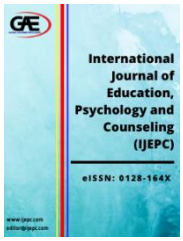

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INTERACTIVE E-MODULES IN EDUCATION: A SYSTEMATIC LITERATURE REVIEW OF DESIGN CHARACTERISTICS, PEDAGOGICAL APPROACHES, AND EDUCATIONAL OUTCOMES

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Abstract:

The increasing adoption of digital learning technologies has accelerated the development of interactive e-modules as innovative instructional tools in educational contexts. Despite their growing implementation, evidence regarding the design characteristics, pedagogical approaches, and educational outcomes of interactive e-modules remains fragmented across the literature, creating challenges for educators and instructional designers seeking to develop learner-centred digital learning environments. Therefore, this systematic literature review aims to synthesise evidence on the design characteristics, pedagogical approaches, and educational outcomes of interactive e-modules in educational contexts. The review was conducted using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework. An advanced search strategy was applied to the Scopus and ERIC databases using keywords related to interactive e-modules, instructional design, and educational contexts. The search was limited to studies published between 2017 and 2026. Following screening and eligibility assessment, 40 primary studies were included in the final qualitative synthesis. The thematic synthesis revealed three major themes. The first theme, E-Modules for Cognitive and Higher-Order Thinking Skills (n=18) highlighted the role of interactive e-modules in enhancing critical thinking, problem-solving, conceptual

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understanding, and higher-order cognitive processes. The second theme, Instructional Design and Pedagogical Models in E-Module Development (n = 14) emphasised the integration of instructional design frameworks, multimedia principles, scaffolding strategies, and learner-centred pedagogies to improve engagement and learning outcomes. The third theme, Contextual, Cultural, Environmental and Values-Based E-Modules (n=8) demonstrated the importance of contextualised content in fostering meaningful learning experiences, educational relevance, and learner engagement. Overall, the findings suggest that well-designed interactive e-modules can serve as effective tools for enhancing learning outcomes in educational contexts. The review provides practical implications for instructional designers, educators, and policymakers seeking to develop future-ready digital learning environments that support meaningful, independent, and lifelong learning.

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Keyword:

Educational Outcomes, Instructional Design, Interactive E-Modules, Pedagogical Approaches, Educational Contexts

Introduction

Interactive e-modules are increasingly positioned as a promising response to the need for more flexible, engaging, and student-centred learning in educational contexts. In this context, e-learning technologies help create adaptable and personalised environments, widen access to learning beyond time and place constraints, and encourage adolescents to develop autonomy and self-managed learning habits that are central to 21st-century education (Cardona-Acevedo et al., 2025). Interactive e-modules extend these advantages by organizing content systematically while integrating text, images, video, quizzes, simulations, and feedback, allowing learners to study at their own pace and revisit material as needed (Cena et al., 2025; Elistiana et al., 2024). Evidence from school-based and module-development studies suggests that such tools can enhance conceptual understanding, creative thinking, engagement, and learning independence when they are designed to be interactive, accessible, and instructionally coherent (Albana & Sujarwo, 2021; Lasala, 2023; Mutia, 2025). In secondary settings specifically, Interactive E-Modules provide opportunities for learner control, flexible navigation, self-paced learning, and active engagement through multimedia resources and embedded assessments, which contribute to meaningful learning experiences and positive educational outcomes (Ibrahim et al., 2025; Lasala, 2023; Mutia, 2025). This is especially relevant because learner autonomy is not simply the absence of teacher control, but a developmental capacity involving self-management, resource use, monitoring, and evaluation, shaped by both technological affordances and pedagogical support (Dang, 2026; Pratiwi & Waluyo, 2023; Tsai, 2019).

At the same time, the literature shows that the effectiveness of interactive e-modules depends less on digitisation alone than on the quality of their instructional design characteristics. Learner control over when, where, and how learning takes place can improve cognitive and affective outcomes, but excessive freedom without guidance can produce overload, weak motivation, and difficulty sustaining self-regulation (Konstantinidou & Nisiforou, 2022; Sinaga, 2025). Consequentl, effective e-modules are typically designed as self-instructional, self-paced, communicative, multimedia-rich, and flexible materials, while also embedding structured support through clear objectives, topic-based organisation, feedback systems, authentic tasks, and opportunities for reflection or peer response (Albana & Sujarwo, 2021; Cena et al., 2025; Konstantinidou & Nisiforou, 2022). Studies on digital and autonomy-supportive learning further indicate that transparent task rationales, mastery-oriented feedback, student choice, and broad access to learning content can strengthen intrinsic motivation, confidence, and ownership of learning (Moses Terhemen et al., 2026; Wijaya et al., 2024). However, evidence also shows that digital literacy, teacher facilitation, and scaffolding remain decisive conditions, since students benefit most from interactive e-modules when they possess or are helped to develop the skills needed to navigate resources, solve problems, and manage their own progress (Dang, 2026; Lasala, 2023; Sanova et al., 2022). Therefore, examining interactive e-modules through the interrelated dimensions of design characteristics, pedagogical approaches, and educational outcomes is essential for understanding how these digital learning tools support meaningful, engaging, and effective learning. Such an examination is particularly important because the effectiveness of interactive e-modules depends not only on their technological features, but also on how instructional design, scaffolding, multimedia integration, contextual learning, feedback, and learner support are embedded to promote cognitive development, learner engagement, and independent learning (Cena et al., 2025; Ibrahim et al., 2025; Sinaga, 2025).

