

# The Mediating Effects of Artificial and Ethical Intelligence on the Relationship Between Pedagogical Competence and Preservice Teachers' Performance

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pedagogical competence, artificial intelligence, ethical intelligence, mediation analysis, preservice teachers' performance

**Abstract.** Behind every effective preservice teacher is a blend of competence, technology, and ethical insight. This study investigated the mediating effects of emerging technology and ethical intelligence on the relationship between pedagogical competence and preservice teachers' performance. Using a cross-sectional predictive correlational research design with mediation analysis, the study involved 231 fourth-year preservice teachers from Region X who participated in the 2024 PAFTE ASTER 10 Conference. Validated instruments measured pedagogical competence, use of emerging technology, ethical intelligence, and teaching performance. Data were collected via Google Forms and analyzed in Jamovi, using statistical tools including the mean, standard deviation, Pearson product-moment correlation, and generalized linear model (GLM) mediation analysis. Results revealed that preservice teachers exhibited high levels of pedagogical competence, technology use, and ethical intelligence, particularly in empathetic engagement and professional integrity. Their performance was rated satisfactory in lesson planning, adaptive teaching, professional development, and collaboration. Significant correlations were found between pedagogical competence and performance, as well as between technology use and performance. Ethical intelligence also showed a meaningful relationship with performance. GLM mediation analysis showed that emerging technology partially mediated the relationship between pedagogical competence and performance. Although ethical intelligence was positively related to both pedagogical competence and technology use, it did not significantly mediate the direct relationship with performance. However, its indirect effect, in combination with technology, strengthened this relationship. Pedagogical competence significantly influences preservice teachers' performance, and emerging technology further enhances this effect. Teacher education programs should intensify pedagogy training, integrate technology, and enrich ethical learning to improve professional readiness.

## Introduction

The demands of teacher education are continuously evolving in response to the rapid transformation of educational landscapes driven by technological innovation, learner diversity, and global competence requirements. In this context, pedagogical competence is pivotal in preparing preservice teachers for the multifaceted challenges of 21st-century classrooms. Central to this evolution is the emphasis on pedagogical competence, which encompasses the ability of preservice teachers to effectively integrate content knowledge, pedagogical strategies, and technology into their teaching practices.

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Literature emphasizes the value of integrating various knowledge domains—specifically, technology, pedagogy, and content knowledge, often interlinked within the framework of TPACK (Technological Pedagogical Content Knowledge)—as a foundation for effective teaching. Studies show that preservice teachers who learn in a way that stresses these connections become better at using technology in the classroom, which leads to more student-centered teaching methods (Gao et al., 2009; Tondeur et al., 2016). Their research showed that preservice teachers who take technology-based education courses feel more comfortable and skilled at using student-centered teaching methods. Moreover, pedagogical competence in teacher education is increasingly being framed within culturally responsive pedagogies that acknowledge the diverse backgrounds of students. This approach advocated for a more profound understanding of one's relationship with students as co-creators of knowledge, reinforcing the need for preservice teachers to become aware of their pedagogical decisions and strategies in context (Chong & Cheah, 2009; Burton, 2011). As Burton (2011) emphasized, understanding cultural relevancy is crucial for preservice teachers in music education, where they must navigate and respond to varied musical needs reflective of their students' cultural contexts. Across disciplines, a universal demand for culturally competent educators echoes this sentiment.

Despite the growing recognition of technological advancement and moral responsibility in education, there are significant research gaps in exploring the mediating roles of artificial and ethical intelligences in teacher education. While artificial intelligence (AI) has been increasingly integrated into learning analytics (Chai et al., 2020), its role as a cognitive-enabling mechanism influencing teaching efficacy has not been well-documented. Ethical intelligence, essential in navigating difficult moral decisions in education, is not well-documented in its measured influence on teacher performance. Few studies have sought to understand how these two intelligences could improve or moderate preservice teachers' teaching behaviors and professional readiness. Knowledge of teacher performance does not effectively integrate multi-intelligence models, especially those that extend beyond cognitive and emotional aspects.

