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Generative AI literacy among pre-service teachers: Focusing on physical education majors

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Abstract

Generative artificial intelligence (GenAI) is transforming educational practice, yet limited research has examined how pre-service teachers in non-STEM disciplines are prepared to use it critically and pedagogically. This study investigated the level of GenAI literacy among pre-service teachers majoring in physical education in South Korea, where AI literacy is emphasized in national policy but unevenly implemented across disciplines. Using a descriptive survey design, students at a four-year university completed an online questionnaire during the fall semester of 2025. The survey, adapted from the Generative AI Literacy for Learning Scale, measured four dimensions: needs analysis, prompt and language skills, autonomous learning, and critical thinking. The results showed that participants demonstrated relatively strong competence in selecting appropriate AI tools and using GenAI for autonomous and collaborative learning. However, their perceived ability to critically evaluate AI-generated content, particularly in identifying bias and verifying information, was comparatively weaker. These findings suggest a gap between functional GenAI use and the evaluative and ethical reasoning required for responsible classroom integration. The study offers baseline evidence for developing discipline-sensitive GenAI literacy frameworks and highlights the need for teacher education programs to strengthen critical verification, bias awareness, and ethical decision-making.

Keywords: AI literacy, GenAI, Higher education, Physical education, Pre-service teachers, Teacher preparation.

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Contents

Contribution of this paper to the literature
This study extends GenAI literacy research beyond STEM by examining pre-service physical education teachers in South Korea. Using a multidimensional framework, it identifies strong functional and collaborative AI use but weaker critical evaluation skills, highlighting the need for discipline-sensitive teacher education that emphasizes ethical reasoning, verification, and responsible GenAI integration.

1. Introduction

Artificial intelligence(AI) is fundamentally altering how educators design instruction, assess learning, and support student engagement across K–12 contexts (Celik, 2023; Kim, So, & Lim, 2023). In South Korea, the 2022 Revised National Curriculum responded to this shift by mandating AI literacy as a cross-curricular competency in all subject areas (Han, 2025; Kim, 2024). Yet the pace of policy ambition has outstripped institutional readiness. Pre-service teacher preparation programs remain unevenly equipped to deliver AI-related training, and the disparity is most pronounced outside STEM fields, where structured curricular models and discipline-specific pedagogical resources are largely absent (Diliberti et al., 2024; Heo & Kang, 2023; Lee, Davis, & Ryu, 2024). Physical education (PE) occupies a particularly conspicuous blind spot in this landscape. PE instruction relies on real-time performance evaluation, kinesthetic feedback, movement analysis, and socio-emotional engagement, pedagogical demands that call for context-aware rather than generic AI applications (Reyes, Valdez, & Santos, 2024; Williams & Pill, 2025).

Despite these distinctive instructional conditions, few studies have examined how pre-service PE teachers conceptualize generative AI or assessed their readiness to integrate it into teaching practice. Existing empirical work has concentrated on STEM-oriented PSTs' attitudes and perceived utility of AI tools (Fu, Weng, & Wang, 2025; Lee & Zhai, 2024), leaving a notable gap in discipline-specific evidence for embodied learning fields. The present study directly addresses this gap. Using a descriptive survey design grounded in the Generative AI Literacy for Learning Scale (GenAI-LLs; Gümüş and Mehmet (2025)), the study examines PE majors' self-reported literacy across four dimensions: Needs Analysis, Prompt and Language Skills, Autonomous Learning, and Critical Thinking.

The guiding research question is as follows: RQ1: What is the current level of generative AI literacy among pre-service teachers majoring in physical education? By providing baseline data from a disciplinary context that national policy targets but the research literature has largely overlooked, this study aims to inform the design of inclusive, discipline-sensitive AI curricula in teacher education that address the instructional realities of PE rather than defaulting to STEM-centric models.

2. Literature Review

2.1. AI Literacy in Teacher Education Programs

Pre-service teachers (PSTs) across international contexts consistently report awareness of AI's educational potential, yet their readiness to deploy AI in authentic instructional settings tells a different story. Large-scale survey evidence from China, Germany, and Turkey indicates that positive attitudes and high motivation toward AI do not, on their own, translate into effective classroom practice (Ning, Zhang, Xu, Zhou, & Wijaya, 2024; Runge, Hebibi, & Lazarides, 2025; Zhang, Schießl, Plößl, Hofmann, & Gläser-Zikuda, 2023). According to these studies, what separates attitudinal receptivity from instructional competence is the availability of structured, practice-oriented training embedded in teacher preparation curricula. This condition remains unevenly met across disciplines and national systems. South Korea exemplifies this unevenness. The 2022 Revised National Curriculum formally mandates AI literacy across all subject areas, and several studies have documented in-service and pre-service teachers' perceptions of AI convergence education (Heo & Kang, 2023; Lee et al., 2024; Park, Hwang, & Lee, 2023).