However, despite the growing number of studies on interactive e-modules, existing evidence remains fragmented across subject areas, instructional models, design features, and reported learning outcomes. Limited synthesis has been conducted to clarify how the design characteristics of interactive e-modules, the pedagogical approaches embedded within them, and their educational outcomes are interconnected in educational contexts. Therefore, this systematic literature review aims to synthesise recent evidence on interactive e-modules in educational contexts by examining their design characteristics, pedagogical approaches, and educational outcomes.

Literature Review

Interactive e-modules have become an increasingly important component of digital learning because they provide opportunities for active engagement, learner interaction, and flexible access to instructional content. Rather than functioning as electronic versions of printed materials, interactive e-modules integrate multimedia resources, interactive exercises, formative feedback, simulations, and self-paced learning activities to facilitate meaningful learning experiences. Previous reviews consistently indicate that interactive e-modules are most effective when their instructional design promotes learner participation, authentic learning experiences, and continuous feedback rather than passive content delivery (Delungahawatta et al., 2022; Kimura et al., 2023; Regmi & Jones, 2020). Similarly, Theelen & Van Breukelen (2022) argued that active learning and scaffolded instruction should be regarded as fundamental design principles as they enable learners to regulate their learning process while reducing unnecessary cognitive load. Although various technological platforms

have been employed, including learning management systems, mobile applications, simulations, gamified environments, augmented reality, virtual reality, and cloud-based learning environments, the literature consistently demonstrates that technological sophistication alone does not determine educational effectiveness. Instead, the successful implementation of interactive e-modules depends primarily on the alignment of technological features with instructional objectives, learner characteristics, and curriculum requirements (Choi-Lundberg et al., 2023; Herlina & Abidin, 2024; Tjorven et al., 2026).

Beyond technological design, pedagogical approaches represent another critical dimension influencing the effectiveness of interactive e-modules. Existing evidence demonstrates that contemporary e-modules are predominantly developed within constructivist and learner-centred paradigms, embedding instructional approaches such as problem-based learning, inquiry-based learning, discovery learning, project-based learning, flipped learning, and STEM or STEAM education (Daniel et al., 2024; Herlina & Abidin, 2024; Sri et al., 2025). These pedagogical approaches consistently encourage learners to explore authentic problems, construct knowledge collaboratively, and develop higher-order thinking through guided inquiry rather than direct instruction. In professional and health education, flipped learning models have further extended the instructional role of interactive e-modules by enabling content acquisition before classroom interaction, thereby maximising opportunities for discussion, problem-solving, and collaborative learning during face-to-face sessions (Naing et al., 2023; Youhasan et al., 2021). More recently, emerging instructional approaches such as chatbot-assisted learning, digital escape rooms, and immersive learning environments have expanded opportunities for personalised learning and learner engagement (Makri et al., 2021; Zhang et al., 2023). Nevertheless, several reviews suggest that many studies continue to emphasise technological innovation without explicitly integrating established instructional design theories, indicating that pedagogical foundations remain underdeveloped in certain areas of interactive e-module research (Abuhassna et al., 2024; Stojan et al., 2021).

The educational outcomes associated with interactive e-modules have also been widely investigated across different educational disciplines. Collectively, previous studies indicate positive effects on knowledge acquisition, conceptual understanding, critical thinking, creative thinking, problem-solving, motivation, engagement, learner satisfaction, and practical skill development when interactive e-modules are supported by active learning strategies and meaningful learner interaction (Daniel et al., 2024; Tjorven et al., 2026; Zhang et al., 2023). Similar findings have been reported in secondary education, where interactive e-modules integrating discovery learning, inquiry learning, problem-based learning, STEM education, virtual laboratories and multimedia resources contributed to improvements in higher-order thinking skills and scientific literacy (Herlina & Abidin, 2024; Nurbaiti et al., 2026). However, evidence regarding educational effectiveness remains inconsistent across contexts. While many studies reported significant improvements in learner engagement and academic performance, others observed substantial variations depending on instructional quality, implementation strategies, learner readiness, and assessment methods (Hwang et al., 2023; Naing et al., 2023). Furthermore, existing reviews highlight that educational outcomes are frequently measured using short-term achievement tests, learner perceptions, or satisfaction surveys, whereas longitudinal evidence and objective assessment of behavioural change remain relatively limited (Stojan et al., 2021; Tjorven et al., 2026; Yue et al., 2022).

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Despite the rapid expansion of research on interactive e-modules, several important gaps remain. Existing studies have largely investigated design characteristics, pedagogical approaches, and educational outcomes as separate research domains, resulting in fragmented evidence regarding their interrelationships. Comparatively fewer reviews have synthesised how instructional design features, pedagogical strategies, and educational outcomes collectively contribute to the effectiveness of interactive e-modules across diverse educational contexts. Furthermore, limited attention has been devoted to the interaction between scaffolding, learner feedback, multimedia integration, learner autonomy, and contextual learning in influencing educational outcomes. Current evidence also remains limited regarding collaborative learning features, long-term learning effects, and comprehensive evaluation of higher-order cognitive outcomes. Consequently, a systematic literature review is needed to consolidate the existing evidence, identify coherent thematic patterns, and provide a comprehensive understanding of the design characteristics, pedagogical approaches, and educational outcomes associated with interactive e-modules in education.