Gardner's Multiple Intelligences Theory (2019) broadened knowledge of human capacities, but its practical application in preservice teacher training has mainly stayed with learners rather than with the teachers themselves. This leads to a conceptual gap in understanding how various intelligences, particularly artificial and ethical intelligence, impact the development and advancement of preservice teachers. In the Philippine and Southeast Asian contexts, the exploration of AI and ethical intelligence in teacher education is still in its nascent stage. While there have been initiatives to integrate digital literacy and values education into preservice curricula, there is limited scholarship that connects these elements in a theoretically grounded and empirically tested model (Acedo & Tan, 2021). Furthermore, Southeast Asian nations differ widely in terms of policy support, resource availability, and cultural orientations, which influence how teacher competencies—including ethical discernment and digital fluency—are cultivated (Ng et al., 2020).

This study investigated how ethical intelligence and artificial intelligence mediated the relationship between pedagogical competency and preservice teacher performance in Region 10. Focusing on subject knowledge, instructional design, strategies, differentiation, and adaptation, it evaluates among preservice teachers the degrees of pedagogical competency, AI use, and ethical intelligence. The study rates ethical intelligence according to ethical awareness, professional integrity, sympathetic involvement, and reflective practice. Emphasizing lesson planning, adaptive teaching, constant professional development, and teamwork, it also looks at the general performance of preservice teachers. When AI and EI are taken as mediating variables, the study seeks to determine the overall, direct, and indirect effects of pedagogical competence on teacher performance.

#### *Statement of the Problem*

Specifically, it sought answers to the following questions:

1. What is the level of pedagogical competence among preservice teachers in terms of subject knowledge, instructional design, instructional strategies, and differentiation and adaptation?
2. What is the extent of artificial intelligence use among preservice teachers in terms of AI skills, integration into instruction, adaptability and innovation, and digital citizenship?
3. What is the level of ethical intelligence demonstrated by preservice teachers in terms of ethical awareness, professional integrity, empathetic engagement, and reflective practice?
4. What is the performance of preservice teachers in lesson planning, adaptive teaching practices, continuous professional development, and collaboration and support?
5. Is there a significant relationship between
  - 5.1 pedagogical competence and preservice teachers' performance?
  - 5.2 between pedagogical competence and preservice teachers' performance?
  - 5.3 the use of artificial intelligence and preservice teachers' performance?
  - 5.4 ethical intelligence and preservice teachers' performance?
  - 5.5 pedagogical competence and artificial intelligence?

- 5.6 pedagogical competence and ethical intelligence?
6. Does the extent of Artificial Intelligence use mediate the relationship between pedagogical competence and preservice teachers' performance?
7. Does ethical intelligence mediate the relationship between pedagogical competence and Preservice teachers' performance?
8. What is the total, direct, and indirect effect of pedagogical competence on preservice teachers' performance when both artificial intelligence and ethical intelligence are included as mediators?

#### *Literature Review*

Teacher education programs are increasingly incorporating critical reflection practices alongside pedagogical and cultural competencies. Miftah et al. (2023) advocated for critical reflection as a strategy for developing preservice teachers' pedagogical competencies, suggesting that engaging with reflective practices during teacher training aids in a more profound understanding of instructional methods and enhances overall teaching effectiveness. Mardhatillah (2023) supports this view, noting that preservice teachers enhance their pedagogical knowledge by actively engaging and reflecting in their learning environments.

Meanwhile, the rise of artificial intelligence (AI) in education presents both opportunities and challenges, necessitating a strong focus on ethical intelligence among future educators. As AI technologies increasingly influence educational practices, educators must understand and address the ethical implications associated with this integration. A significant body of literature highlights the transformative potential of AI in personalized learning environments. AI tools enable the customization of learning experiences to meet diverse student needs by utilizing adaptive learning frameworks (Göçen & Aydemir, 2020).

However, the effective implementation of these technologies requires educators to possess not only digital competence but also an ethical understanding of AI's impact on student learning and privacy (Akgün & Greenhow, 2021). As explored by Göçen and Aydemir (2020), AI's capability for personalization is considered a crucial aspect of its educational utility, prompting discussions about the ethical responsibilities of educators who utilize these technologies. Moreover, the integration of AI in educational contexts involves navigating complex ethical considerations surrounding issues such as bias, fairness, and transparency (Jobin et al., 2019; Svetlova, 2022). They argued that establishing robust ethical guidelines is essential for building trust in AI systems used in education. This sentiment is also echoed by Black et al. (2024), who point out the importance of comprehensive educational frameworks that not only train preservice and in-service teachers on effective AI integration but also prepare them to address ethical dilemmas such as algorithmic bias. As educators engage with AI, they must scrutinize the underlying algorithms and ensure equitable outcomes for all students.

