

Research Article

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Designing Interactive FIVES E-Modules with a Deep Learning Approach to Enhance Reading Literacy of Elementary School Students

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Abstract

Background/purpose. Reading literacy is essential for elementary students' academic success. However, in Indonesia, it continues to face obstacles such as low motivation, limited teaching strategies, insufficient higher-order thinking skills, and technological gaps. This study aims to design an interactive e-module based on the FIVES (Facts, Inference, Vocabulary, Experiences, Summary) model integrated with a deep learning approach to enhance reading literacy.

Materials/methods. A mixed methods approach with an exploratory-sequential design was employed. Quantitative data were collected from 124 teachers across 17 provinces, while qualitative data were obtained through interviews with 14 teachers and 70 students. The needs analysis informed the design of the interactive e-module, which integrates deep learning principles (mindful, meaningful, joyful) and learning experiences (understanding, applying, reflecting). At this stage, the study produced only a design framework, which will later be validated by experts and tested in both limited and broader settings.

Results. Four categories of barriers to reading literacy were identified: ontogenic, didactic, epistemological, and technological. The e-module design offers a structured strategy to address these barriers by combining the FIVES framework with deep learning, demonstrating potential to improve students' motivation, comprehension, and critical thinking.

Conclusion. The study underscores the need for a holistic approach to reading literacy. The interactive FIVES-based e-module, grounded in deep learning principles, shows promise as an effective learning medium, supported by policies for technology infrastructure and teacher training to ensure optimal implementation.



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1. Introduction

Reading literacy serves as a foundational pillar of elementary education. It shapes students' ability to comprehend a wide range of disciplinary knowledge and to develop critical thinking skills (Song et al., 2025). This competence goes beyond recognizing basic words or decoding texts; it involves complex cognitive, linguistic, and social processes that support sustained lifelong learning (Chiu et al., 2024). The rapid advancement of digital technologies has further broadened the concept of reading literacy to encompass the ability to understand, communicate, and solve problems through texts presented in diverse formats and contexts (Qiao, 2024). At the elementary level, reading literacy is essential for enabling students to communicate effectively, cultivate creativity, and achieve academic success across subject areas (Sari et al., 2024; Khan et al., 2022).

Despite its significance, reading literacy in Indonesia faces significant challenges (Nasrullah et al., 2024; Afiyah, 2025). Only about 25% of students reach Level 2 or higher, with almost none achieving higher levels (Level 5–6) of proficiency, indicating weak reflective and evaluative reading skills (Prameswari & Suyono, 2025). The 2025 Education Report also shows a 2.55-point decline in students' ability to locate textual information (Level 1), suggesting persistent difficulties in identifying explicit details. While competencies in interpreting text (Level 2) and critically evaluating text content (Level 3) rose to 63.25 (up 5.59 points) and 63.63 (up 6.91 points), respectively, these scores remain moderate, reflecting ongoing limitations in understanding implicit meanings and conducting deeper textual evaluations. These outcomes are influenced by weak reading habits, scarce use of innovative learning models, and ineffective instructional strategies in reading education (Prabowo et al., 2024; Zami et al., 2025).

Previous studies have shown that many elementary students struggle to identify essential information, which hinders their ability to summarize texts coherently (Jin et al., 2024). Findings from Rollins et al. (2022) and Otaiba et al. (2023) further indicate that poor literacy skills not only limit text comprehension but also weaken students' capacity to draw evidence-based conclusions. Meanwhile, Le et al. (2025) and Akbar et al. (2025) highlight that a major obstacle is students' higher-order thinking skills, specifically their ability to discern key facts and connect them to a text's main ideas. However, much of this research diagnoses problems without proposing comprehensive, pedagogically-driven, and technology-integrated solutions. Moreover, existing studies often examined narrow contexts and have not explored how deep learning approaches can merge with structured literacy models through interactive digital media. Therefore, challenges in reading literacy extend beyond technical decoding skills; they also involve underdeveloped critical and analytical thinking skills. This underscores the need for instructional approaches that foster deep understanding and promote higher-order thinking (Soufghalem, 2024; Nityasanti et al., 2025; Rizkina et al., 2025).

A promising solution is the deep learning approach, which prioritizes three core principles: meaningful, mindful, and joyful learning (Viczo, 2026; Feriyanto & Anjariyah, 2024; Alazemi, 2024; Khasawneh et al., 2025). This approach encourages students to construct knowledge through reflective reading, connect texts to real-life experiences, and sharpen critical reasoning skills—principles that align with the demands of 21st-century literacy, which requires students not only to read but also to interpret and apply textual information across broader contexts. Similar challenges are observed globally, where literacy instruction often remains focused on basic skills without effectively integrating higher-order thinking and technology. However, elementary schools still underutilize teaching strategies that embody these principles (Mirra & Garcia, 2021; Mahayanti et al., 2025; Marini et al., 2025).

Most instructional practices continue to focus on technical skills such as word decoding and literal comprehension, leaving more advanced competencies—including identifying key facts, producing summaries, and drawing inferences—underdeveloped (Fox, 2020). To support a deep

learning approach, the FIVES (Facts, Inference, Vocabulary, Experiences, and Summary) model can serve as a pedagogical bridge that connects the needs of deep learning with concrete classroom practices. FIVES not only strengthens students' technical reading abilities but also their critical and reflective thinking skills through systematic engagement in identifying facts, constructing inferences, enriching vocabulary, linking texts with personal experiences, and producing coherent summaries (Shea & Roberts, 2016; Nirmala & Puspita, 2025).

Previous studies have extensively explored efforts to develop reading literacy, but several gaps remain. Nirmala (2018) demonstrated the effectiveness of the FIVES model and guided reading in improving critical thinking, although the approach had not yet incorporated technology. Feriyanto and Anjariyah (2024) emphasized the importance of deep learning, but their work did not specifically target reading literacy. Nirmala et al. (2025) highlighted the role of differentiated instruction, yet technological integration was still lacking. Viantho and Nirmala (2024) underscored the benefits of social-emotional learning and mindfulness in literacy skill development. Research by Anggun et al. (2025) reported the positive impact of deep learning on literacy and numeracy, but the use of technology remained suboptimal. The main gap lies in the limited number of studies that comprehensively integrate a structured literacy model such as FIVES, a deep learning approach, and interactive learning technologies into a coherent pedagogical framework suited for elementary school contexts. At the same time, educational technologies—such as interactive e-modules, instructional videos, and digital applications—have shown potential to enhance students' reading literacy skills (Herlina & Abidin, 2024; Dewi et al., 2024).

Integrating deep learning and the FIVES model through interactive e-modules offers a strategic response to these needs. Interactive e-modules support dynamic, engaging, and individualized delivery of instructional content (Gunawan et al., 2024). They also provide flexible access and promote meaningful, mindful, and joyful learning experiences by embedding FIVES-based strategies throughout the learning activities. This combination is expected to cultivate students' reading literacy skills in a deeper, more structured, and sustainable manner (Buaga & Supartinah, 2025; Nirmala & Puspita, 2025; Puteri & Sulistina, 2025).

