

The Use of Artificial Intelligence (AI) as a Medium for Digital Literacy in Learning at SMP Negeri 5 Sidoarjo

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ABSTRACT

This study examines the integration of Artificial Intelligence (AI) tools, specifically ChatGPT and Gemini, as digital literacy media in secondary education, focusing on the learning process and its impacts at SMP Negeri 5 Sidoarjo. Employing a mixed-methods design, data were collected from 85 ninth-grade students and 15 teachers through Likert-scale questionnaires and in-depth interviews, which were analyzed using descriptive statistics and qualitative triangulation. The findings reveal that AI adoption is predominantly driven by students' independent initiatives (*informal learning*) with high technical readiness, standing in contrast to the inconsistent instructional integration by teachers. While AI serves as an effective procedural scaffolding tool that improves information retrieval efficiency and problem-solving speed, it does not replace direct educator interaction in developing foundational conceptual understanding. Importantly, students exhibit a positive shift toward critical AI literacy by habitually verifying and re-curating AI outputs. However, challenges such as digital distractions, limited prompt literacy, network constraints, and fears of cognitive dependency remain. These results underscore the necessity of implementing a *Human-in-the-Loop Pedagogy*, enhancing teacher capacity through the AI-TPACK framework, and formulating institutional AI ethics guidelines to address *Digital Divide 2.0* in developing contexts.

Keywords: Artificial Intelligence, Digital Literacy, Secondary Education, Human-in-the-Loop Pedagogy

INTRODUCTION

The rapid adoption of technology in the digital era has become an integral part of various aspects of life. In the realm of education, Artificial Intelligence (AI) is one technology that has garnered widespread attention; it offers innovative learning solutions by providing numerous benefits, such as automated feedback, the delivery of learning outcomes, and the enhancement of students' digital literacy. Digital literacy is a crucial 21st-century competency that students must possess, as stated by Gilster (1997), literasi digital tidak hanya sekadar kemampuan menggunakan perangkat teknologi, Digital literacy goes beyond the mere ability to use technological devices; it also encompasses the capacity for critical thinking, information evaluation, and effective communication within the digital environment. Integrating AI into education can make

learning engaging and adaptive to the specific needs of learners (Abimanto & Iwan, 2023).

At SMP Negeri 5 Sidoarjo, AI tools such as ChatGPT and Gemini are utilized in the classroom to hone various language skills and facilitate an innovative understanding of learning concepts. Students can leverage AI to comprehend complex texts through interactive explanations and reflective questioning. AI also provides feedback on grammar, sentence structure, and creative ideas, thereby helping students improve their writing proficiency. Furthermore, regarding the comprehension of learning concepts, students can access explanations tailored to their individual learning styles—whether through text, diagrams, or interactive simulations. In this way, AI assists students in strengthening academic skills while fostering the critical thinking and digital literacy capabilities increasingly essential in the technological era. The selection of SMP Negeri 5 Sidoarjo as the research site is based on empirical considerations: the school has actively initiated the integration of generative AI technology into daily instruction, thereby offering a real-world setting rich in data for in-depth evaluation. Despite AI's immense potential, research on its use as a digital literacy tool within an educational context—particularly at the junior high school level—remains limited. At SMP Negeri 5 Sidoarjo, the implementation of AI as a learning tool requires further in-depth study to evaluate its effectiveness, especially in supporting the development of students' digital literacy. Consequently, conducting research on the use of AI as a digital literacy tool at SMP Negeri 5 Sidoarjo is crucial; such research aims to provide a comprehensive overview of AI integration in the learning process to enhance student digital literacy and address the educational challenges of the digital age.

Relevant research on the use of AI as a digital literacy medium in learning has been conducted by Zega (2024) who explored the application of Artificial Intelligence (AI) in the education of Library Science students; the study examined how they respond to opportunities and enhance strategies for gaining in-depth knowledge regarding digital literacy. The findings indicated that the AI proficiency of the Class of 2021 Library Science students at UIN Sumatera Utara, Medan, fell into the "good" category, and a strong correlation was observed between their AI proficiency and digital literacy skills. Additionally, research Su & Chu (2023) highlighted the importance of AI literacy as a component of 21st-century digital literacy, particularly in early childhood education. Their study demonstrated that, despite persisting challenges—such as teachers' lack of knowledge and confidence, curriculum design limitations, and a scarcity of instructional guidelines—AI offers significant opportunities to enhance children's literacy skills, including critical thinking, collaboration, and an ethical understanding of technology use. Based on this existing research, it is evident that no studies have yet explored the use of AI as a digital literacy tool within the context of secondary education.

