

Article

Preparing Preservice Teachers for AI-Supported Classrooms: Perceptions and Competencies, and Psychometric Characteristics of the Survey Instrument

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Abstract

Preparing future educators for technology-enhanced learning environments has become increasingly important as artificial intelligence (AI) continues to influence teaching and learning. Guided by the Intelligent Technological Pedagogical Content Knowledge (i-TPACK) framework, this mixed-methods study examined preservice teachers' perceptions of AI and the competencies they considered necessary for effective AI integration. Participants included 108 preservice teachers enrolled in a teacher preparation program at a public university in the southeastern United States. Data were collected using a survey containing Likert-scale and open-ended questions. Quantitative data were analyzed using descriptive statistics, exploratory factor analysis, and independent-samples *t*-tests, while qualitative responses were analyzed using thematic coding. The exploratory factor analysis identified a four-factor empirical structure that partially corresponded with the original theoretical domains, with varying levels of internal consistency. Preservice teachers generally viewed AI favorably and recognized its potential to support teaching and learning. Participants with internship experience reported significantly higher scores for perceived changes brought by AI and reasons for using AI than those without internship experience. Qualitative findings identified five competencies considered important for responsible AI integration: AI literacy, prompt engineering, critical evaluation, ethical AI use, and pedagogical balance. Participants also expressed concerns about academic dishonesty, misinformation, overreliance on AI, reduced critical thinking, and loss of human interaction. The findings highlight the importance of preparing preservice teachers to integrate AI in pedagogically meaningful and ethically responsible ways.

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1. Introduction

Artificial intelligence (AI) is increasingly shaping educational practice through a wide range of technologies, including AI-enhanced educational platforms and generative AI applications that support teaching, learning, assessment, and instructional planning. Recent developments in generative AI technologies, including systems such as ChatGPT,

have accelerated the presence of AI in K–12 classrooms and teacher preparation programs. AI-supported tools can assist teachers in designing instructional materials, differentiating instruction, providing personalized feedback, and supporting student learning through adaptive and interactive technologies (Luckin & Holmes, 2016; Kasneci et al., 2023). As AI technologies continue to expand across educational settings, teacher education programs face growing expectations to prepare future teachers for AI-supported classrooms.

AI is a broad field that includes systems capable of performing tasks that typically require human intelligence, such as learning, reasoning, problem solving, and decision-making. Within education, AI applications include both AI-enhanced educational platforms, which use AI features to support functions such as adaptive learning, assessment, and instructional planning, and generative AI, which creates new content, including text, images, lesson materials, and feedback, in response to user prompts. Because these technologies serve different instructional purposes, it is important to distinguish among them when examining how future teachers perceive and use AI in educational settings.

Although AI offers important opportunities for teaching and learning, it also raises significant instructional and ethical concerns. Researchers have identified challenges related to algorithmic bias, academic integrity, data privacy, overreliance on technology, and the accuracy of AI-generated information (Ashwin et al., 2023; O’Neil, 2017; Rudin, 2019). AI systems can generate incorrect or misleading responses, reinforce biases embedded in training data, or encourage passive learning if used without critical evaluation (Kasneci et al., 2023). As a result, educators must understand not only how to use AI technologies, but also how to evaluate their pedagogical appropriateness, limitations, and ethical implications in classroom settings.

These concerns are especially important in teacher education because preservice teachers are likely to enter schools where AI technologies are already integrated into instructional planning, assessment, and student learning activities. According to Bae et al. (2024), while many preservice teachers may be familiar with AI technologies through their personal or academic lives, they often have limited preparation for integrating AI into teaching in pedagogically meaningful and ethically responsible ways. Because they are still developing their teaching philosophies and instructional practices, teacher preparation programs play a critical role in helping them critically evaluate AI technologies and develop the knowledge and skills needed for responsible classroom integration. Existing research has documented generally positive attitudes toward AI in education, including perceptions that AI can improve efficiency, personalization, and engagement (Long & Magerko, 2020; Kumar et al., 2020).

Recent scholarship increasingly emphasizes that teachers must develop AI-related competencies that extend beyond basic technology use. Teachers need knowledge of how AI systems function, how AI-generated outputs should be evaluated, and how AI technologies can support meaningful instructional practices while maintaining ethical and professional standards (Holmes et al., 2021; Long & Magerko, 2020). In addition, teachers must be able to guide students in the responsible use of AI technologies, particularly in areas related to plagiarism, misinformation, privacy, and critical evaluation of AI-generated content. As generative AI technologies become more accessible in educational contexts, teacher preparation programs increasingly need frameworks that help conceptualize the knowledge and competencies required for AI-supported teaching.

To address this need, the present study draws on the Intelligent Technological Pedagogical Content Knowledge (i-TPACK) framework. Building on the traditional TPACK model developed by Mishra and Koehler (2006), the i-TPACK framework extends teachers’ technological, pedagogical, and content knowledge to include competencies related to AI-supported instruction and ethical decision-making (Celik, 2023). The framework emphasizes that teachers must understand not only how to use intelligent technologies,

but also how to interact with AI systems critically and responsibly within instructional contexts. According to Celik (2023), effective AI integration requires competencies related to technological knowledge of AI systems, pedagogical strategies for AI-supported teaching, content-specific applications of AI, and ethical considerations such as transparency, fairness, inclusiveness, and accountability.

Guided by the i-TPACK framework, this study examines preservice teachers' perceptions of AI in education and the competencies they identify as necessary for effective AI integration in classroom instruction. Using a mixed-methods design, the study explores preservice teachers' attitudes toward AI, the AI technologies they consider most relevant for educational use, their concerns about AI integration, and the competencies they believe future teachers need in order to teach effectively in AI-supported classrooms. By examining these perspectives, the study contributes to the growing literature on AI in teacher education by identifying the competencies preservice teachers believe are necessary for responsible AI integration. The findings may inform teacher education curriculum design, strengthen teacher readiness for AI-supported classrooms, and support institutional policies related to ethical integration of AI in education.

Understanding preservice teachers' perceptions of AI is important because these perceptions may influence how they adapt and use AI in future classroom practice. Their views can also inform the design of teacher education curricula by identifying the AI competencies that should be emphasized during preparation programs. As schools increasingly integrate AI technologies into teaching and learning, teacher education programs must ensure that future educators are prepared to use these tools effectively, ethically, and pedagogically. In addition, the findings may inform institutional and educational policy by highlighting areas where guidance, professional standards, and curriculum development are needed to support responsible AI integration in schools.