The central problem addressed in this study is how to design an interactive e-module that integrates the FIVES model and a deep learning approach to overcome reading literacy barriers among elementary school students in Indonesia. The research questions are grouped into three focal areas: (1) identifying the main barriers—ontogenic, didactic, epistemological, and technological factors—based on teachers' perceptions and students' experiences; (2) designing an interactive e-module based on the FIVES model and the deep learning approach in a systematic manner to overcome these barriers; and (3) determining the specific features that support the five components of FIVES while applying the mindful, meaningful, and joyful principles of deep learning. Since this study is in the design phase, the hypothesis is conceptual, proposing that integrating the FIVES model and deep learning principles into an interactive e-module can improve elementary students' reading literacy skills.

This study provides a theoretical contribution by presenting an integrated framework that connects a structured literacy model (FIVES), a pedagogical approach (deep learning), and educational technology in the form of an interactive e-module. Its practical contribution lies in the development of a prototype e-module that can serve as a reference for teachers, curriculum developers, and education policymakers. Although this study focuses on the Indonesian context, the generated design principles have the potential to be adapted to other developing countries facing similar challenges, such as low reading literacy performance at the elementary level, limited implementation of innovative pedagogical strategies, unequal access to and use of educational technology, and the need to develop higher-order thinking skills from an early age. Adaptations may

be made by considering cultural contexts, local curricula, and the technological infrastructure available in each country.

2. Literature Review

2.1. Reading Literacy in Elementary School Students

Reading literacy is a fundamental skill that shapes students' academic success. Literacy is not merely a technical ability to recognize words; it encompasses comprehension, interpretation, evaluation, and reflection on texts (Afflerbach, 2025; Dewayani et al., 2021). Reading is an active meaning-making process in which readers link the text to their prior knowledge (Tracey & Morrow, 2024; Spivey, 2023). This perspective is supported by Vygotsky's (1978) concept of the zone of proximal development, which highlights the importance of social interaction in literacy learning (Xi & Lantolf, 2021). Research shows that reading ability results from the combination of decoding skills and language comprehension (Wawire & Zuilkowski, 2021). Recent studies by Duke (2021) and Catts (2015) further affirm the continued relevance of these theories in the development of elementary students' literacy.

Reading proficiency should extend beyond combining letter sounds into words; it must advance toward understanding and analyzing new knowledge. Chall (as cited in Dewayani, 2021) outlines six stages of reading development that illustrate students' growing competencies: (1) the initial stage, which includes pre-reading and early reading in the preschool years; (2) fluent reading and comprehension of familiar texts in elementary school; (3) reading to learn new information at the lower secondary level; and (4) analytic and critical reading in upper secondary school, enabling learners to construct and deconstruct knowledge independently. These stages demonstrate that reading is a progressive process that develops from basic recognition to deeper levels of analysis and reflection. Although Chall's framework remains widely referenced, some scholars question its linearity, arguing that literacy develops in a more sophisticated and nonsequential manner. Additionally, the model does not fully incorporate digital literacy, which has become integral to reading competence in the modern era (Coiro, 2021).

These theories remain highly relevant to elementary education. Vaughn (2024) notes that many young learners struggle to identify key ideas in texts, making it difficult for them to produce effective summaries. Similarly, Furlong (2021) reports that limited literacy skills hinder students' ability to draw evidence-based conclusions. Smith (2021) emphasizes that reading comprehension is strongly influenced by background knowledge, which accounts for up to 81% of students' academic performance. These findings reinforce the view that reading literacy is a higher-order thinking skill that requires a holistic approach that extends beyond technical decoding to include the cognitive, social, and motivational dimensions of learning in elementary school.

2.2. Deep Learning Approach in Reading Literacy

The concept of deep learning was introduced by Marton and Säljö (1976), who distinguished between surface learning, which focuses on memorization, and deep learning, which emphasizes meaningful understanding. Similarly, Ausubel's (1968) theory of meaningful learning highlights the importance of linking new information with existing cognitive structures. In the context of reading literacy, deep learning moves beyond word recognition and literal comprehension, requiring students to construct deeper meaning through meaningful connections between the text and their experiences (McTighe & Silver, 2020). The deep learning approach in reading literacy is grounded in three core principles: mindful learning, which encourages conscious and attentive engagement with the reading process; meaningful learning, which connects text with the reader's context and personal experiences; and joyful learning, which fosters enjoyment and motivates students to participate actively in literacy practices (Santhosh, 2024). These three principles work together to facilitate deep

understanding, active engagement, and holistic learning experiences that support students' reading literacy development.

The implementation of deep learning in reading literacy involves three interconnected stages of learning: understanding, applying, and reflecting. The understanding stage extends beyond literal comprehension and requires students to construct deeper meaning through mindful reading, in which they consciously process information, attending to detail, context, and relationships among ideas within the text (Cebollero-Salinas, 2025). The application stage enables students to apply their understanding in new contexts by making meaningful connections, thereby transferring and applying knowledge from the text in different situations, creating contextual and purposeful learning (Weng, 2023). The reflecting stage, as the culmination of the deep learning process, promotes joyful learning through reflective thinking, enabling students to evaluate their learning experiences, identify achievements and challenges, and develop metacognitive awareness essential for higher-order literacy (Zayed, 2024). Jiang (2022) confirms that these three stages form a continuous learning cycle in which each stage reinforces and deepens students' literacy development.

In response to these challenges, the deep learning approach is considered highly relevant for enhancing reading literacy. Deep learning emphasizes meaningful understanding by connecting new information to existing cognitive structures (Ausubel, 1968; Marton & Säljö, 1976). Its application allows students to explore the meaning of texts through mindful, meaningful, and joyful activities (Viczko, 2026; Feriyanto & Anjariyah, 2024). However, various studies indicate that implementing deep learning at the elementary school level continues to face global challenges, such as teacher readiness, the availability of learning media, and insufficiently structured pedagogical design (Mirra & Garcia, 2021; Marini et al., 2025). Moreover, research on integrating deep learning into technology-supported literacy instruction remains limited and largely conceptual.

2.3. Interactive E-Module in Learning

The theoretical foundation for using interactive e-modules is grounded in the constructivist perspectives of Piaget (1970) and Vygotsky (1978), both of whom emphasize that knowledge is constructed through active experience and social interaction. This principle aligns with the characteristics of interactive e-modules, which encourage students to learn independently while also engaging collaboratively. Recent studies reinforce the relevance of this approach. Ahmad and Iqbal (2023) and Gillies (2022), for example, demonstrate that technology-based constructivist learning can enhance student engagement and literacy.

