Ricerche di Pedagogia e Didattica – Journal of Theories and Research in Education 21, 1 (2026). ISSN 1970-2221.

SIBISA: Improving critical thinking skills through digital library applications

Muhammad Hakiki
Universitas Negeri Surabaya

Halomoan
Universitas Negeri Padang

M. Agphin Ramadhan
Universitas Negeri Jakarta

Subhanadri
Universitas Muhammadiyah Muara Bungo

Abdul Haris Setiawan
Universitas Sebelas Maret

Mustofa Abi Hamid
Universitas Sultan Ageng Tirtayasa

Erik Rahman
Universitas Negeri Surabaya

Abdulnassir Yassin
Islamic University in Uganda

Abstract

The integration of digital technologies in education offers strong potential to foster higher-order thinking, particularly critical thinking. This study introduces SIBISA, a digital library application designed to support critical thinking through interactive e-books and instructional videos. The development followed the 4D model (Define, Design, Develop, and Disseminate), ensuring systematic alignment with pedagogical needs. Validation by four media experts and four material experts yielded high ratings across three aspects: content, media, and learning validity, with average scores of 0.94 and 0.95, respectively. Practicality testing with 297 elementary students and teachers at Buah Hati Integrated Islamic Elementary School, Padang, Indonesia, showed overall scores of 92.9% from students and 93.1% from teachers, confirming its usability and effectiveness. The findings indicate

DOI: https://doi.org/10.60923/issn.1970-2221/22905

that SIBISA functions not only as a digital repository but also as an interactive environment that enhances engagement, motivation, and reflective learning, thereby significantly contributing to the digital transformation of education.

L'integrazione delle tecnologie digitali nell'istruzione offre un forte potenziale per promuovere il pensiero di ordine superiore, in particolare il pensiero critico. Questo studio presenta SIBISA, un'applicazione di biblioteca digitale progettata per supportare il pensiero critico attraverso e-book interattivi e video didattici. Lo sviluppo ha seguito il modello 4D (Definizione, Progettazione, Sviluppo e Diffusione), garantendo un allineamento sistematico con le esigenze pedagogiche. La validazione da parte di quattro esperti di media e quattro esperti di materiali ha prodotto valutazioni elevate in tre aspetti: contenuto, media e validità dell'apprendimento, con punteggi medi rispettivamente di 0,94 e 0,95. I test di praticità condotti su 297 studenti e insegnanti della scuola primaria integrata islamica Buah Hati di Padang, in Indonesia, hanno mostrato punteggi complessivi del 92,9% da parte degli studenti e del 93,1% da parte degli insegnanti, confermando la sua usabilità ed efficacia. I risultati indicano che SIBISA funziona non solo come archivio digitale, ma anche come ambiente interattivo che migliora il coinvolgimento, la motivazione e l'apprendimento riflessivo, contribuendo in modo significativo alla trasformazione digitale dell'istruzione.

Keywords: SIBISA; digital library; critical thinking; educational technology; 4D development model

Parole chiave: SIBISA; biblioteca digitale; pensiero critico; tecnologia didattica; modello di sviluppo 4D

DOI: https://doi.org/10.60923/issn.1970-2221/22905

1. Introduction

The development of digital technology has profoundly changed the landscape of education, shifting the focus from traditional teacher-centered approaches to more student-centered, technology-supported learning environments (Onanuga & Saka, 2025). In this context, mastery of 21st-century skills, particularly critical thinking, has become a crucial educational priority (Herlinawati et al., 2024; Mahmud & Wong, 2022). This is reinforced by research findings (Thornhill-Miller et al., 2023; Williamson, 2023), which show that critical thinking enables learners to process information systematically, question assumptions, construct logical arguments, and make evidence-based decisions. These skills are essential in preparing students to face the challenges of a rapidly changing and knowledge-driven society (Chaika, 2024; Martin-Alguacil et al., 2024).

Several studies (Li et al., 2021; Rothinam et al., 2025; Suwarno et al., 2022), explain that at the elementary school level, the development of critical thinking skills is very important. Early interventions that encourage students to observe, analyze, and reflect not only strengthen their academic achievement but also build a foundation for lifelong learning (Essalih et al., 2025; Hamkah et al., 2025). However, despite its recognized importance, the development of critical thinking skills in basic education often faces significant challenges (Mugabekazi et al., 2025; Mauidah et al., 2025). Among the most pressing issues is the limited availability of interactive and structured learning resources (Abdelghaffar & Eid, 2025). This is in line with the findings of studies (Abbas & Faiz, 2013; Buyannemekh et al., 2024; Tu & Hwang, 2020), which show that traditional libraries, despite providing access to books and printed materials, do not always meet the needs of students who are accustomed to technology (digital natives) and prefer learning experiences that are engaging, accessible, and technology-supported. As a result, many students turn to online resources that are often fragmented, unverified, and lack pedagogical value (Jurianto et al., 2025; Martzoukou, 2020).

To address these challenges, researchers and educators are increasingly turning to digital libraries as a means of transforming access to information and supporting higher-level learning processes (Abdelghaffar & Eid, 2025; Halomoan et al., 2025; Rafique et al., 2020). Digital library applications offer curated collections of rich multimedia resources, integrate interactive features, and provide flexible access across multiple devices (Hyman et al., 2014). Several previous studies conducted by Tsekea and Chigwada (2021) and Nurhayati et al. (2024) show that digital learning platforms can improve reading comprehension, collaborative learning, independent inquiry, and motivation among students. However, most of these studies focus on secondary or higher education, with relatively limited exploration of digital libraries in the context of elementary schools (Malizia et al., 2010; Suwarto et al., 2022; Toharudin et al., 2021). These results are supported by research conducted by Beširević (2020) and Llewellyn (2019), which explains that the potential of digital library applications in developing critical thinking skills in early childhood students has been under-explored, creating a research gap that requires systematic investigation.

In response to this gap, this study introduces SIBISA (Digital Library Application-Based Information System), a digital library application specifically designed to support the development of critical thinking skills among elementary school students. Unlike conventional digital platforms, SIBISA is tailored to the cognitive characteristics and developmental stages of young students, combining structured digital resources with interactive features that encourage questioning, reflection, and problem-solving. By positioning the digital library not only as an information repository but also as a pedagogical tool for developing higher-order thinking, SIBISA aims to bridge the gap between technology accessibility and meaningful learning outcomes (Rafique et al., 2020; Strover et al., 2019).

This study is significant in two main respects. First, it advances theoretical understanding by providing empirical evidence of how digital library applications can be strategically designed to enhance critical thinking skills in

DOI: https://doi.org/10.60923/issn.1970-2221/22905

elementary education. Second, it offers practical insights for educators, policymakers, and technology developers seeking to integrate digital innovations into the classroom in ways that align with pedagogical goals. In doing so, this research contributes to the broader discourse on educational technology and underscores the importance of leveraging digital platforms not only to facilitate information access but also to nurture essential 21st-century competencies in the early stages of formal education.

2. Literature review

2.1 Critical thinking in education

Critical thinking has long been recognized as a key educational objective, commonly associated with students' ability to analyze problems, evaluate evidence, and make reasoned judgments (Yusuf et al., 2024; Manousou, 2025). In this study, critical thinking is conceptually positioned not as a directly measured cognitive outcome, but as a pedagogical capacity that can be fostered through structured learning environments and instructional design. In the context of elementary education, developing this capacity is particularly important, as it provides the foundation for higher-level learning and lifelong intellectual development (Lubbe et al., 2025; Nuroh & Liansari, 2018; Trisnawati et al., 2025).

However, existing instructional practices in many elementary classrooms continue to privilege rote learning and content transmission, limiting students' opportunities to engage in inquiry, analysis, and reflection (Budiarto et al., 2025). From a constructivist perspective, critical thinking emerges through sustained interaction with meaningful tasks rather than through passive content consumption. Previous studies (Song et al., 2025; Zeng & Ravindran, 2025) demonstrate that learning environments integrating interactive content, discovery-oriented activities, and reflective practice are more effective in supporting conditions for critical thinking than conventional teacher-centered approaches.

These findings suggest that the role of educational technology should be understood not merely as a tool for content delivery, but as a design-based intervention that creates affordances for critical engagement. Consequently, there is a need for innovative educational tools that systematically structure opportunities for questioning, reasoning, and reflection, while remaining sensitive to learners' developmental stages and classroom contexts.

2.2 Digital libraries in learning

Digital libraries have emerged as transformative tools in education, expanding access to diverse learning materials and supporting flexible, learner-centered engagement (Mdodana-Zide & Chimbi, 2025; Yadav et al., 2024). Unlike traditional libraries, digital platforms integrate multimedia content, search functionalities, and interactive features, making them more aligned with the preferences of digitally native learners (Zou et al., 2025). Prior research demonstrates that digital libraries can enhance reading comprehension (Farid et al., 2023), motivation for independent study (Okunlaya et al., 2022), and collaborative learning (Abrizah & Zainab, 2011). Furthermore, digital libraries allow real-time updates and scalability, enabling institutions to provide learners with curated and relevant resources. Despite these advantages, studies also reveal limitations, such as information overload, lack of critical evaluation of sources, and insufficient integration with pedagogical frameworks (Kyva et al., 2022; Riady et al., 2025). These limitations suggest that while digital libraries hold promise, their effectiveness depends heavily on thoughtful design and educational alignment.

2.3 Integration of digital libraries and critical thinking

DOI: https://doi.org/10.60923/issn.1970-2221/22905

The continuity between digital libraries and critical thinking is still a developing field of study (Beširević, 2020). Research conducted by Li and Liu (2019) and Martzoukou (2020) in the context of higher education shows that digital platforms can encourage critical thinking by providing students with opportunities to compare perspectives, evaluate the credibility of information, and engage in problem-solving tasks. However, evidence at the elementary school level is still limited. Studies by Astiti et al. (2023) and Mulyawati and Marini (2022) show that younger students need structured guidance and tailored digital content to effectively develop higher-level skills. This highlights the need for customized digital library applications that not only serve as information repositories but also as pedagogical tools designed to enhance analytical and reflective learning (Suwarto et al., 2022).

