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Evaluation of Digital Learning Integration to Improve Junior High School Students' Digital Literacy

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Abstract

This study examines the role of digital literacy in mathematics education, focusing on students' learning experiences with the Pythagorean Theorem and Linear Equations. Digital literacy, which includes the ability to search, evaluate, and synthesize online information, is increasingly vital in supporting effective learning. A total of 60 students participated in face-to-face lessons supported by digital applications such as Photomath, Microsoft Math Solver, and Mathway. Data were collected through classroom observation, worksheet analysis, documentation of interactions with digital tools, semi-structured interviews, and a validated digital literacy questionnaire covering three aspects: information searching, content evaluation, and knowledge assembly. The findings show that students achieved a very high level in information searching (80%), while content evaluation (75%) and knowledge assembly (70%) were categorized as high. These results highlight the effectiveness of digital tools in facilitating quick access to problem-solving procedures, but also reveal the need to strengthen students' ability to critically evaluate and reconstruct knowledge. In conclusion, digital literacy is essential for enriching mathematics learning, enhancing engagement, and deepening conceptual understanding. However, instructional designs must emphasize critical and reflective thinking so that students can move beyond passive use of technology toward becoming active, independent, and critical problem-solvers in the digital era.

Keywords*:* Digital Learning Integration; Junior High School; Digital Literacy; Mathematics Education

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1. INTRODUCTION

The rapid development of information and communication technology has transformed many aspects of human life, including education. In this context, digital literacy has emerged as a fundamental competence that students must master to adapt and remain competent in the digital era era (Lim & Tan-Chia, 2022; Nopitasari et al., 2023). Digital literacy extends beyond technical skills in operating digital devices to encompass the ability to critically evaluate, manage, and produce information ethically and effectively (Alsowat, 2022; Reddy et al., 2023). Responding to this demand, the Indonesian government has introduced the Independent Curriculum (*Kurikulum Merdeka*), which emphasizes competency-based, student-centered learning and the meaningful integration of digital technology into classroom practice (Edgel et al., 2021; Hafizah, 2023; Supriyadi, 2022).

The Independent Curriculum, developed during the challenges of the Covid-19 pandemic, highlights essential competencies (Frison, 2023; Nisa et al., 2023), including digital literacy and numeracy, through project-based and contextual learning (Damiati et al., 2024; Idhartono & Badi'ah, 2022; Nopitasari et al., 2023). This approach provides students with opportunities to actively explore problems, build character, and develop adaptability aligned with the Profil Pelajar Pancasila (Fatqurhohman, 2025; Hannigan et al., 2022). Within mathematics education, this is particularly important, as the subject is characterized by abstract concepts that require not only mastery of procedures but also the use of digital tools to support visualization, simulation, and conceptual understanding (Aksenta et al., 2023; Amin et al., 2023; Mavlutova et al., 2020).

Despite increasing recognition of digital literacy, studies examining the integration of digital tools into mathematics learning at the junior high school level remain limited (Kugler & Kárpáti, 2023; Magnusson, 2023). Existing research often addresses digital literacy in general but rarely connects it with mathematics-specific learning processes, such as problem-solving, representation, and critical reasoning (Indefenso & Yazon, 2020; Kusumastuti & Priatna, 2020; Satar et al., 2023). Moreover, challenges such as limited infrastructure, uneven student digital skills, and insufficient teacher readiness remain obstacles to optimizing technology in mathematics classrooms (de Gamboa et al., 2023; Fatqurhohman & Huda, 2025; Upadhayaya, 2023).

Therefore, this study aims to evaluate the integration of digital learning in mathematics education at the junior high school level with a specific focus on improving students' digital literacy skills. Strengthening these skills is expected not only to facilitate more effective access to mathematical concepts but also to equip students with critical, creative, and collaborative thinking abilities that are essential in the digital era (Indefenso & Yazon, 2020; Kugler & Kárpáti, 2023). Theoretically, digital integration enriches learning resources, promotes contextual and project-based learning, and enhances student motivation and outcomes (Al Farabi & Rohmah, 2023; Lestari & Rahmawati, 2020; Tytler et al., 2023). Thus, combining mathematics instruction with digital literacy development represents a strategic effort to meet the educational challenges of the 21st century (Susantiningdyah et al., 2022; Tai & Wei, 2021; van Garderen et al., 2018).