Material and Methods

Identification

The first and one of the most important steps of the Systematic Literature Review (SLR) process presented in the PRISMA framework is the identification phase. The purpose of this phase is to ensure that a systematic search strategy is employed to identify all potentially relevant studies for the topic of the review thoroughly and transparently. In the current review, two globally recognised academic databases, Scopus and ERIC (Education Resources Information Centre), were chosen due to their extensive coverage of peer-reviewed educational research and instructional technology studies. A pre-defined combination of keywords related to “e-module”, “secondary school” and “instructional design” resulted in a total of 722 records from the database search. Specifically, Scopus retrieved 278 records, and 444 records were retrieved from ERIC.

The compilation of 722 records reveals the significant academic interest that has been given to the topic and indicates a rising trend of literature on the design and implementation of e-modules in educational contexts. At this stage, no assessments were made on the quality of studies, methodological rigour or relevance to the review objectives, as the primary purpose of identification is to maximise sensitivity and ensure that potentially eligible studies are not missed. The high number of retrieved records also highlights the need for a stringent screening process in the later PRISMA stages for the removal of duplicates and exclusion of studies not meeting pre-defined inclusion criteria. Additionally, the use of multiple databases increases the thoroughness of the review by decreasing publication bias and the risk of missing relevant studies that may be indexed in a single database. The review adheres to PRISMA reporting guidelines and demonstrates methodological rigour by documenting the databases searched, keywords employed, and number of records retrieved from each database, thereby increasing the credibility, trustworthiness, and replicability of the findings.

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The Search String

Table 1: The Search String.

Scopus	TITLE-ABS-KEY (("interactive e-module" OR "e-module" OR "module education" OR "educational module") AND ("educational contexts" OR "secondary school" OR "high school" OR "instructional design" OR "curriculum design" OR "teaching design")) AND (LIMIT-TO (SUBJAREA , "SOCI") OR LIMIT-TO (SUBJAREA , "COMP") OR LIMIT-TO (SUBJAREA , "PSYC")) AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (LANGUAGE , "English")) AND (LIMIT-TO (SRCTYPE , "j"))AND (LIMIT-TO (PUBSTAGE , "final")) AND (LIMIT-TO (PUBYEAR , 2017) OR LIMIT-TO (PUBYEAR , 2018) OR LIMIT-TO (PUBYEAR , 2019) OR LIMIT-TO (PUBYEAR , 2020) OR LIMIT-TO (PUBYEAR , 2021) OR LIMIT-TO (PUBYEAR , 2022) OR LIMIT-TO (PUBYEAR , 2023) OR LIMIT-TO (PUBYEAR , 2024) OR LIMIT-TO (PUBYEAR , 2025) OR LIMIT-TO (PUBYEAR , 2026)) **Date of Access: June 2026**
Eric	(("interactive e-module" OR "e-module" OR "module education" OR "educational module") AND ("educational contexts" OR "secondary school" OR "high school" OR "instructional design" OR "curriculum design" OR "teaching design")) **Date of Access: June 2026**

Keywords related to interactive e-modules, instructional design and educational contexts were used to develop the search strategy. Pedagogical approaches and educational outcomes were reviewed during data abstraction and thematic synthesis. These dimensions were derived from the coded findings of the included studies rather than being used as independent search terms.

Screening

The screening process is the second phase of the systematic literature review and acts as a methodological filter that narrows the initial corpus of records into a more focused and relevant evidence base. Subsequently, records from Scopus and ERIC were identified and all retrieved studies were screened based on predefined exclusion criteria. A total of 577 records were excluded because they did not meet the pre-determined parameters of the review. We excluded non-English publications, studies published before 2017, conference papers, books, review articles, in-press publications, and studies indexed outside the subject areas of Social Sciences, Computer Science, and Psychology.

After applying these screening criteria, 146 records were retained for further review, 71 from Scopus and 75 from ERIC. Then, a duplicate check procedure was carried out to find overlapping records retrieved from both databases. Eight duplicate papers were excluded, and 138 unique records remained for the eligibility stage. Overall, the screening process narrowed the initial evidence base substantially but retained those studies most likely to provide useful findings for the purposes of the review.

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Table 2: Inclusion and Exclusion Criteria

Criterion	Inclusion	Exclusion
Language	English	Non-English
Timeline	2017 – 2026	< 2017
Literature type	Journal (Article)	Conference, Book, Review
Publication Stage	Final	In Press
Subject	Social science, computer Science and Psychology	Besides Social Science, Computer Science and Psychology

Eligibility

The eligibility stage represents a critical quality assurance process within the PRISMA framework, highlighting a detailed review of the studies that were successfully screened. Duplicates were removed and 138 articles were thoroughly reviewed in full text to determine their eligibility for inclusion in the present systematic literature review. While the screening stage is predominantly based on bibliographical information such as titles, abstracts and publication details, the eligibility phase requires a more detailed assessment of each study's conceptual fit, methodological relevance and contribution to the objectives of the review.