2.4 Research gap and contribution

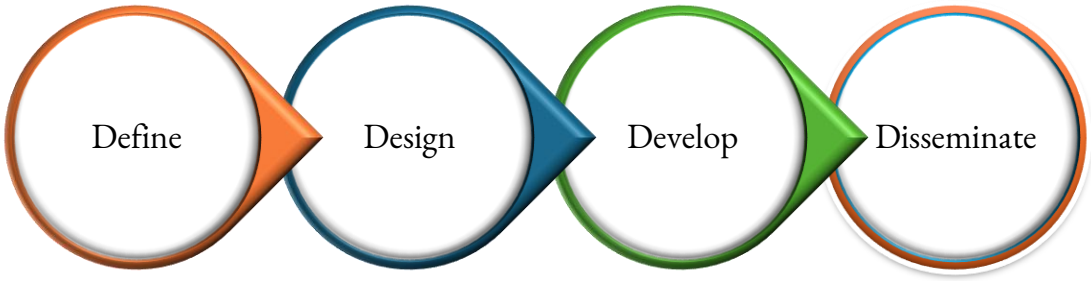
Although digital libraries have been widely studied in relation to information access and literacy, relatively few investigations have examined their role in improving critical thinking skills among elementary school students (Druin, 2005). Most prior research has focused either on higher education contexts or on the technical aspects of digital library implementation, leaving a gap in understanding how such platforms can be pedagogically optimized for younger learners (Ali et al., 2025; Waterman et al., 2020). Addressing this gap, the present study proposes SIBISA, a digital library application designed specifically to enhance critical thinking skills in elementary education. By situating digital libraries within a pedagogical framework that emphasizes analysis, evaluation, and reflection, this study extends current scholarship and offers empirical evidence on how technology can be leveraged to nurture essential 21st-century skills in early education.

3. Methodology

3.1 Research design

This study employed a developmental research design based on the 4D model (Define, Design, Develop, and Disseminate) as proposed by Huda et al. (2020). The model provides a systematic framework for developing and validating educational innovations to ensure theoretical relevance, technical accuracy, and practical usability. Figure 1 presents the SIBISA development research design.

Figure 1
SIBISA development research design



DOI: https://doi.org/10.60923/issn.1970-2221/22905

In the context of this study, the model was adapted for the development of SIBISA (Digital Library Application-Based Information System), a digital library application designed to enhance critical thinking skills in elementary school students.

Define Stage. The Define stage aimed to systematically identify instructional challenges, user needs, and the scope of development for the SIBISA application. A comprehensive needs analysis was conducted through curriculum review, semi-structured teacher interviews, and direct classroom observations at Buah Hati Integrated Islamic Elementary School, Padang, Indonesia.

The curriculum review revealed a strong emphasis on content mastery but limited integration of learning activities that explicitly promote higher-order thinking skills, particularly critical thinking. Learning materials were predominantly textbook-based and linear, offering few opportunities for students to engage in inquiry, analysis, or reflection. This misalignment between curriculum expectations and instructional practices highlighted the need for a digital solution that could enrich learning resources and support cognitive skill development.

Teacher interviews further indicated that educators faced difficulties in providing varied and interactive learning materials due to time constraints and limited access to digital resources. Teachers reported reliance on conventional teaching strategies and expressed the need for a platform that could support independent learning while remaining aligned with curriculum objectives. Importantly, teachers emphasized that existing digital resources were often fragmented and lacked pedagogical coherence.

Classroom observations supported these findings by revealing low levels of student engagement in analytical and reflective activities. Although students demonstrated familiarity with digital devices and basic navigation skills, they tended to consume information passively rather than critically evaluating or synthesizing it. This indicated a gap between students' digital literacy and their ability to engage in critical thinking.

Learner analysis confirmed that students possessed strong technological readiness but limited critical engagement with information. Consequently, the Define stage concluded that an integrated digital library application was needed to provide structured, interactive, and pedagogically aligned learning resources. These findings collectively informed the formulation of learning objectives and functional requirements for SIBISA, ensuring alignment with curriculum demands, instructional challenges, and students' technological readiness. This strengthened the theoretical and practical foundation of the development process.

Design Stage. The Design stage translated the defined objectives into detailed application specifications and prototypes. Learning objectives were mapped into features that directly support critical thinking indicators such as questioning, analyzing, and reflecting. The interface was designed to be visually engaging, user-friendly, and age-appropriate for elementary students. Content organization emphasized accessibility and interactivity through the integration of text, images, and multimedia resources. In addition, the design explicitly aligned digital content with the findings of the Define stage to ensure relevance and pedagogical coherence. Evaluation instruments for expert validation and practicality assessment were also developed, focusing on content accuracy, media quality, and pedagogical effectiveness.

Development Stage. The Development stage involved the creation of the SIBISA prototype, followed by iterative revisions based on expert validation. Collaboration between instructional designers, software developers, and media experts ensured that both pedagogical and technical aspects were addressed comprehensively. Expert validation encompassed media validity and material validity, including indicators of content validity, media validity, and learning validity, to ensure accuracy, usability, and alignment with critical thinking objectives.

Dissemination Stage. The Dissemination stage focused on the classroom implementation and evaluation of the revised SIBISA application. The application was introduced to 297 students and 10 teachers at Buah Hati Integrated Islamic Elementary School, Padang, Indonesia, to assess its practicality and acceptance in real learning contexts.

DOI: https://doi.org/10.60923/issn.1970-2221/22905

By systematically applying the 4D model, this study ensures that the SIBISA application is not only pedagogically valid and technically feasible, but also practically effective in developing critical thinking skills at the elementary school level.

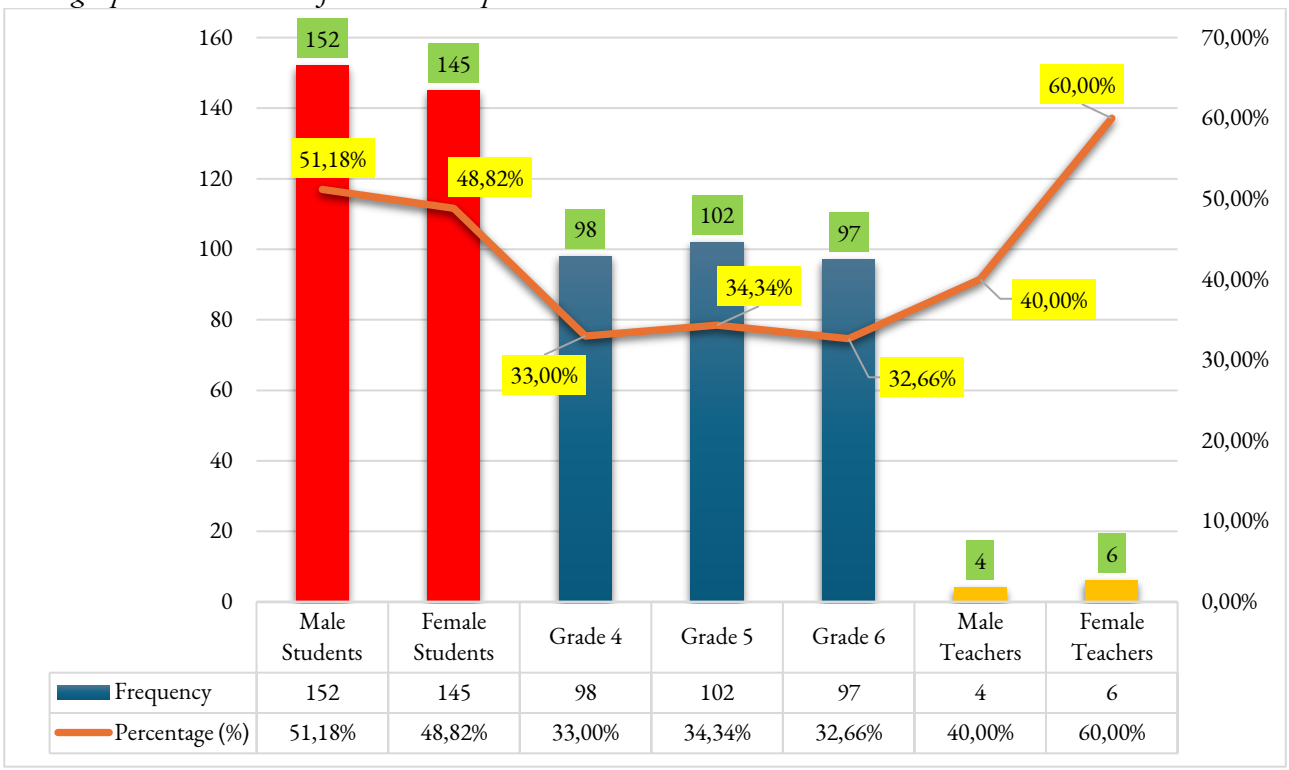
3.2 Research sample

The research was conducted at Buah Hati Integrated Islamic Elementary School, Padang, Indonesia, a public elementary school that was selected because of its representativeness in terms of student diversity and its readiness to integrate digital learning innovations. The total sample consisted of 297 students from grades four to six, along with a group of teachers who participated in the practicality assessment. These grade levels were specifically chosen because students at this stage are considered developmentally capable of engaging in higher-order thinking processes such as analysis, reasoning, and reflection, which are essential for the cultivation of critical thinking skills.

The sampling technique used in this study was purposive sampling, which is appropriate in developmental research where the target population must meet certain predefined characteristics (Arnab, 2017). In this case, the criteria included: (1) students actively enrolled in upper elementary grades, (2) students with basic digital literacy to operate mobile devices and navigate applications, and (3) teachers responsible for delivering instructional content aligned with the national curriculum. This technique allowed the researchers to ensure that participants were not only representative of the target user group for the SIBISA application but also capable of providing relevant feedback regarding its usability and effectiveness. Figure 2 presents data on the demographic distribution of the research sample.

Figure 2

Demographic distribution of research sample



DOI: https://doi.org/10.60923/issn.1970-2221/22905

In addition to students, 10 teachers were included in the study to assess the practicality of the application from a pedagogical perspective. Teachers provided insights into the extent to which SIBISA could be integrated into classroom practices, its potential to save instructional time, and its contribution to enhancing student engagement and higher-order learning. Their participation was critical in validating the broader applicability of the developed product.

3.3 Research instruments

The research employed a set of instruments designed to evaluate the validity, practicality, and effectiveness of the SIBISA digital library application in enhancing students' critical thinking skills. The instruments were developed based on established guidelines in educational technology research and validated through expert judgment to ensure accuracy, consistency, and reliability of measurement.

3.3.1 Validity instruments

Validity assessment involves evaluation by experts from both fields, namely media experts and content experts. Media experts focus on aspects such as content validity, media validity, and digital library learning validity with a critical thinking skills development framework. Table 1 presents the media expert validation instrument.