Based on the background and the findings described above, this study addresses the following research questions:

1) How is students' digital literacy reflected in mathematics learning, particularly in the aspects of information searching, content evaluation, and knowledge assembly?
2) In what ways do digital applications such as Photomath, Microsoft Math Solver, and Mathway support students' understanding of mathematical concepts?
3) What challenges and implications arise from integrating digital tools into mathematics learning at the junior high school level?

2. METHOD

This study employed a quantitative descriptive method to analyze students' digital literacy skills in Mathematics learning at SMPN Kepanjen Malang. The research was conducted from Descember 2024 to January 2025. The population consisted of all tenth-grade students at SMPN Kepanjen. The sample comprised students from classes VIII, totaling 60 students, selected through random sampling to ensure representativeness.

The data were collected from students' learning experiences on the topics of Pythagoras and Linear Equations during face-to-face sessions, each lasting 3 × 40 minutes. Throughout the lessons, students were guided to use mathematics applications such as Photomath, Microsoft Math Solver, and Mathway. These applications scan problems and provide step-by-step explanations, enabling students to trace solution procedures aligned with the Student Worksheet (LKPD). This strategy was designed to enrich conceptual understanding while fostering students' skills in identifying relevant problem-solving information.

Mathematics learning experience data were collected through face-to-face instruction on the topics of Pythagoras and Linear Equations, with each session lasting 3 × 40 minutes. In these activities, students were guided to utilize mathematics applications such as Photomath, Microsoft Math Solver, and Mathway to scan problems and obtain step-by-step explanations. The use of these applications not only assisted students in tracing solution procedures aligned with the Student Worksheet (LKPD) and enriching their conceptual understanding but also served as a means of strengthening digital literacy, particularly in the aspects of information searching, content evaluation, and knowledge assembly. Additional data were obtained through classroom observations, analysis of student worksheets, and documentation of student interactions with the applications, and were further complemented by semi-structured interviews to explore students' reflections on the role of technology in supporting problem-solving. Triangulation of these data sources was conducted to ensure validity and to provide a comprehensive picture of students' mathematics learning experiences.

Table 1. Digital Literacy Indicators in Mathematics Learning

Aspect	Indicator	Description Respondent	Data Collection Technique
Information Searching	1. Ability to use applications (Photomath, Microsoft Math Solver, Mathway) to find problem solutions. 2. Identify relevant mathematical information from search results	1. Scanning problems accurately. 2. Determining solution steps appropriate to the topic (e.g., Pythagoras Theorem or Linear Equations).	Observation, Worksheet Analysis, Questionnaire
Content Evaluation	1. Assess the accuracy of solutions provided by the application. 2. Compare application results with concepts or methods taught in class.	1. Criticizing when steps are inconsistent. 2. Selecting the most appropriate solution method among alternatives.	Interview, Observation, Questionnaire
Knowledge Assembly	1. Reorganize information from applications into conceptual understanding.	1. Writing a complete and structured answer on the worksheet. 2. Using application outputs to explain the	Worksheet Analysis, Interview, Questionnaire

	2. Apply the knowledge to other problems or different contexts.	concept in their own words.

Table 2. Rubric of Digital Literacy Indicators in Mathematics Learning

Aspect	Indicator	Score 1 (Very Low)	Score 2 (Low)	Score 3 (High)	Score 4 (Very High)
1	Use of applications to find solutions	Unable to use applications correctly	Uses applications with frequent errors	Uses applications independently with minor errors	Uses applications accurately and independently
	Identify relevant mathematical information	Cannot identify relevant information	Identifies partly relevant information	Identifies mostly relevant information	Consistently identifies highly relevant information
2	Assess the accuracy of application solutions	Accepts results without evaluation	Evaluates but often incorrectly	Frequently evaluates correctly	Consistently evaluates accurately and critically
	Compare results with classroom concepts/methods	No comparison is made	Attempts comparison but inaccurate	Makes mostly accurate comparison	Consistently makes accurate and critical comparisons
3	Reorganize information into conceptual understanding	Unable to reorganize	Reorganizes but inaccurate	Reorganizes mostly correct	Reorganizes comprehensively and correctly
	Apply knowledge to other problems/contexts	Cannot apply knowledge	Applies in limited or incorrect cases	Applies correctly in most cases	Consistently applies knowledge accurately in various contexts

**note:*

Aspect 1: Information Searching; Aspect 2: Content Evaluation; Aspect 3: Knowledge Assembly

3. RESULTS AND DISCUSSION

3.1. Results

The findings of this study illustrate students' digital literacy achievements in mathematics learning, particularly on the topics of the Pythagorean Theorem and Linear Equations. Data analysis focused on three main aspects: information searching, content evaluation, and knowledge assembly. From a total of 60 participating students, the results show that the use of digital applications such as Photomath, Microsoft Math Solver, and Mathway significantly contributed to their learning experiences. However, the outcomes across these aspects revealed variations that highlight both the strengths and challenges of integrating digital technology into mathematics education.