In addition, the cognitive theory of multimedia learning (Mayer, 2001, 2009) explains that integrating text, images, and animation can optimize cognitive processing. This theory has been further supported by contemporary research, such as studies by Fiorella (2020) and Mayer (2021), which show that well-designed multimedia materials effectively improve reading comprehension. Meanwhile, cognitive load theory (Sweller, 1988, 1994) highlights the importance of managing cognitive load to support efficient learning. This has become increasingly relevant in the digital era, as noted by Paas et al. (2019) and Kalyuga (2022), who argue that instructional design must remain focused and simple to prevent cognitive overload. Accordingly, interactive e-modules can be regarded as learning media grounded in classical theories and strengthened by recent empirical evidence in improving reading literacy.

A strong theoretical base supports the use of interactive e-modules in learning. Philosophically, this concept is rooted in the constructivist ideas of Piaget (1970) and Vygotsky (1978), which assert that knowledge is not merely transmitted but actively constructed through learning experiences and social interaction. In the context of elementary education, constructivism emphasizes the importance of engaging students in exploring, interpreting, and constructing new understanding (Zajda, 2021). Interactive e-modules align with these principles by enabling students to learn independently while

also providing opportunities for collaboration, such as through digital discussions or structured exercises. They function not only as tools for delivering content but also as platforms that foster mindful, meaningful, and joyful learning experiences. Their use in literacy instruction is particularly relevant because they integrate cognitive, affective, and social dimensions within an adaptive learning ecosystem, thereby supporting improvements in reading literacy (Khotimah & Astawan, 2024).

2.4. FIVES Model in Reading Literacy

The FIVES (Facts, Inference, Vocabulary, Experiences, and Summary) model is a literacy strategy designed to integrate reading comprehension with vocabulary development. Developed by Shea and Roberts (2016), FIVES serves as an integrated framework to promote more applicable literacy instruction in classrooms. Rather than functioning as a rigid set of technical reading steps, FIVES represents a cognitive, metacognitive, and linguistic thinking process that operates simultaneously. This framework encourages students to engage in active reading, connect texts to personal experiences, and articulate their understanding systematically.

Each element of the FIVES model contributes significantly to strengthening literacy. The Facts component trains students to identify explicit information, forming a foundation for deeper understanding (Lipponen, 2000). Inference encourages students to link textual information with prior knowledge, allowing them to develop more meaningful interpretations (Gauche & Flores, 2022). Vocabulary emphasizes the importance of word knowledge, as breadth of vocabulary is strongly associated with reading comprehension quality (Lawrence et al., 2022). Experiences provide opportunities for students to relate the text to their personal experiences, making reading more relevant, contextual, and meaningful (Mann, 2000). Finally, the Summary component guides students in coherently reconstructing main ideas, promoting critical and reflective thinking rather than mere repetition (Davies & Jones, 2022). The FIVES model is not a strict linear process but a flexible framework that allows students to move between elements depending on the text and learning context (Shea & Roberts, 2016).

Integrating FIVES into digital learning through interactive e-modules further enhances its impact. Dong et al. (2024) reported that interactive multimedia based on social-cognitive theory effectively improves early literacy skills. Additionally, digital tools can reduce cognitive load while enhancing vocabulary and reading comprehension (Liu, 2024). As a result, the FIVES strategy serves as a comprehensive literacy framework that not only supports technical reading skills but also nurtures critical, analytical, and reflective thinking. Its incorporation into interactive e-modules makes it particularly relevant for addressing reading literacy challenges in elementary schools. Moreover, it aligns well with 21st-century literacy demands, which emphasize the ability to understand, interpret, and apply information in real-world contexts.

3. Methodology

3.1. Research Design

This study employed a mixed-methods approach with an exploratory–sequential design, beginning with the collection of quantitative data through surveys, followed by qualitative data gathered through interviews, and culminating in the design phase of the interactive e-module. This approach was selected because it offers a comprehensive understanding by combining the generalizability of quantitative data with the depth of meaning obtained from qualitative data (Melani et al., 2025; Hirose & Creswell, 2023). The exploratory-sequential design is highly suitable for development-oriented research, as it enables broad identification of needs through quantitative findings and subsequently allows in-depth exploration through qualitative insights to produce an evidence-based product design (Creswell & Clark, 2018).

3.2. Participant

In the quantitative phase, data were collected from 124 elementary school teachers across 17 provinces through an online questionnaire. Most participants were female (71.8%) and male (28.2%), with age distributions of 25-35 years (33.9%), 36-45 years (46.8%), and above 45 years (19.3%). Teaching experience varied, with 22.6% having fewer than 5 years, 36.3% having 5-10 years, 25% having 11-15 years, and 16.1% having more than 15 years. In terms of educational background, 79% held a bachelor's degree in Primary Education, 14.5% held bachelor's degrees in other fields with teaching certifications, and 6.5% held a master's degree in Education. School locations were distributed across urban (62.9%) and rural (37.1%) areas, with school status comprising public (82.3%) and private (17.7%) institutions. Inclusion criteria required participants to be actively teaching Grades 4-6, have a minimum of two years of teaching experience, be involved in literacy instruction, and provide informed consent after receiving an explanation of the study's objectives.

The qualitative phase involved 14 teachers from seven cities (Bogor, Bandung, Tangerang, Jakarta, Yogyakarta, Semarang, and Surabaya) and 70 elementary students from the same cities, with five students selected from each school to represent varying levels of literacy. Most teachers were female (78.6%), aged 28-52 years (mean age 38.5), with teaching experience ranging from 5 to 18 years (mean 10.2). Their educational backgrounds included bachelor's degrees (71.4%) and master's degrees (28.6%). The distribution of assigned grade levels included Grades 4 (5 teachers), 5 (5 teachers), and 6 (4 teachers). Student participants included 38 females (54.3%) and 32 males (45.7%), aged 10-13 years, with 25 students from Grade 4, 25 from Grade 5, and 20 from Grade 6. Socioeconomic backgrounds were categorized as middle (60%), upper-middle (25.7%), and lower-middle (14.3%). Regarding access to technology, 52 students (74.3%) had access to digital devices, while 18 students (25.7%) had limited access. Student selection was based on literacy proficiency levels identified by teachers and internal assessments, resulting in two high-performing, two moderate-performing, and one low-performing student from each school. Participants were purposively selected for their active involvement in literacy learning and willingness to share experiences of literacy challenges and needs.

3.3. Research Instruments

The quantitative instrument consisted of a 25-item questionnaire that included four aspects: literacy habituation (15-minute reading, consistency, feedback), students' literacy skills (fact identification, drawing conclusions, vocabulary, personal experiences, summarizing, explicit-implicit information, critical thinking), the teacher's role (literacy integration, curriculum alignment, instructional models, assessment), and technology integration (use of e-modules, digital media, and technology-based assessment). The qualitative instrument involved semi-structured interviews focusing on teachers' perspectives regarding literacy barriers, technology use, and instructional strategies, as well as students' challenges in understanding texts, their digital learning experiences, and their perceptions of teachers' strategies. These instruments provided the foundation for designing the interactive FIVES-based e-module using a deep learning approach, aligned with development research principles that emphasize meeting users' real needs (McGraw & Harbison, 2020; Balasubramaniam et al., 2023).

