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Generative AI in Elementary Teacher Education: Opportunities, Risks, and Professional Ethics

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ABSTRACT

Generative artificial intelligence (GenAI) may influence how prospective elementary school teachers design, implement, and evaluate learning. It can support idea generation, lesson planning, differentiated activities, assessment rubrics, and reflective practice. However, fluent outputs are not necessarily accurate, developmentally appropriate, unbiased, or aligned with the curriculum and local sociocultural contexts. This article synthesizes the pedagogical opportunities, risks, and professional-ethical implications of GenAI use in Indonesian elementary teacher education and proposes directions for responsible integration. The study employs a narrative literature review based on exploratory searches of SciSpace, journal-publisher websites, academic sources, UNESCO publications, and Indonesian education-policy documents. The core literature covers 2020–2026, complemented by relevant foundational theory. The thematic synthesis identifies potential benefits for lesson planning and differentiation, alongside risks involving hallucinations, bias, developmental inappropriateness, privacy, copyright, unequal access, and cognitive overdependence. Responsible use requires AI literacy beyond prompt writing, including critical evaluation, ethical judgment, transparency, and accountability. The article proposes the KONTEKS framework as a guide for contextualizing, verifying, adapting, and taking responsibility for GenAI outputs. As a narrative review, it does not claim exhaustive systematic coverage or quantitative effect estimates; its recommendations require empirical testing in Indonesian elementary teacher education programs.

INTRODUCTION

The development of large language models (LLMs) and generative artificial intelligence tools has expanded the possibilities for using technology in education. Unlike digital tools that primarily store, display, or process existing information, GenAI can generate text, images, questions, examples, and lesson plans based on user instructions. These capabilities open opportunities to support academic and pedagogical work, but they also raise concerns about the reliability of information, academic integrity, bias, privacy, and the limits of human

responsibility (Kasneci et al., 2023; Tlili et al., 2023; Dwivedi et al., 2023).

In pre-service teacher education, GenAI is not merely a productivity tool. Its use can influence how students understand course material, make pedagogical decisions, design assessments, and shape their professional identities. Preliminary reviews of artificial intelligence in higher education have highlighted that educational AI research often focuses on technology and students, while the perspectives of educators and the pedagogical implications receive less attention (Zawacki-Richter et al., 2019). The development of GenAI reinforces

the need to position teachers as critical decision-makers, not merely as technology operators.

The context of Elementary School Teacher Education (PGSD) has its own unique characteristics. Prospective teachers must be able to translate abstract concepts into concrete learning experiences, take into account children's cognitive and social-emotional development, manage diverse abilities, and connect the material to local language, culture, and environment. A lesson plan that appears well-structured on paper is not necessarily appropriate for lower-grade students, aligned with learning outcomes, or safe to implement. Therefore, GenAI outputs should be treated as preliminary material that needs to be tested and adapted based on the prospective teachers' professional knowledge.

Empirical evidence on the use of GenAI by pre-service teachers is beginning to emerge, including research on collaborative lesson planning, TPACK development, and the use of AI during teaching practicums (Sun & Huang, 2025; Saputra et al., 2025; Tran et al., 2026). Systematic reviews are also beginning to map the use of GenAI in the education of elementary school teacher candidates, science teacher candidates, and teacher education in general (Martino et al., 2025; Spasopoulos et al., 2025; Yuan et al., 2026). This literature highlights the potential for broad application but also indicates that well-developed pedagogical integration, structured training, and long-term evaluation remain essential.

Thus, the novelty of this article does not lie in the claim that no review of GenAI in pre-service teacher education has been conducted. Rather, this article develops a synthesis focused on the intersection of PGSD pre-service teachers' pedagogical competencies, AI literacy, professional ethics, and Indonesian policy. This focus is important because international guidelines emphasize a human-centered approach, while Indonesian policies are beginning to provide specific guidance for the use of artificial intelligence in education (Miao & Holmes, 2023; Miao & Cukurova, 2024; Kusumawardani et al., 2024; Purwarianti et al., 2025).