A recurring finding across this body of work is that teachers express moderate to high awareness of AI's instructional value while simultaneously reporting limited confidence in pedagogical application. Park et al. (2023), for instance, developed a teaching competence scale for AI convergence education and found that PSTs scored highest on awareness-level items but lowest on implementation-oriented dimensions. Heo and Kang (2023) reached a similar conclusion in their analysis of teacher competencies for AI-integrated lesson design, noting that conceptual understanding outpaced procedural readiness. These converging results suggest a systemic pattern rather than an isolated finding: teacher education programs have succeeded in raising awareness but have not yet closed the gap between knowing about AI and knowing how to teach with it.

The gap widens further when non-STEM disciplines are taken into account. STEM teacher education programs have benefited from a longer history of integrating computational thinking and from access to discipline-specific digital tools, which provide a natural scaffold for AI adoption (Kim, 2024; Sun, Tian, Sun, Fan, & Yang, 2024). Fields such as physical education, the arts, and social studies lack comparable scaffolding. In PE specifically, several structural constraints compound the problem: the scarcity of training materials tailored to movement-based learning, limited exposure to AI-supported performance analysis, and the near-total absence of interdisciplinary collaboration between PE educators and AI specialists (Wang & Wang, 2024). These constraints are not merely logistical. They reflect a deeper conceptual challenge; the field has yet to articulate what AI literacy means within an embodied, kinesthetic pedagogical tradition, rather than borrowing frameworks designed for text-based or computational learning environments.

2.2. AI Literacy for PE Teachers

The small but growing body of research that does address AI in PE contexts reveals two instructive patterns. The first concerns the dimensionality of AI competence. Wang and Wang (2024) assessed PSTs' AI competency across six domains: awareness, basic knowledge, basic skills, problem-solving, teaching practice, and ethics, following a dedicated AI course. Their participants demonstrated relatively strong awareness and ethical sensitivity but weaker problem-solving skills and teaching practice. Kim, Moon, Yang, and Kim (2024) examined a different but related question: whether an AI-converged education program linked to PE content could simultaneously improve computational Thinking and AI literacy. Their intervention produced significant gains on both outcomes, suggesting that PE-specific learning activities can serve as a viable context for developing AI-related competencies when the curricular design is intentional. Reading these two studies together exposes a productive tension. Wang and Wang's findings imply that general AI courses raise awareness without fully developing the applied skills teachers need. In contrast, Kim et al.'s results suggest that discipline-embedded instruction may be more effective at bridging that divide.

Generative AI tools differ from earlier AI applications in that they require users to formulate effective prompts, iteratively refine outputs, and exercise epistemic judgment about the reliability and bias of machine-generated text, images, and data (Gümüş & Mehmet, 2025; Karataş & Yüce, 2024). The present study addresses this gap by applying the GenAI-LLs framework (Gümüş & Mehmet, 2025), a validated instrument designed to assess generative AI literacy across four dimensions: Needs Analysis, Prompt and Language Skills, Autonomous Learning, and Critical Thinking, to a population that existing research has largely bypassed. Where prior work has examined general AI competence in broad PST samples or tested intervention effects in controlled settings, this study provides a descriptive baseline of how PE majors perceive their generative AI literacy in naturalistic settings, without prior GenAI-specific training. The resulting profile offers empirical ground for identifying which literacy dimensions are relatively well established and which require targeted curricular investment, a necessary first step before intervention design can proceed on discipline-specific terms.

3. Methodology

3.1. Study Participants

This study was conducted at a four-year private institution in South Korea. The university offers an accredited teacher preparation track leading to secondary PE teaching certification. Students enrolled in this track complete a standard curriculum that combines sport coursework, pedagogical theory, and a supervised teaching practicum, consistent with the requirements. At the time of data collection, the department did not offer a standalone course dedicated to AI or generative AI. However, several participants had encountered AI-related content through university-wide electives or extra-curricular programs. A total of 21 PSTs enrolled in the PE teacher education track participated in the study during the fall semester of 2025. The sample was drawn through convenience sampling: all PSTs in the department who were present during the recruitment period were invited to participate, and those who consented completed the survey. While the sample size is modest, it represents a substantial proportion of the eligible PST population in this single-department context and is consistent with the study's descriptive, exploratory aims.