Nevertheless, the call for ethical intelligence in education extends beyond awareness to the cultivation of critical analytical skills among future teachers. Yeh et al. (2023) discussed how critical engagement with AI applications in educational settings can empower educators to make informed decisions, balancing the benefits of AI with the ethical implications. Additionally, Zhu and Wang highlighted the necessity of incorporating ethical training into teacher education curricula, promoting an understanding of how AI operates and its potential societal ramifications (D'Souza et al., 2024).

Three relevant theoretical frameworks—technological pedagogical content knowledge (TPACK), multiple intelligences theory, and transformational learning theory—formulate the basis for the study. Introduced by Mishra and Koehler (2006), the TPACK framework emphasizes the interactive integration of technology, pedagogy, and subject matter, thereby building on Shulman's concept of pedagogical content knowledge. TPACK is especially important in modern digital classrooms for understanding how preservice teachers include digital tools and artificial intelligence in their curricula. Recent research shows that teachers with strong TPACK are more suited to design technologically enhanced, pedagogically successful learning environments (Chai, Deng, & Tsai, 2020; Cox & Graham, 2021).

Furthermore, Gardner's (2019) Multiple Intelligences Theory underscores the need for ethical intelligence as a fundamental component in evaluating teacher performance. This perspective traditionally acknowledges various forms of intelligence, including linguistic, logical-mathematical, and interpersonal. Recent uses, however, emphasize that one must have moral and ethical intelligence for professional life. Ethical sensitivity is, according to Tirri and Kuusisto (2020), absolutely essential for guiding teachers' decisions, encouraging integrity, and establishing confidence in learning settings. This framework acknowledges several intelligences and gives an in-depth evaluation of the various competencies of preservice teachers, thereby influencing their performance. Lastly, the transformative learning theory developed by Taylor and Cranton (2019) clarified the process by which people undergo significant changes in perspective via introspection and critical interaction with confusing events. Experiences in teacher preparation often come from negotiating ethical conundrums or handling complex technological environments. Transformative learning clarifies the process by which

preservice teachers absorb and adapt to the criteria of including ethical thinking and artificial intelligence tools in their professional practice. Hoggan (2020) asserted that this transformation enhances self-awareness, autonomy, and commitment to professional development—factors intrinsically linked to improved teaching efficacy. These theoretical models taken together provide a strong foundation for the current research. Multiple Intelligences Theory supports the integration of ethical intelligence in teacher development; TPACK positions artificial intelligence as a necessary pedagogical facilitator; and Transformative Learning Theory helps one to understand the reflective and developmental processes influencing performance. Their combination confirms the multidimensional character of teaching competency in modern education and improves the conceptual rigor of the research.

## Methodology

### *Research Design*

This study employed a causal-comparative research design with a focus on mediation analysis to explore the mediating effects of artificial intelligence and ethical intelligence on the relationship between pedagogical competence and preservice teachers' performance. A causal-comparative design aims to understand how and to what extent certain independent variables, such as pedagogical competence, can influence the dependent variable of preservice teachers' performance (Creswell, 2014). Artificial intelligence and ethical intelligence are examined as mediators in this relationship.

### *Research Locale*

The research was conducted in Region X, a region that includes various tertiary education institutions offering teacher education programs. These thirty-four (34) institutions are members of the Philippine Association for Teacher Education (PAFTE), and the study was carried out during the PAFTE ASTER 10 Conference 2024, which gathers preservice teachers for educational activities and workshops. This setting provided a rich context for studying pedagogical skills, AI, and ethics in teacher education.

### *Research Respondents*

The respondents of this study were fourth-year preservice teachers from the teacher education institutions in Region X who attended the PAFTE ASTER 10 Conference 2024. These participants included 231 preservice teachers, through simple random sampling, ensuring that all preservice teachers had an equal opportunity to participate and minimizing selection bias (Creswell, 2014).