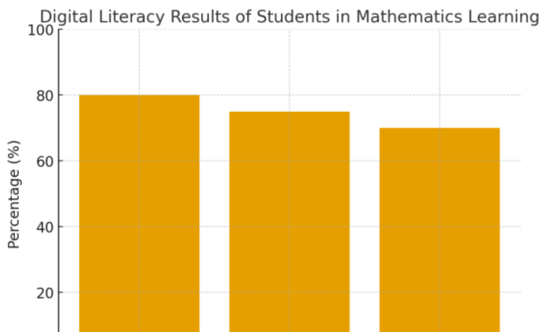

Figure 1. Digital Literacy in Mathematic Learning

The analysis of students' digital literacy skills in mathematics learning, involving a total of 60 participants, is presented in Table 1. The results are categorized into three main aspects: information searching, content evaluation, and knowledge assembly.

Table 3. Students' Digital Literacy Results in Mathematics Learning

Aspect	Percentage (%)	Category
Information Searching	80 %	Very High
Content Evaluation	75 %	High
Knowledge Assembly	70 %	High

Table 3 presents students' digital literacy achievements in mathematics learning across three key aspects. The highest result was found in information searching (80%, very high), indicating that students were highly proficient in using digital applications to locate information and explore solution steps. Content evaluation reached 75% (high), showing that students were generally able to judge the accuracy of solutions, though many still tended to accept results uncritically. Knowledge assembly scored 70% (high), reflecting students' ability to reconstruct information into conceptual understanding, yet this skill appeared less consistent when applied to new problems or unfamiliar contexts. Overall, the findings place students' digital literacy in the high to very high category, with notable strength in information searching, while underscoring the need to further enhance critical evaluation and knowledge integration to foster deeper mathematical understanding.

The main findings reveal that students' digital literacy in mathematics learning is predominantly strong in the aspect of information searching (80%, very high), demonstrating their ability to effectively utilize digital applications to access problem-solving steps. However, their performance in content evaluation (75%, high) indicates that while students can recognize the accuracy of solutions, many still rely on applications without engaging in critical assessment. In knowledge assembly (70%, high), students show the capacity to reconstruct information into conceptual understanding, though this skill remains less optimal when knowledge is transferred to new problems or unfamiliar contexts. Overall, the results position students' digital literacy in the high to very high category, with information searching as the strongest competency, while critical evaluation and knowledge integration require further reinforcement to ensure deeper and more independent mathematical learning.

3.2. Discussion

Literacy, broadly defined as the capacity to communicate effectively through reading, speaking, listening, and writing, is a foundational competency that supports human development and social participation. It plays a crucial role in enabling individuals to solve problems, analyze information, and critically interpret messages, thereby functioning as a prerequisite for lifelong learning (Aggarwal, 2023; Durmaz, 2023). Despite its fundamental importance, literacy levels, particularly in terms of reading interest, remain relatively low in several regions, including Indonesia. This situation emphasizes the urgency of addressing literacy in a comprehensive manner that is relevant to contemporary demands.

In the 21st century, literacy is no longer limited to traditional skills but extends into digital literacy, which has become a key competency across all levels of education (Jumriani & Prasetyo, 2022; Rochmawati et al., 2020). Digital literacy encompasses the ability to access, evaluate, and utilize digital information effectively, requiring not only technical proficiency but also critical thinking in processing online content (Huang et al., 2023). Internet use, therefore, goes beyond data retrieval and involves reflective judgment to discern credible information from misinformation. This expanded understanding of literacy reflects the demands of a society increasingly shaped by technological advancements and information abundance (Stoddart & Selanders, 2022; Zhu & Evans, 2024).