Several theoretical frameworks and validated instruments informed the development of the questionnaire. First, the reading literacy framework from PIRLS (Progress in International Reading Literacy Study) and Indonesia's AKM (Minimum Competency Assessment), which includes three competency levels: locating information (Level 1), interpreting and integrating (Level 2), and evaluating and reflecting (Level 3). Second, the framework of learning barriers proposed by Brousseau (Nditafon, 2018), which identifies ontogenic barriers originating from the learner, didactic barriers arising from instruction, and epistemological barriers associated with the nature of

knowledge, is complemented by technological barriers based on the technology acceptance model (Davis, 1989). Third, the principles of deep learning from Fullan and Langworthy (2014) emphasize meaningful, mindful, and joyful learning. Fourth, the components of the FIVES model by Shea and Roberts (2016), consisting of Facts, Inference, Vocabulary, Experiences, and Summary.

The research questionnaire was structured around four main dimensions. The first dimension, literacy habituation (six items), assessed the consistency of pre-reading activities, the variety of reading materials, and the provision of feedback. The second dimension, students' literacy skills (eight items), examined fact identification, inference-making, vocabulary mastery, connecting texts to personal experiences, summarizing, and critical thinking. The third dimension, teachers' roles and strategies (six items), evaluated the integration of literacy across subjects, the alignment of instructional strategies with the curriculum, the use of innovative learning models, and the implementation of varied literacy assessments. The fourth dimension, technology integration in literacy learning (five items), assessed the use of e-modules or digital media, the application of multimedia, and technology-based assessments.

The student interview protocol consisted of 10 core questions adapted to elementary students' language level and organized into 4 themes. The first theme, reading experiences, explored students' reading preferences, difficulties encountered, and feelings when creating summaries, with additional probing on text types and examples of challenges. The second theme, learning strategies, examined how students understand new vocabulary and connect text content to personal experiences. The third theme, technology experiences, investigated their use of digital applications or media for reading, their experiences learning with digital tools, and the features they expect in enjoyable digital reading materials. The fourth theme, learning preferences, asked about the reading activities they enjoy in class and the factors that motivate them to read and learn.

3.4. Research Procedure

This study consisted of three stages: collecting quantitative data through a questionnaire, conducting interviews with teachers and students to explore literacy barriers and needs, and designing an interactive e-module based on the FIVES model using a deep learning approach. At this stage, the study has produced only the design prototype, while validation and pilot testing, both small-scale and large-scale, will be conducted in subsequent research. These follow-up stages are aligned with standard educational development procedures, which emphasize needs analysis, design, validation, and testing to ensure validity, practicality, and effectiveness (Ramdhani et al., 2025; Suwandi et al., 2023; Sintawati & Margunayasa, 2021; Marlina, 2025).

The research procedure began with the collection of quantitative data through an online questionnaire. The data were analyzed to identify general patterns of reading literacy barriers. The next stage involved qualitative data collection through online interviews lasting 30 to 45 minutes to deepen the interpretation of the quantitative results. The entire process followed a sequential explanatory approach, integrating quantitative findings with qualitative insights during the final interpretation stage to provide a more comprehensive understanding. Additionally, during the e-module design process, the study employed formative evaluation consisting of expert review by two digital literacy specialists and one instructional design expert, a prototype walkthrough to assess the learning flow and module interactivity, and a minor group tryout involving five teachers to evaluate usability, clarity of instructions, and alignment of activities with the FIVES components.

3.5. Research Validity and Ethics

The validity of the quantitative instrument was established through expert judgment to ensure alignment with the research objectives. At the same time, its reliability was tested through a pilot study involving a group of teachers prior to large-scale distribution. For the qualitative instrument,

data reliability was strengthened through inter-rater agreement during coding. This study received ethical approval, and all participants provided voluntary informed consent. For elementary school students, additional consent was obtained from parents or legal guardians in accordance with ethical standards for educational research.

Three experts further examined the validity of the quantitative instrument in literacy and educational technology, and its reliability was demonstrated by a Cronbach's alpha of 0.892, indicating strong internal consistency. In the qualitative phase, data trustworthiness was ensured through member checking, source triangulation, and peer debriefing. The analysis followed systematic procedures, including open coding, axial coding, and selective coding, to generate key themes that represent teachers' barriers and needs. To evaluate the initial design of the interactive e-module, the study employed a set of indicators to assess usability for teachers and students, the clarity of content flow, the alignment of activities with the FIVES components, and the module's potential to support deep learning principles. The evaluation was conducted using expert review sheets and feedback from a small-group tryout, enabling improvements before broader implementation. All participants signed informed consent forms, and their identities were kept confidential in accordance with ethical guidelines for educational research.

4. Results

4.1. Challenges in Enhancing Literacy Skills

Efforts to improve reading literacy in elementary schools have become a main priority in Indonesian education. Literacy is not only the foundation for mastering other subjects but also a crucial life skill in the 21st century. Interviews with teachers and students from various schools revealed that literacy practices in the field continue to face multiple challenges. Teachers agreed that literacy is not merely a technical ability to read, but also involves understanding text content, drawing conclusions, and connecting reading materials to everyday experiences. From the students' perspective, Bahasa Indonesia is considered an important subject, yet difficulties arise when they encounter lengthy passages, unfamiliar vocabulary, or are required to produce summaries and conclusions.

These findings highlight that literacy problems are complex and interrelated. The challenges experienced by both students and teachers stem not only from individual factors but also from teaching practices, the nature of the knowledge to be mastered, and the limited use of technology in schools. Based on the analysis, these challenges can be grouped into four main categories: ontogenic barriers, didactic constraints, epistemological barriers, and technological barriers. Table 1 presents the challenges experienced by students and teachers from 14 elementary schools in the learning process.

Table 1. Barriers to Literacy Skills

Barrier Categories	Key Findings	Number of Schools	Percentage
Ontogenic	1. Low reading interest due to online gaming. 2. Difficulty comprehending lengthy texts and unfamiliar vocabulary. 3. Frequent confusion in distinguishing main ideas from key facts. 4. Wide variation in literacy skills among students.	9	64%

Didactic	1. Teachers struggle to design instruction that accommodates variations in student abilities. 2. Teachers face challenges in selecting effective strategies and instructional models to strengthen literacy. 3. Limited teacher experience in developing e-modules. 4. Innovative strategies (morning literacy, reading corners, storytelling) exist but have not adequately addressed the needs of all students.	8	57%
Epistemological	1. Students struggle to connect reading materials with their daily experiences. 2. Limited practice in summarizing and drawing conclusions. 3. Minimal use of metacognitive strategies in reading instruction.	6	43%
Technological	1. Unequal access to devices, as some students do not have personal gadgets. 2. Limited digital infrastructure (internet and devices). 3. Teachers face difficulties in selecting appropriate digital media and are not yet accustomed to developing e-modules. 4. Differences in the readiness of facilities and infrastructure across schools	10	71%

4.1.1. Ontogenic Obstacles

Barriers arising from students' internal conditions are particularly significant. Some students show low reading interest because they are more attracted to digital games than to books. When confronted with long texts, unfamiliar vocabulary, or the task of writing a summary, they often feel overwhelmed. Several students also remain uncertain about distinguishing between main ideas and supporting facts. This situation suggests that reading readiness is strongly influenced by motivation and the diverse cognitive capacities among students. Previous studies have emphasized that intrinsic motivation and active engagement are decisive factors for reading success in elementary schools (Kanonire, 2022). In addition, simple metacognitive strategies such as rereading and noting new vocabulary have been proven to improve comprehension, especially for students with lower abilities (Soto et al., 2023).