Table 1 presents the full demographic profile of the participants. The sample was predominantly male (n = 13, 61.9%), with females comprising 38.1% (n = 8), a gender distribution that reflects broader enrollment patterns in PE teacher education programs. In terms of academic standing, juniors constituted the largest group (47.6%), followed by sophomores (33.3%) and seniors (19.0%); no freshmen participated, likely because lower-division students had not yet entered the core teacher preparation sequence. Three-quarters of respondents (76.2%) reported some prior exposure to AI-related education, most commonly through university-level courses (61.9%), with smaller proportions citing non-credit programs (9.5%) or K–12 software education (4.8%). Coding experience was mixed: 42.9% had engaged in block-based coding, 28.6% in text-based coding, and 23.8% reported no coding background. Two-thirds of the sample (66.7%) expressed a willingness to pursue further AI-related education, indicating general receptivity and providing useful context for interpreting the literacy scores reported in the Results section.

Table 1. Demographic information of survey participants.

Category		Frequency (N=21)	Percentage (%)
Gender	Male	13	61.9
	Female	8	38.1
Grades	Sophomore	7	33.3
	Junior	10	47.6
	Senior	4	19.0
AI education (courses) previously	Yes	16	76.2
	No	5	23.8
Type of AI learning	K-12 Software (SW) education	1	4.8
	University courses	13	61.9
	Non-credit / extra-curricular courses	2	9.5
	None	5	23.8
Type of coding education	Unplugged Education	1	4.8
	Block coding	9	42.9
	Text-based coding	6	28.6
	None	5	23.8
Willingness to receive AI-related education in the future	Yes	14	66.7
	No	7	33.3

3.2. Survey Measurement

The measurement instrument used in this study was adopted from the questionnaire development study by Gümüş and Mehmet (2025). The instrument was designed to capture learners' key competencies and orientations in AI-supported learning contexts and provides a clearly defined multidimensional structure. In the present study, the questionnaire consisted of 29 items (Items 1–29) organized into four subscales: Needs Analysis, Prompt and Language Skills, Autonomous Learning, and Critical Thinking. The item composition for each subscale is reported in Table 2: Needs Analysis includes Items 1, 2, 3, 4, 5, 7, and 8; Prompt and Language Skills cover Items 9–13; Autonomous Learning comprises Items 14–22; and Critical Thinking includes Items 23–29.

Reliability evidence in the current dataset indicated excellent internal consistency across all dimensions. Cronbach's alpha coefficients were .973 for Needs Analysis, .972 for Prompt and Language Skills, .969 for

Autonomous Learning, and .945 for Critical Thinking. The overall scale reliability was also very high (α = .987), suggesting that the instrument functioned consistently for this participant group and was appropriate for subsequent analyses. Table 2 shows the reliability of survey items.

Table 2. Composition and reliability of measurement tools.

Category	Question	Cronbach's alpha
Needs Analysis	1, 2, 3, 4, 5, 7, 8	0.973
Prompt and Language Skills	9, 10, 11, 12, 13	0.972
Autonomous Learning	14, 15, 16, 17, 18, 19, 20, 21, 22	0.969
Critical Thinking	23, 24, 25, 26, 27, 28, 29	0.945
Total	1-29	0.987

3.3. Data Collection and Analysis

The survey items were adopted and translated into Korean. Authors who majored in bilingual education translated the survey and administered it. Data were collected during the fall semester of 2025 through a structured online survey administered via Google Forms. All participants were pre-service teachers enrolled in the teacher education program at W University in South Korea. The online format ensured accessibility and convenience while maintaining respondent anonymity, thereby encouraging candid responses. PSTs were recruited through course announcements and departmental communication channels. All respondents were provided with a detailed informed consent statement explaining the study's purpose, the voluntary nature of participation, confidentiality protections, and their right to withdraw at any time without penalty. Participants who agreed to participate electronically indicated their consent before proceeding to the survey questions. No incentives were provided for participation. The survey remained open for three weeks, during which reminder messages were sent to maximize response rates.