Preservice teachers are a distinct population from practicing teachers. They are forming their instructional habits before entering the classroom, which means the competencies they develop during preparation may shape how they use AI for the rest of their careers. Unlike experienced teachers, they cannot draw on years of classroom judgment to offset gaps in their AI knowledge. This makes their preparation especially consequential.

The study addresses the following research questions:

1. What are preservice teachers' attitudes toward AI in education?
2. Are there differences in preservice teachers' perceptions of AI based on internship experience?
3. Which AI tools do preservice teachers find most relevant for educational use?
4. What instructional and ethical concerns do preservice teachers express about integrating AI into educational settings?
5. What AI competencies do preservice teachers believe future teachers need to effectively integrate AI into classroom instruction?

Guided by the i-TPACK framework, these research questions examine different aspects of preservice teachers' readiness for AI-supported teaching. Research Questions 1 and 2 address their perceptions and beliefs about AI integration. Research Question 3 examines their interest in AI tools for educational use, while Research Question 4 addresses instructional and ethical concerns. Research Question 5 focuses on the competencies needed for responsible and pedagogically meaningful AI integration.

In this study, AI competencies refer to the integrated knowledge, skills, and professional judgment required to use AI effectively, ethically, and pedagogically in educational settings. These competencies extend beyond operating AI tools. They include understanding AI's capabilities and limitations, critically evaluating AI-generated content, using AI to support teaching and learning, and making informed instructional and ethical

decisions. From an i-TPACK framework, AI competencies involve integrating technological, pedagogical, content, and ethical knowledge for responsible AI-supported teaching.

2. Literature Review

2.1. Intelligent-TPACK Framework

The present study is guided by the i-TPACK framework, which extends the widely applied TPACK model (Mishra & Koehler, 2006) to address competencies necessary for integrating AI into educational settings (Celik, 2023; Dogan, 2026).

The framework emphasizes that effective AI integration requires more than basic technological knowledge. Teachers must understand how AI systems function, how AI-generated outputs can support instructional goals, and how AI technologies should be evaluated critically and ethically in classroom practice. According to Celik (2023), i-TPACK includes technological knowledge related to interacting with AI systems, pedagogical knowledge for AI-supported teaching, content-specific applications of AI technologies, and ethical knowledge involving transparency, fairness, accountability, and inclusiveness. Similarly, Dogan (2026) emphasizes that teachers must develop instructional decision-making skills that support responsible and pedagogically meaningful AI integration in classroom environments.

Unlike many traditional educational technologies, AI systems can generate instructional content, provide adaptive feedback, analyze learner data, and support personalized learning experiences, expanding teachers' opportunities to design more responsive and individualized instruction (Létourneau et al., 2025). As a result, teachers must develop competencies related to prompt design, evaluation of AI-generated information, instructional decision-making, and responsible AI use. The i-TPACK framework therefore provides an appropriate lens for examining preservice teachers' perceptions of AI, their concerns about AI integration, and the competencies they believe future teachers need in order to effectively integrate AI into classroom instruction. Figure 1 illustrates the conceptual framework guiding the study.

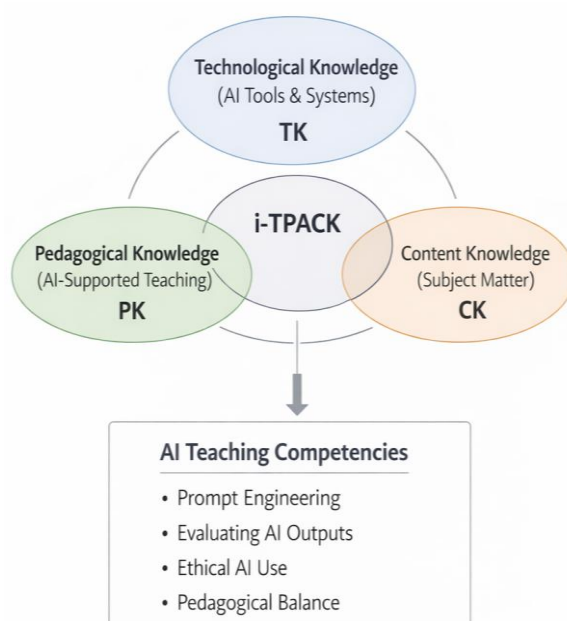


Figure 1. Intelligent Technological Pedagogical Content Knowledge (i-TPACK) Framework. Note. Adapted from Celik (2023), Dogan (2026), and Mishra and Koehler (2006). The framework illustrates the interaction among technological knowledge, pedagogical knowledge, content knowledge, and ethical considerations necessary for effective AI-supported teaching.

2.2. Preservice Teachers' Perceptions of AI and AI Competencies

Preservice teachers represent the next generation of educators who will likely work in classrooms where AI technologies are increasingly integrated into instructional planning, assessment, and learning support. Because of this growing presence of AI in schools, researchers have increasingly examined preservice teachers' perceptions of AI and their readiness to integrate AI into teaching practices (Holmes et al., 2021).

Studies consistently show that preservice teachers view AI as a meaningful support for teaching and learning. The research indicates that preservice teachers perceive AI as useful for enhancing personalized learning, improving instructional efficiency, supporting grading and feedback, and increasing student engagement (Kumar et al., 2020). Recent studies on generative AI technologies further suggest that systems such as ChatGPT may support lesson planning, differentiated instruction, formative assessment, and content generation in educational settings (Kasneci et al., 2023; Cheah et al., 2025).

Although previous research generally reports positive perceptions of AI, it has focused more on teachers' acceptance of AI than on the competencies needed to use it effectively. A teacher may view AI favorably yet still lack the knowledge and skills required to evaluate AI-generated content and integrate it responsibly into classroom practice.

At the same time, preservice teachers also express concerns about AI integration in education. Common concerns include academic dishonesty, overreliance on AI systems, reduced critical thinking, and the reliability of AI-generated information. Additional concerns involve ethical issues such as bias, transparency, and the responsible use of AI in classroom settings (Ashwin et al., 2023).

Recent scholarship increasingly argues that teacher education programs should move beyond examining attitudes toward AI and instead focus on developing AI-related competencies. Teachers must develop AI literacy, understand how AI systems function, critically evaluate AI-generated outputs, and integrate AI into pedagogically meaningful learning activities (Holmes et al., 2021; Long & Magerko, 2020). In addition, teachers must help students use AI responsibly and ethically while supporting critical thinking and academic integrity.