Therefore, this study aims to explore the use of AI as a medium for digital literacy in the learning process at SMP Negeri 5 Sidoarjo—analyzed from the perspectives of both teachers and students—and to examine the impact of its implementation on learning. The scope of this research focuses on the use of generative AI platforms in classroom instruction and their impact on students' digital literacy indicators at the junior high

school level. This study is expected to contribute to the utilization of AI in secondary education, particularly in supporting the transformation of learning in the digital era.

METHOD

This study employs a mixed-methods approach. According to Sugiyono (2017), the mixed-methods approach combines quantitative and qualitative methods to obtain comprehensive data. The study was conducted at SMP Negeri 5 Sidoarjo, involving 85 ninth-grade students and 15 teachers as respondents selected through purposive sampling. The data consists of student and teacher responses regarding the use of AI technology as a digital literacy medium in the learning process. Data collection techniques included questionnaires—designed using a Likert scale with categories ranging from "Strongly Agree" (SS) to "Strongly Disagree" (STS)—to gather information on student responses and teacher perspectives based on their experiences using AI for digital literacy in learning. Additionally, interviews were conducted to gain deeper insight into teacher perspectives, student responses, and the impact of using AI as a digital medium in instruction. Quantitative data from the questionnaires are presented using descriptive statistics (percentages and means), while qualitative data from the interviews were analyzed using the Miles and Huberman analysis technique, comprising data reduction, data display, and conclusion drawing/verification. The results from both methods were integrated through data triangulation to provide a holistic answer to the research problem.

RESULTS AND DISCUSSIONS

This study examines the use of AI as a medium for digital literacy in the learning process at SMP Negeri 5 Sidoarjo, as well as the impact of its implementation. Questionnaires were distributed to explore the use of AI as a digital literacy tool from the perspectives of both students and teachers. The data were further enriched through in-depth interviews to qualitatively explore contextual experiences and the impact of AI usage. The discussion regarding its application and impact is outlined below:

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This data was obtained through a questionnaire distributed to 85 ninth-grade student respondents to measure their perceptions regarding the use of AI (ChatGPT/Gemini) as a digital literacy tool in learning. The questionnaire comprised statements covering five aspects: the use of AI in learning, the impact of AI usage, student engagement and motivation, effectiveness, and the challenges associated with using AI in learning.

Table 1. Questionnaire Data Regarding Students' Perspectives on the Use of AI in Learning

No	Statement	SS	S	TS	STS
1	I understand how to use ChatGPT/Gemini in learning.	10,6%	80%	9,4%	0%
2	My teacher often uses AI (ChatGPT/Gemini) as a learning tool.	2,4%	44,7%	44,7%	8.2%
3	ChatGPT/Gemini helps me understand the study material better.	12,9%	62,4%	23,5%	1,2%

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No	Statement	SS	S	TS	STS
4	I feel comfortable using AI (ChatGPT/Gemini) to complete school assignments.	11,8%	61,2%	24,7%	2,3%
5	AI (ChatGPT/Gemini) makes it easier for me to find information or references for my studies.	20%	69,4%	10,6%	0%
Average		11,54%	63,54%	22,58%	2.34%

Based on the data in Table 1, students generally demonstrate an excellent level of operational readiness regarding AI adoption; the vast majority feel they understand the technology and benefit from its ability to facilitate rapid searches for study resources. However, there is a striking disparity between the students' own acceptance of the technology and the frequency with which teachers integrate AI into classroom instruction, with half the student population noting that AI usage by teachers remains inconsistent across subjects. This phenomenon indicates that AI adoption in the school is still driven primarily by students' independent initiatives rather than by structured integration within classroom instruction. This was confirmed through an in-depth interview with a student, who stated:

"When looking for assignment materials or explanations that are difficult to find in the textbook, I usually ask Gemini first at home because it's quick. But in class, it depends on the teacher; some forbid it entirely, while others allow it." (Interview with Student from Class IX-B, October 2024)

This situation aligns with Kaffah (2023) findings regarding the efficiency of AI utilization in learning; however, viewed within a broader discourse, the disparity between students' independent literacy and teachers' instructional readiness is a hallmark of technology adoption in developing nations (the Global South). As highlighted by UNESCO (2023) in its **Guidance for Generative AI in Education and Research**, learners in developing countries often gain instant access to AI before schools are pedagogically or regulatorily prepared. Consequently, AI usage tends to be exploratory and unsupervised; without the concurrent development of critical skills, this risks widening substantial literacy gaps among students.