### *Research Instrument*

Data were collected using researcher-made instruments that were carefully validated and tested for reliability. All instruments employed a 4-point Likert scale and were self-assessed by the preservice teachers to represent their perceptions and experiences. The first instrument, the Pedagogical Competence Questionnaire (PCQ), assessed the respondent's perceived pedagogical skills and demonstrated strong internal consistency, with a Cronbach's alpha of 0.87. The second instrument, the Artificial Intelligence Instrument (AII), measured participants' perceived proficiency in using emerging AI technologies in educational settings, with a Cronbach's alpha of 0.91. The third instrument, the Ethical Intelligence Instrument (EII), evaluated preservice teachers' self-perceived ethical decision-making abilities and achieved a Cronbach's alpha of 0.89. Lastly, the Preservice Performance Questionnaire (PPQ) assessed the respondents' perceived overall performance, with a pilot-tested Cronbach's alpha of 0.90. All instruments were thoroughly validated and pilot-tested to ensure reliability and accuracy in measuring the intended variables from the perspective of the preservice teachers.

### *Data Collection Procedure*

Data collection was conducted online during the PAFTE ASTER 10 Conference using Google Forms. During scheduled breaks, the survey link was sent to participants through official conference communication channels. Participants were informed that their responses would remain confidential and that participation was entirely voluntary, with the option to withdraw from the study at any time without any consequences. Informed consent was obtained digitally at the beginning of the online survey form. Once responses were submitted, the data were automatically collected, securely stored, and later coded for analysis. The study strictly followed all ethical rules. The research followed established ethical guidelines, making sure that all participants were treated with respect, their rights were protected, and their data were kept private and safe.

*Data Analysis*

The data were analyzed using Jamovi software, which is well-suited for performing mediation analysis. The analysis followed several steps, starting with descriptive statistics (mean and standard deviation) to summarize the respondents' responses to pedagogical competence, artificial intelligence, ethical intelligence, and preservice teachers' performance. The Pearson product-moment correlation coefficient was computed to explore the relationships between the key variables: pedagogical competence, artificial intelligence, ethical intelligence, and preservice teachers' performance. GLM mediation analysis was used to assess whether artificial intelligence and ethical intelligence mediated the relationship between pedagogical competence and preservice teachers' performance.

**Results and Discussion**

Table 1 presents the level of pedagogical competence among preservice teachers across four key domains: subject knowledge, instructional design, instructional strategies, and differentiation and adaptation. The overall pedagogical competence of the preservice teachers was rated as very highly competent (M = 3.66, SD = 0.44). Among the components, subject knowledge received the highest rating (M = 3.69, SD = 0.41), closely followed by instructional design (M = 3.68, SD = 0.44). Both instructional strategies and differentiation and adaptation received slightly lower but still strong ratings (M = 3.63, SD = 0.44; M = 3.63, SD = 0.46, respectively), indicating consistent perceptions of competence across all dimensions. Preservice educators exhibit the highest degree of self-efficacy regarding subject-matter expertise, which serves as the cornerstone of proficient pedagogical practice, as well as notable proficiency in instructional design, thereby indicating effective lesson formulation and objective alignment. Despite instructional methodologies and differentiation exhibiting marginally lower confidence levels, they still fall within an exceptionally elevated range, indicating an emerging aptitude for applying theoretical constructs across varied classroom environments. These results corroborate the assertions made by Afalla and Fabelico (2020) and Zhang et al. (2017), who emphasized the importance of subject mastery and instructional design as fundamental competencies in teacher education. Ajani (2024) similarly identified difficulties in applying theoretical knowledge to adaptive instructional practices. In summary, teacher education programs within Region 10 are successfully cultivating essential competencies; however, integrating enhancement activities, microteaching, collaborative planning, and inclusive practicum experiences could further strengthen instructional methodologies and differentiation, thereby promoting comprehensive preparedness for 21st-century teaching.

<b>Constructs</b>	<b>M</b>	<b>SD</b>	<b>Descriptive Level</b>
Subject Knowledge	3.69	0.41	Very Highly Competent
Instructional Design	3.68	0.44	Very Highly Competent
Instructional Strategies	3.63	0.44	Very Highly Competent
Differentiation and Adaptation	3.63	0.46	Very Highly Competent
Overall Competence	3.66	0.44	Very Highly Competent

*Scale: 3.25-4.0(Very Highly Competent); 2.50-3.24(Highly Competent); 1.75-2.49 (Less Competent); 1.0-1.74 (Not Competent)*

*Table 1. Level of Pedagogical Competence Among Preservice Teachers*

Table 2 presents the extent of artificial intelligence use among preservice teachers, as measured across five components: technical skills, integration into instruction, adaptability and innovation, pedagogical knowledge, and digital citizenship and ethics. Overall, preservice teachers reported using artificial intelligence to a very great extent (M = 3.49, SD = 0.50). Among the specific indicators, pedagogical knowledge was rated the highest (M = 3.57, SD = 0.50), closely followed by digital citizenship and ethics (M = 3.56, SD = 0.51) and integration into instruction (M = 3.53, SD = 0.50). Adaptability and innovation also scored well (M = 3.48, SD = 0.51), while technical skills had the lowest rating within the group, though still within the "very great extent" range (M = 3.31, SD = 0.50).