This article addresses three questions: (1) what pedagogical opportunities does GenAI offer to

prospective elementary school teachers; (2) what risks and ethical dilemmas need to be managed; and (3) what competencies, principles, and institutional measures are necessary to ensure that its use reinforces—rather than replaces—the professional judgment of prospective teachers? The ultimate goal is to develop an operational framework that can be used in lectures, teaching practice, and academic policy development.

METHODS

This article employs a narrative literature review approach. The narrative approach was chosen because the study's objective is to integrate empirical findings, theory, and policy documents to construct a conceptual interpretation of GenAI use by PGSD teacher candidates, rather than quantifying the magnitude of effects or ranking interventions. An exploratory search was conducted on October 22, 2026, via SciSpace, along with targeted searches on journal publishers' websites, as well as repositories and the official websites of UNESCO and relevant ministries in Indonesia.

The English keywords used in various combinations included “generative AI,” “large language models,” “preservice teachers,” “teacher education,” “elementary teacher education,” “lesson planning,” “TPACK,” “AI literacy,” “academic integrity,” “professional ethics,” “privacy,” and “bias.” Indonesian-language keywords included “generative artificial intelligence,” “prospective teachers,” “PGSD,” “AI literacy,” “teacher professional ethics,” and “AI policies in education.” The primary publication range was 2020–2026. Older conceptual works are still considered if they serve as a theoretical foundation, particularly the Technological Pedagogical Content Knowledge (TPACK) framework.

Sources are considered if they are relevant to the use of GenAI in learning or teacher education, have traceable bibliographic information, and provide empirical, conceptual, or policy contributions to the research questions. Priority is given to scientific journal articles, literature reviews, international competency frameworks, and official documents. Sources that are not relevant to education, lack sufficient metadata for verification, or merely repeat claims without traceable evidence are not used as primary foundations.

The analysis was conducted through reading and thematic grouping of relevant sources. Initial themes included pedagogical use, pre-service teacher competencies, epistemic and ethical risks, human-centered approaches, the Indonesian policy context, and the research agenda. Findings across sources were compared to distinguish empirical evidence from normative recommendations. Because this study is narrative in nature, the authors do not claim to have conducted a comprehensive systematic review; they did not use a PRISMA diagram, did not count all search records, and did not perform a formal risk of bias assessment. These limitations should be understood when interpreting the scope of this synthesis.

RESULTS AND DISCUSSION

Understanding GenAI as a probabilistic system, not an authority on knowledge

GenAI refers to systems that generate new content based on patterns learned from data. LLMs generate language sequences through probabilistic modeling; these systems do not inherently guarantee that the fluent responses are factually correct, source-accurate, or pedagogically appropriate. Kasneci et al. (2023) emphasize that language models can support explanations, material development, and feedback, but they are also prone to generating erroneous and biased information. Tlili et al. (2023) caution that the use of educational chatbots requires caution, clear guidelines, and human supervision.

For prospective elementary school teachers, the distinction between linguistic fluency and content validity is crucial. The system may generate questions that appear convincing but have incorrect answer keys, unmeasurable learning objectives, age-inappropriate examples, or narrow cultural representations. This risk aligns with the criticism by Bender et al. (2021) regarding the limitations of language models that learn from statistical patterns and may reproduce biases or generate convincing language without human-like contextual understanding. Therefore, GenAI outputs should be treated as hypotheses or drafts for review, not as definitive sources of truth.

Pedagogical Opportunities for Prospective Elementary School Teachers Instructional Planning and Development of Teaching Materials

GenAI can help prospective teachers begin designing instructional modules, organizing sequences of activities, generating contextual examples, designing prompt questions, and preparing a variety of activities based on learning objectives. In studies of pre-service teachers, the use of GenAI for instructional planning was found to be particularly useful when user prompts included specific context, objectives, learner characteristics, and source materials. Kim and Lee (2024), for example, reported the benefits of ChatGPT in selecting and organizing materials and designing certain learning activities, while its support for assessment design and specific activities was more limited.