Despite growing interest in AI in teacher education, research examining preservice teachers' AI competencies through the i-TPACK framework remains limited. Much of the existing literature has focused on attitudes, technology acceptance, or behavioral intentions rather than on instructional and ethical competencies needed for effective AI integration in classroom practice (Milutinović, 2025; Kul et al., 2026).

Although previous studies have examined preservice teachers' perceptions of AI, less is known about how internship experience influences these perceptions and how they relate to the competencies needed for AI-supported teaching. The present study addresses these gaps through the i-TPACK framework.

3. Materials and Methods

3.1. Research Design

This study employed a mixed-methods design to develop a more complete understanding of preservice teachers' perceptions of AI and the competencies they considered necessary for effective classroom integration. A mixed-methods approach was appropriate because the research questions addressed both measurable patterns in participants' perceptions and the explanations underlying those perceptions. Quantitative survey data were used to examine overall attitudes toward AI, perceptions of its usefulness, anticipated educational changes, and reasons for using AI. The quantitative data also allowed comparisons between preservice teachers with and without internship experience.

Qualitative responses were used to explore participants' concerns, experiences, and views of the competencies needed for responsible AI integration. These responses provided context for the quantitative findings.

Participants in this study were 108 preservice teachers enrolled in upper-level teacher preparation courses at a public university in the southeastern United States. Participants were enrolled in programs including Elementary Education, Early Childhood Education, and Elementary/Special Education. During the study, participants were completing advanced coursework and field experiences in local schools, where they observed classrooms, assisted cooperating teachers, and participated in instructional activities.

Data were collected over five consecutive academic semesters during 2025 and 2026 using an online Qualtrics survey. Preservice teachers enrolled in selected teacher education courses taught by one of the researchers were invited to participate through an online invitation each semester. Participation was voluntary, the survey took approximately 10 min to complete, and participation or nonparticipation had no effect on students' course grades. After screening the responses, four incomplete surveys were excluded, resulting in a final sample of 108 preservice teachers. Of the 108 participants, 47 reported internship experience, while 61 reported no internship experience. These two groups were used for the comparative analyses in the study.

3.2. Instrument Development and Content Validity

The survey instrument was developed to examine topics related to the i-TPACK framework, including preservice teachers' perceptions of AI, familiarity with AI technologies, instructional and ethical concerns, and the competencies needed for AI-supported teaching. The instrument included five demographic questions, 24 Likert-scale items, one multiple-selection question about AI-related educational tools, and five open-ended questions. The Likert-scale items addressed attitudes toward AI, perceptions of AI usefulness, perceived educational changes associated with AI, and reasons for using AI. The open-ended questions addressed concerns, experiences, changing educator roles, competencies needed for AI integration, and additional comments. Responses to the Likert-scale items were recorded using a five-point scale ranging from 1 (Strongly disagree) to 5 (Strongly agree).

Together, these survey components allowed the study to examine multiple dimensions of the i-TPACK framework, including technological knowledge, pedagogical considerations, ethical awareness, and AI-related competencies for classroom instruction.

The survey instrument was developed based on a review of the literature on AI integration, teacher technology adoption, and the i-TPACK framework (Davis, 1989; Kumar et al., 2020). Rather than adopting a single existing instrument, survey items were developed to address the objectives of the present study (See Appendix A).

To support content validity, the survey was reviewed by two K–12 educators and two faculty members with expertise in educational technology and teacher education. The reviewers examined the items for clarity, relevance, alignment with the research questions, and consistency with the i-TPACK framework. Based on their feedback, several items were revised to improve wording, organization, and overall clarity before the survey was administered.

The AI tools included in the survey were selected based on their widespread use and relevance in K–12 education and teacher preparation at the time of the study. The list represented different categories of AI-related educational technologies, including generative AI systems (e.g., ChatGPT and Perplexity AI), AI-enhanced educational platforms (e.g., MagicSchool AI, Canva AI, Khanmigo, and Curipod), and classroom platforms with embedded AI features (e.g., Google Classroom, Kahoot, Quizlet, and Padlet). Participants were asked to select the tools they found most interesting or relevant for educational use

and were not expected to be familiar with every tool on the list. An “Other” response option was included to allow participants to identify AI tools that were not listed.

Open-ended questions provided deeper insight into participants’ concerns regarding AI integration, changing teacher roles, and responsible AI-supported teaching practices. One open-ended question specifically asked participants to describe the knowledge and skills future teachers need to use AI effectively. This question was included to capture participants’ own descriptions of AI-related competencies that could not be fully represented through fixed-response survey items. These responses were interpreted as AI competencies because teacher competencies integrate knowledge, skills, and professional judgment required for effective classroom practice.

3.3. Data Analysis

Quantitative survey data were analyzed using descriptive statistics, including means and standard deviations. Independent-samples *t*-tests were conducted to examine differences based on internship experience. Before conducting the *t*-tests, normality was examined using the Shapiro–Wilk test and skewness and kurtosis values, while homogeneity of variances was examined using Levene’s test. Two-sided *p* values and Cohen’s *d* effect sizes were reported. The internal structure of the Likert-type items was examined using principal axis factoring and Direct Oblimin rotation. A theory-specified four-factor solution was examined based on the proposed item groupings. Sampling adequacy and factorability were evaluated using the Kaiser–Meyer–Olkin measure and Bartlett’s test of sphericity. Statistical significance was set at $p < 0.05$.

Internal consistency was examined using Cronbach’s alpha in SPSS version 31. Reliability analyses were conducted for the four original theoretical constructs, the four empirical factors identified through the exploratory factor analysis, and the retained total scale.

Open-ended responses were analyzed using the six-phase thematic analysis approach described by Braun and Clarke (2006). The first author read the responses multiple times and generated initial codes by identifying recurring ideas. Related codes were organized into broader themes, and a structured coding matrix was used to document the analysis. Responses could receive more than one code when they addressed multiple themes. Theme frequencies were calculated based on the number of participants mentioning each theme. Non-substantive responses, such as “N/A” and “I do not know,” were excluded. Fifty participants answered at least one open-ended question. Of these, 45 provided substantive responses about concerns related to AI integration, and 40 provided substantive responses about the competencies teachers need to use AI. The themes were interpreted through the i-TPACK framework and reviewed by the researchers.