The collected data were exported to SPSS (Version 26.0) for analysis. To examine the current status of AI literacy among pre-service physical education teachers, descriptive statistics were calculated, with means and standard deviations used to summarize participants' overall AI literacy level and performance across relevant dimensions. Additionally, to verify the questionnaire's reliability, an internal consistency analysis was conducted, and Cronbach's alpha coefficients were computed for each subscale and the overall instrument.

4. Survey Results

Table 3 reports the descriptive statistics for all 29 items across the four GenAI-LLs domains. Overall, item-level means ranged from 3.38 to 3.86 on a five-point Likert scale, indicating that participants perceived themselves as moderately competent generative AI users. The domain-level patterns, however, revealed a notable asymmetry between functional and evaluative competencies. Autonomous Learning yielded the strongest overall profile (domain-level M=3.76). Four items with the highest mean across the entire dataset (M=3.86) pertained to collaborative and partner-oriented uses of generative AI, including treating AI as a learning companion, facilitating group activities, and completing team-based tasks with diverse AI tools. Needs Analysis followed closely (M=3.73), with participants reporting high confidence in selecting the appropriate generative AI tool for a given content need (M=3.86, SD=.910) and in applying AI to solve problems (M=3.81, SD=.873). Across both domains, standard deviations remained moderate (SD=.85–1.06), suggesting reasonable consistency in these self-assessments.

Prompt and Language Skills occupied a middle position (M=3.61) but exhibited the widest within-domain variability. While entering detailed prompts to retrieve needed content received relatively favorable ratings (M=3.76, SD=.995), items requiring iterative refinement, improving prompts based on output quality (M=3.62, SD=1.117), detecting prompt deficiencies (M=3.52, SD=1.030), and adapting prompts across different AI platforms (M=3.57, SD=1.165), clustered lower with standard deviations exceeding 1.0. This dispersion indicates that prompt competence is unevenly distributed within the sample, with some participants reporting systematic strategies and others relying on less refined approaches. Critical thinking registered the lowest domain-level mean (M=3.60) and contained the single weakest item in the entire instrument: drawing logical conclusions about bias in AI-generated content (M=3.38, SD=.921). A similar pattern appeared for distinguishing scientific knowledge from subjective viewpoints (M=3.52, SD=.928). Verification-oriented behaviors fared somewhat better, referencing external sources to judge accuracy (M=3.62, SD=0.805) and checking AI-generated content before use (M=3.76, SD=0.889), yet even these items fell below the top-performing Autonomous Learning and Needs Analysis scores.

The gap between verification behaviors and biased reasoning suggests that participants may engage in surface-level checking without applying the deeper epistemic judgment that bias detection requires. Taken together, the results point to a moderately high but structurally uneven literacy profile. Functional, task-oriented, and collaborative competencies cluster at the upper end of the observed range, while evaluative competencies, particularly those demanding bias detection and epistemic differentiation, sit consistently at the lower end. This domain-level asymmetry provides the empirical basis for the discussion that follows.

Table 3. Descriptive analysis results of the AI literacy of PSTs.

Category	Question	M	SD
Needs analysis	1. I can select the right generative AI tool for the content I need.	3.86	0.910
	2. I can use generative AI tools to solve a problem.	3.81	0.873
	3. I can determine the content type I need through generative AI tools.	3.71	0.956
	4. I can decide whether I need generative AI tools at any stage of solving a problem.	3.62	0.973
	5. I can determine whether the content I will get from the generative AI tools is the knowledge I need to use to solve the current problem.	3.76	0.889
	6. I know how to benefit from the generative AI tools to achieve my learning goals.	3.71	0.956
	7. I can use generative AI tools to simplify a topic.	3.71	1.056
	8. I can use generative AI tools to detail a topic.	3.62	1.024
Prompt and language skills	9. I can enter detailed prompts into the generative AI tools to get access to the content I need.	3.76	0.995