Studies on collaborative planning show that GenAI can serve as an information source and a drafting partner, but it does not automatically function as a deep cognitive support. Sun and Huang (2025) found that AI's contribution to pre-service teachers' planning process tends to be stronger in the early stages, whereas continued cognitive engagement requires facilitation and clear activity structures. Celik et al. (2026) also highlight the importance of prompting strategies and pedagogical-technological knowledge when pre-service teachers design adaptive learning plans. Yadav et al. (2025) found that pre-service teachers view GenAI as useful for planning and creating learning resources, but remain concerned about student dependence and limitations in teacher-student interaction. Consequently, PGSD instructors need to evaluate not only the final product but also the pedagogical rationale, revisions, and verification processes carried out by students.

Differentiation and Responsiveness to Student Diversity

Prospective teachers can ask GenAI to generate variations in explanations, examples, tiered exercises, diagnostic questions, or alternative activities for students with different levels of readiness. In elementary school education, this capability has the potential to help students explore more than one way to explain concepts—for

example, through concrete objects, images, stories, games, or problems relevant to the students' environment. A review by Spasopoulos et al. (2025) identified the use of GenAI for concept clarification, lesson planning, differentiation, and classroom situation simulations in science teacher education. Abualrob's (2025) study also examined pre-service teachers' use of AI to teach science to fourth-grade students, thereby demonstrating the relevance of this research to elementary school education.

However, the differentiation generated by the model still needs to be reviewed. The system does not always account for real classroom conditions, students' specific needs, the language spoken at home, resource limitations, or cultural sensitivities. Prospective teachers need to provide a sufficiently detailed context—without including students' personal data—and then assess whether the proposed activities are truly inclusive and realistic. GenAI can expand pedagogical options, but decisions regarding the appropriateness of children's developmental stages and needs remain the responsibility of humans.

Assessment, Feedback, and Reflection on Teaching Practice

GenAI can help draft formative assessments, question variations, preliminary rubrics, sample feedback, and microteaching scenarios. Prospective teachers can also use the model to review the clarity of instructions or compare several activity alternatives. During the reflection phase, students can request guiding questions to evaluate student engagement, the alignment of objectives and assessments, and potential improvements for the next session. However, the generated rubrics and answer

keys must be validated based on learning outcomes, conceptual accuracy, and principles of fair assessment.

Research by Tran et al. (2026) on teacher candidate training in instructional planning shows that an approach combining tool training with the development of an AI mindset fosters a more reflective and iterative interaction process compared to tool training alone; this group also produced instructional designs with higher average scores in the context of their study. These findings suggest that the quality of AI utilization is related to how users interact with and evaluate the results, not merely access to the application. However, results from a single context and a limited sample cannot be directly generalized to all PGSD programs.

GenAI can also help students prepare discussion materials and engage in written reflections during field practice. A study by Saputra et al. (2025) on prospective English teachers in Indonesia found that ChatGPT was used to explore digital tools, develop lesson plans, and design interactive activities, alongside the practice of modifying and reviewing outputs to maintain academic integrity. Since this context does not involve the PGSD program, the findings are more appropriately used as relevant indicators rather than direct evidence regarding all prospective elementary school teachers.

Synthesis of Research Findings

Table 1 summarizes several sources representing the main themes. This table is not a ranking of quality and does not replace a critical assessment of the design, context, and limitations of each study.

Table 1. Synthesis of Selected Research Findings

Source	Focus, Findings, and Interpretive Limitations
Martino et al. (2025)	<p>Focus: A systematic review of elementary school teacher candidates</p> <p>Relevant findings: Mapping the use of GenAI for pedagogical design, technological agency, and critical evaluation.</p> <p>Limitations: The synthesis is broad; this article focuses on professional ethics and Indonesian policy.</p>