Table 1

Instruments for expert validation

Aspect	Indicators	Item
Content validity	Relevance of materials, accuracy, alignment with curriculum	1, 2, 3, 4, 5, 6, 7
Media validity	Interface design, navigation, technical quality, interactivity	8, 9, 10, 11, 12, 13, 14
Learning validity	Contribution to critical thinking, engagement, clarity of instructions	15, 16, 17, 18, 19, 20, 21

3.3.2 Practicality instruments

Practicality was measured using a questionnaire distributed to students and lecturers after the implementation of SIBISA in classroom learning activities. The instrument included indicators of ease of use, engagement and motivation, and effectiveness of using the digital library application. Table 2 presents the Practicality Test Instrument.

Table 2

Instruments for Practicality Test

Aspect	Indicators	Item
Ease of use	Accessibility, user-friendliness, navigation	1, 2, 3, 4, 5, 6, 7
Engagement and motivation	Attractiveness, enjoyment, stimulation of independent learning	8, 9, 10, 11, 12, 13, 14
Effectiveness	Support for critical thinking, problem-solving, and collaborative learning	15, 16, 17, 18, 19, 20, 21

DOI: https://doi.org/10.60923/issn.1970-2221/22905

3.4 Data analysis techniques

The data analysis in this study was focused on evaluating the validity and practicality of the SIBISA digital library application. These two aspects were essential in ensuring that the developed product was not only theoretically robust but also practically feasible for classroom implementation.

Validity Analysis. Validity was assessed through expert evaluations, covering three primary aspects: content validity, media validity, and learning validity. The evaluation process applied Aiken's V coefficient, which is commonly used in development research to measure expert agreement on item relevance (Eliza et al., 2025). Experts rated each indicator on a five-point Likert scale ranging from very irrelevant (1) to very relevant (5). The formula used was:

$$V = \frac{\sum s}{n\,(c-1)}$$

Where:

$s = r - lo$ (expert's score minus the lowest scale point),

n = number of experts,

c = number of scale categories.

Practicality Analysis. The practicality of the SIBISA application was measured through student and teacher responses during implementation. The practicality instrument focused on three aspects: ease of use, engagement and motivation, and effectiveness. The practicality index was calculated using the following formula (Fadli et al., 2024):

$$P = \frac{Total\ Score\ Obtained}{Maximum\ Posible\ Score}\ X\ 100$$

The interpretation criteria were as follows: *81–100% = Very Practical, *61–80% = Practical, *41–60% = Moderately Practical, *21–40% = Less Practical and *≤20% = Impractical).

4. Results and discussion

4.1 Development of SIBISA

The development of SIBISA (Digital Library Application-Based Information System) was carried out using the 4D model proposed by (Huda et al., 2020), which consists of four systematic stages: define, design, develop, and disseminate. This model was chosen due to its structured approach in instructional design and its ability to ensure both theoretical and practical robustness in digital learning applications.

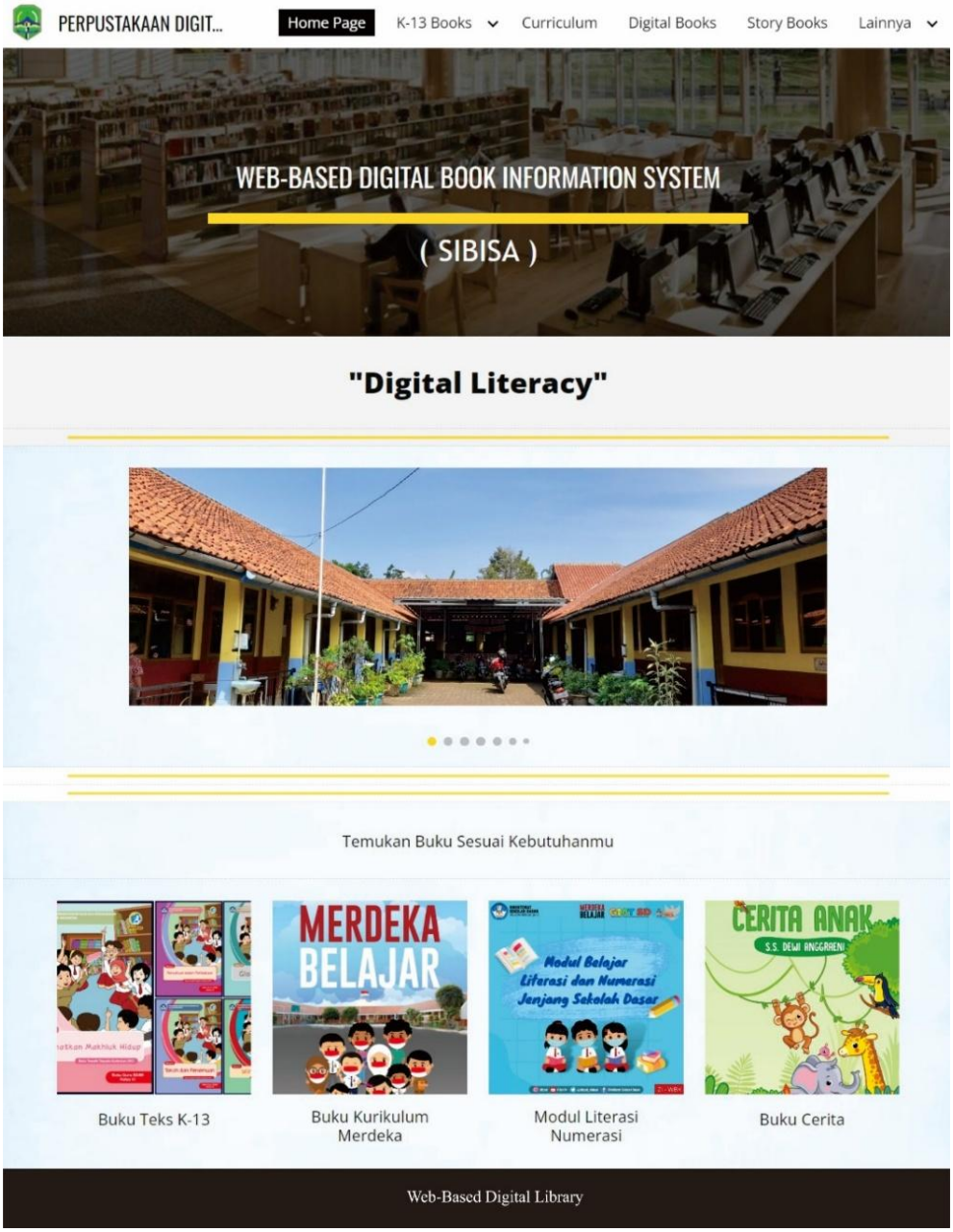
Define stage. The Define stage focused on identifying learners' needs, existing problems in critical thinking skill development, and determining relevant learning objectives. A preliminary study involving students and teachers revealed that conventional learning resources often lack interactivity and flexibility, thereby limiting opportunities to enhance higher-order thinking skills. Based on this analysis, the core requirement identified was the development of a digital library platform that integrates interactive multimedia resources (e-books, videos, and learning modules) while embedding features that promote critical thinking, collaboration, and autonomous learning.

Design stage. In the Design stage, the blueprint of the SIBISA application was constructed. The dashboard menu was carefully designed to provide intuitive navigation and user-friendly accessibility. The application integrates various features such as a digital learning book module, interactive learning videos, and evaluation tools that support active engagement. The interface design emphasized simplicity and clarity to reduce cognitive load,

DOI: https://doi.org/10.60923/issn.1970-2221/22905

ensuring both teachers and students could access resources efficiently. Figure 3 illustrates the main interface, where users can directly access all features including the library, videos, and evaluation modules.

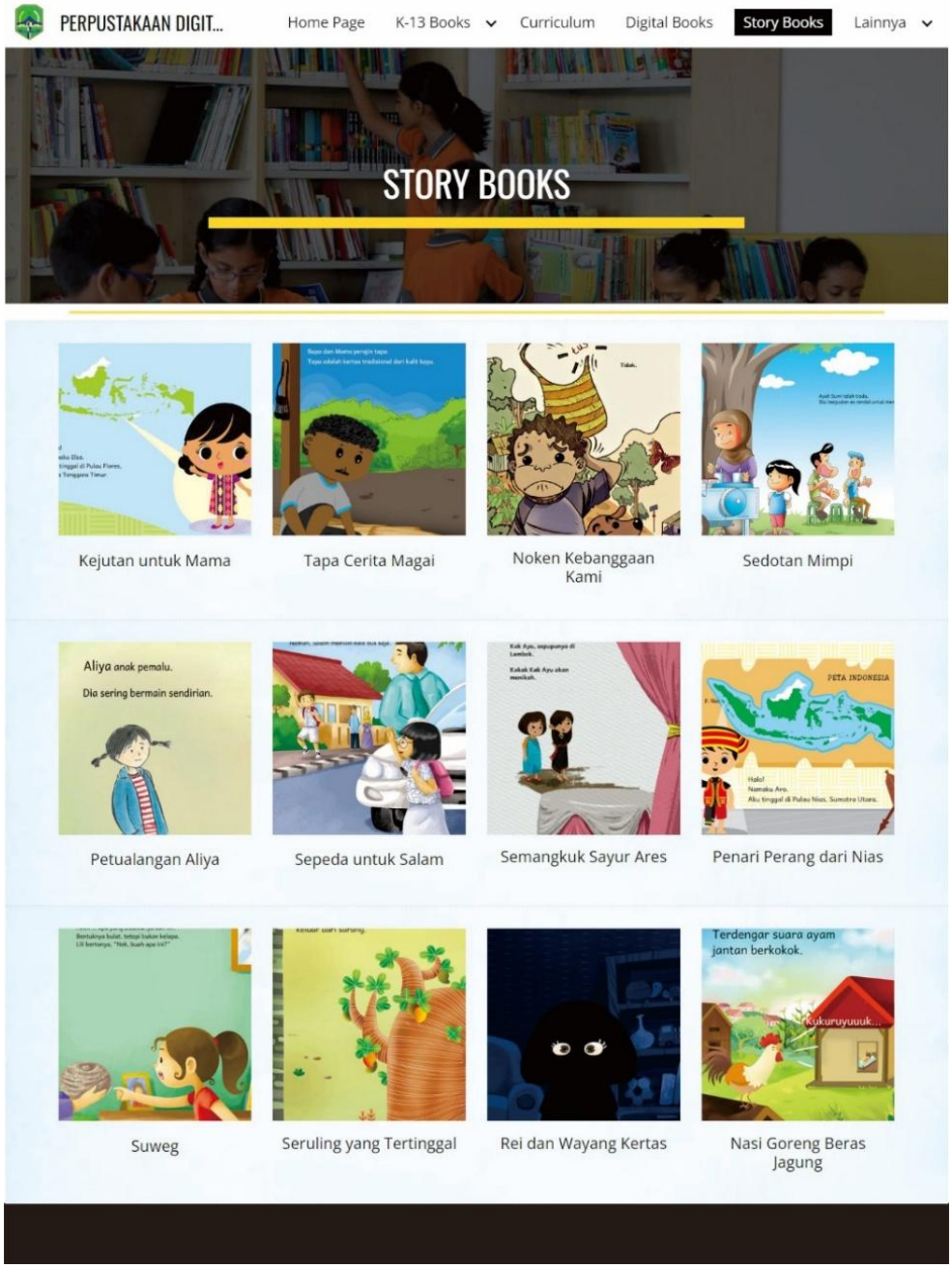
Figure 3
SIBISA dashboard menu



Develop stage. The Develop stage involved the actual creation and refinement of the SIBISA application. This phase included programming, integration of multimedia learning resources, and iterative testing. The learning book module was developed as the primary repository of structured instructional content, presented in digital book format that supports annotation and bookmarking. Figure 4 demonstrates the digital book feature, which enables students to engage with structured materials interactively, enhancing comprehension and reflective thinking.