After the eligibility assessment, 98 articles were excluded due to the reason that they were out of the scope of the review field, their titles were not substantially aligned with the research focus, their abstracts did not address the objectives of the study, or the full-text version was not available for detailed evaluation. Thus, 40 studies fulfilled all eligibility criteria and were included in the qualitative synthesis.

Data Abstraction and Analysis

In this review, we adopted an integrative analysis approach to synthesise evidence from diverse qualitative studies included. This approach allowed for a systematic evaluation, comparison and integration of results from several studies to identify common patterns, concepts and emerging themes regarding e-modules in educational contexts. Thematic development started with data extraction, where all eligible studies were carefully reviewed to extract statements, findings and evidence relevant to the objectives of the review. A total of 40 studies were analysed in detail.

The extracted data were coded and organised into meaningful categories through an iterative process of comparison and interpretation. Authors worked together to review the coded data, developing tentative themes that described common patterns across the included studies. Throughout the review process, an audit trail was kept documenting analytical decisions, emerging interpretations, reflections and potential conceptual issues to increase the transparency and credibility of the analysis. The ultimate themes extracted from the thematic

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synthesis gave a holistic picture of the design features and pedagogic functions of interactive e-modules in educational contexts.

The following research questions guided the investigation: (1) What cognitive and higher-order thinking skills are supported by interactive e-modules in educational contexts? (2) What instructional design features and pedagogical strategies are used in interactive e-modules for educational contexts? (3) How are contextual, cultural, environmental and values-based elements integrated into interactive e-modules to support meaningful learning and educational outcomes in educational contexts?

Quality Appraisal

The methodological quality of the included studies was assessed to strengthen the credibility of the review evidence. The appraisal focused on the clarity of research objectives, appropriateness of research design, relevance of sample and context, suitability of data collection procedures, alignment of findings with the review objectives, and contribution to the thematic synthesis. The quality appraisal was used to determine the strength of evidence rather than to automatically exclude studies from the review.

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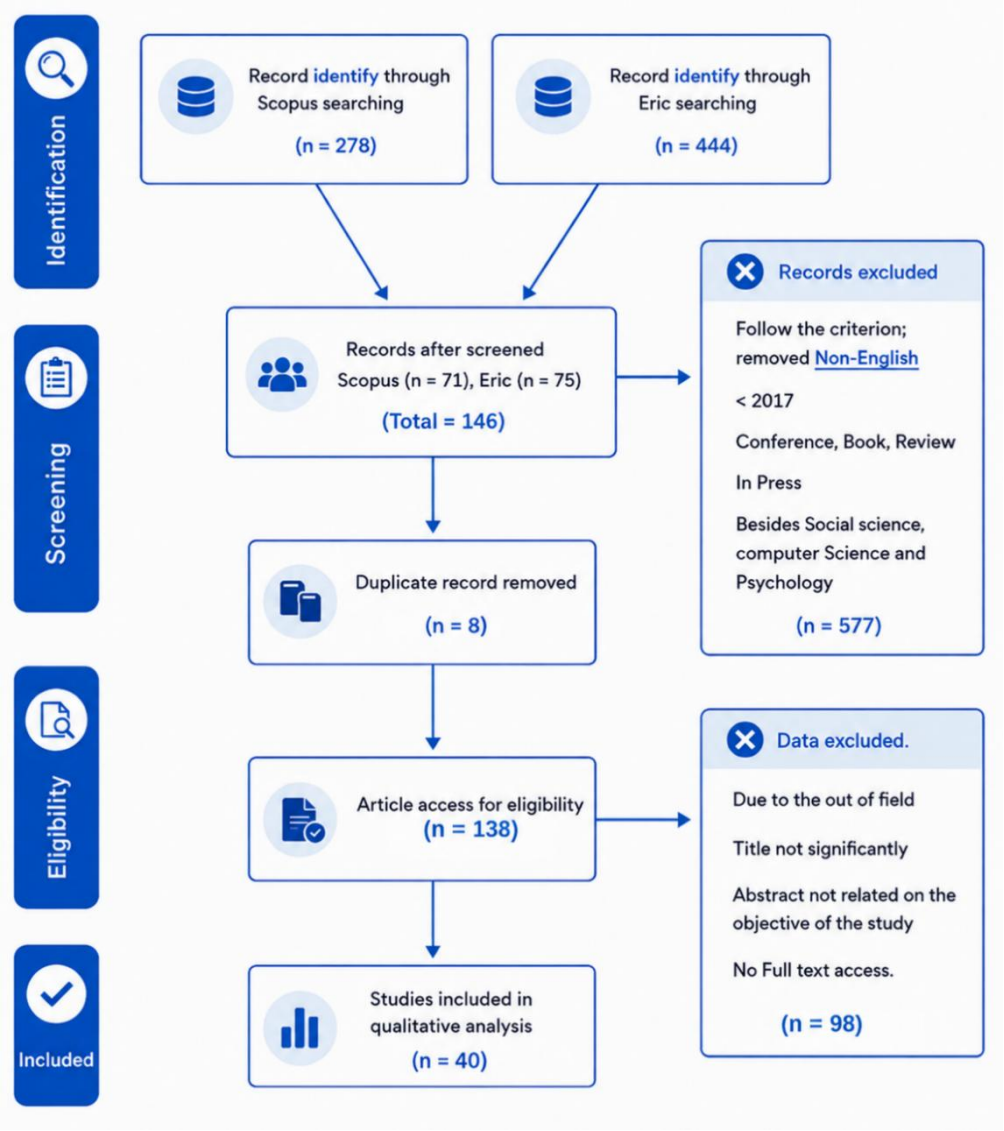

Figure 1: PRISMA 2020 Flow Diagram of the Study Selection Process.