Source	Focus, Findings, and Interpretive Limitations
Spasopoulos et al. (2025)	<p>Focus: Science teacher candidates</p> <p>Relevant findings: GenAI is used for clarifying concepts, ideas, planning, differentiation, and classroom simulations.</p> <p>Limitations: Integration into the program remains fragmented; the science context does not represent all subjects.</p>
Sun & Huang (2025)	<p>Focus: Collaborative lesson planning</p> <p>Relevant findings: AI is particularly helpful in the early stages; advanced cognitive scaffolding needs to be facilitated.</p> <p>Limitations: Specific samples and learning contexts; does not demonstrate long-term impact.</p>
Celik et al. (2026)	<p>Focus: Adaptive Planning and Intelligent-TPACK</p> <p>Relevant findings: The quality of prompts is related to the ability to develop adaptive designs.</p> <p>Limitations: The quality of the output is influenced by prior knowledge and task design.</p>
Tran et al. (2026)	<p>Focus: AI mindset training versus tool training</p> <p>Relevant findings: Reflective and iterative training is associated with better interaction patterns and design quality.</p> <p>Limitations: Findings stem from a limited context and sample; replication is needed.</p>
L. Yuan et al. (2026)	<p>Focus: Systematic review of teacher education</p> <p>Relevant findings: Highlights diverse applications, geographic disparities, and limitations of longitudinal studies.</p> <p>Limitations: Evidence across countries and disciplines remains inconsistent.</p>
Saputra et al. (2025)	<p>Focus: TPACK and the academic integrity of prospective teachers in Indonesia</p> <p>Relevant findings: Demonstrates its use for planning and the importance of verifying and modifying outcomes.</p> <p>Limitations: Focuses on prospective English teachers, not prospective elementary school teachers.</p>

Challenges and Risks of Using GenAI Hallucinations, Bias, and Pedagogical Inappropriateness

Hallucinations occur when the system generates incorrect or unsourced information but presents it in a convincing manner. In elementary education, minor errors in definitions, scientific facts, mathematical operations, local history, or answer keys can lead to misconceptions if passed on to students. Bias can emerge in examples, representations of professions, or assumptions about family, gender, language, or social groups. Kasneci et al. (2023), Bender et al. (2021), and Tlili et al. (2023) emphasize the importance of verification,

transparency regarding limitations, and human oversight.

Prospective teachers should compare AI-generated content with the textbooks used, curriculum documents, official sources, and academic references. For questions or assessments, students need to check the appropriateness of the learning objectives, the level of difficulty, the clarity of the language, the answer keys, and the possibility of more than one correct answer. For teaching materials, students must ensure that examples are not stereotypical, do not disparage specific groups, and are appropriate for the students' sociocultural context.

Privacy, Data Security, and Child Protection

Prompts entered into GenAI services may contain information that is processed by the service provider in accordance with their settings and policies. Therefore, prospective teachers should not enter students' full names, photos, addresses, individual grades, behavioral records, diagnoses, or other sensitive information into public services without a legitimate basis and appropriate safeguards. This principle aligns with the human-centered approach and privacy protection emphasized by UNESCO (Miao & Holmes, 2023), as well as the obligation to protect personal data under Law No. 27 of 2022.

In case studies, students can replace identities with codes, omit unnecessary details, and use hypothetical scenarios. Elementary teacher education programs must provide guidelines explaining which tools may be used, the types of data that are prohibited from being shared, and procedures to follow in the event of a data breach. Child protection must be a fundamental requirement, not an optional add-on after technology has been implemented.

Academic Integrity, Attribution, and Copyright

The use of GenAI does not automatically constitute academic misconduct; its assessment depends on the purpose of the assignment, institutional rules, transparency, and the level of student contribution. Problems arise when students present AI output as the result of independent thinking, fabricate references, conceal required disclosures, or are unable to explain the content of their work. Cotton et al. (2023) discuss the need to reevaluate approaches to academic integrity amid the rise of chatbots, while Dwivedi et al. (2023) outline the implications of GenAI for academic practices and policies.

Proportional academic ethics need to shift from merely detecting AI use to assessing the thought process. Instructors can ask students to attach relevant prompt logs, mark sections assisted by AI, indicate sources used for verification, explain changes made, and verbally defend their pedagogical decisions. Students remain responsible for the accuracy of the content, the originality of their contributions, and compliance with copyright laws as stipulated in Law No. 28 of 2014.

Cognitive Dependency and Access Gaps

The use of AI that is solely focused on quick results may reduce prospective teachers' opportunities to practice formulating objectives, selecting strategies, identifying misconceptions, and designing assessments independently. This risk does not mean that GenAI always diminishes critical thinking skills; its impact depends on task design, the level of assistance, prior knowledge, and the demand for reflection. When AI is used as a source of final answers, students may bypass the reasoning process that is precisely necessary to become teachers. Conversely, if used to compare alternatives, identify design flaws, or test arguments, AI can serve as a catalyst for reflection.