Themes were considered meaningful when similar ideas were expressed by multiple participants across the dataset. Individual responses that did not reflect broader patterns were retained as illustrative quotations but were not treated as separate themes.

3.4. Ethical Considerations

This study followed ethical research standards for studies involving human participants. Institutional Review Board (IRB) approval (Protocol H25001) was obtained from the university prior to data collection. Participation was voluntary, and participants were informed about the purpose of the study before providing informed consent. No personally identifiable information was collected, and all responses were analyzed in aggregate form to protect participants’ anonymity.

4. Results

4.1. Factor Structure and Reliability of the Quantitative Scale

The data were suitable for exploratory factor analysis, as indicated by a Kaiser–Meyer–Olkin value of 0.778 and a statistically significant Bartlett’s test of sphericity, $\chi^2(276) = 1578.18, p < 0.001$. Principal axis factoring with Direct Oblimin rotation was used to examine a theory-specified four-factor solution. The solution explained 51.20% of the total variance, and the rotation converged after 43 iterations (See Table 1).

Table 1. Summary of the exploratory factor analysis.

Indicator	Result	Interpretation
KMO measure	0.778	Acceptable sampling adequacy
Bartlett’s test	$\chi^2(276) = 1578.18, p < 0.001$	Data suitable for factor analysis
Variance explained	51.20%	Moderate explanatory value
Oblimin rotation	Converged in 43 iterations	Stable computational solution
Correspondence with proposed groupings	Partial	Four dimensions not fully confirmed

Note. Extraction method: Principal Axis Factoring. Rotation method: Direct Oblimin with Kaiser normalization. The resulting scores were interpreted as exploratory indicators.

To compare the proposed and observed structures, each item’s original theoretical domain was examined alongside its primary empirical factor. Table 2 presents the primary factor and loading for each retained item. It also identifies cross-loadings of 0.30 or higher. The empirical factors were provisionally named based on the shared content of their highest-loading items.

Table 2. Comparison of theoretical domains and empirical factor structure.

Item	Theoretical Domain	Empirical Factor	Loading	Note
Sufficient knowledge to explain AI	Attitudes	F4	0.640	Consistent with knowledge/awareness
Know how to exploit AI benefits	Attitudes	F4	0.637	Cross-loaded on F3 (−0.494)
AI changes the educator’s role	Attitudes	F4	0.402	Cross-loaded on F3 (0.397)
Able to teach using AI	Usefulness	F3	−0.776	Shifted to self-efficacy/intended use
Future teachers must master AI	Usefulness	F2	0.421	Shifted to pedagogical benefits/change
More advantages than disadvantages	Usefulness	F1	0.791	Shifted to perceived advantages
Willing to use AI in future teaching	Usefulness	F3	−0.588	Shifted to self-efficacy/intended use
Teachers will use AI as a teaching tool	Educational changes	F3	−0.621	Shifted to self-efficacy/intended use
AI as the teacher’s virtual assistant	Educational changes	F2	0.382	Related to pedagogical benefits/change
Learners will use AI to customize learning	Educational changes	F3	−0.385	Shifted to self-efficacy/intended use
AI will replace the teacher	Educational changes	F3	−0.448	Shifted to self-efficacy/intended use
Educator’s role will shift to facilitation	Educational changes	F2	0.586	Related to pedagogical benefits/change
AI will provide personalized feedback	Educational changes	F2	0.474	Related to pedagogical benefits/change
Shift from mass to personalized learning	Educational changes	F2	0.614	Related to pedagogical benefits/change

AI will enable instant lesson design	Educational changes	F2	0.463	Cross-loaded on F4 (0.396)
AI will extend learning time	Educational changes	F2	0.703	Related to pedagogical benefits/change
AI will reduce administrative tasks	Educational changes	F2	0.506	Related to pedagogical benefits/change
Students value teachers who use AI	Reasons for using AI	F2	0.634	Cross-loaded on F1 (−0.322)
AI improves student–teacher interaction	Reasons for using AI	F2	0.712	Shifted to pedagogical benefits/change
AI improves learning and personalization	Reasons for using AI	F2	0.546	Cross-loaded on F1 (0.460)
AI will offer more future advantages	Reasons for using AI	F1	0.737	Shifted to perceived advantages
Capable of teaching using AI	Reasons for using AI	F3	−0.633	Cross-loaded on F4 (0.330)
See myself using AI professionally	Reasons for using AI	F3	−0.688	Shifted to self-efficacy/intended use

Note. Only items with factor loadings of 0.30 or higher are presented. F1 = Perceived Advantages of AI; F2 = Pedagogical Benefits and Educational Change; F3 = AI Teaching Self-Efficacy and Intended Use; F4 = AI Knowledge and Role Awareness.

As shown in Table 3, the empirical structure partially corresponded with the original theoretical domains. Items related to the perceived advantages of AI formed Factor 1, while items addressing pedagogical benefits and educational changes primarily formed Factor 2. Items concerning AI teaching self-efficacy and intended use formed Factor 3, and items related to AI knowledge and role awareness formed Factor 4. Several items loaded on factors different from their original theoretical domains, and some demonstrated cross-loadings.

Table 3. Reliability of the theoretical constructs and empirical factors.

Structure	Construct or Factor	Number of Items	Cronbach's Alpha
Theoretical	Attitudes Toward AI	3	0.63
Theoretical	Perceptions of AI Usefulness	4	0.75
Theoretical	Perceived Changes Brought by AI	11	0.77
Theoretical	Reasons for Using AI	6	0.80
Empirical	Perceived Advantages of AI	2	0.81
Empirical	Pedagogical Benefits and Educational Change	11	0.86
Empirical	AI Teaching Self-Efficacy and Intended Use	7	0.87
Empirical	AI Knowledge and Role Awareness	3	0.62
Overall	Retained total scale	23	0.90

Note. The theoretical constructs reflect the original survey organization. The empirical factors were identified through principal axis factoring with Direct Oblimin rotation. The two-item Perceived Advantages of AI factor had an inter-item correlation of $r = 0.684$.

The four original theoretical constructs showed varying levels of internal consistency, with Cronbach's alpha coefficients ranging from 0.63 to 0.80. Three constructs met or exceeded 0.70, while Attitudes Toward AI demonstrated lower reliability ($\alpha = 0.63$). The empirical factors had reliability coefficients ranging from 0.63 to 0.87. Three factors demonstrated acceptable to good internal consistency, while AI Knowledge and Role Awareness showed lower reliability ($\alpha = 0.63$). The retained 24-item scale demonstrated strong overall internal consistency ($\alpha = 0.90$; see Table 3).