Table 2. Questionnaire Data related to Student Perspectives Regarding the Impact of Using AI on Digital Literacy

No	Statement	SS	S	TS	STS
1	ChatGPT/Gemini helps improve my reading skills.	7,0%	70,6%	21,2%	1,2%
2	I feel more confident in my writing after using AI.	7,1%	48,2%	43,5%	1,2%
3	AI helps me think critically when processing information.	7,1%	68,2%	24,7%	0%
4	Using AI makes me more creative in completing tasks.	10,6%	72,9%	16,5%	0%
5	AI helps me better understand digital literacy.	10,6%	76,5%	12,9%	0%
6	I know how to verify the accuracy of information provided by AI.	10,6%	72,9%	16,5%	0%

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No	Statement	SS	S	TS	STS
7	I re-process the information provided by AI.	31,8%	63,5%	4,7%	0%
Average		12,1%	67,5%	20%	0,3%

The findings in Table 2 confirm that the impact of AI is most strongly felt in the areas of information processing and re-curation. The students' strong tendency not to accept AI-generated answers at face value indicates a growing awareness of the need for digital verification. However, AI-enhanced writing skills garnered relatively lower approval ratings compared to reading or ideation skills. This suggests that AI is viewed more as a tool for sparking ideas than as a substitute for the entire process of text construction.

The students' critical approach to managing AI output is explicitly revealed in the following verbatim interview excerpt "I don't just copy and paste ChatGPT's answers directly into my assignment. The language is sometimes too stiff or uses terms that junior high students wouldn't normally use, so I read through it, check things on Google, and then write it in my own words." (Interview with a Class IX-A student, October 2024).

These qualitative and quantitative findings align with the perspectives of Roswell & Pahl (2015) and Yusuf (2024) regarding the varied impacts of digital technology. Within the global context of developing nations, the ability of students at SMPN 5 Sidoarjo to filter AI-generated information reflects a positive transition from basic digital literacy to critical AI literacy. A similar trend has been observed in studies on GenAI adoption among Southeast Asian students (such as the MDPI study from 2024 on adoption in Vietnam and the Philippines), where limitations in AI accuracy – particularly in local contexts or non-English languages – indirectly compel learners in developing countries to cross-check information, thereby honing their critical scrutiny.

Table 3. Questionnaire Data on Student Perspectives Regarding Engagement and Learning Motivation Using AI

No	Statement	SS	S	TS	STS
1	I feel more motivated to learn when using AI tools like ChatGPT or Gemini.	8,2%	55,3%	34,1%	2,4%
2	I am more enthusiastic about lessons when AI is used in the learning process.	3,5%	49,4%	44,7%	2,4%
3	In my opinion, AI makes learning more engaging and enjoyable.	8,2%	45,9%	44,7%	1,2%
Average		6,6%	50,2%	41,1%	2%

The findings in Table 3 reveal a shift in dynamics from purely affective motivation to challenges regarding the learning interaction itself. Although the majority of students were motivated by the speed of AI responses, a significant proportion – exceeding 40% – exhibited resistance or a lack of enthusiasm. These engagement barriers stemmed from technical-operational constraints, as well as the emergence of technostress and digital distractions. This empirical reality is reinforced by student feedback: "Sometimes, when

using AI, I'm actually confused about what to ask (how to phrase the prompt). Also, when I open my phone to ask Gemini, I often get distracted by WhatsApp or TikTok notifications, so I end up losing focus on my studies" (Interview with Student from Class IX-C, October 2024). These statements indicate that limited "prompting literacy" and the barrage of social media notifications are primary factors disrupting students' learning focus.

While the results of this study support Diantama's (2024) findings regarding ChatGPT's effectiveness in boosting learning motivation through instant feedback, the observed resistance reflects UNESCO's (2025) global findings concerning AI-induced distraction and cognitive offloading. In many schools across developing nations – where technology penetration is rapid yet lacks a robust pedagogical framework – AI integration often encounters the phenomenon of superficial engagement: students are initially drawn in by the novelty effect, but their enthusiasm quickly wanes if AI interactions are not integrated into authentic, problem-solving-based tasks.