Access to devices, connectivity, language proficiency, and digital skills are also unevenly distributed. Learning policies that mandate a specific commercial service may create financial burdens or inequities. A review of GenAI in K–12 education indicates that teacher adoption and engagement are also influenced by socio-technical contexts and institutional support (R. Yuan et al., 2026). The UNESCO framework emphasizes inclusion, a human-centered approach, and the development of sustainable competencies (Miao & Cukurova, 2024). Therefore, the use of GenAI in elementary teacher education programs must provide equivalent non-AI alternatives, avoid penalizing students due to limited access, and teach skills that are transferable across platforms.

Professional Ethics and the Teacher's Role as a Decision-Maker

The ethics of GenAI use for prospective teachers cannot be reduced to a simple "do's and don'ts" list regarding app usage. The more fundamental issue is whether decisions regarding technology use uphold students' dignity and safety, support learning objectives, respect privacy, reduce inequality, and maintain teacher accountability. UNESCO (2021, 2023) identifies human dignity, justice, privacy, inclusion, and human oversight as key principles in AI governance. The European Commission's guidelines for educators also emphasize critical evaluation of the use of AI and data in teaching (European Commission, Directorate-General for Education, Youth, Sport and

Culture, 2022). In the context of education, these principles must be translated into concrete actions when developing instructional materials, assessments, and communication with students.

Law No. 14 of 2005 on Teachers and Lecturers identifies pedagogical, personal, social, and professional competencies as essential components of a teacher's professionalism. GenAI does not eliminate these four competencies. Rather, the use of technology requires prospective teachers to demonstrate pedagogical competence through the selection of appropriate strategies; professional competence through content verification; social competence through communication and respect for diversity; and personal competence through honesty, responsibility, and setting a good example.

From this perspective, professional ethics encompasses at least six obligations. First, the epistemic obligation: verifying facts, sources, and the limits of the system's knowledge. Second, the pedagogical obligation: assessing alignment with learning objectives, children's development, and learning needs. Third, the protective obligation: safeguarding student data and safety. Fourth, the duty of fairness: examining biases and providing inclusive options. Fifth, the obligation of transparency: explaining the use of AI in accordance with assignment guidelines or journal requirements. Sixth, the obligation of accountability: not shifting decision-making responsibility to the application. This principle aligns with UNESCO recommendations and guidelines for the use of GenAI in Indonesian higher education institutions (Kusumawardani et al., 2024).

It must be emphasized that human responsibility is not merely about clicking an "approve" button after AI generates content. Prospective teachers must be able to explain why a particular activity was chosen, how the material was verified, who might be disadvantaged by a specific example, and how assessment results are used to support learning. If students are unable to justify these decisions, the process of using GenAI cannot yet be considered a mature professional integration.

Integration of TPACK and AI Literacy in Elementary Teacher Education

The TPACK framework explains that meaningful technology integration requires the

integration of content, pedagogical, and technological knowledge (Mishra & Koehler, 2006). When using GenAI, it is not enough for prospective teachers to simply know how to create prompts. They need to understand the subject matter, identify appropriate learning strategies, assess the model's capabilities and limitations, and determine when technology is not necessary. In other words, the key question is not "what can AI create?" but rather "what learning problem do we want to solve, what evidence indicates that this design is appropriate, and which parts require the teacher's judgment?"

AI literacy expands upon digital literacy. Long and Magerko (2020) describe AI literacy as a set of competencies that help individuals understand, use, evaluate, and critically interact with AI systems. Ng et al. (2021) also note that AI literacy must be understood in a multidimensional way, not merely as a technical skill. For prospective teachers, this literacy includes a basic understanding of how AI works and its limitations, skills in using it, critical evaluation of its outputs, social and ethical considerations, and the ability to integrate it into instructional design.