DOI: https://doi.org/10.60923/issn.1970-2221/22905

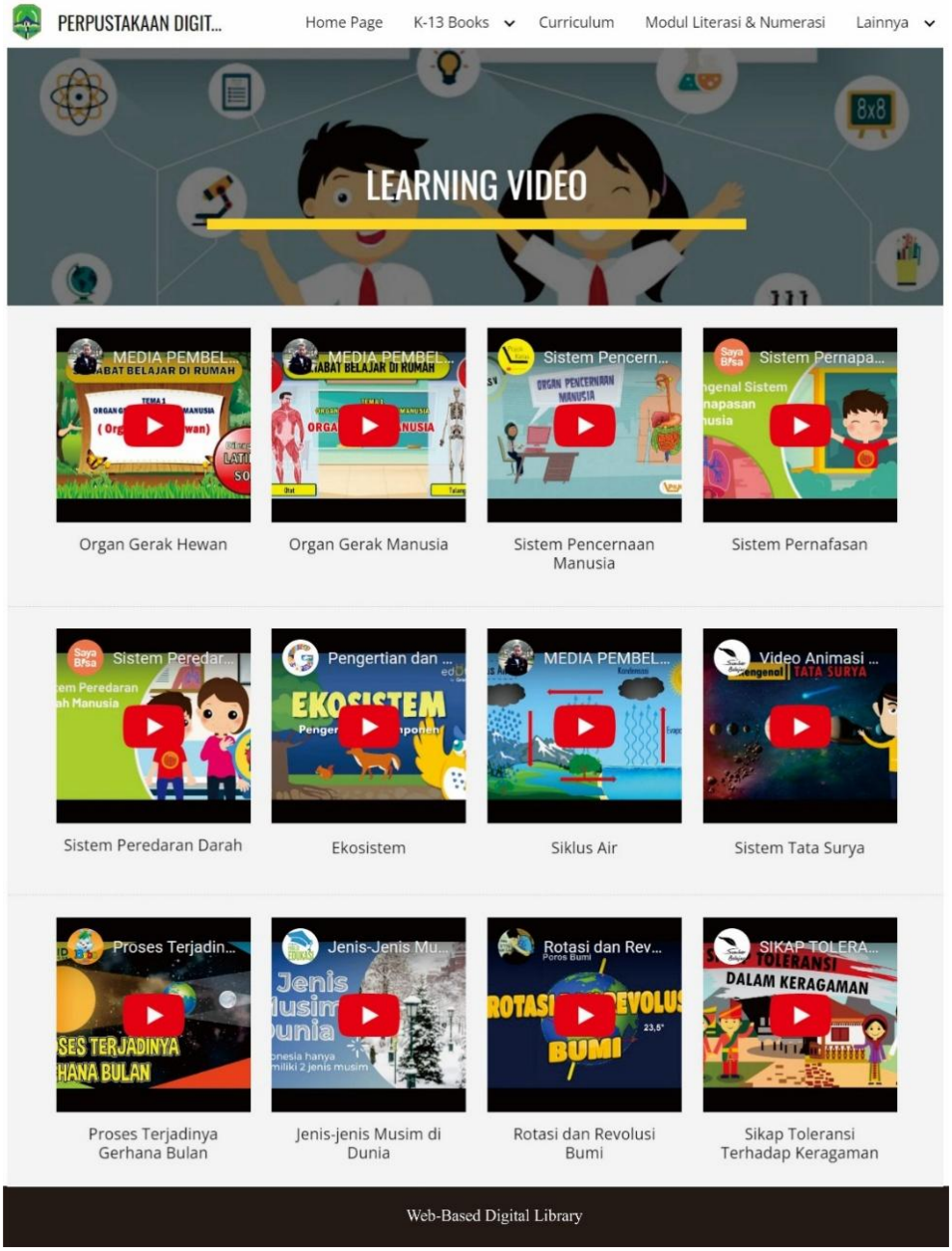
Figure 4
SIBISA learning book



In addition, learning videos were developed to provide visual and auditory reinforcement of key concepts. These videos were designed with problem-based learning elements to encourage students to analyze, evaluate, and reflect on real-world contexts. Figure 5 showcases the video-based learning interface, designed to support multimodal learning and stimulate critical discussion among learners.

DOI: https://doi.org/10.60923/issn.1970-2221/22905

Figure 5
SIBISA learning videos



Dissemination stage. The Disseminate stage involved implementation and field testing of SIBISA within actual classroom contexts. The application was introduced to both students and teachers, accompanied by training sessions to maximize its utilization. Feedback was collected through surveys and focus group discussions, allowing developers to refine the application further. Dissemination also included academic publication and knowledge-sharing sessions to encourage broader adoption across educational institutions.

DOI: https://doi.org/10.60923/issn.1970-2221/22905

4.2 Research results

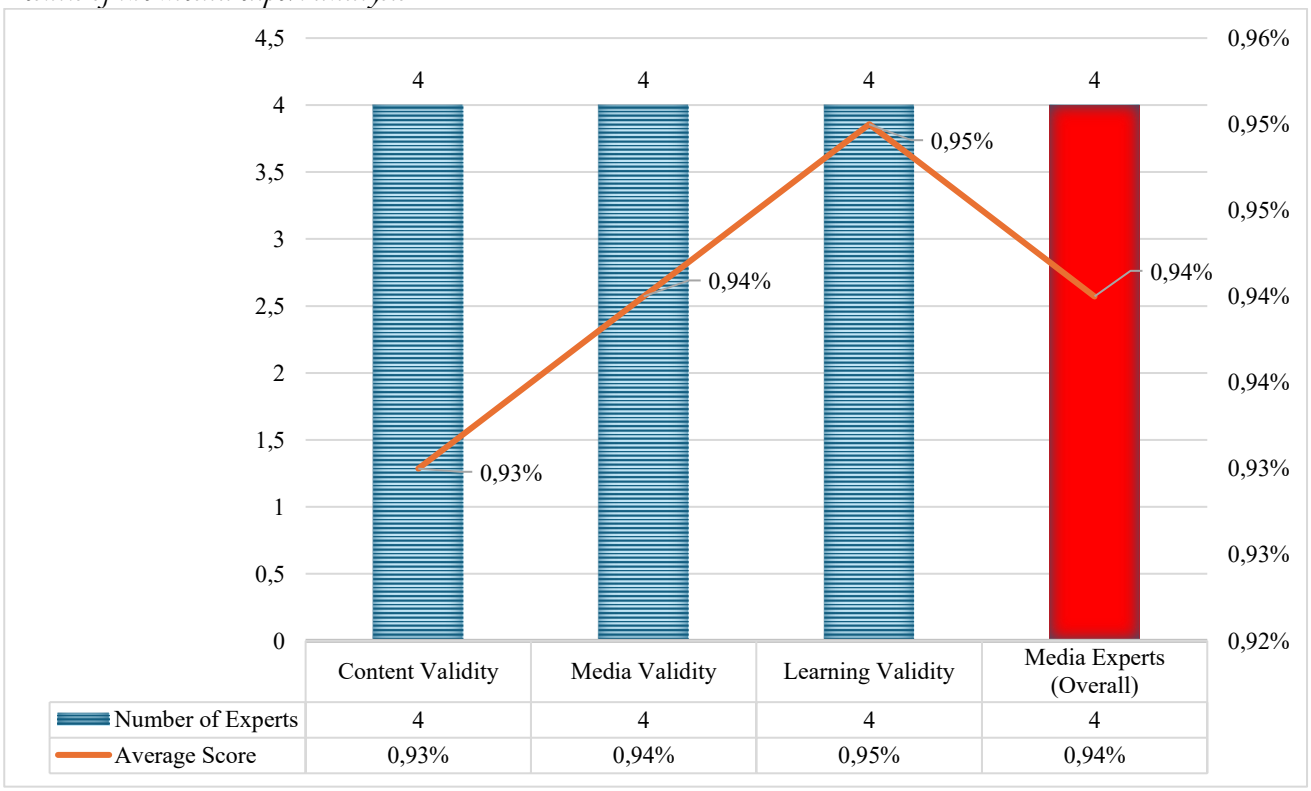
The outcomes of this study are presented in two major components, namely validity testing and practicality testing. These components were analyzed comprehensively to provide empirical evidence regarding the theoretical robustness and practical feasibility of the SIBISA digital library application in enhancing students' critical thinking skills.

4.2.1 Validity Testing

Validity analysis was conducted to ensure that the SIBISA application aligned with educational content standards, met media development principles, and supported learning objectives in accordance with the curriculum. The evaluation involved four media experts and four material experts, who provided assessments on three main aspects: content validity, media validity, and learning validity. The analysis applied Aiken's V coefficient, which is recognized as a reliable statistical measure to quantify expert agreement on item relevance. Figures 6 and 7 show the results of the analysis conducted by media experts and materials experts from four experts.