Table 3: Quality Appraisal Criteria

Quality Criterion	Assessment Focus
Research objective clarity	Alignment with e-module design, pedagogy, or outcomes
Methodological relevance	Suitability of research design and method
Context clarity	Clear education level and subject context
Evidence relevance	Relevance of findings to review questions
Contribution to synthesis	Contribution to theme development

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Results and Discussion

Table 4: Characteristics of the Included Studies

No.	Author/Year	Education Level / Subject / Field Context	E-Module Focus	Key Contribution / Main Finding	Theme
1	Achmad (2020)	Secondary school / Mathematics	RME-based e-module	Supported creative thinking and flexible problem-solving	1
2	Aliyah & Widiyatmoko, (2022)	Secondary school / Biotechnology / Science	Entrepreneurship-based e-module	Improved critical and creative thinking skills	1
3	Aziz, (2020)	Secondary school / Mathematics	Inquiry-based mathematical e-module	Addressed students' low creative thinking skills	1
4	Desnita et al., (2022)	Senior high school / Physics	CTL-based physics e-module	Enhanced creative and critical thinking skills	1
5	Fitrisyah & Mulyono (2025)	Secondary school / Mathematics	Interactive e-module on exponential material	Supported computational thinking development	1
6	Kurniawan & Octavia (2024)	Secondary school / Physics	Assembler Edu e-module	Improved argumentation skills, perseverance, and curiosity	1
7	Mahardika et al., (2025)	Secondary school / Physics	Physics modelling e-module	Reduced misconceptions in static fluid concepts	1
8	Pantiwati et al., (2025)	Secondary school / Science	LI-PRO-GP e-module	Improved conceptual understanding and problem-solving abilities	1
9	Pertiwi et al., (2024)	Secondary school / STEM Science	STEM contextual e-module with virtual experiment	Improved students' critical thinking skills	1
10	Sedayu et al., (2024)	Secondary school / Physics	OER-assisted PBL digital learning materials	Enhanced creative thinking and self-efficacy	1

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11	Serevina et al., (2022)	Secondary school	Physics	Android-based e-module	Produced stronger critical thinking outcomes than printed modules	1
12	Setiaji et al., (2025)	Secondary school	Physics	Local wisdom-based PBL e-module	Improved analytical thinking and scientific attitudes	1
13	Sujanem & Putu Suwindra (2023	Secondary school	Physics	Problem-based interactive physics e-module	Enhanced critical thinking skills through blended PBL	1
14	Syahfitri (2024)	Secondary school	Science	Local wisdom-based interactive digital module	Improved students' critical thinking disposition	1
15	Thobejane et al., (2026)	Grade 11 / Secondary school	Life Sciences	E-modules and learning applications	Supported scientific literacy in life sciences classrooms	1
16	Tobing & Susanti, (2022)	High school	Mathematics	HOTS-based e-module	Supported analysis and solution development in mathematics learning	1
17	Wijayanto, Sumarmi, et al., (2023)	Secondary school	Geography	Problem-based e-module	Improved higher-order thinking and learning interest	1
18	Yerimadesi et al., (2023)	Secondary school	Chemistry	Guided discovery chemistry e-module	Enhanced students' higher-order thinking skills	1
19	Artika et al., (2026)	Senior high school	Biology	Inquiry-based interactive e-module	Improved learning outcomes on plant structure and tissues	2
20	Budiman & Abdurrahman, (2025)	Educational / teacher context	Pedagogical competence	E-module for teacher pedagogic competence	Improved pedagogical competence in border education context	2

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21	(Dewi et al., 2026)	Senior high school	English language	Android-based English e-module	Improved students' interest and achievement	2
22	(Guadagno et al., 2021)	Secondary / classroom application	Physics / Mechanics	Hybrid modelling and simulation module	Supported usability and classroom applicability	2
23	(Handayani & Alperi, 2021)	High school	Chemistry	Guided discovery electronic module	Achieved high validity and positive student responses	2
24	(Lisdayenti et al., 2023) et al. (2023)	High school	Chemistry	Discovery learning e-module with probing-prompting	Improved chemistry learning outcomes	2
25	(Nandiyanto et al., 2020) et al. (2020)	Vocational school	Production / Engineering education	Video and e-module learning materials	Increased students' knowledge of briquette production	2
26	(Nugroho & Arianto, 2023) & Arianto (2023)	Vocational education	Instructional design	E-module development for vocational instructors	Highlighted systematic instructional design for e-module development	2
27	(Priyani et al., 2026)i et al. (2026)	Secondary school	Biology / Science	Inquiry-based e-module using Black Soldier Fly maggots	Enhanced students' science process skills	2
28	(Suwandi et al., 2024) et al. (2024)	Secondary school	Science	Discovery learning e-module with scaffolding questions	Improved science literacy skills	2
29	(Yoda et al., 2024) et al. (2024)	Seventh-grade students	Physical education	ADDIE-based e-module for volleyball bump pass skills	Improved students' understanding and practical skills	2
30	Yulando et al. (2019)	Secondary / science learning context	Science / Digital learning	Self-instructional e-module design	Highlighted systematic, self-contained, and user-friendly e-module features	2
31	Ady et al., (2025)	Secondary / digital	Science / E-learning	Multimedia-based e-module	Emphasised multimedia,	2