UNESCO (Miao & Cukurova, 2024) offers the AI Competency Framework for Teachers, which organizes teacher competencies into the dimensions of human-centered mindset, AI ethics, AI fundamentals and applications, AI pedagogy, and AI for professional development. Recent reviews on teachers and GenAI also highlight AI literacy, pedagogical knowledge, professional development, and socio-technical conditions as interrelated themes (Ayubian et al., 2026; Shenoy & Saarela, 2026). This framework serves as a useful reference for developing learning outcomes for teacher education courses, instructional materials, lesson planning, learning assessment, and field experience. AI competencies should be integrated across courses, rather than limited to a single application training session.

Based on this synthesis, the PGSD curriculum can develop authentic assessments that evaluate students' ability to (a) formulate learning problems before using AI; (b) create contextual prompts; (c) test the validity and bias of outputs; (d) adapt materials to students' ages and needs; (e) safeguard data and ensure proper attribution; and (f) explain pedagogical decisions. Process-based assessment

helps distinguish students' professional competencies from the mere ability to generate text.

The Indonesian Policy Context

Indonesia's policy context has evolved from guidelines on the use of GenAI in higher education toward guidelines that more directly target elementary education and the national education ecosystem. Kusumawardani et al. (2024) developed guidelines for the use of GenAI in higher education. Purwarianti et al. (2025) published guidelines on the use of artificial intelligence for early childhood education (PAUD), elementary, and secondary school teachers. Additionally, Decision of the Minister of Elementary and Secondary Education No. 127/P/2025 provides guidelines for the implementation of coding and artificial intelligence in early childhood education (PAUD) as well as elementary and secondary education. In March 2026, the government also announced joint guidelines for the use and learning of digital technology and artificial intelligence in formal, non-formal, and informal education, with an emphasis on ethical, safe, wise, and responsible use, as well as child protection (Ministry of Primary and Secondary Education, 2026).

For the PGSD program, these policies are relevant in two ways. First, students need to understand the direction of AI policies in the schools where they will eventually teach. Second, teacher education institutions must ensure that the use of AI

in coursework prepares prospective teachers to apply these same principles critically and contextually. Educational policies should not be interpreted as an unlimited license to use applications, but rather as a foundation for establishing governance, guidance, and protection.

In addition to specific AI guidelines, general regulations remain relevant. Law No. 27 of 2022 on Personal Data Protection is crucial when the use of services involves information that can identify students or other individuals. Law No. 28 of 2014 on Copyright provides the legal framework for the use, modification, and distribution of materials. Law No. 14 of 2005 on Teachers and Lecturers serves as the basis for placing the use of technology under the professional responsibility of teachers. This article does not interpret these provisions as rules that specifically govern every feature of GenAI; application to specific cases must take into account applicable regulations, institutional policies, and terms of service.

The KONTEKS Operational Framework for Prospective Elementary School Teachers

To translate the above principles into practice, this article proposes the KONTEKS framework. This framework is the author's conceptual synthesis, not an empirically validated instrument. Its purpose is to help prospective teachers move from a practice that merely produces content toward a process that is contextual, critical, and accountable.

Table 2. KONTEKS Operational Framework

Stage	Principles, Actions, and Reflection Questions
K — Contextualization	Principles and actions: Determine learning outcomes, the class, prior knowledge, learning needs, the local context, and resource limitations before using AI. Reflection question: What learning problem are you trying to solve? What context must be taken into account?
O — Goal Orientation	Principles and actions: Craft a prompt that requests a targeted output, clarifies boundaries, and specifies the expected format and quality criteria. Reflection question: Does the prompt guide the AI toward pedagogical goals, rather than simply requesting general content?
N — Validity and Verification	Principles and actions: Verify facts, sources, terminology, answer keys, difficulty levels, bias, and curriculum alignment using reliable sources. Reflection question: Which parts have been verified? What remains questionable or needs improvement?