4.2. Descriptive Statistics

Descriptive statistics indicated that preservice teachers moderately held favorable perceptions of AI across all four dimensions: attitudes toward AI ($M = 3.66$, $SD = 0.50$), perceptions of AI usefulness ($M = 3.43$, $SD = 0.56$), perceived changes brought by AI ($M = 3.49$, $SD = 0.38$), and reasons for using AI in education ($M = 3.49$, $SD = 0.49$) (See Table 4).

Table 4. Descriptive statistics for AI attitudes and perceptions.

Variable	N	Mean	SD
Attitudes toward AI	108	3.66	0.50
Perceptions of AI usefulness	108	3.43	0.56
Perceived changes brought by AI	108	3.49	0.38
Reasons for using AI	108	3.50	0.49

4.3. Internship Experience Differences

Before conducting the independent-samples t -tests, the assumptions of normality and homogeneity of variance were examined. Although some Shapiro–Wilk tests were statistically significant, the skewness and kurtosis values indicated no substantial departures from normality. Levene's tests were nonsignificant for all four variables, indicating that the homogeneity-of-variance assumption was met. Therefore, independent-samples t -tests were conducted.

The results showed no statistically significant differences between preservice teachers with internship experience ($n = 47$) and those without prior experience ($n = 61$) in attitudes toward AI or perceptions of AI usefulness. However, preservice teachers with internship experience reported significantly higher scores for perceived changes brought by AI and reasons for using AI in education. As shown in Table 5, the effect sizes were moderate for perceived changes brought by AI and small to moderate for reasons for using AI.

Table 5. Independent sample t -tests comparing preservice teachers with and without internship experience.

Variable	Internship/Teaching Experience	Mean	SD	t	Two-Sided p	Cohen's d
Attitudes toward AI	Experience: 47	3.69	0.49	0.50	0.621	0.10
	No experience: 61	3.64	0.52			

Perceptions of AI usefulness	Experience: 47	3.43	0.57	−0.11	0.915	−0.02
	No experience: 61	3.44	0.56			
Perceived changes brought by AI	Experience: 47	3.61	0.39	2.96	0.004	0.58
	No experience: 61	3.40	0.36			
Reasons for using AI	Experience: 47	3.62	0.51	2.30	0.024	0.45
	No experience: 61	3.40	0.46			

Note. $p < 0.05$.

4.4. AI Tools Preservice Teachers Find Most Interesting

Preservice teachers were asked to identify the AI tools they found most interesting or useful for educational purposes. Because participants could select multiple tools, a multiple-response frequency analysis was conducted.

As shown in Table 6, the most frequently identified tools were ChatGPT-5 (78.7%), Canva AI (75.9%), and Grammarly (72.2%). Other commonly selected platforms included Google Classroom (67.6%), MagicSchool AI (63.0%), Kahoot (62.0%), and Padlet AI (62.0%). Additional tools such as Khanmigo, Perplexity AI, and Curipod were selected by more than half of the participants. Because participants could select multiple tools, the percentages reflect the range of tools teachers found relevant rather than a single preferred tool or exclusive use. A high percentage for a given tool indicates broad familiarity across participants; it does not indicate that those participants relied on it alone.

Table 6. AI tools preservice teachers find most interesting for educational use.

AI Tool	Frequency	% of Participants
ChatGPT	85	78.7%
Canva AI	82	75.9%
Grammarly	78	72.2%
Google Classroom	73	67.6%
MagicSchool AI	68	63.0%
Kahoot	67	62.0%
Padlet AI	67	62.0%
Khanmigo	63	58.3%
Perplexity AI	58	53.7%
Curipod	58	53.7%
Quizlet	49	45.4%
Microsoft Copilot	49	45.4%

The AI tools identified by participants represent different categories of educational technologies. Some, such as ChatGPT and Perplexity AI, are generative AI systems that

produce text-based responses or instructional content. Others, including MagicSchool AI, Canva AI, Khanmigo, and Curipod, are AI-enhanced educational platforms that integrate AI features into instructional planning, content creation, or classroom activities. Several widely used educational platforms, such as Kahoot, Quizlet, Google Classroom, and Padlet, also incorporate AI-supported features while serving broader instructional purposes. The variety of tools selected suggests that participants viewed AI as encompassing multiple forms of technology that support teaching and learning.

4.5. Concerns About AI Integration

Preservice teachers were asked to describe their concerns about integrating AI into educational settings. Of the 49 responses received, 45 were substantive and included in the analysis. Five recurring themes were identified: AI inaccuracies and misinformation, reduced critical thinking and learning, over-reliance on AI, academic dishonesty, and loss of human interaction. Table 7 presents the frequency and percentage of participants who mentioned each theme.

Table 7. Preservice teachers' concerns about AI integration.

Theme	Frequency	Percentage	Example Responses
AI inaccuracies and misinformation	13	28.9%	"The information it gives us is not always the most accurate."
Reduced critical thinking and learning	13	28.9%	"Students will no longer enhance their critical thinking skills."
Over-reliance on AI	12	26.7%	"People start using AI and have it do everything instead of using it as a learning tool."
Academic dishonesty	9	20%	"I worry that students will try to use AI as means of cheating instead of helping them."
Loss of human interaction	9	20%	"Less personal interaction between students, parents, and teachers."

Note. Percentages were calculated using the 45 substantive responses. Because responses could receive more than one code, the percentages do not total 100%.

Thematic analysis identified five major concerns regarding AI integration. The most frequently mentioned concerns were AI inaccuracies and misinformation, as well as reduced critical thinking and learning, followed by over-reliance on AI, academic dishonesty, and loss of human interaction. Overall, participants recognized the instructional potential of AI but emphasized that its use should be carefully monitored to support student learning while preserving academic integrity and meaningful teacher–student relationships.

4.6. AI Competencies Preservice Teachers Identify as Necessary for AI Integration

Participants were also asked to describe the competencies future teachers need to integrate AI effectively. Of the 41 responses received, 40 were substantive and included in the analysis. Five themes were identified: AI literacy, pedagogical balance, critical evaluation, ethical AI use, and prompt engineering. Table 8 presents the frequency and percentage of participants who mentioned each theme.