4.1.2. Didactic Obstacles

Teachers face challenges in designing literacy instruction that accommodates the diverse abilities of their students. Differences in reading skills within the same classroom make it difficult for teachers to determine strategies that can reach all learners. Many teachers acknowledge that they are not yet proficient in selecting specific models or strategies that can effectively enhance literacy, nor are they accustomed to developing e-modules. Although initiatives such as morning literacy activities, reading

corners, and storytelling have been introduced, these strategies do not fully meet students' needs. Kizil and Kizil (2024) emphasize that literacy instruction without differentiation risks widening the gap among students. This highlights the need for specialized training to help teachers master innovative, contextual, and adaptive literacy teaching strategies (Rincon-Flores et al., 2024).

4.1.3. Epistemological Obstacles

Students' difficulties extend beyond the technical aspects of reading to the construction of meaning from texts. Many are not accustomed to connecting the content of readings with their daily experiences. They are also rarely trained to conclude, engage in reflection, or apply metacognitive strategies. As a result, reading activities often stop at a mechanical level, limited to word decoding without deeper comprehension. Yerdelen-Damar and Eryilmaz (2021) highlight that metacognitive strategies, such as monitoring and evaluation, are highly effective in cultivating conceptual understanding. In other words, strengthening literacy should not only emphasize reading fluency but also nurture critical and reflective thinking skills (Fletcher, 2023).

4.1.4. Technological Obstacles

The integration of technology in literacy instruction presents two contrasting dimensions. On the one hand, nearly all students reported feeling more motivated when learning involved digital media such as videos, interactive quizzes, or educational apps. They expressed that these learning tools made learning more enjoyable and easier to understand. On the other hand, limited facilities remain a significant challenge. Not all students have personal devices, and internet access in some schools is inconsistent. From the teachers' perspective, the lack of training has made it difficult for them to select appropriate digital media or develop e-modules. Mpuangnan (2024) found that digital infrastructure readiness and teachers' technological literacy are critical factors for successful technology integration. Similarly, Mhlongo (2023) emphasized that without adequate training, teachers often struggle to optimize technology despite its considerable potential benefits.

The analysis shows that reading literacy in elementary schools continues to face complex barriers, including low student motivation, limited instructional strategies, and technological gaps. Nevertheless, students' enthusiasm for digital media provides a promising opportunity for innovation. Therefore, the development of interactive e-modules supported by specific instructional models such as the FIVES framework, oriented toward deep learning, is essential for enhancing students' motivation, comprehension, and critical thinking skills while strengthening literacy as a foundation for 21st-century learning.

4.2. Design of FIVES-Integrated Deep Learning Interactive E-Module

The development of the interactive e-module in this study stems from the urgent need to provide a learning medium that not only enhances technical reading skills but also fosters the ability to understand, connect, and reflect on texts. The FIVES model was selected because it offers a systematic framework for building reading literacy through structured stages, beginning with the presentation of facts, followed by meaning analysis, vocabulary enrichment, contextual learning experiences, and culminating in reflection. The integration of the FIVES e-module with the principles and learning experiences of deep learning is illustrated in Table 2.

Table 2. Integration of FIVES Model with Deep Learning

Stages of the FIVES Model	Learning Principles			Learning Experiences
	Meaningful	Mindful	Joyful	
FACTS	Connecting facts in the text with students' real-life experiences	Focusing on key information through guided reading activities	Fact-sorting games with a point or badge system	Understanding – identifying key facts and information
INFERENCE	Connecting inference outcomes to everyday decision-making	Organizing evidence and logical reasoning to support inferences	Engaging in mystery-solving activities and collaborative group discussions	Applying – using inferences to solve problems
VOCABULARY	Applying newly acquired vocabulary in meaningful sentences aligned with the context of the reading	Recognizing word meanings through contextual cues and reflective usage	Vocabulary games such as crosswords or word challenges	Understanding & Applying – comprehending word meanings and using them in context
EXPERIENCES	Connecting the content of the reading with students' personal experiences	Reflecting on feelings and thoughts while reading	Activities such as storytelling, creating photo stories, or role-playing	Applying – connecting the content of the reading with real-life experiences
SUMMARY	Summarizing the content of the reading by emphasizing its relevance to real life	Identifying key points and conducting self-evaluation	Summary competitions, digital poster creation, or creative presentations	Reflecting – formulating conclusions and learning reflections

4.2.1. Integration of Fact Aspect with Deep Learning

In the interactive FIVES-based e-module, the Facts aspect serves as the foundation for training students to recognize, identify, and understand key information from texts or learning media. This aspect is designed not merely to promote memorization but to help students connect and categorize information, allowing them to form a more comprehensive understanding. The integration of deep learning principles at this stage enables students to learn mindfully, relate facts to real-life contexts in meaningful ways, and reflect on their understanding within a joyful and engaging learning atmosphere.

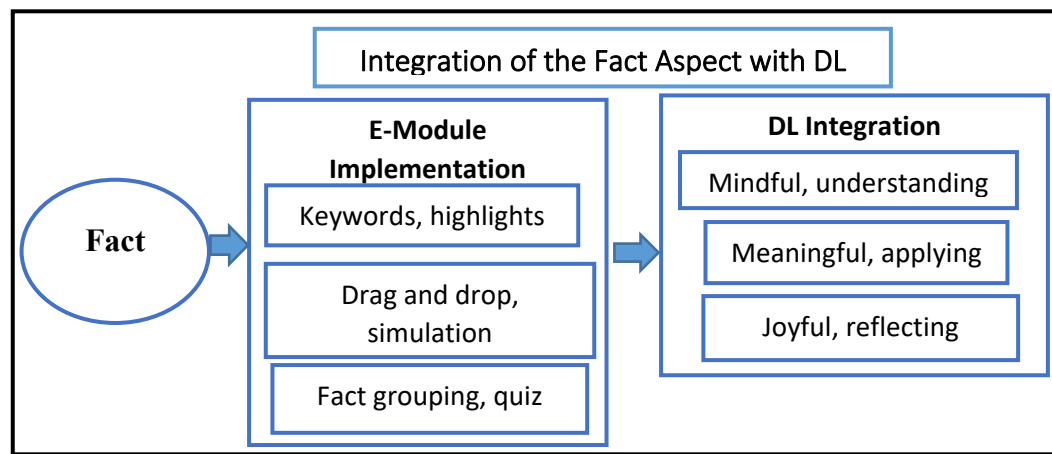


Figure 1. Integration of the Fact Aspect with DL

4.2.2. Integration of Inference Aspect with Deep Learning

The Inference aspect of the FIVES model emphasizes students' ability to conclude, identify relationships, and develop logical reasoning based on the information they have obtained. Within the context of an interactive e-module, this aspect plays a crucial role in encouraging students to think critically—not merely receiving information passively but actively connecting it with their prior knowledge and experiences. The integration of deep learning principles strengthens this process by helping students learn mindfully, relate information to real-life contexts meaningfully, and reflect on their reasoning and ideas in a joyful learning atmosphere.