Figure 6

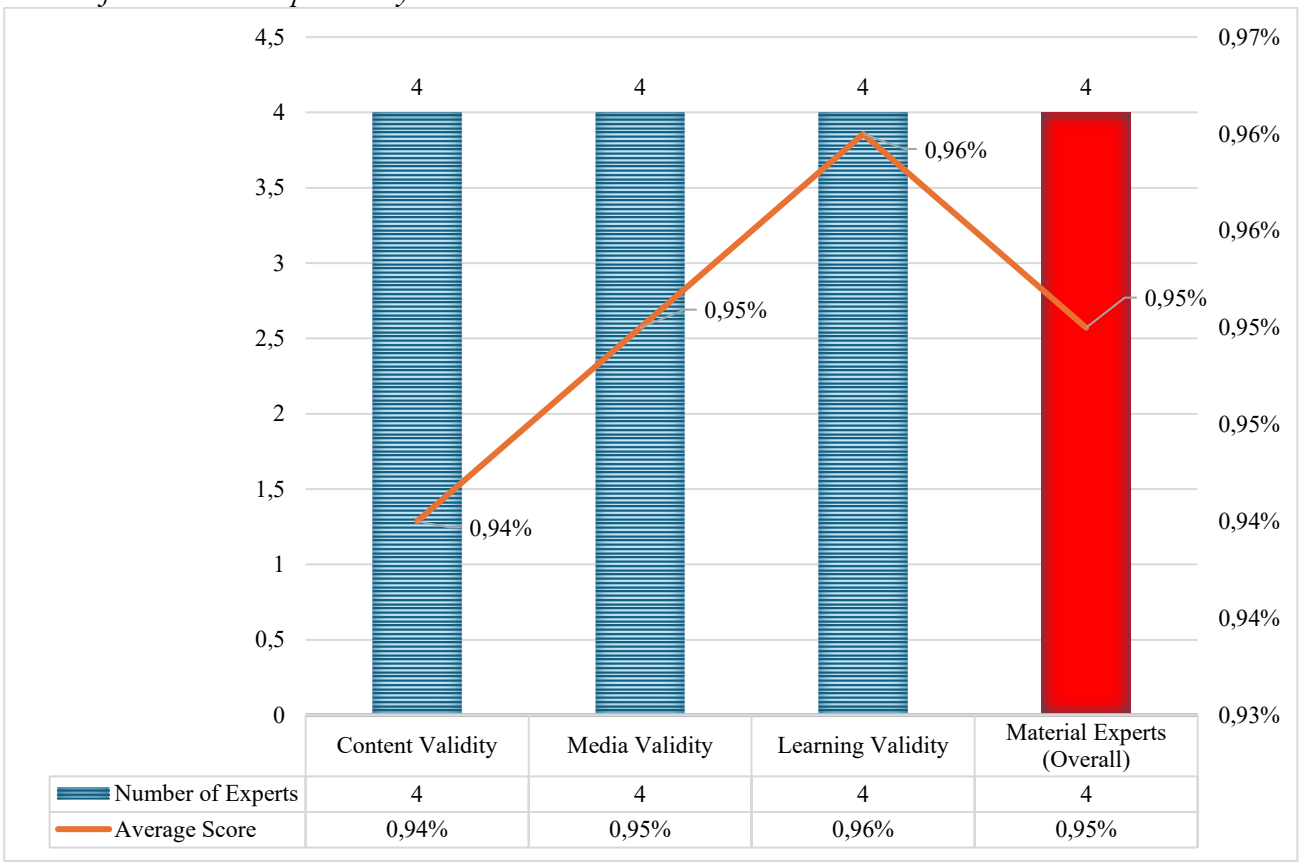
Results of the media expert analysis



DOI: https://doi.org/10.60923/issn.1970-2221/22905

Figure 7

Results of the material expert analysis



The results showed that media experts provided an average score of 0.94 %, while material experts reported an average of 0.95 %. Both values fall within the "very valid" category, reflecting strong consensus among experts that the application has high quality in terms of accuracy of content, appropriateness of media design, and alignment with learning objectives. These findings demonstrate that the SIBISA application is theoretically robust and capable of addressing the needs of students in the context of digital learning. The consistency of the scores across all three aspects indicates that the SIBISA application does not only offer appropriate instructional content but also provides high-quality media elements and effective learning integration. This establishes a strong theoretical foundation for further implementation and large-scale dissemination.

4.2.2 Practicality Testing

In addition to validity, the practicality of the SIBISA application was assessed to determine its usability, accessibility, and overall effectiveness in real classroom contexts. Practicality testing was conducted with the participation of 297 students and 10 teachers, ensuring that the perspectives of both primary users (students) and facilitators (teachers) were comprehensively represented. The practicality assessment focused on three essential aspects: ease of use, engagement and motivation, and effectiveness. Figures 8 and 9 present the results of the practicality analysis by students and teachers.

DOI: https://doi.org/10.60923/issn.1970-2221/22905

Figure 8

Results of the practicality analysis by students (N=297)

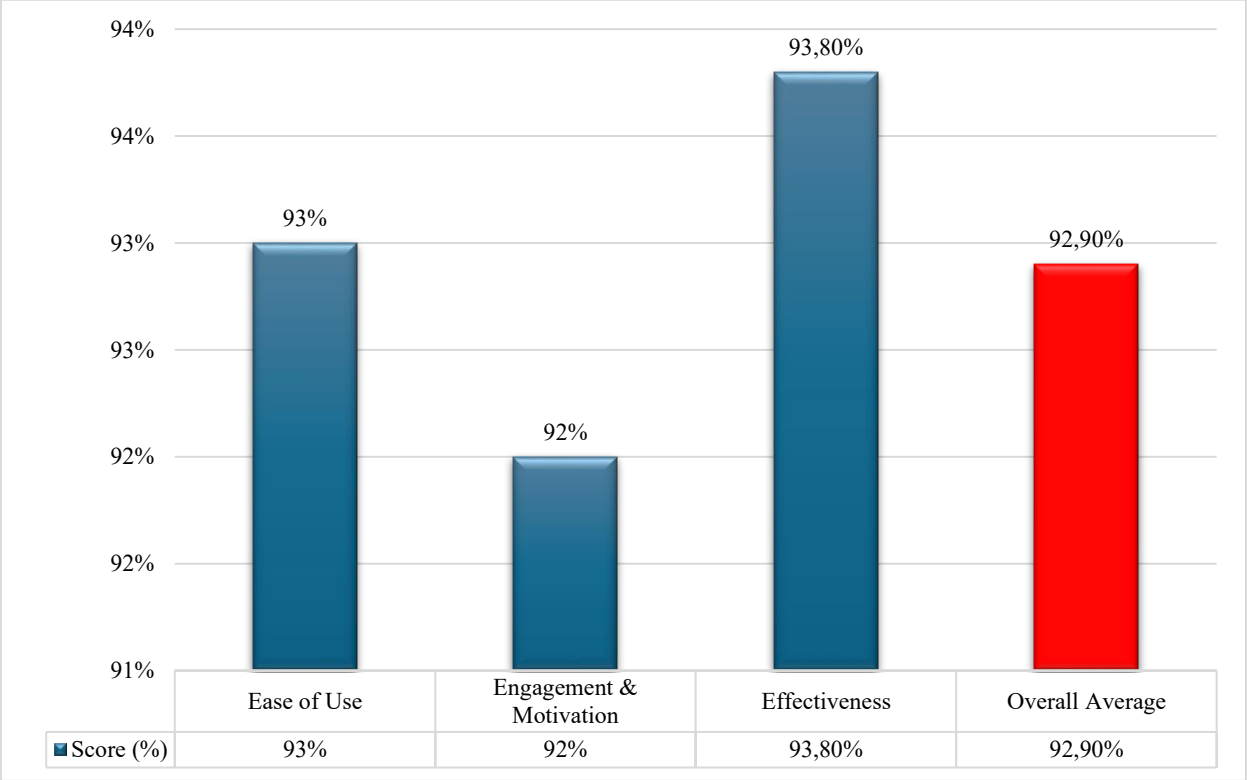
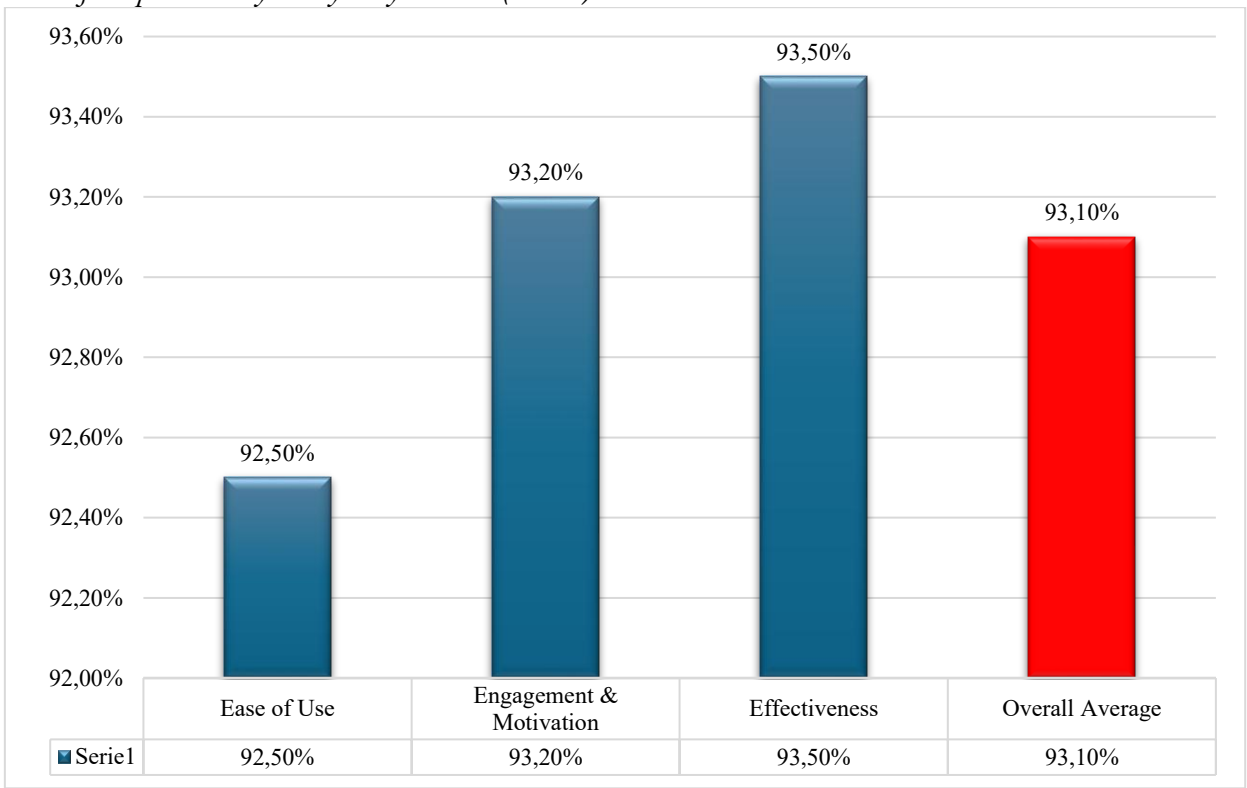


Figure 9

Results of the practicality analysis by teachers (N=10)



DOI: https://doi.org/10.60923/issn.1970-2221/22905

The analysis revealed that students rated the application highly, with an overall practicality score of 92.9%, while teachers provided a slightly higher overall rating of 93.1%. Both scores fall within the "very practical" category, confirming that the application is not only user-friendly but also capable of enhancing learning engagement and supporting critical thinking development. The data demonstrates strong alignment between students' and teachers' perceptions, suggesting that the SIBISA application is broadly acceptable, practical, and effective for use in elementary education. The results also emphasize that the application supports active engagement, fosters intrinsic motivation, and enhances learning effectiveness, all of which are essential for the development of critical thinking skills.