Table 8. Competencies needed for AI integration.

AI Competency	Frequency	Percentage	Example Responses
AI literacy	19	47.5%	“Know what it is and how it works.”
Pedagogical balance	17	42.5%	“It can be an addition, but not a replacement for the traditional education process.”
Critical evaluation	10	25%	“They should double-check and preview anything from AI.”
Ethical AI use	7	17.5%	“Teachers [should] be aware of plagiarism that comes with AI.”
Prompt engineering	5	12.5%	“Teachers need to know how to correctly prompt AI.”

Note. Percentages were calculated using the 40 substantive responses. Because responses could receive more than one code, the percentages do not total 100%.

The competencies identified by participants consisted of interconnected knowledge, skills, and professional practices rather than isolated abilities. Together, these competencies reflect the broader capacity to integrate AI effectively, ethically, and pedagogically into classroom instruction.

As shown in Table 6, preservice teachers identified several competencies they considered essential for effective AI integration. These included AI literacy, prompt engineering, critical evaluation of AI-generated content, and ethical AI use—the ability to balance AI-supported instruction with effective teaching practices. Collectively, these competencies highlight the importance of preparing future teachers to use AI responsibly, critically, and pedagogically.

As illustrated in Figure 2, these competencies reflect the interconnected knowledge and decision-making processes associated with AI-supported teaching and align closely with the principles of the i-TPACK framework.

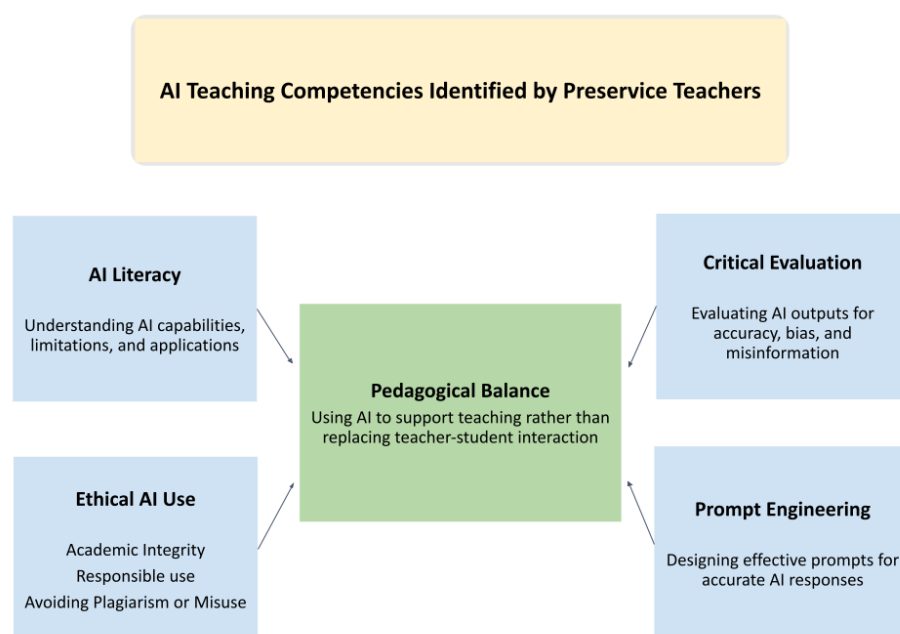


Figure 2. AI Teaching Competencies Identified by Preservice Teachers.

5. Discussion

Across both quantitative and qualitative data, preservice teachers demonstrated an awareness of AI that was neither outright enthusiasm nor outright skepticism. Preservice teachers with internship experience reported higher scores for perceived changes brought by AI and reasons for using AI than those without internship experience. Classroom experience may help preservice teachers move beyond general ideas about AI and consider how AI can support lesson planning, differentiation, and student learning. Prior research similarly suggests that authentic teaching experiences help preservice teachers connect technological knowledge with pedagogical practice and develop stronger technology integration competencies (Tondeur et al., 2018; Valtonen et al., 2017). In the context of AI, teachers often use AI-supported technologies for instructional tasks such as adapting materials, generating learning activities, and supporting diverse learners (Diliberti et al., 2024). From the perspective of the i-TPACK framework, internship experience may support the development of the pedagogical judgment needed to select and use AI technologies in meaningful and responsible ways by connecting technological knowledge with classroom practice.

The psychometric findings provided partial support for the proposed organization of the survey. The EFA identified four empirical factors that did not fully correspond with the original theoretical domains, as several items shifted across factors or demonstrated cross-loadings. Three empirical factors demonstrated acceptable to good internal consistency, while AI Knowledge and Role Awareness showed lower reliability. These findings suggest that the instrument provides useful preliminary evidence but that its factor structure should be examined further with larger and more diverse samples.

Participants identified a diverse range of AI-related educational technologies, including generative AI systems, AI-enhanced educational platforms, and educational platforms with embedded AI features. These categories differ in both their functionality and instructional purpose. Generative AI systems, such as ChatGPT and Perplexity AI, create original text and other content in response to user prompts. In contrast, AI-enhanced educational platforms, such as MagicSchool AI, Canva AI, Khanmigo, and Curipod, integrate AI features to support instructional planning, content creation, assessment, and student engagement. Other classroom platforms, including Google Classroom, Kahoot, Quizlet, and Padlet, incorporate AI-supported features within broader digital learning environments.

This suggests that preservice teachers perceive AI as a broad collection of technologies that support different aspects of teaching and learning. The popularity of tools such as Canva AI and Curipod also reflects the growing role of AI-supported multimedia and design tools in instructional material development, while platforms such as Kahoot, Padlet, and Quizlet highlight the use of AI-supported technologies for student engagement and interactive learning. From an i-TPACK perspective, interest in a broad range of AI-supported technologies may contribute to preservice teachers' technological knowledge and their ability to consider meaningful pedagogical applications of AI in future classroom settings.

Overall, these findings are consistent with recent studies reporting generally positive perceptions of AI among preservice and in-service teachers (Celik, 2023; Mujahidah et al., 2025). Similar to previous research, participants recognized AI's potential to support teaching while also expressing concerns about ethical use, academic integrity, and the accuracy of AI-generated information. The present study extends this literature by examining not only preservice teachers' perceptions of AI but also the competencies they believe are necessary for responsible AI integration through the i-TPACK framework.