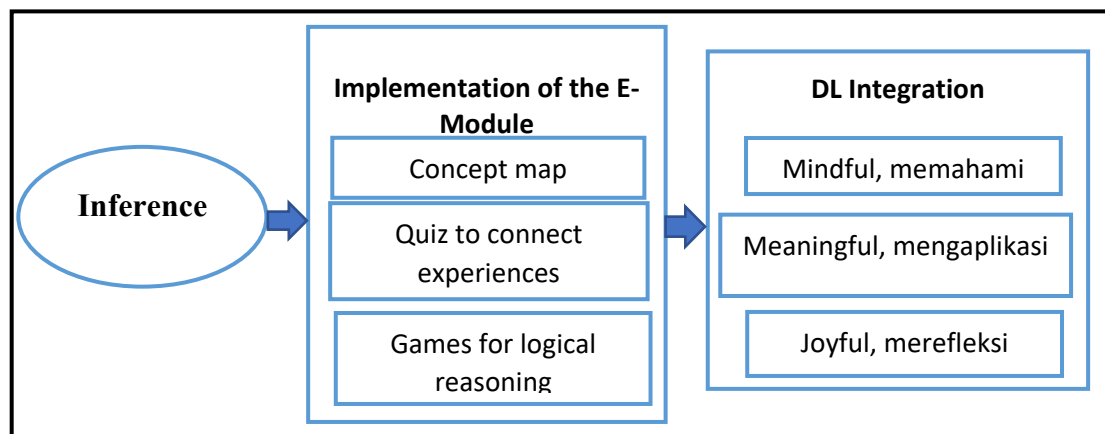


Figure 2. Integration of Inference with DL

4.2.3. Integration of Vocabulary Aspect with Deep Learning

The Vocabulary aspect in the FIVES model focuses on developing students' vocabulary as a key to text comprehension. A strong vocabulary enables students not only to recognize words but also to understand their meanings, use them in context, and connect them with learning experiences. In the interactive e-module, this aspect is designed to actively engage students in discovering, interpreting, and practicing vocabulary through a variety of engaging digital activities. The integration of deep learning principles improves vocabulary acquisition by helping students become mindful of new words, apply them appropriately in reading contexts, and practice them through joyful activities that encourage reflection.

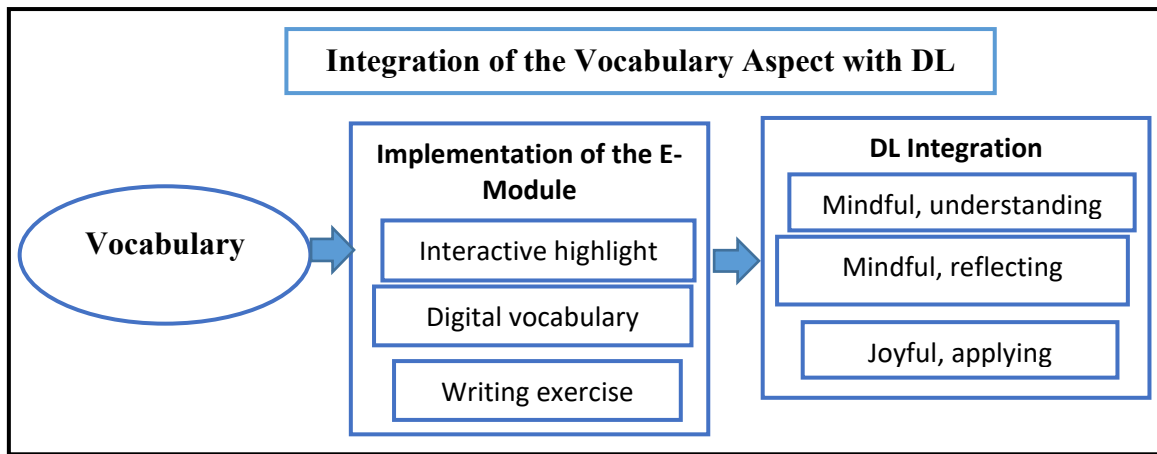


Figure 3. Integration of the Vocabulary Aspect with DL

4.2.4. Integration of Experiences Aspect with Deep Learning

The Experiences aspect of the FIVES interactive e-module is designed to encourage students to connect newly acquired knowledge to their personal experiences and real-life contexts. Through these learning experiences, students not only gain deeper conceptual understanding but also apply knowledge in authentic situations and reflect on their own learning processes. The implementation of the Experiences aspect aligns with the principles of deep learning: mindful learning that fosters awareness of experiences, meaningful learning that ensures relevance to students' contexts, and joyful learning that creates an engaging, enjoyable learning environment. Moreover, Experiences support the three stages of learning—understanding the material, applying knowledge, and reflecting on the learning process—allowing students to develop holistic, meaningful comprehension.

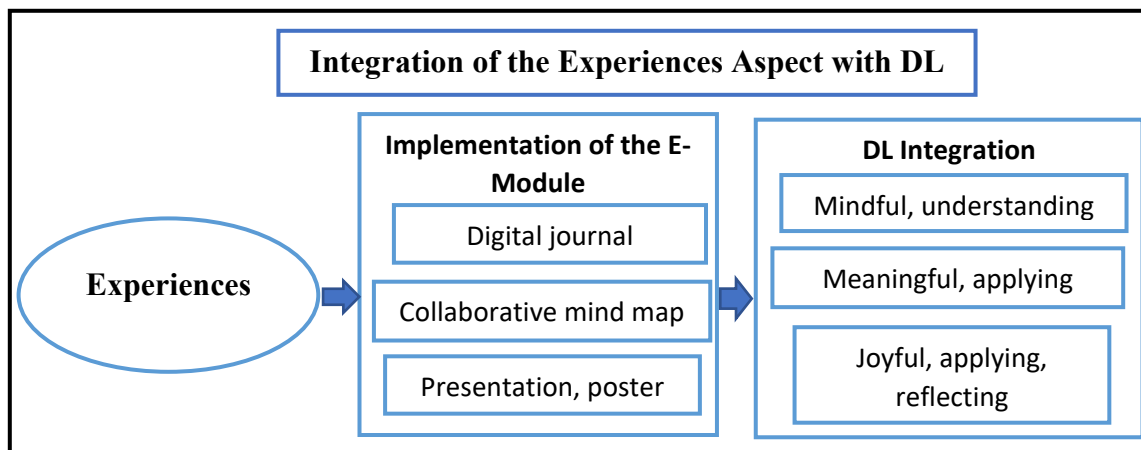


Figure 4. Integration of the Experiences Aspect with DL

4.2.5. Integration of Summary Aspect with Deep Learning

The Summary section in the FIVES interactive e-module is intended to help students synthesize and reconstruct knowledge acquired in previous stages. Through the process of creating summaries, students can evaluate their understanding, draw accurate conclusions, and connect new information with prior experiences and concepts. The implementation of Summary aligns with the principles of deep learning: mindful learning to enhance awareness of core learning points, meaningful learning to ensure that conclusions are relevant and significant for students, and joyful learning to ensure that the process of summarizing remains engaging and enjoyable. Additionally, the Summary aspect supports the three stages of learning experiences—understanding information, applying the