Table 4. Questionnaire Data Regarding Students' Perspectives on the Effectiveness of AI Use in Learning

No	Statement	SS	S	TS	STS
1	I find it easier to understand the material being taught with the help of AI compared to without it.	3,5%	48,3%	44,7%	3,5%
2	Using AI allows me to complete assignments faster.	11,8%	70,6%	16,4%	1,2%
3	AI helps me solve difficult problems in my studies.	18,8%	72,9%	7,1%	1,2%
Average		11,3%	63,93%	22,7%	1,9%

The findings in Table 4 indicate that the effectiveness of Artificial Intelligence (AI) is most pronounced in terms of time efficiency for task completion and the articulation of solutions to technical problems. In contrast, AI's role in replacing initial conceptual explanations is not yet dominant, as nearly half of the students still require direct explanations from the teacher to grasp the material's essence in depth. This need for balance is underscored by student feedback: "AI is really great when I'm stuck and confused about formulas or the steps to solve complex math problems. But for the initial conceptual explanation from scratch, I still understand better when the teacher explains it directly on the whiteboard" (Interview with Student IX-A, October 2024). This suggests that students view AI as a form of procedural scaffolding to assist with complex problem-solving, whereas the development of fundamental conceptual understanding still requires direct pedagogical interaction with an educator.

These results align with the arguments of Priskusanti et al. (2023) regarding task completion efficiency. Within the global educational landscape, these findings reinforce the "Human-in-the-Loop Pedagogy" recommended by UNESCO (2025). In developing countries where teacher-student ratios remain suboptimal, AI has proven effective in acting as an adaptive supplementary tutor to resolve bottlenecks in independent task completion, without displacing the teacher's central role as the primary facilitator of conceptual understanding.

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Table 5. Questionnaire Data Regarding Students' Perspectives on the Challenges of Using AI in Learning

No	Statement	SS	S	TS	STS
1	Internet connectivity is a major challenge when using AI.	14,1%	65,9%	18,8%	1,2%
2	I struggle to understand how to use ChatGPT/Gemini.	5,9%	31,8%	55,3%	7,0%
3	Sometimes, AI responses are difficult to understand or lack relevance.	24,7%	64,7%	10,6%	0%
4	I am concerned about becoming too dependent on AI for learning.	35,3%	56,5%	7,0%	1,2%
5	I need more guidance from teachers when using AI.	16,5%	57,6%	25,9%	0%
Average		19,3%	55,3%	23,5%	1,8%

The findings in Table 5 reveal that the primary obstacles to Artificial Intelligence (AI) adoption at SMP Negeri 5 Sidoarjo lie not in students' technical incompetence, but rather in external and psychological factors—specifically, network infrastructure constraints and the fear of cognitive dependence. The students' strong need for teacher guidance indicates a metacognitive awareness regarding AI's limitations, as evidenced by a student's statement.

"I worry that if I use AI too often, my brain will become lazy and stop thinking during national exams or tests where phones aren't allowed. That is why we need teachers to define the boundaries regarding what can be asked of AI and what must be done independently" (Interview with Class IX-D Student, October 2024).

This statement highlights the urgent need for educators to establish ethical and pedagogical boundaries to prevent cognitive atrophy—a decline in critical thinking abilities—when integrating AI into the learning process.

These findings regarding dependency concerns support the theories of Li & Huang (2020) and Holmes et al. (2019). Globally, the findings in Sidoarjo reflect a tangible manifestation of "Digital Divide 2.0" in developing nations (UNESCO, 2023). The gap is no longer merely a matter of hardware availability, but rather one of access to stable connectivity and disparities in AI literacy skills. While developed nations have advanced to integrating AI infrastructure within schools, schools in developing countries continue to struggle with internet bandwidth stability and the lack of a standardized AI ethics curriculum at the secondary education level.

Table 6. Questionnaire Data Regarding Teachers' Perspectives on the Use of AI in Learning

No	Statement	SS	S	TS	STS
1	I understand the functions and workings of ChatGPT/Gemini as learning tools.	53,3%	40%	6,7%	0%
2	I frequently use AI (ChatGPT/Gemini) in the learning process.	26,7%	53,3%	20%	0%
3	AI makes it easier for me to deliver material to students.	46,7%	40%	13,3%	0%

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No	Statement	SS	S	TS	STS
4	AI helps students better understand the material being taught.	26,7%	53,3%	20%	0%
5	AI tools like ChatGPT/Gemini help improve learning efficiency.	40%	46,7%	13,3%	0%
6	Using AI helps me create engaging and varied teaching materials.	53,3%	40%	6,7%	0%
7	I use AI (ChatGPT/Gemini) to explain complex concepts.	20%	53,3%	26,7%	0%
8	I can distinguish between AI-generated outputs that have been processed and those that have not.	6,7%	40%	40%	13,3%
Average		34,1%	45,8%	18,3%	1,6%