5. Discussion

The findings of this study indicate that the SIBISA digital library application is valid and practical for use in improving students' critical thinking skills. The high validity scores from media experts (average 0.94) and subject matter experts (average 0.95) indicate that SIBISA meets the necessary standards in terms of content quality, media design, and pedagogical relevance. These results are in line with previous studies (Gayatri et al., 2023; Llewellyn, 2019; Yolanda et al., 2025), which emphasize that digital learning tools with strong content validity and well-structured media design are essential for improving higher-order thinking skills in students.

In terms of practicality, the analysis shows consistently high practicality scores from both students and teachers. Students gave an overall practicality score of 92.9%, highlighting its ease of use, engaging features, and effectiveness in supporting independent learning. Teachers, on the other hand, gave a slightly higher overall score of 93.1%, indicating that SIBISA not only meets students' needs but also aligns with educators' expectations regarding instructional efficiency and classroom integration. This convergence of scores shows that SIBISA is considered a reliable and pedagogically supportive tool by the two main stakeholders in the learning process. This double validation from teachers and students reinforces SIBISA's credibility as a practical digital learning innovation.

These findings further reinforce the idea that digital libraries, when developed with clear pedagogical objectives, can be powerful tools for developing critical thinking skills by providing diverse, multimodal, and problem-based learning resources (Abdelghaffar & Eid, 2025; Druin et al., 2003; Li & Liu, 2019; Martzoukou, 2020). The use of interactive e-books and instructional videos in the SIBISA application contributes significantly to the learning experience of students. Interactive e-books allow students to access structured content while conducting independent exploration, which has been proven to increase cognitive flexibility and deep learning (Nuroh & Liansari, 2018; Owusu-Ansah et al., 2019; Rafi et al., 2019; Saib et al., 2023). Meanwhile, learning videos integrated into SIBISA create opportunities for visual and auditory stimulation, encouraging students to analyze real-world problems and critically reflect on solutions (Abbas & Faiz, 2013; Allard, 2002; McMartin et al., 2008). This is in line with the principles of constructivist learning theory, in which knowledge is actively constructed through exploration, interaction, and reflection (Apedoe & Reeves, 2006; Chen & Chen, 2010; Sumner & Marlino, 2004; Tuominen et al., 2003).

Practical research results also show that SIBISA increases student engagement and motivation, which are very important in encouraging critical thinking. Motivation is a key determinant of learning outcomes, and digital applications that combine interactivity, accessibility, and multimedia resources have been shown to increase students' intrinsic motivation (Berkovich & Hassan, 2024; Börner & Chen, 2002; Lee, 2024; Nurhayati et al., 2024). In addition, the fact that teachers give slightly higher ratings than students indicates the system's potential for instructional integration, as educators recognize the platform's efficiency and relevance in supporting teaching strategies (Druin, 2005; Eliza et al., 2025; Rhodes et al., 2025; Vasishta et al., 2025). This is in line with the results of research conducted by Chen and Tsai (2012), Dewi (2022) and Guo et al. (2024), which found that

DOI: https://doi.org/10.60923/issn.1970-2221/22905

collaborative features integrated into the platform also encourage knowledge sharing and discussion among classmates, both of which are important strategies in developing critical thinking.

From a broader perspective, this study confirms that the integration of digital libraries into educational practices can bridge the gap between traditional learning resources and modern pedagogical demands. The development of SIBISA reflects an emerging trend in education, where digital platforms are increasingly utilized not merely as repositories of information but as active learning environments designed to support 21st -century skills.

The findings suggest that SIBISA is both valid and practical; however, it is essential to delineate the extent of the empirical claims. The findings of this study predominantly indicate users' perceptions regarding usability, engagement, and pedagogical effectiveness, rather than providing direct evidence of measurable gains in students' critical thinking abilities. Consequently, the role of SIBISA should be interpreted as facilitating a supportive digital learning environment that enhances opportunities for instruction focused on critical thinking, rather than as an established intervention that definitively enhances critical thinking outcomes. This distinction is essential for maintaining methodological rigor and ensuring alignment between evidence and interpretation.

From a contextual perspective, the implementation of SIBISA in an integrated Islamic elementary school in Padang should not be regarded solely as a neutral site for technological application. The design and utilization of digital libraries are influenced by particular cultural, epistemological, and institutional norms that determine the selection, presentation, and interpretation of knowledge. Decisions related to content curation, interaction methods, and authority representations reveal foundational assumptions about legitimate knowledge and suitable learning practices. Recognizing these contextual dimensions underscores the necessity of critically analyzing the ways in which digital educational technologies may either perpetuate or contest prevailing power dynamics and cultural norms within specific educational environments. This reflection highlights potential directions for future research in the area of culturally responsive digital library design.

Nevertheless, while the study findings are encouraging, several limitations must be acknowledged. First, the research sample was limited to a specific educational context, which may affect the generalizability of the results. Second, the practicality test primarily focused on usability and engagement; future research should explore the long-term impact of SIBISA on measurable improvements in critical thinking performance using experimental or quasi-experimental designs. Additionally, integrating adaptive learning analytics into SIBISA could further personalize learning pathways and provide richer insights into student progress.

Overall, the results of this study contribute to the growing body of literature on digital learning innovation by showing that SIBISA, as a digital library application, can enhance students' critical thinking skills. By providing an interactive, accessible, and pedagogically sound platform, SIBISA represents a valuable contribution to the digital transformation of education.

6. Conclusion

This study underscores the importance of developing innovative digital applications to strengthen students' critical thinking skills in the 21st century. The SIBISA digital library application was designed as a pedagogically grounded platform that integrates interactive learning resources, including e-books and videos, to promote engagement, self-directed learning, and reflective thinking. Its development process followed rigorous design principles to ensure that both content and media align with educational objectives. The findings affirm that SIBISA is capable of functioning not only as a repository of digital learning materials but also as an active learning environment that fosters higher-order thinking. By providing an accessible and interactive platform, SIBISA contributes to bridging the gap between traditional teaching methods and modern digital pedagogies, supporting both students and teachers in creating meaningful learning experiences. Nevertheless, this study also acknowledges certain limitations. The implementation was conducted within a specific educational context, which may

DOI: https://doi.org/10.60923/issn.1970-2221/22905

restrict its broader applicability. This study illustrates that SIBISA provides a valid, practical, and pedagogically aligned digital infrastructure that can facilitate the implementation of critical thinking-oriented learning at the elementary level, rather than asserting a direct causal enhancement in students' critical thinking skills. Future research utilizing experimental or longitudinal designs alongside performance-based critical thinking assessments is essential for a more rigorous examination of learning outcomes. Future research should examine the long-term effectiveness of SIBISA across diverse learning environments and explore the integration of adaptive technologies to personalize the learning experience. In conclusion, SIBISA represents a promising contribution to the field of educational technology. By prioritizing critical thinking as a central learning outcome, it provides valuable insights for educators, policymakers, and researchers seeking to integrate digital innovations into formal education, thereby advancing the digital transformation of learning.

References

Abbas, A., & Faiz, A. (2013). Usefulness of digital and traditional libraries in higher education. *International Journal of Services Technology and Management*, *19*(1–3), 149–161. https://doi.org/10.1504/ijstm.2013.054203

Abdelghaffar, A., & Eid, L. (2025). A critical look at equity in international doctoral education at a distance: A duo's journey. *British Journal of Educational Technology*, *56*(2), 834–851. https://doi.org/10.1111/bjet.13566

Abrizah, A., & Zainab, A. N. (2011). Digital libraries in the classroom: Secondary school teachers' conception. *Journal of Librarianship and Information Science, 43*(4), 224–236. https://doi.org/10.1177/0961000611418811

Ali, G., Samuel, A., Mijwil, M. M., Al-Mahzoum, K., Sallam, M., Salau, A. O., Bala, I., Dhoska, K., & Melekoglu, E. (2025). Enhancing cybersecurity in smart education with deep learning and computer vision: A survey. *Mesopotamian Journal of Computer Science, 5*(1), 115–158. https://doi.org/10.58496/mjcsc/2025/008

Allard, S. (2002). Digital libraries: A frontier for LIS education. *Journal of Education for Library and Information Science*, *43*(4), 233. https://doi.org/10.2307/40323950

Apedoe, X. S., & Reeves, T. C. (2006). Inquiry-based learning and digital libraries in undergraduate science education. *Journal of Science Education and Technology*, *15*(5–6), 321–330. https://doi.org/10.1007/s10956-006-9020-8

Arnab, R. (2017). Repetitive Sampling. *Survey Sampling Theory and Applications*, 367–407. https://doi.org/10.1016/b978-0-12-811848-1.00011-x

Berkovich, I., & Hassan, T. (2024). Principals' digital instructional leadership during the pandemic: Impact on teachers' intrinsic motivation and students' learning. *Educational Management Administration and Leadership*, *52*(4), 934–954. https://doi.org/10.1177/17411432221113411

Beširević, K. (2020). Digital library of required classical literature for elementary and secondary school curricula in domestic languages of Bosnia and Herzegovina. *Digital Library Perspectives*, *36*(3), 319–330. https://doi.org/10.1108/dlp-05-2020-0041

Börner, K., & Chen, C. (2002). Visual interfaces to digital libraries: Motivation, utilization, and socio-technical challenges. In K. Börner & C. Chen (Eds.), *Visual interfaces to digital libraries. Lecture notes in computer science* (pp. 1–9). Springer. https://doi.org/10.1007/3-540-36222-3_1