The integration of digital technology into education has been shown to increase student engagement, knowledge acquisition, and essential skills such as collaboration, creativity, and critical thinking (Alsowat, 2022; De Vega & Rahayu, 2023). While many studies have focused on digital literacy in general education or scientific disciplines, similar opportunities and challenges arise in mathematics education. Mathematics, as a discipline that often requires abstract reasoning, benefits greatly from the use of interactive digital applications. Tools such as Photomath, Microsoft Math Solver, and Mathway enable students to scan problems and receive step-by-step explanations. These applications support conceptual understanding by visualizing problem-solving procedures and encouraging students to actively engage with mathematical content (Atin et al., 2022; Hidajat, 2023; Shaghaghian et al., 2022).

However, the integration of such digital tools is not without challenges. One major concern is the tendency of students to adopt solutions passively, relying on application-generated answers without engaging in deeper evaluation or critical reflection (Edgel et al., 2021; Kim & Ryoo, 2023). This pattern mirrors broader challenges in digital literacy, where youth among the highest users of digital media are particularly vulnerable to misinformation due to their still-developing skills in critical information processing (Fatqurhohman & Huda, 2025; Hafizah, 2023; Yanuari & Turmudi, 2023). To mitigate these risks, it is essential to cultivate students' reflective judgment and critical thinking, ensuring that digital tools serve as meaningful aids rather than shortcuts that limit deeper learning (Caneva & Pulfrey, 2023; Heryani et al., 2022).

Research indicates that structured guidance and systematic integration of digital resources can enhance students' internet searching and online content evaluation skills (Edgel et al., 2021; Kim & Ryoo, 2023). Moreover, repeated practice in seeking, analyzing, and interpreting information, whether in face-to-face or online contexts significantly improves students' ability to think critically and creatively (Kugler & Kárpáti, 2023; Molin & Godhe, 2020). When applied to mathematics education, digital technology has the potential to create a more engaging and relevant learning environment for digital-native students. It not only strengthens conceptual understanding but also promotes collaboration and fosters essential competencies in digital literacy (Alfia et al., 2021). Thus, integrating technology into mathematics classrooms is not merely a matter of adopting tools but of designing pedagogical strategies that align with the skills required in the digital era.

Findings from the present study reinforce these perspectives. Students demonstrated a very high ability in information searching (80%), reflecting their proficiency in using applications to locate problem-solving steps efficiently. However, their performance in content evaluation (75%) and knowledge assembly (70%) was relatively lower. These outcomes indicate that while students can access information quickly, they often face difficulties in critically assessing the validity of solutions and reconstructing knowledge into deeper conceptual frameworks. Such patterns suggest a reliance on technology that prioritizes efficiency over reflection, which, if unaddressed, risks reducing students to passive consumers of digital content.

Overall, the integration of digital technology in mathematics education holds considerable promise but must be strategically managed. Students' strength in information searching highlights the potential of digital tools to democratize access to knowledge and support immediate problem-solving needs. Nevertheless, the weaker outcomes in content evaluation and knowledge assembly reveal the necessity of fostering critical literacy skills that enable students to navigate digital resources responsibly and creatively. Strengthening these competencies will not only enhance students' mathematical learning but also equip them with the digital literacy required to thrive in an increasingly complex and technology-driven society.

4. CONCLUSION

The findings of this study demonstrate that students exhibit strong digital literacy in information searching, achieving the highest score among the three aspects assessed. However, their performance in content evaluation and knowledge assembly remains relatively lower, indicating that while digital tools effectively provide quick access to information, students have not yet maximized their ability to critically assess and reconstruct knowledge into deeper conceptual understanding. These results highlight that digital literacy in mathematics education extends beyond technical skills, requiring critical thinking and reflective judgment to ensure meaningful learning.

The implications of these findings emphasize the necessity of integrating digital literacy into the mathematics curriculum in a structured and comprehensive manner. By embedding the use of digital tools in learning activities, supported by adequate technological infrastructure and continuous teacher training, schools can foster both cognitive and metacognitive skills. Moreover, developing students' ability to critically evaluate digital content helps address the risks of misinformation and passive technology use. Such integration not only strengthens mathematical understanding but also equips learners with essential competencies for navigating academic and social challenges in the digital era.

Based on these insights, it is recommended that educators design instructional strategies that position digital applications as pedagogical aids rather than mere solution providers. Teachers should encourage students to engage in questioning, validating, and applying concepts in diverse problem-solving contexts. Schools are also advised to complement classroom practices with extracurricular programs that enhance creativity, collaboration, and responsible digital engagement. By reinforcing these aspects, mathematics education can effectively prepare students to become active, independent learners and responsible digital citizens in the 21st century.

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