The findings in Table 6 indicate that teachers possess a strong conceptual understanding of and a highly positive attitude toward Artificial Intelligence (AI), particularly regarding the enhancement of administrative efficiency and the creation of diverse teaching materials. However, the effectiveness of AI utilization diminishes when applied to advanced functions, such as conveying complex abstract concepts and verifying the authenticity of student assignments. This limitation regarding assessment is highlighted by an educator: "AI is incredibly helpful for us in preparing lesson plans, modules, and varied question sets within minutes. Yet, the biggest challenge arises when grading student assignments. It is very difficult to distinguish between the students' original writing and content generated by ChatGPT, as even AI detection tools are often inaccurate" (Interview with an Indonesian Language Teacher, October 2024). This demonstrates that while AI serves effectively as an administrative accelerator, its integration creates new challenges for academic integrity, necessitating a shift toward authentic assessment.

These findings align with research by Anwar (2024), Ariestya (2024), Fitriani et al. (2024), and Pinski & Benlian (2024). Globally, the challenges faced by teachers at SMPN 5 Sidoarjo reflect a gap between technological knowledge and mastery of AI-pedagogical content knowledge (AI-TPACK). Referring to the UNESCO ICT Competency Framework for Teachers (2024), the primary challenge for teachers in developing countries is no longer resistance to technology (technophobia), but rather the lack of specialized training in AI assessment literacy—specifically, the ability to design AI-resistant assessment instruments and employ process-based task evaluation techniques.

Table 7. Questionnaire Data Regarding Teachers' Perspectives on the Impact of AI Use in Learning

No	Statement	SS	S	TS	STS
1	AI enhances student engagement in the learning process.	26,7%	60%	13,3%	0%
2	AI helps students think critically and complete tasks.	13,3%	46,7%	26,7%	13,3%
3	AI fosters greater student independence in learning.	20%	60%	20%	0%
4	AI improves students' digital literacy.	20%	53,3%	20%	6,7%

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No	Statement	SS	S	TS	STS
5	The use of AI has a positive impact on student learning outcomes.	6,7%	53,3%	40%	0%
Average		17,3%	54,6%	24%	4%

The findings presented in Table 7 indicate that the majority of teachers acknowledge the positive impact of Artificial Intelligence (AI) in fostering self-regulated learning and active student engagement. However, approximately 40% of teachers remain skeptical regarding AI's substantive impact on improving academic learning outcomes; they argue that increased activity does not necessarily correlate with a deep understanding of the material if AI is merely utilized as a shortcut for completing assignments. This cautious stance is underscored by teacher feedback: "Students certainly become more active and submit assignments faster. Yet, during oral exams or pop quizzes conducted without mobile phones, some students who rely too heavily on AI are unable to answer. Thus, while AI boosts activity, it does not automatically ensure deep understanding" (Science Teacher Interview, October 2024). This phenomenon points to a disparity between superficial engagement and deep conceptual understanding, wherein reliance on AI risks creating an "illusion of competence" among students.

This dynamic reinforces the theories of constructivist learning (Huang et al., 2024) and self-regulated learning (HS & Samsinar, 2024). In a global comparative context, the findings in Sidoarjo align with Selwyn's (2022) analysis regarding the "dilemma of automated learning" in developing nations: AI often creates an "illusion of learning" – where the speed and ease of task completion are mistaken for successful learning – whereas the process of deep knowledge construction requires cognitive struggle that cannot be fully replaced by algorithms.

Table 8. Questionnaire Data on Teachers' Perspectives Regarding Challenges and Obstacles to Using AI in Learning

No	Statement	SS	S	TS	STS
1	I need further training on using AI in teaching.	33,3%	46,7%	13,3%	6,7%
2	Not all students have adequate internet access to use AI.	20%	33,3%	33,3%	13,4%
3	The use of AI sometimes leads to miscommunication when delivering material.	13,3%	53,3%	26,7%	6,7%
4	I am concerned that students might become overly dependent on AI.	40%	40%	13,3%	6,7%
Average		26,6%	43,3%	21,6%	8,3%

The findings in Table 8 confirm that the need for continuous training and concerns regarding learner dependency are two critical issues requiring urgent attention. Educators recognize that without appropriate pedagogical interventions based on the Technological Pedagogical Content Knowledge (TPACK) framework, the use of Artificial Intelligence (AI) risks fostering subject-matter misconceptions and diminishing students'

critical thinking abilities. The urgency of this capacity building is underscored by a teacher's statement: "We need practical AI training workshops, not just theory. We want to learn how to craft task instructions—prompt engineering—that compel students to think critically, as well as how to establish ethical guidelines for AI use in schools" (Mathematics Teacher Interview, October 2024). This statement highlights that teacher professional development requires mastering prompt engineering and formulating ethical frameworks to leverage AI as a tool that supports higher-order thinking skills.