Recognition of AI's instructional value did not prevent participants from raising serious concerns about its integration. Academic dishonesty was one concern, as participants worried that students might use generative AI to complete assignments without fully engaging in the learning process. This concern may reflect the ease with which

generative AI systems can produce essays, written responses, and other academic work, making it more difficult for teachers to determine whether students completed assignments independently. Participants also expressed concerns about the accuracy and reliability of AI-generated information, suggesting that they recognized the limitations of AI outputs and the need to verify information before using it in educational settings. These findings are consistent with previous research identifying academic integrity and unreliable AI-generated information as major challenges associated with AI integration in education (Arslan et al., 2021; Holmes et al., 2021; Kasneci et al., 2023). From the perspective of the i-TPACK framework, these concerns highlight the importance of preparing future teachers to combine technological knowledge with ethical judgment and pedagogical decision-making when integrating AI into assessment, feedback, and classroom instruction.

In addition, participants expressed concern about overreliance on AI technologies and the possibility that excessive dependence on AI could reduce opportunities for independent problem-solving and critical thinking. These concerns may reflect participants' belief that immediate AI-generated responses could discourage students from engaging in deeper reasoning and productive struggle during learning. Similar concerns have been reported in previous research suggesting that generative AI technologies may reduce cognitive engagement when learners rely heavily on automated responses (Kasneci et al., 2023). Preservice teachers also emphasized the importance of maintaining meaningful teacher–student interaction and worried that increased AI use could weaken the relational aspects of teaching and learning. These findings suggest that effective AI integration requires teachers to balance technological capabilities with pedagogical practices that continue to promote critical thinking, collaboration, and meaningful human interaction.

At the same time, existing research suggests that when used intentionally, AI can serve as a valuable instructional support rather than a replacement for teachers. AI technologies may enhance personalized learning, support instructional planning, and reduce administrative workload, allowing educators to focus more on student interaction and pedagogical decision-making (Arslan et al., 2021; Kasneci et al., 2023). Together, the results highlight the importance of preparing preservice teachers to critically evaluate AI technologies and integrate them in ways that support both student learning and human-centered teaching practices. Teacher education programs should provide preservice teachers with opportunities to evaluate AI-generated content, design appropriate classroom activities, and make ethical instructional decisions when using AI-supported technologies. They should also embed AI-related knowledge, ethical reasoning, and practical classroom applications throughout teacher preparation programs rather than presenting AI as a standalone technology topic.

The most frequently identified competency was AI literacy, which refers to understanding how AI systems function and recognizing their capabilities and limitations. Participants emphasized that educators need foundational knowledge of AI technologies in order to use them responsibly and effectively. Prior research similarly identifies AI literacy as an essential competency for educators working with intelligent technologies in educational settings (Long & Magerko, 2020).

Generative AI became particularly relevant to the competency findings because prompt engineering involves interacting with systems that generate new content in response to user input.

Participants emphasized the ability to formulate clear and purposeful prompts that guide generative AI systems to produce meaningful and relevant outputs. As tools such as ChatGPT become increasingly integrated into educational contexts, educators must learn how to interact strategically with AI systems to support instructional planning and learning activities (Kasneci et al., 2023).

Critical evaluation of AI-generated content also emerged as an important competency. Participants highlighted the need to verify AI-generated information and recognize possible inaccuracies, bias, or misinformation. Ethical AI use also emerged as a theme, including awareness of plagiarism, bias, responsible technology use, and academic integrity. These findings are consistent with previous research emphasizing the importance of ethical awareness and professional judgment when integrating AI into educational settings (Holmes et al., 2021; Zawacki-Richter et al., 2019).

Finally, preservice teachers emphasized the importance of maintaining pedagogical balance when integrating AI into classroom instruction. Participants repeatedly noted that AI should support teaching rather than replace teacher expertise, student thinking, or meaningful teacher–student interaction. From an i-TPACK perspective, these findings suggest that effective AI integration involves balancing technological knowledge with pedagogical decision-making and ethical considerations in order to support meaningful and human-centered learning experiences.

Each of the competencies identified in the study related to a component of the i-TPACK framework. AI literacy and prompt engineering reflect the technological knowledge needed to understand and use AI systems. Critical evaluation and pedagogical balance draw on pedagogical and content knowledge because teachers must determine whether AI-generated content aligns with instructional goals and students' needs. Ethical AI use reflects the framework's ethical dimension, including academic integrity, bias awareness, and responsible use. Together, these competencies represent the practical application of i-TPACK in AI-supported classrooms.

Together, these competencies highlight the technological, pedagogical, and ethical knowledge preservice teachers need to integrate AI effectively and responsibly into classroom instruction. Preparing future teachers in these areas may better equip them to use AI in ways that enhance student learning while maintaining sound pedagogical and ethical practices.

6. Conclusions, Implications, Limitations and Future Research

6.1. Conclusions

This study examined how preservice teachers perceive AI and what competencies they believe are effective for integration. The findings indicate that preservice teachers hold moderately favorable attitudes toward AI and recognize its potential to support instructional tasks such as lesson planning, content creation, and student engagement. At the same time, participants expressed concerns about academic integrity, the accuracy of AI-generated information, and overreliance on AI technologies.

The EFA identified four empirical factors that partially corresponded with the original theoretical domains, while reliability varied across the factors. These findings provide preliminary evidence regarding the psychometric characteristics of the survey instrument and indicate the need for further examination with larger and more diverse samples.

The competencies identified by participants align with the i-TPACK framework, which emphasizes the integration of technological knowledge, pedagogical decision-making, and ethical considerations in AI-supported learning environments. What emerges from this study is not a call for more AI in teacher preparation, but for more intentional AI use that is structured, ethically grounded, and connected to real classroom practice. Ultimately, preparing teachers for AI-supported classrooms is less about familiarity with individual tools and more about developing the integrated competencies i-TPACK describes: the technological, pedagogical, and ethical knowledge needed for effective and responsible AI use.

6.2. Implications

The findings of this study have implications for teacher education curriculum design, teacher readiness, and institutional policies supporting responsible AI integration in schools. First, teacher preparation programs should provide structured opportunities for preservice teachers to develop AI literacy and explore instructional applications of AI technologies. AI literacy—including understanding how AI systems function, recognizing their limitations, and critically evaluating AI-generated outputs—has been identified as an essential competency for educators in technology-enhanced learning environments (Long & Magerko, 2020; Ashwin et al., 2023).