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		learning context			navigation, and visual support features	
32	Putri & Habiddin (2026)	Secondary / science learning context	Science / Chemistry	Adaptive and user-friendly e-module	Supported independent learning through structured and accessible design	2
33	Aqil et al. (2026)	Secondary school	Environmental education	Project-based e-module with reflective video tasks	Improved students' environmental sensitivity	3
34	Kemp et al. (2024)	High school	Health / Nutrition education	Guided learning modules	Improved understanding of health risks and food choices	3
35	Ng (2019)	Year 10 / Secondary school	Climate science	Online climate science module	Supported climate science literacy, with need for additional scaffolding	3
36	Prihatiningtyas et al. (2025)	Islamic boarding school / secondary context	Science / STEM Qur'an	Flipbook-based STEM Qur'an e-module	Improved science literacy and inquiry indicators	3
37	Supriyadi et al., (2024)	Junior high school	Mathematics	Sundanese Gamelan ethnomathematics e-module	Improved understanding, motivation, and cultural awareness	3
38	Susanta & Sumardi (2022)	Junior high school	Mathematics	Bengkulu context-based e-module	Improved students' literacy skills through local contexts	3
39	Yosef et al., (2023)	Islamic and public high school	Guidance and counselling	E-module for guidance lessons	Improved multicultural self-efficacy	3
40	Yuliatun et al., (2024)	Secondary school	Natural sciences	Android-based SETS e-module	Supported independent learning and understanding of earth structure	3

E-Modules for Cognitive and Higher-Order Thinking Skills

Across the reviewed studies, there is a consistent trend of a significant contribution of interactive e-modules to the development of creative thinking skills in high school students. Sedayu et al. (2024) reported that Problem-Based Learning with the help of Open Educational Resources (OER) and digital learning materials significantly improved the performance of creative thinking in physics education. Similarly, Achmad (2020) found that students had limited creative thinking abilities and that e-modules designed with a Realistic Mathematics Education (RME) approach were needed to generate ideas and solve problems flexibly. Similarly, the inquiry-based mathematical e-modules were specifically designed to tackle the low level of students' creative thinking, as indicated by Aziz (2020). Desnita et al. (2022) and Aliyah & Widiyatmoko (2022) also reported similar improvements, stating that contextual and entrepreneurship-based e-modules significantly improved creative and critical thinking skills. In conclusion, the findings suggest that cognitive development takes place when e-modules include authentic tasks, inquiry processes, contextualised learning activities, and chances for independent exploration.

The second major finding pertains to the effectiveness of e-modules in fostering critical thinking skills. Pertiwi et al. (2024) proved that context-based e-modules combined with virtual experiments integrated with STEM were effective in improving students' critical thinking ability compared to the use of conventional learning resources. Serevina et al. (2022) reported similar results, suggesting that e-modules improved critical thinking outcomes more than printed modules in distance learning. Sujanem & Putu Suwindra (2023) also found that interactive physics e-modules based on problems consistently improved critical thinking skills in several groups of students. The results suggest that the development of critical thinking is highly associated with the incorporation of problem-solving activities, contextual scenarios, interactive multimedia features and learner-centred instructional strategies embedded in e-modules.

Beyond critical and creative thinking, several studies highlighted the role of e-modules in strengthening higher-order thinking skills, conceptual understanding, and problem-solving abilities. Pantiwati et al. (2025) found that the combination of literacy, character, and project-based learning in the LI-PRO-GP e-module significantly improved conceptual understanding and problem-solving performance. Tobing & Susanti (2022) stated that the use of e-modules based on HOTS positively impacted students' ability to analyse and find solutions in learning mathematics. Similarly, Wijayanto et al. (2023) found that problem-based e-modules significantly improved higher-order thinking skills in geography education. Yerimadesi et al. (2023) showed that guided discovery-based chemistry e-modules improved students' higher-order cognitive performance through structured investigative learning activities.

Another trend is emerging in the use of e-modules to address specific cognitive challenges such as misconceptions, computational thinking, analytical reasoning, and scientific argumentation. Mahardika et al. (2025) observed that the implementation of physics modelling e-modules was effective in lowering misconceptions concerning static fluid concepts, highlighting the role of visualisation and modelling capabilities in conceptual change. Fitrisyah & Mulyono (2025) reported that problem-based interactive e-modules were able to support the development of computational thinking. Similarly, Setiaji et al. (2025) proved that physics e-modules based on local wisdom could improve analytical thinking skills and scientific attitudes. Kurniawan &

Octavia (2024) also reported the e-module based on Assembler Edu increased the argumentation skills, perseverance, and curiosity of physics students.