synthesized concepts, and reflecting on comprehension—enabling students to build knowledge that is both holistic and clearly documented.

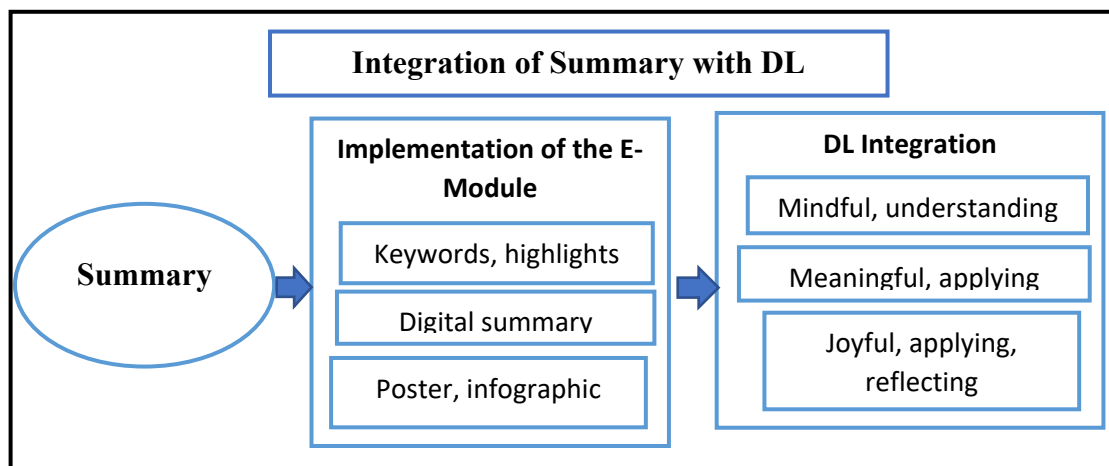


Figure 5. Integration of Summary with DL

5. Discussion

This study reveals a range of complex challenges in developing reading literacy among elementary school students in Indonesia. These challenges can be grouped into four interrelated types of barriers: ontogenic barriers (originating from the students themselves), didactic barriers (related to instructional practices), epistemological barriers (related to understanding knowledge), and technological barriers. Student-related barriers were identified in 64% of the participating schools. The main issues include declining interest in reading, as students increasingly prefer playing digital games (Li & Chu, 2021), and difficulties comprehending long texts and unfamiliar vocabulary (Allen, 2023). These findings align with international research, such as a study in Finland by Torppa et al. (2020), which found that even in high-performing education systems, students experienced reduced reading motivation due to the dominance of digital media. However, Indonesia presents additional challenges, including limited access to quality books and different levels of family support—factors that are less pronounced in more developed countries. Students also frequently struggle to distinguish main ideas from supporting details, indicating insufficient metacognitive skills (Wang et al., 2024). These challenges are further compounded by frequent digital distractions, underscoring the need for instructional practices that connect traditional reading skills with contemporary learning demands.

Didactic barriers were identified in 57% of the schools, illustrating the difficulty teachers face in designing instruction that accommodates diverse student abilities. Teachers struggle to develop learning activities that meet the needs of both high-performing students and those who require additional support. Churchill et al. (2024) emphasize that teachers need a strong understanding of both content and pedagogy, particularly when implementing strategies proven effective for addressing variation in student abilities. International comparisons reveal an important pattern. In Singapore, for example, teachers receive systematic support through professional learning communities that facilitate the sharing of best practices for differentiated instruction (Chen et al., 2021). These communities meet regularly to share teaching experiences, solve problems collaboratively, and support continuous improvement in instructional quality. In contrast, teachers in Indonesia often work individually with limited professional support, making didactic barriers more difficult to overcome. These findings underscore the need for policies that not only focus on teacher training but also establish sustained professional support systems. Although various innovative

strategies have been introduced, their effectiveness is limited due to gaps between implementation and expected outcomes.

Barriers in understanding knowledge occurred in 43% of schools and represent one of the most fundamental challenges. Students struggled to connect the content of the texts with their everyday experiences. This finding aligns with learning theories emphasizing the importance of linking new knowledge to prior knowledge during reading comprehension (Rahman, 2024). Interestingly, a study in South Korea by Cho (2025) found that although students excel on international literacy assessments, they still experience similar difficulties connecting texts to personal experiences due to instructional practices that heavily emphasize memorization and testing. This indicates that barriers in understanding knowledge are universal and not solely related to the quality of an education system, but also to the learning approaches. Students were also rarely trained to summarize and draw conclusions, even though these higher-order thinking skills are essential for deep comprehension. Recent studies emphasize that teaching students to think about their own learning significantly improves comprehension and vocabulary mastery, especially when they are explicitly guided to monitor and regulate their reading processes (Kärbla, 2021).

Technological barriers affected 71% of schools and present a contradictory situation. On the one hand, students showed high enthusiasm for learning with digital media, displaying greater engagement and motivation when using videos, applications, or educational games. On the other hand, several technical challenges persisted, such as limited access to personal devices and restricted internet connectivity. Weisberg and Dawson (2023) explain that successful technology integration depends heavily on teacher readiness, institutional support, and equitable access to resources. Global comparisons reveal that gaps in access and digital competence are not unique to Indonesia. These disparities include differences in internet access, device ownership, and digital literacy across socioeconomic, geographic, and educational groups. Even in the United States, Reich et al. (2020) found that the COVID-19 pandemic worsened technological inequities, with students from low-income families facing significant barriers to online learning. These findings underscore the need for comprehensive national policies to address technological disparities beyond the school or regional level. From the teachers' perspective, many struggled to select and use appropriate digital media for literacy instruction.

The FIVES model was selected as a response to the identified barriers. This model provides a structured approach that simultaneously addresses multiple dimensions of reading comprehension. Its strength lies in its comprehensive nature, combining cognitive processes and learning awareness that are essential for deep learning. The Facts component helps students overcome internal barriers by offering clear strategies for identifying key information in a text. Zimmermann and Reed (2020) found that explicit instruction in recognizing factual information can significantly improve students' ability to understand text structure. Through engaging activities such as fact-classification games with point and badge systems, students who are typically more drawn to digital games can remain motivated in reading activities.