Category	Question	M	SD
	10. I can improve the prompts I enter into the generative AI tools to reach the content I need.	3.62	1.117
	11. I can detect the deficiencies in my prompts depending on the content generated by generative AI.	3.52	1.030
	12. I can detect the deficiencies in my prompts depending on the content generated by generative AI.	3.57	1.028
	13. I can create prompts appropriate to diverse generative AI tools to reach the content I need.	3.57	1.165
Autonomous learning	14. I can use generative AI to get feedback on what I learn.	3.71	1.007
	15. I can use generative AI to evaluate my performance on a specific issue.	3.67	1.107
	16. I can gain awareness through generative AI for my general learning progress in a field.	3.57	0.926
	17. I can use generative AI as a classmate role.	3.86	0.964
	18. I can use generative AI to improve my dialogue with my teammates in group work.	3.81	0.873
	19. I can use generative AI to collaborate with my teammates to solve a problem.	3.86	0.964
	20. I can use generative AI to facilitate group activities to solve a problem.	3.86	0.910
	21. I can evaluate the quality of the tasks I have completed by using generative AI tools.	3.71	1.007
	22. I can complete my tasks in group work by using diverse generative AI tools.	3.86	0.854
Critical thinking	23. I can question the content generated by generative AI.	3.57	1.028
	24. I can reason about the accuracy of the content presented by generative AI.	3.57	1.028
	25. I can draw a logical conclusion about the bias in the content presented by generative AI.	3.38	0.921
	26. I reference other sources to decide on the accuracy of the content presented by generative AI.	3.62	0.805
	27. I reference other sources to decide on the objectivity of the content presented by generative AI.	3.76	0.995
	28. I can decide whether the content presented by generative AI is scientific knowledge or a subjective view.	3.52	0.928
	29. I verify the accuracy of the content presented by generative AI before using it.	3.76	0.889

5. Discussion

The present study addressed the research question by examining the current level of generative AI literacy among PSTs majoring in physical education. This population remains relatively underexamined in the broader literature on AI readiness in teacher education. Although national and international policy discourses increasingly emphasize cross-curricular AI literacy, empirical research has tended to focus on STEM-oriented teacher education contexts, leaving comparatively limited discipline-sensitive evidence (Fu et al., 2025; Heo & Kang, 2023). Against this background, the descriptive results of this study suggest that PSTs reported a moderately high yet uneven literacy profile across the four domains of the GenAI-LLs framework. This pattern broadly aligns with prior findings indicating that many PSTs demonstrate openness to AI and a functional capacity to use AI tools, while more advanced competencies, particularly those related to critical evaluation may remain less consistently developed without structured pedagogical training (Karataş & Yüce, 2024; Runge et al., 2025; Zhang et al., 2023).

Across domains, Needs Analysis emerged as a relative strength, with participants reporting confidence in selecting appropriate generative AI tools and in using them to support problem-solving. This finding may be interpreted in light of the growing accessibility of generative AI tools and the tendency for early-stage adoption to be driven by pragmatic learning needs rather than formal pedagogical reasoning (Sun et al., 2024). Similarly, scores in Prompt and Language Skills were moderately positive, suggesting that many participants perceived themselves as able to generate detailed prompts and refine them to obtain more useful outputs.

However, the variability across items and the overall mid-range means may also imply that prompt literacy is not yet fully systematic for all PSTs, which is consistent with recent arguments that prompt engineering should be treated as an explicit and teachable competence rather than an assumed byproduct of tool exposure (Karataş & Yüce, 2024; Lee & Zhai, 2024). From a PE perspective, this domain may be particularly relevant because PE lesson planning often involves contextual constraints (e.g., class size, equipment, safety, and differentiated performance levels), which may require teachers to formulate particular prompts and evaluate whether AI-generated suggestions are pedagogically feasible.

Autonomous learning was among the highest-performing domains, with participants reporting strong use of generative AI for feedback, task evaluation, and especially collaborative learning. This result may reflect the increasing use of generative AI by university students as a 'learning companion,' supporting self-regulated learning routines and group-based communication (Rahman, Ibrahim, & Hassan, 2023). In PE teacher education, where peer-based practice, performance demonstration, and cooperative training activities are common, the relatively high scores in AI-supported collaboration may indicate that PSTs are already integrating generative AI into learning practices that mirror the social and interactive nature of their discipline. At the same time, the literature suggests that such functional engagement does not necessarily translate into instructional readiness unless teacher education programs provide opportunities to connect AI use with pedagogical decision-making, classroom management, and ethical responsibility (Ning et al., 2024; Park et al., 2023). Thus, while the present results appear to indicate relatively active engagement with AI for learning support, they may also point to the need for PE-specific scaffolding that bridges autonomous use with classroom-facing professional practice.