Budiarto, M. K., Asrowi, G., & Rahman, A. (2025). A new era of education: Exploring teachers' perspectives on the utilization of ICT-based learning resources in schools. *Journal of Teaching and Learning*, *19*(2), 24–40. https://doi.org/10.22329/jtl.v19i2.8771

DOI: https://doi.org/10.60923/issn.1970-2221/22905

Buyannemekh, B., Gil-Garcia, J. R., & Gasco Hernandez, M. (2024). The expanding role of public libraries in tribal settings: From traditional services to (advanced) digital skills, citizen engagement, and innovation. *Public Library Quarterly*, *44*(6), 684–710. https://doi.org/10.1080/01616846.2024.2430060

Chaika, O. (2024). Bridging the gap: Traditional vs. modern education (a value-based approach for multiculturalism). In F. G. Paloma (Ed.), *Lifelong Learning - Education for the Future World.* IntechOpen. https://doi.org/10.5772/intechopen.114068

Chen, C. M., & Chen, C. C. (2010). Problem-based learning supported by digital archives. Case study of Taiwan Libraries' History Digital Library. *The Electronic Library*, *28*(1), 5–28. https://doi.org/10.1108/02640471011005414

Chen, C. M., & Tsai, Y. N. (2012). Interactive augmented reality system for enhancing library instruction in elementary schools. *Computers & Education*, *59*(2), 638–652. https://doi.org/10.1016/j.compedu.2012.03.001

Dewi, C. (2022). Digital literacy analysis of elementary school students through implementation of e-learning based learning management system. *Journal of Education Technology*, *6*(2), 199–206. https://doi.org/10.23887/jet.v6i2.44160

Druin, A. (2005). What children can teach us: Developing digital libraries for children with children. *The Library Quarterly, 75*(1), 20–41. https://doi.org/10.1086/428691

Druin, A., Revelle, G., Bederson, B. B., Hourcade, J. P., Farber, A., Lee, J., & Campbell, D. (2003). A collaborative digital library for children. *Journal of Computer Assisted Learning*, *19*(2), 239–248. https://doi.org/10.1046/j.0266-4909.2003.00024.x

Eliza, F., Hakiki, M., Muhtaj, M., Putri, D. A., Hidayah, Y., Fricticarani, A., Fakhri, J., Arpannudin, I., Subroto, D. E., Sussolaikah, K., Hamid, M. A., Fadli, R., & Ramadhan, M. A. (2025). Game-D: Development of an educational game using a line follower robot on straight motion material. *International Journal of Information and Education Technology, 15*(1), 49–58. https://doi.org/10.18178/ijiet.2025.15.1.2217

Essalih, S., Kouchou, I., Ourahay, M., & Khzami, S. E. (2025). Development of critical thinking: Issues and challenges to overcome at the Moroccan Primary Schools. *Education 3-13*, *53*(5), 782–793. https://doi.org/10.1080/03004279.2023.2223544

Farid, G., Warraich, N. F., & Iftikhar, S. (2023). Digital information security management policy in academic libraries: A systematic review (2010–2022). *Journal of Information Science, 51*(4), 1000-1014. https://doi.org/10.1177/01655515231160026

Gayatri, P., Sit, H., Chen, S., & Li, H. (2023). Sustainable EFL blended education in Indonesia: Practical recommendations. *Sustainability, 15*(3), 2254. https://doi.org/10.3390/su15032254

Guo, Y., Yuan, Y., Li, S., Guo, Y., Fu, Y., & Jin, Z. (2024). Applications of metaverse-related technologies in the services of US urban libraries. *Library Hi Tech*, *42*(5), 1477–1495. https://doi.org/10.1108/lht-10-2022-0486

Halomoan, H., Hakiki, M., Putra, R., Subroto, D. E., Khotimah, K., Bulan, I., Nofrita, M., Arianti, R., Rahmadani, K., Utami, R., Yassin, A. (2025). Effectiveness of web-based digital library for elementary school. *International Journal of Information and Education Technology, 8*(15), 1698–1708. https://doi.org/10.18178/ijiet.2025.15.8.2371

Hamkah, M., Retnawati, H., Muthmainah, M., Hakiki, M., Hamid, M. A., Hasruddin, H., ... Mutiara, I. (2025). Unraveling factors affecting engineering students' acceptance of artificial intelligence in the context of a blended learning environment. *Online Learning, 29*(4), 560–594. https://doi.org/10.24059/olj.v29i4.4890

DOI: https://doi.org/10.60923/issn.1970-2221/22905

Herlinawati, H., Marwa, M., Ismail, N., Junaidi, Liza, L. O., & Situmorang, D. D. B. (2024). The integration of 21st century skills in the curriculum of education. *Heliyon*, *10*(15), e35148. https://doi.org/10.1016/j.heliyon.2024.e35148

Huda, A., Azhar, N., Almasri, Anshari, K., & Hartanto, S. (2020). Practicality and effectiveness test of graphic design learning media based on Android. *International Journal of Interactive Mobile Technologies (IJIM), 14*(04), 192–203. https://doi.org/10.3991/ijim.v14i04.12737

Hyman, J. A., Moser, M. T., & Segala, L. N. (2014). Electronic reading and digital library technologies: Understanding learner expectation and usage intent for mobile learning. *Educational Technology Research and Development*, *62*(1), 35–52. https://doi.org/10.1007/s11423-013-9330-5

Jurianto, H, S., Yulistio, D., Rizal, S., Wince, E., Sutriono, S., & Syahril, S. (2025). The role of librarian and the transformation of students' information literacy education: A case study at IAIN curup. *International Journal of Education Research and Development*, *5*(2), 111–124. https://doi.org/10.52760/ijerd.v5i2.115

Kyva, V., Koshlan, O., Krykun, V., Zaika, L., Shapran, O., & Sudnikov, Y. (2022). The experience of implementing a digital library in the educational and research activities of the National Defense University of Ukraine named after Ivan Cherniakhovskyi. *TEM Journal*, *11*(3), 1128–1139. https://doi.org/10.18421/tem113-18

Lee, P. C. (2024). Transitioning elementary school libraries to joint-use spaces: Insights from organizational learning. *IFLA Journal*, *50*(3), 605–619. https://doi.org/10.1177/03400352241266151

Li, Y., & Liu, C. (2019). Information resource, interface, and tasks as user interaction components for digital library evaluation. *Information Processing & Management*, *56*(3), 704–720. https://doi.org/10.1016/j.ipm.2018.10.012

Li, Y., Xu, S., & Liu, J. (2021). Development and validation of computational thinking assessment of Chinese elementary school students. *Journal of Pacific Rim Psychology*, *15,* 1-22. https://doi.org/10.1177/18344909211010240

Llewellyn, A. (2019). Innovations in learning and teaching in academic libraries: A literature review. *New Review of Academic Librarianship*, *25*(2–4), 129–149. https://doi.org/10.1080/13614533.2019.1678494

Lubbe, A., Marais, E., & Kruger, D. (2025). Cultivating independent thinkers: The triad of artificial intelligence, Bloom's taxonomy and critical thinking in assessment pedagogy. *Education and Information Technologies*, *30*(12), 17589–17622. https://doi.org/10.1007/s10639-025-13476-x

Mahmud, M. M., & Wong, S. F. (2022). Digital age: The importance of 21st century skills among the undergraduates. *Frontiers in Education*, *7*, 950553. https://doi.org/10.3389/feduc.2022.950553

Malizia, A., Bottoni, P., & Levialdi, S. (2010). Generating collaborative systems for digital libraries: A model-driven approach. *Information Technology and Libraries*, *29*(4), 171–186. https://doi.org/10.6017/ital.v29i4.3128

Manousou, E. (2025). Critical thinking in distance education: The challenges in a decade (2016–2025) and the role of artificial intelligence. *Education Sciences 2025, 15*(6), 757. https://doi.org/10.3390/educsci15060757

Martin-Alguacil, N., Avedillo, L., Mota-Blanco, R., & Gallego-Agundez, M. (2024). Student-centered learning: Some issues and recommendations for its implementation in a traditional curriculum setting in health sciences. *Education Sciences, 14*(11), 1179. https://doi.org/10.3390/educsci14111179

Martzoukou, K. (2020). Academic libraries in COVID-19: A renewed mission for digital literacy. *Library Management*, *42*(4–5), 266–276. https://doi.org/10.1108/lm-09-2020-0131

DOI: https://doi.org/10.60923/issn.1970-2221/22905

Mauidah, S., Nusantara, T., Arifin, S., Anggraini, A. E., & Faizah, S. (2025). Pop-up book as a science learning media to improve visualization abilities and understanding of science concepts in SDN Pandanrejo II. *Cetta: Jurnal Ilmu Pendidikan*, *8*(4), 24–34. https://doi.org/10.37329/cetta.v8i4.4277

McMartin, F., Iverson, E., Wolf, A., Morrill, J., Morgan, G., & Manduca, C. (2008). The use of online digital resources and educational digital libraries in higher education. *International Journal on Digital Libraries*, *9*(1), 65–79. https://doi.org/10.1007/s00799-008-0036-y

Mdodana-Zide, L., & Chimbi, G. T. (2025). Transforming education in a rural ecosystem: School libraries as hubs for teaching-learning innovation. *Frontiers in Education*, *10*, 1601206. https://doi.org/10.3389/feduc.2025.1601206

Mugabekazi, J. C., Mukanziza, J., Nizeyimana, P., & Manirahari, P. (2025). Integrating collaborative learning strategies in the curriculum: Enhancing critical thinking and communication skills in primary education. *European Journal of Education Studies*, *12*(3). https://doi.org/10.46827/ejes.v12i3.5848

Mulyawati, Y., & Marini, A. (2022). Utilization of digital library to increase reading interest in elementary school students. *Jurnal Pendidikan Dan Pengajaran Guru Sekolah Dasar (JPPGuseda)*, *5*(1), 20–24. https://doi.org/10.55215/jppguseda.v5i1.5021

Nurhayati, S., Fitri, A., Amir, R., & Zalisman, Z. (2024). Analysis of the implementation of training on digital-based learning media to enhance teachers' digital literacy. *AL-ISHLAH: Jurnal Pendidikan*, *16*(1), 545–557. https://doi.org/10.35445/alishlah.v16i1.4029

Nuroh, E. Z., & Liansari, V. (2018). *Digital Age Literacy in Elementary School*. Proceedings of the 1st International Conference on Intellectuals' Global Responsibility (ICIGR 2017), 119–123. https://doi.org/10.2991/icigr-17.2018.29

Okunlaya, R. O., Syed Abdullah, N., & Alias, R. A. (2022). Artificial intelligence (AI) library services innovative conceptual framework for the digital transformation of university education. *Library Hi Tech*, *40*(6), 1869–1892. https://doi.org/10.1108/lht-07-2021-0242

Onanuga, P. A., & Saka, A. O. (2025). Emerging digital technologies: Building competencies of STEM pre-service teachers. *Journal of Teaching and Learning*, *19*(1), 155–169. https://doi.org/10.22329/jtl.v19i1.8810

Owusu-Ansah, C. M., Rodrigues, A. da S., & van der Walt, T. B. (2019). Integrating digital libraries into distance education: A review of models, roles, and strategies. *Turkish Online Journal of Distance Education*, *20*(2), 89–104.