Second, field experiences may play an important role in helping preservice teachers understand the instructional potential of AI technologies. Authentic classroom experiences allow preservice teachers to connect theoretical knowledge about educational technologies with instructional challenges. Prior research similarly emphasizes that practicum experiences are important for developing meaningful technology integration skills (Tondeur et al., 2018; Valtonen et al., 2017). Integrating AI-related activities into field experiences may therefore help preservice teachers develop more practical understandings of how AI can support instructional planning, differentiation, and student engagement.

Third, ethics should not be treated as an afterthought in AI-focused teacher preparation. As generative AI technologies become increasingly common in educational settings, future teachers must be prepared to address academic integrity, misinformation, bias, and over-reliance on AI-generated content (Holmes et al., 2021; Kasneci et al., 2023).

Underlying these implications is a consistent message: AI competency in teaching is not a single skill but an integrated set of capacities spanning technology, pedagogy, and ethics. Teacher education programs may therefore benefit from incorporating coursework, instructional modules, or professional learning experiences focused on AI literacy, ethical AI use, critical evaluation of AI-generated information, and pedagogically meaningful applications of generative AI technologies.

6.3. Limitations and Future Research

Although this study provides important insights into preservice teachers' perceptions of AI in education, several limitations should be considered. First, the study was conducted with preservice teachers from a single university, and the sample was drawn from elementary, early childhood, and special education programs, which may limit the generalizability of the findings to other institutions, regions, or secondary preparation programs. Additional research across multiple institutions and geographic regions may provide a broader understanding of AI integration in teacher preparation programs.

Second, the study relied on self-reported survey data, which may be shaped by social desirability and may not fully reflect how preservice teachers actually use AI technologies in instructional settings. Future studies may benefit from incorporating observational methods, classroom-based research, or analyses of instructional practice during field experiences and student teaching.

Third, the survey presented a predefined list of AI tools. Although this ensured that participants responded to a common set of technologies, the reported frequencies represent participants' interest in or perceived relevance of the listed tools rather than their familiarity with or actual use of those tools.

Fourth, the psychometric findings should be considered preliminary because the EFA was conducted with a relatively small sample from one institution. Several items demonstrated cross-loadings, and one empirical factor showed lower reliability. Future studies should examine the factor structure using larger and more diverse samples and confirmatory factor analysis.

Finally, the study focused on preservice teachers' perceptions rather than directly measuring AI-related instructional performance. Longitudinal studies may also help

researchers better understand how teachers' AI-related knowledge and instructional practices develop as they transition into in-service teaching roles.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available from the corresponding author upon reasonable request. The data are not publicly available due to privacy and ethical restrictions associated with human participant research.

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Abbreviations

The following abbreviations are used in this manuscript:

AI	Artificial Intelligence
i-TPACK	Intelligent Technological Pedagogical Content Knowledge
IRB	Institutional Review Board
K–12	Kindergarten through Grade 12
SD	Standard Deviation

Appendix A. Survey Instrument

Appendix A.1. Preservice Teachers AI Survey

Appendix A.1.1. Section 1: Demographic Information

1. Age Group:
 - 20–24
 - 25 and more
2. Gender:
 - Female
 - Male
3. Current Academic Year:
 - Freshman—First year
 - Sophomore—Second Year
 - Junior—Third Year
 - Senior—Fourth Year
4. Specialization/Concentration:

- Elementary Education
 - Early Childhood Education
 - Elem/Special Education
5. Prior Experience with Teaching or Internships:
- Yes
 - No

Instructions: For the following statements, please indicate your level of agreement using the scale provided: Strongly Agree (5), Agree (4), Neutral (3), Disagree (2), Strongly Disagree (1).

Appendix A.1.2. Section 2: Attitudes Towards AI

Please indicate your level of agreement with the following statements:

1. I have sufficient knowledge and can explain what AI means.
2. I know how to exploit the benefits of AI in school.
3. AI changes the role of the educator.

Appendix A.1.3. Section 3: Perception of AI Usefulness

1. I consider myself able to teach using AI.
2. A future teacher must master and use AI.
3. I think there are more advantages to AI than disadvantages.
4. I am willing to use AI in my future teaching career.

Appendix A.1.4. Section 4: Perceived Changes Brought by AI in Education

Please indicate your level of agreement with the following statements about changes AI may bring:

1. Teachers will use AI as a teaching tool.
2. AI will be the virtual assistant of the teacher.
3. AI will be used by learners to customize the learning experience.
4. AI will not change the educational process.
5. AI will replace the teacher.
6. AI will shift the educator's role from traditional instruction to facilitation and mentoring.
7. AI will provide instant and personalized feedback instead of general and delayed feedback.
8. AI will facilitate a shift from mass learning to personalized learning.
9. AI will enable instant lesson design without preplanning.
10. AI will extend learning time outside the classroom.
11. AI will relieve teachers from administrative tasks (e.g., parent feedback, centralization of various situations).

Appendix A.1.5. Section 5: Reasons for Using AI in Education

1. Schoolchildren value the teacher who applies AI.
2. AI will help to improve student-teacher interaction.
3. AI will contribute to improving the learning experience and transitioning to personalized education.
4. I believe there are more future advantages generated by AI than there are disadvantages.
5. I consider myself capable of teaching using AI.
6. I can see myself using AI in my future profession.

Appendix A.2. Multi-Select Questions

- Which of the following AI tools or applications do you find most interesting or relevant for educational use? (Select all that apply).
 - ChatGPT
 - Canva AI
 - Grammarly
 - Magic Schools
 - Kahoot
 - Quizlet
 - Google Classroom
 - Padlet AI
 - Perplexity AI
 - Khanmigo
 - Curipod
 - CoPilot
 - Other: (Please specify)

Negatively worded items: From this survey, these items are negative or potentially opposite in meaning:

AI will not change the educational process

AI will replace the teacher

Section 6: Open-Ended Questions

These questions cover concerns, potential changes, personal experiences, and required competencies, offering a comprehensive view of the topic.

Concerns and Reservations:

What concerns or reservations do you have about integrating AI into educational settings?

Impact on Educators:

How do you think AI will change the role of educators in the future?

Experiences and Observations:

Can you share any experiences or observations you've had with AI in an educational context, either as a student or during your teacher training?

Skills and Knowledge:

In your opinion, what are the most important skills and knowledge future teachers need to effectively use AI in their classrooms?

Please provide any additional comments or thoughts on the use of AI in education.

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