In contrast, Critical Thinking emerged as the lowest-performing domain, particularly in bias reasoning and epistemic judgment regarding AI-generated content. This finding resonates with concerns raised in the teacher education literature that PSTs may develop functional confidence with AI earlier than they develop the critical literacy needed to evaluate accuracy, objectivity, and value-laden assumptions embedded in algorithmic outputs

(Wang & Wang, 2024; Yue, Jong, & Ng, 2024). Although participants reported some tendency to verify AI-generated information using external sources, their comparatively lower confidence in detecting bias may suggest that evaluative routines remain partial or uneven.

In PE contexts, this issue may be especially salient because AI-supported recommendations such as those related to physical performance, body norms, injury risk, or training progression can implicitly reproduce biased assumptions or oversimplified models of learners' bodies and abilities. Therefore, the present findings tentatively suggest that PE teacher preparation programs may benefit from moving beyond general exposure to AI tools toward structured training in verification practices, bias-sensitive reasoning, and ethical decision-making aligned with embodied, data-rich PE learning environments (Kim et al., 2024; Liu & Keating, 2022). Overall, the results provide preliminary evidence that PE PSTs may be relatively capable users of generative AI for learning support and collaboration. At the same time, critical evaluation competencies remain an area where targeted curricular attention could be particularly valuable.

6. Conclusion

Using a multidimensional framework, the findings suggest that PSTs reported a moderately high yet uneven competency profile across four domains. In particular, Needs Analysis and Autonomous Learning appeared to be relatively stronger, indicating that PSTs may already be able to select appropriate tools, use generative AI for task completion, and integrate AI into self-regulated and collaborative learning routines. However, Critical Thinking emerged as comparatively weaker, especially for bias reasoning and epistemic judgment, suggesting that evaluative competencies may not yet be as consistently developed as functional uses of AI. Taken together, the results tentatively indicate a readiness mismatch in PE teacher education: while PSTs may be increasingly capable of using generative AI for learning support, they may require more structured opportunities to develop verification routines, critical evaluation strategies, and ethical decision-making practices. As generative AI becomes more embedded in educational environments, PE teacher preparation programs may benefit from moving beyond general exposure to AI tools toward discipline-sensitive literacy training that reflects the embodied, interactive, and data-rich characteristics of PE instruction.

7. Recommendations and Implications

The findings of this study offer several preliminary recommendations for PE teacher education programs seeking to respond to emerging policy demands for cross-curricular AI literacy. First, teacher preparation curricula may benefit from explicitly positioning generative AI literacy as a staged competence, beginning with needs-driven tool selection and prompt development and progressively extending toward critical evaluation and ethical reasoning. In this respect, prompt literacy could be treated as a teachable instructional design skill rather than an informal practice acquired through trial and error. Second, the comparatively lower scores in critical thinking suggest that PE programs may need to embed structured verification routines into coursework, including source triangulation, bias identification, and epistemic differentiation between evidence-based knowledge and plausible but unsubstantiated AI-generated claims.

Third, given the collaborative nature of PE learning environments, the relatively strong Autonomous Learning profile could be leveraged pedagogically by designing PE-specific tasks in which PSTs use generative AI to support lesson planning, feedback scripting, differentiated instruction, and reflective practice, while simultaneously requiring justification and critical review of AI outputs. Finally, at the institutional level, the results may support the development of discipline-sensitive guidelines and professional learning modules that help PE educators integrate generative AI responsibly, particularly in contexts involving performance assessment, learner safety, body-related norms, and data-informed instructional decisions. Although these implications remain tentative, they may provide a helpful starting point for curriculum redesign and future intervention research in PE teacher preparation.

8. Limitations of the Study

Several limitations should be considered when interpreting the findings of this study. First, the sample size was relatively small (N = 21) and drawn from a single four-year university in South Korea, limiting statistical generalizability and suggesting that the observed patterns should be interpreted as preliminary. Second, the study relied on self-reported survey responses rather than performance-based measures, which may not fully capture how PSTs would apply generative AI literacy in authentic lesson planning, practicum teaching, or real-time instructional decision-making. Third, the descriptive design did not allow for causal inferences regarding the influence of prior AI education experiences, coding backgrounds, or academic standing on literacy levels. Future research could address these limitations by employing larger multi-site samples, integrating behavioral assessments or scenario-based tasks, and testing targeted PE-specific interventions designed to strengthen critical evaluation and ethical reasoning competencies.

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