The Inference component directly addresses barriers in understanding knowledge by teaching students to construct meaning that is not explicitly stated in the text. Inferential ability is a critical aspect of reading competence, as real-life information is not always presented explicitly, requiring students to draw conclusions and understand deeper meanings (Rice & Wijekumar, 2024). Comparative studies show that students in East Asian countries such as Japan and China tend to excel in literal comprehension but struggle with higher-level inferencing (Duke & Cartwright, 2021), a pattern consistent with the findings of this research. Vocabulary development within the FIVES framework addresses both ontogenic and epistemological barriers by providing a systematic approach to learning new words. Strong vocabulary mastery has a substantial impact on reading comprehension, enabling students to navigate complex texts more effectively.

The Experiences component is the most innovative aspect of the FIVES model, directly addressing epistemological barriers by helping students connect textual content with their lived experiences. When students are able to relate a text to personal experiences, their understanding becomes deeper and more meaningful (Teng, 2020). Through storytelling, role-play, and creative expression, students strengthen their ability to reflect on what they read while appreciating the diversity of backgrounds among their peers. However, the emphasis on personal experiences also has limitations. In Indonesia's highly diverse socioeconomic and cultural context, not all students have experiences relevant to certain topics, especially texts related to urban settings or modern technologies. Therefore, the design of the e-module should provide additional scaffolding or alternative examples for students who may not have direct experience with the topic. The Summary component integrates all previous elements while cultivating higher-order thinking skills essential for independent learning. Summarization skills are crucial for reading comprehension, particularly when supported by explicit strategies and guided practice (Rukthong & Brunfaut, 2019).

The integration of the FIVES model with deep learning principles—meaningful, mindful, joyful—creates a comprehensive instructional framework. This integration develops not only students' technical reading skills but also the emotional and social dimensions of learning. The meaningful principle ensures that all learning activities are connected to students' real lives and cultural backgrounds, which is essential for addressing epistemological barriers. Meaningful learning significantly enhances motivation and retention, especially for students from diverse backgrounds (Pedler, 2022). It also helps students feel valued and included, an important consideration in Indonesia's richly diverse cultural and linguistic context. A comparison with Finland shows similarities in the emphasis on meaningful learning, although the contexts differ. In Finland, meaningful learning is facilitated through phenomenon-based learning that integrates multiple subjects (Schaffar & Wolff, 2024). In Indonesia, where the curriculum remains more subject-based, integrating meaningful learning through a FIVES-based e-module offers a more feasible implementation alternative. The mindful principle encourages students to be aware of their own learning processes, teaching them to monitor their understanding, recognize confusion, and apply appropriate strategies to overcome difficulties. Meanwhile, the joyful principle leverages children's natural curiosity and enthusiasm, which is crucial for overcoming motivational barriers commonly found among elementary school learners.

The findings of this study carry important implications for educational practice, teacher professional development, and policy-making. A thorough analysis of learning barriers demonstrates that improving reading literacy demands coordinated efforts across multiple fronts, including curriculum development, teacher training, technological infrastructure, and community involvement. For teachers and practitioners, this study highlights the importance of diagnostic approaches to identify the specific barriers students and schools face. The FIVES-based e-module offers a practical and coherent pedagogical framework capable of addressing multiple challenges simultaneously while keeping students engaged.

Effective implementation hinges on continuous professional development for teachers. Educators must not only grasp how to use the e-module but also understand the theoretical foundations behind its design. With a strong conceptual understanding, teachers can tailor the approach to address the specific needs of their students. From a policy standpoint, the findings further underscore the importance of coordinated initiatives to bolster technological infrastructure and teacher readiness. The successful integration of technology relies heavily on robust support systems, including equitable access to devices and sustained capacity-building for educators. Educational policies must promote fairness in resource distribution and professional learning opportunities to ensure all students, regardless of school location or socioeconomic background, receive high-quality literacy instruction.

Overall, this study offers a valuable contribution to understanding the complex challenges of reading literacy in Indonesia while proposing an innovative solution through the integration of the FIVES model, deep learning principles, and interactive e-module technology. However, the success of this solution cannot depend solely on strong instructional design. It requires a holistic support system that includes appropriate policy measures, ongoing professional development for teachers, adequate technological infrastructure, and—most importantly—a shared commitment among stakeholders to position literacy as a national priority. Further research involving empirical validation, trials across diverse educational contexts, and long-term impact evaluations is essential to ensure that the FIVES-based e-module can deliver meaningful improvements in students' reading literacy. With a realistic, critical, and evidence-based approach, this innovation holds strong potential as a long-term solution for advancing literacy education in Indonesia.

6. Conclusion

This study shows that reading literacy in elementary schools continues to be hindered by ontogenic, didactic, epistemological, and technological barriers, all of which shape students' reading abilities. To address these challenges, the study designed an interactive e-module based on the FIVES model, integrating deep learning principles (mindful, meaningful, joyful) and three learning experiences: understanding, applying, and reflecting. The e-module was systematically developed by aligning each FIVES component (facts, inference, vocabulary, experiences, and summary) with digital features that promote active engagement, strengthen reading comprehension, and support the development of critical thinking skills. While particularly relevant to Indonesia's educational context, this approach can be adapted for schools in other countries by considering cultural backgrounds, resource availability, and technological conditions. The design offers a new contribution by merging the FIVES model with deep learning principles, aligning with global educational trends that prioritize technology-enhanced deep learning.

7. Suggestion

Given that this study is still limited to the design phase of the FIVES-based interactive e-module, further research is strongly recommended to conduct expert validation as well as small-scale and large-scale trials in various elementary school settings. This is essential for assessing the effectiveness of the e-module both quantitatively and qualitatively across diverse learning contexts, including urban and rural schools with differing resource conditions. In addition, because the survey data from teachers may be influenced by perception bias, subsequent studies should incorporate classroom observations and empirical evidence drawn directly from teaching practices. Long-term involvement of both teachers and students is also necessary to ensure that the e-module is not only valid and practical but also sustainable, relevant, and adaptable to educational contexts in Indonesia and in other countries with different cultural and technological conditions.

Declarations

Author Contributions.

Sri Dewi Nirmala: Conceptualization of the interactive e-module design, Writing - Original Draft, Software, Editing

Ryan Dwi Puspita: Writing - Review, Editing, Analysis, Methodology

Sendi Ramdhani: Validation, Resources, Investigation, Supervision

Conflicts of Interest. The authors declare that they have no competing interests.

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Ethical Approval. All datasets were collected and stored in compliance with institutional research ethics and privacy standards. To ensure anonymity, all participant identifiers were removed.

Data Availability Statement. The datasets generated and analyzed during the study are not publicly available due to ethical restrictions regarding participants' confidentiality. However, the data are available from the corresponding author upon reasonable request.

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