In general, the evidence points to interactive e-modules as effective instructional tools for promoting multiple dimensions of cognitive development in educational contexts. The most effective results were obtained across diverse subject areas like physics, mathematics, chemistry, biology and geography when the e-modules contained problem-based learning, inquiry-based approaches, contextual learning experiences, virtual experimentation, modelling activities and interactive multimedia elements. Overall, the studies reviewed seem to suggest cognitive improvements not due to the digital format itself but due to the pedagogical features of the e-module design. Therefore, instructional design features such as scaffolding, feedback mechanisms, authentic problem contexts, inquiry activities and learner autonomy seem to be important factors that contribute to the effectiveness of interactive e-modules in the development of higher-order thinking skills among learners across educational contexts. The evidence indicates that interactive e-modules consistently promote higher-order thinking through learner-centred instructional activities.

Instructional Design and Pedagogical Models In E-Module Development

The results of the reviewed studies suggest that instructional design plays an important role in the quality, usability and effectiveness of e-modules in secondary and vocational education. Guadagno et al. (2021) devised a hybrid modelling and simulation module that supported teachers' use in the classroom and user experience via scaffolded physics programming activities. In addition, Nugroho & Arianto (2023) also emphasised that the development of e-modules in vocational education requires systematic instructional planning that balances content, media, learning strategy, and student response. Yoda et al. (2024) also found that an e-module developed based on the stages of analysis, design, development, implementation, and evaluation resulted in a better understanding and practical skills of bump pass in volleyball among students. The studies indicate that it is the structured instructional design, not the digital format per se, that is closely associated with the effectiveness of the e-modules.

Discovery learning and guided discovery became the dominant pedagogical models for the development of e-modules. Lisdayenti et al. (2023) reported that the use of discovery learning e-modules integrated with probing-prompting questions improved students' learning outcomes in chemistry. The validation results of the Interactive E-Module of redox reaction material based on guided discovery were very valid and received a positive response from students in small-scale trials and large-scale trials (Widanta et al., 2025). Suwandi et al. (2024) also showed that discovery learning with scaffolding questions improved students' science literacy skills with high feasibility scores for content, media, learning instruments, and assessment tools. Findings suggest that discovery-based e-modules are effective when they guide students through questioning, exploration, concept formation, and reflection.

Inquiry-based pedagogy was also found to increase active learning, independent learning, and scientific competencies. Priyani et al. (2026) showed that the students' science process skills improved significantly using an inquiry-based e-module with Black Soldier Fly maggots than traditional teaching. Similarly, Artika et al. (2026) found that the inquiry-based interactive e-module on plant structure and tissues was pedagogically feasible and statistically effective on biology learning outcomes. The research of Nandiyanto et al. (2020) showed that the knowledge of vocational students increased significantly after learning through video and e-

module materials related to the production of briquettes. Combination of inquiry-oriented and practice-based e-modules seems to encourage deeper learning, since students approach the content through investigation, experimentation, observation and application.

Overall, the literature under this theme shows that e-module development is most effective when guided by explicit instructional design models and pedagogical principles. Studies using ADDIE, 4D, Dick and Carey, discovery learning, guided discovery, inquiry learning, project-based learning, scaffolding, and modelling approaches reported positive outcomes in feasibility, practicality, learning achievement, science process skills, pedagogic competence, and student engagement. The findings indicate that e-modules should be designed as structured learning systems rather than simple digital reading materials. The findings suggest that instructional design quality is a determining factor influencing the effectiveness of interactive e-modules

Contextual, Cultural, Environmental and Values-Based E-Modules

The reviewed studies suggest that contextual and culture-based e-modules support learning by connecting academic content with students' social, cultural, and local realities. Supriyadi et al. (2024) found that the integration of Sundanese Gamelan ethnomathematics in an e-module improved students' understanding, motivation and cultural awareness in mathematics learning. Susanta et al. (2022) also stated that applying Bengkulu contexts in mathematics e-modules helped students to improve their literacy skills by making abstract ideas become more meaningful using familiar local situations. Tantri et al. (2025) proved that the Flip PDF literary history e-module enriched with character values, video, infographic, and project-based tasks improved students' literary competence.

Values-based e-modules also seem to contribute to personal, social and moral development. Yosef et al. (2023) revealed that the e-module used in the guidance lessons significantly increased the multicultural self-efficacy of Islamic and public high school students. Prihatiningtyas et al. (2025) stated that the STEM Qur'an-based flipbook e-module improved science literacy in Islamic boarding schools, especially in the scientific inquiry and problem-solving indicators. According to Kemp et al. (2024), high school students who took guided learning modules on health, nutrition, food security, and ultra processed foods were also more likely to understand their personal health risks and make healthy food choices.

Another important direction within this theme is environmental and sustainability-oriented e-modules. Aqil et al. (2026) developed a transformative project-based e-module with reflective video tasks on waste management and found a moderate improvement of students' environmental sensitivity. Yuliatun et al. (2024) found that the Android-based natural science e-module using the Science, Environment, Technology, and Society approach was a feasible tool for teaching Earth structure and dynamics while supporting students' independent learning. Similarly, Ng (2019) found that an online climate science module, developed through a partnership, improved climate science literacy, but it required additional scaffolding to enhance student understanding.