These findings reinforce the importance of the TPACK framework (MZ et al., 2024; Ning et al., 2022). Internationally, the findings align with calls from UNESCO (2023, 2025) emphasizing that the successful integration of AI in secondary schools across developing nations hinges largely on institutional policy readiness. Without formal AI ethics guidelines and structured teacher training programs, AI integration will likely remain fragmented, raising concerns about a potential decline in learner autonomy.

The Impact of Using AI as a Digital Literacy Medium in Learning at SMP Negeri 5 Sidoarjo

Holistically, the use of Artificial Intelligence (AI) as a medium for digital literacy at SMP Negeri 5 Sidoarjo has had a transformative impact, enhancing both the efficiency of information retrieval and the creativity applied to completing assignments. While AI-based tools such as ChatGPT and Gemini have proven to be catalysts for 21st-century digital literacy skills, their impact is not linear; rather, it presents a dual dynamic. On one hand, this technology fosters self-regulated learning; on the other, it risks triggering over-reliance and distorting understanding in the absence of pedagogical guidance. The urgent need for synergy between AI technology and the role of educators is aptly summarized by a teacher representative: "AI cannot and must not replace the teacher's role in the classroom. We must position AI as an additional analytical tool for students. It is the teacher's duty to ensure this tool is used to build critical thinking, rather than as a shortcut that undermines the learning process" (Interview with Curriculum Coordinator Teacher, October 2024). This assertion underscores that AI should function as a cognitive tool, balanced by pedagogical guidance, to preserve the depth of students' critical thinking processes.

In a broader context, the findings at SMP Negeri 5 Sidoarjo offer a microcosm of the trend toward integrating Generative Artificial Intelligence (GenAI) in developing nations. As emphasized in the UNESCO frameworks (2023, 2025) regarding AI in Education, the successful adoption of AI in secondary schools depends not merely on algorithmic sophistication or device availability, but on three key pillars: (1) equitable infrastructure and digital inclusion to prevent literacy disparities among students; (2) strengthening the Technological Pedagogical Content Knowledge (TPACK) framework and Critical AI Literacy among teachers; and (3) formulating regulations and providing ethical guidance at the school level. By integrating these holistic strategies, AI utilization can be optimized—moving beyond a mere technical aid for completing assignments to become a medium for digital literacy that is humanistic, critical, and sustainable in preparing students for the era of global digital transformation.

CONCLUSION

This study concludes that the use of artificial intelligence (AI) tools—such as ChatGPT and Gemini—at SMP Negeri 5 Sidoarjo is primarily driven by students' independent initiatives (informal learning) and high technical readiness; however, there is a disparity regarding the frequency of use and the level of instructional readiness among teachers in the classroom. Although AI has proven effective in enhancing the efficiency of information retrieval and the completion of procedural tasks, the technology cannot replace the role of direct teacher interaction in fostering an understanding of fundamental concepts. Furthermore, students are beginning to demonstrate a positive shift toward critical AI literacy by habitually verifying and reprocessing information generated by AI.

The pedagogical implications of these findings underscore the importance of adopting a "Human-in-the-Loop Pedagogy" approach, wherein AI serves as an adaptive supporting tutor without displacing the educator's central role. To mitigate risks such as cognitive atrophy and limitations in prompting literacy, schools must enhance teacher capacity—grounded in the AI-TPACK framework—and foster proficiency in process-based assessment. Furthermore, formulating school-level AI ethics guidelines and strengthening internet infrastructure are essential prerequisites for sustainably addressing the digital divide (Digital Divide 2.0).

This study has limitations as it focuses on the context of a single junior high school in a developing country (the Global South). Therefore, future studies are recommended to experimentally evaluate the effectiveness of prompt engineering training and AI-resistant task design for teachers, as well as to test the implementation of AI ethics curricula across a broader range of schools.

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