Stage	Principles, Actions, and Reflection Questions
T — Pedagogical Transformation	Principles and actions: Adapt the AI draft into instructional materials appropriate for the students’ age, language, culture, needs, and school conditions. Reflection question: Is the material truly suitable for the students who will be learning it?
E — Ethics and Protection	Principles and actions: Avoid personal data; verify the rights to use the material; disclose AI assistance in accordance with regulations; ensure fairness and access. Reflection question: Does this use protect students, respect intellectual property, and ensure transparency?
K — Professional Control	Principles and actions: Make the final decision based on content knowledge, pedagogy, observation, and the teacher’s responsibility; do not delegate the decision to AI. Reflection question: Can I explain and justify this decision without hiding behind AI?
S — Keep a record and reflect	Principles and actions: Document relevant usage, key revisions, verification sources, and lessons learned for future evaluation. Reflection question: What was changed, why was it changed, and what can be done better next time?

The CONTEXT framework positions human verification and judgment as a core part of the process, not an additional step. This framework can be applied to tasks such as developing instructional modules, creating test items, conducting teaching simulations, and reflecting on field practice. Instructors can assess each stage using a rubric: clarity of context, quality of prompts, accuracy and validation, pedagogical adaptation, adherence to ethical standards, quality of justification, and reflective documentation. Further research is needed to test the reliability of the rubric and the effectiveness of this framework across various PGSD programs.

Implications for Stakeholders

For PGSD students, GenAI should be used as a partner for exploration and draft development, not as a substitute for learning or a final source. Students need to master cross-checking, source literacy, pedagogical revision, and transparency in usage. For instructors, assignments should assess the thought process, not just the quality of the written product; tasks may include decision logs, verification annotations, oral defenses, and comparisons of drafts before and after AI assistance.

For program administrators, AI literacy and professional ethics must be incorporated into learning outcomes and aligned across courses. Programs must issue clear guidelines regarding permitted tools, data privacy, attribution, the use of AI in assessments, and the consequences of violations. A one-time training session on prompting is not sufficient; continuous learning is required that integrates technological knowledge, pedagogy, content, ethics, and reflective practice.

For partner schools and mentor teachers, the use of GenAI during student teaching must be discussed openly. Students must understand that materials created for children require review by supervising teachers and must not contain student data without proper protection. For researchers, the next steps include longitudinal studies, cross-program and cross-regional comparisons, analysis of learning artifacts, classroom observations, and performance-based competency assessments. Studies need to distinguish between positive perceptions of AI and evidence that the quality of learning and learning outcomes have actually improved.

Limitations of the Review and Research Agenda

As a narrative review, this article does not guarantee that all relevant publications have been identified or included. The search was exploratory, and source selection was purposive; there was no PRISMA flowchart, formal risk-of-bias assessment, or meta-analysis. The GenAI literature is evolving rapidly, so conclusions may change as new models and policies emerge. Furthermore, some of the studies on pre-service teachers originated from the fields of language and science, rather than Indonesian elementary teacher education (PGSD), so the transfer of findings must be approached with caution. Future research should test the KONTEKS framework through classroom studies and fieldwork, compare the use of GenAI with and without ethical-pedagogical scaffolding, and evaluate the quality of instructional design, verification capabilities, and its impact on students' learning processes.

CONCLUSION

GenAI offers opportunities for prospective elementary school teachers to develop ideas, design lesson plans, generate a variety of activities, prepare initial assessments, and reflect on teaching practices. However, these opportunities do not automatically lead to better learning. The quality of its use depends on content-pedagogical knowledge, the quality of instruction, the ability to evaluate outputs, and the willingness to revise and take responsibility for decisions.

Significant risks include misinformation, bias, mismatches with children's developmental levels, data breaches, attribution and copyright issues, cognitive dependence, and access disparities. These risks must be managed as part of teachers' professional ethics, not merely as technical issues related to the application. AI literacy for prospective teachers needs to encompass an understanding of the system, purposeful use, critical evaluation, ethics, and the ability to integrate technology pedagogically.

This article proposes the KONTEKS framework—Contextualization, Goal Orientation, Values and Verification, Pedagogical Transformation, Ethics and Protection, Professional Control, and Record-Keeping and Reflection—as an

initial guide for the responsible use of GenAI. This framework needs to be empirically tested and adapted to institutional policies and regulatory developments. The main direction is clear: GenAI can help prospective teachers work more broadly and reflectively, but the responsibility for educating, protecting, assessing, and making decisions remains with humans.

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