Rafi, M., JianMing, Z., & Ahmad, K. (2019). Technology integration for students' information and digital literacy education in academic libraries. *Information Discovery and Delivery*, *47*(4), 203–217. https://doi.org/10.1108/idd-07-2019-0049

Rafique, H., Almagrabi, A. O., Shamim, A., Anwar, F., & Bashir, A. K. (2020). Investigating the acceptance of mobile library applications with an extended technology acceptance model (TAM). *Computers & Education*, *145*, 103732. https://doi.org/10.1016/j.compedu.2019.103732

Rhodes, M. J., Visscher, A., Van Keulen, H., & Gijsel, M. (2025). Fostering teachers' competencies for integrated language arts, science, and technology instruction: An exploratory study. *Journal of Teaching and Learning*, *19*(3), 182–200. https://doi.org/10.22329/jtl.v19i2.8909

DOI: https://doi.org/10.60923/issn.1970-2221/22905

Riady, Y., Habibi, A., Mailizar, M., Alqahtani, T. M., Riady, H., & Al-Adwan, A. S. (2025). TAM and IS success model on digital library use, user satisfaction and net benefits: Indonesian open university context. *Library Management*, *46*(1–2), 173–188. https://doi.org/10.1108/lm-06-2024-0065

Rothinam, N., Vengrasalam, R., Naidu, S., Nachiappan, S., & Jabamoney, S. (2025). Systematic literature review on critical thinking in higher education. *Edelweiss Applied Science and Technology*, *9*(5), 2046–2063. https://doi.org/10.55214/25768484.v9i5.7377

Song, X., Razali, A. B., Sulaiman, T., & Jeyaraj, J. J. (2025). Effectiveness of online project-based learning on Chinese EFL learners' critical thinking skills and reading comprehension ability. *Thinking Skills and Creativity*, *56*, 101778. https://doi.org/10.1016/J.TSC.2025.101778

Strover, S., Whitacre, B., Rhinesmith, C., & Schrubbe, A. (2019). The digital inclusion role of rural libraries: Social inequalities through space and place. *Media, Culture & Society, 42*(2), 242–259. https://doi.org/10.1177/0163443719853504

Sumner, T., & Marlino, M. (2004). *Digital libraries and educational practice*. In Proceedings of the 4th ACM/IEEE-CS joint conference on Digital libraries (JCDL '04), 170-178. https://doi.org/10.1145/996350.996389

Suwarno, I., Baballe, M. A., Ahmad, I., Rimban, E. L., Aljanabi, M., & Raharja, N. M. (2022). Development of Digital Learning and Literacy with the Socialization of Digital Library and E-Learning in Cuwelo 1 Elementary School. *Jurnal Pengabdian Dan Pemberdayaan Masyarakat Indonesia*, *2*(4), 117–122.

Suwarto, D. H., Setiawan, B., & Machmiyah, S. (2022). Developing digital literacy practices in Yogyakarta elementary schools. *Electronic Journal of E-Learning*, *20*(2), 101-111. https://doi.org/10.34190/ejel.20.2.2602

Thornhill-Miller, B., Camarda, A., Mercier, M., Burkhardt, J. M., Morisseau, T., Bourgeois-Bougrine, S., Vinchon, F., El Hayek, S., Augereau-Landais, M., Mourey, F., Feybesse, C., Sundquist, D., & Lubart, T. (2023). Creativity, critical thinking, communication, and collaboration: Assessment, certification, and promotion of 21st century skills for the future of work and education. *Journal of Intelligence, 11*(3), 54. https://doi.org/10.3390/jintelligence11030054

Toharudin, M., Sari, H. K., Pranoto, B. A., & Fitri, R. M. (2021). Literacy culture and digital literacy in elementary schools. *Pedagogik Journal of Islamic Elementary School*, *4*(2), 175–190. https://doi.org/10.24256/pijies.v4i2.2916

Trisnawati, W., Sulistiyo, U., Sofyan, S., Haryanto, E., & Bashir, A. (2025). Systematic literature review: 21st-century English learning media utilizing augmented reality. *Vocational: Journal of Educational Technology*, *1*(2), 63–73. https://doi.org/10.58740/vocational.v1i2.337

Tsekea, S., & Chigwada, J. P. (2021). COVID-19: Strategies for positioning the university library in support of e-learning. *Digital Library Perspectives*, *37*(1), 54–64. https://doi.org/10.1108/DLP-06-2020-0058/FULL/XML

Tu, Y. F., & Hwang, G. J. (2020). Transformation of educational roles of library-supported mobile learning: A literature review from 2009 to 2018. *The Electronic Library*, *38*(4), 695–710. https://doi.org/10.1108/el-10-2019-0230

Tuominen, K., Talja, S., & Savolainen, R. (2003). Multiperspective digital libraries: The implications of constructionism for the development of digital libraries. *Journal of the American Society for Information Science and Technology*, *54*(6), 561–569. https://doi.org/10.1002/asi.10243

DOI: https://doi.org/10.60923/issn.1970-2221/22905

Vasishta, P., Dhingra, N., & Vasishta, S. (2025). Application of artificial intelligence in libraries: A bibliometric analysis and visualisation of research activities. *Library Hi Tech*, *43*(2–3), 693–710. https://doi.org/10.1108/lht-12-2023-0589

Waterman, A. D., Wood, E. H., Ranasinghe, O. N., Lipsey, A. F., Anderson, C., Balliet, W., Holland-Carter, L., Maurer, S., & Salas, M. A. P. (2020). A digital library for increasing awareness about living donor kidney transplants: Formative study. *JMIR Formative Research, 4(7),* e17441. https://doi.org/10.2196/17441

Williamson, E. (2023). The effectiveness of project-based learning in developing critical thinking skills among high school students. *European Journal of Education*, *1*(1), 1–11.

Yadav, N., Lal, S. E., & Shastri, B. (2024). The impact of digital learning on education. *International Journal of Multidisciplinary Research in Arts, Science and Technology*, *2*(1), 24–34. https://doi.org/10.61778/ijmrast.v2i1.34

Yolanda, S., Agustina, D., & Abidin, Y. (2025). *Are Elementary School Library Books Appropriate? A Content Analysis of Children's Books*. Proceedings of the 8th International Conference on Education Innovation (ICEI 2024), 1617–1629. https://doi.org/10.2991/978-2-38476-360-3_136

Yusuf, A., Bello, S., Pervin, N., & Tukur, A. K. (2024). Implementing a proposed framework for enhancing critical thinking skills in synthesizing AI-generated texts. *Thinking Skills and Creativity*, *53*, 101619. https://doi.org/10.1016/j.tsc.2024.101619

Zeng, X., & Ravindran, L. (2025). Design, implementation, and evaluation of peer feedback to develop students' critical thinking: A systematic review from 2010 to 2023. *Thinking Skills and Creativity*, *55*, 101691. https://doi.org/10.1016/j.tsc.2024.101691

Zou, Y., Kuek, F., Feng, W., & Cheng, X. (2025). Digital learning in the 21st century: Trends, challenges, and innovations in technology integration. *Frontiers in Education*, *10*, 1562391. https://doi.org/10.3389/feduc.2025.156239s1

Muhammad Hakiki is a lecturer and researcher in the Information Technology Education Study Program, Faculty of Engineering, Universitas Negeri Surabaya, Indonesia. His research interests include technology and vocational education and training (TVET), new technologies, technical education, educational technology, artificial intelligence (AI) in education, mobile learning, the Internet of Things (IoT), augmented reality (AR), multimedia, hypermedia applications, technology-enhanced learning (TEL), and learning issues.
Contact: muhammadhakiki@unesa.ac.id

Halomoan is a lecturer in the Faculty of Social Sciences at Universitas Negeri Padang, Indonesia. His research interests include education science, educational technology, Arabic language, and foreign language education.
Contact: halomoan@fis.unp.ac.id

M. Agphin Ramadhan is a lecturer and researcher at the Faculty of Engineering, Universitas Negeri Jakarta, Indonesia. His research interests include several articles in the fields of technology and vocational

education and training (TVET), building engineering education, educational technology, and artificial intelligence (AI) in education.
Contact: agphin@unj.ac.id

Subhanadri is a lecturer and researcher at the Faculty of Teacher Training and Education, Universitas Muhammadiyah Muara Bungo, Indonesia. His research interests include several areas of basic education, educational technology, and educational science.
Contact: inet.subhanadri@gmail.com

Abdul Haris Setiawan is a lecturer at the Faculty of Teacher Training and Education, Universitas Sebelas Maret, Surakarta in Indonesia. Research interests include technology and vocational education (TVET) and building engineering education.
Contact: aharis@staff.uns.ac.id

Mustofa Abi Hamid is a lecturer and researcher at the Department of Electrical Engineering Vocational Education, Universitas Sultan Ageng Tirtayasa, Indonesia. He has written several scientific articles in the fields of technology and vocational education (TVET), electrical engineering, artificial intelligence, digital learning, e-learning, learning evaluation, learning media, and information and communication technology (ICT) for learning.
Contact: abi.mustofa@untirta.ac.id

Erik Rahman is a lecturer and researcher at the Faculty of Engineering, Universitas Negeri Surabaya, Indonesia. His research interests include information systems, computer engineering, new technologies, artificial intelligence (AI), mobile learning, and the Internet of Things (IoT).
Contact: erikrahman@unesa.ac.id

Abdulnassir Yassin is a lecturer at the Faculty of Education, Islamic University in Uganda. Research interests include educational technology, artificial intelligence (AI), internet of things (IoT), augmented reality (AR), virtual reality (VR), multimedia, hypermedia applications, technology-enhanced learning (TEL) and learning environments, and cybersecurity and privacy in educational technologies.
Contact: yabdulnassir@iuiu.ac.ug

DOI: https://doi.org/10.60923/issn.1970-2221/22905