The findings indicate that contextual, cultural, environmental and values-based e-modules have a great potential for educational contexts because their design links knowledge to identity, society, environment and ethical understanding. The strongest design features in this theme are contextual problems, cultural representation, values integration, multimedia features, reflective

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tasks, scaffolding and flexible access. The integration of contextual and values-based elements contributes to meaningful and authentic learning experiences

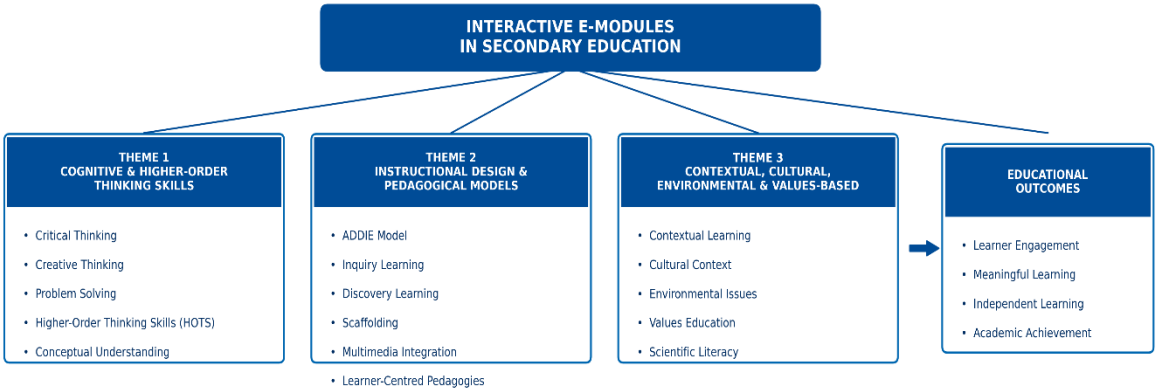

Figure 2: Evidence-Based Thematic Framework of Interactive E-Modules in Educational contexts Derived from 40 Reviewed Studies (n = 40).

Conclusion

The present systematic literature review sought to synthesise current evidence on the design characteristics, pedagogical approaches and educational outcomes of interactive e-modules in educational contexts. The review was conducted in accordance with the PRISMA framework and included empirical studies published between 2017 and 2026 retrieved from the Scopus and ERIC databases. Following the identification, screening, eligibility, and selection process, we included 40 studies in the final qualitative synthesis.

The findings reveal that interactive e-modules increasingly serve as learner-centred instructional tools, supporting diverse educational outcomes. Across the reviewed literature, the most frequently reported outcomes were improvements in critical thinking, creative thinking, problem solving, conceptual understanding, analytical reasoning, scientific literacy and higher order thinking skills. The results were achieved not just by digital delivery but by integrating effective pedagogical strategies such as problem-based learning, inquiry learning, discovery learning, guided exploration, scaffolding, contextualised learning experiences, multimedia integration and feedback mechanisms.

Thematic synthesis produced three broad themes. The first theme, E-Modules for Cognitive and Higher-Order Thinking Skills, illustrates how interactive e-modules can support complex cognitive processes and foster more profound learning. The second theme, Instructional Design and Pedagogical Models in E-Module Development, emphasises the necessity of systematic instructional planning. The third theme, Contextual, Cultural, Environmental and Values-Based E-Modules, highlights the importance of contextual relevance, cultural representation, environmental consciousness, and values infusion. These themes collectively suggest that effective e-modules function as complete instructional systems rather than simply digital containers of content.

Educators, curriculum developers, and instructional designers should prioritise learner-centred design principles when developing interactive e-modules. Features such as multimedia integration, scaffolded activities, feedback mechanisms, self-assessment opportunities,

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authentic tasks, contextual learning experiences, and flexible navigation should be incorporated to support cognitive development, engagement, meaningful learning, and independent learning. Several limitations should be acknowledged: the review was restricted to studies indexed in the Scopus and ERIC databases, published in English, and conducted within the 2017-2026 timeframe. Future research should expand database coverage, incorporate additional educational contexts, examine the longitudinal impacts of interactive e-modules, and investigate the relationships between specific design characteristics, pedagogical approaches, and educational outcomes.

In summary, the growing body of evidence indicates that interactive e-modules can be a useful way to improve the outcomes of education across educational settings. Their effectiveness is significantly impacted by the quality of instructional design, pedagogical alignment, contextual relevance, multimedia integration, scaffolding, feedback and opportunities for active learner engagement. Such evidence-based synthesis is critical for advancing theoretical knowledge, informing educational practice and guiding future research on the development of effective learner-centred digital learning environments. Although this review focused on interactive e-modules in educational contexts, several studies from closely related educational contexts were retained because they provided relevant evidence on e-module design characteristics, instructional models, multimedia integration, scaffolding, and educational outcomes. Therefore, the findings should be interpreted as evidence-informed design implications for educational contexts rather than as evidence drawn exclusively from secondary school settings.

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