The findings reveal that preservice teachers exhibit high confidence in using emerging technologies within pedagogical frameworks, particularly in pedagogical knowledge, digital citizenship, ethics, and instructional integration. These outcomes indicate a robust awareness of AI's educational significance and its responsible application in lesson planning and execution. Nevertheless, the marginally lower mean in technical skills indicates a need for enhanced support in mastering specific digital tools. These trends correspond with Guan et al. (2025), who demonstrated that explicit AI literacy and AI-integrated design initiatives bolster confidence and competence, particularly when supplemented by mentorship and authentic practice. Simultaneously, Finnerty (2024) noted that while many educators appreciate AI, they often lack practical experience with platforms such as learning management systems and analytics tools.

These findings demonstrate that existing teacher education programs effectively foster pedagogical and ethical readiness for AI utilization, yet they must bolster technical training. Implementing targeted workshops, simulation-based training, and guided exploration of digital platforms can further enhance preservice teachers' technical skills and facilitate effective, responsible technology integration in contemporary classrooms.

Constructs	M	SD	Descriptive Extent
Artificial Intelligence Skills	3.31	0.50	Very Great Extent
Integration into Instruction	3.53	0.50	Very Great Extent
Adaptability and Innovation	3.48	0.51	Very Great Extent
Pedagogical Knowledge	3.57	0.50	Very Great Extent
Digital Citizenship	3.56	0.51	Very Great Extent
Overall Extent of AI Use	3.49	0.50	Very Great Extent

*Scale: 3.25-4.0(Very Great Extent); 2.50-3.24(Great Extent); 1.75-2.49 (Less Extent); 1.0-1.74 (Least Extent)*

*Table 2. Extent of Artificial Intelligence Use Among Preservice Teachers*

Table 3 presents the level of ethical intelligence demonstrated by preservice teachers, measured in terms of ethical awareness, professional integrity, empathetic engagement, and reflective practice. The overall level of ethical intelligence among preservice teachers was found to be very high (M = 3.66, SD = 0.49). Among the components, empathetic engagement obtained the highest mean (M = 3.71, SD = 0.49), closely followed by professional integrity (M = 3.70, SD = 0.49). Reflective practice also scored relatively high (M = 3.65, SD = 0.50), while ethical awareness recorded the lowest mean among the indicators but still within the “very high level” range (M = 3.57, SD = 0.49).

Preservice teachers exhibit considerable ethical intelligence, especially in empathy, integrity, and reflection, reflecting a commitment to compassion and self-assessment. Ethical awareness, while slightly lower, still indicates a robust moral foundation. These findings align with Campbell (2014), who identified honesty, respect, and fairness as essential ethical characteristics, while Campbell (2005) and Mushtaq and Atique (2024) noted ongoing difficulties in applying ethical standards. Mouta et al. (2025) noted that some preservice teachers perceive current ethical codes as antiquated, underscoring the necessity for contextualized instruction. Although current ethics training is deemed effective, enhancing theoretical frameworks, case-based discussions, and reflective practices could further enrich ethical awareness and equip future educators for intricate classroom challenges.

Constructs	M	SD	Descriptive Level
Ethical Awareness	3.31	0.50	Very High
Professional Integrity	3.53	0.50	Very High
Empathetic Engagement	3.48	0.51	Very High
Reflective Practice	3.57	0.50	Very High
Overall Level of Ethical Intelligence	3.49	0.50	Very High

*Scale: 3.25-4.0(Very High); 2.50-3.24(High); 1.75-2.49 (Low); 1.0-1.74 (Very Low)*

*Table 3. Level of Ethical Intelligence Demonstrated by Preservice Teachers*

Table 4 presents the performance level of preservice teachers in their teaching internship in the areas of lesson planning, adaptive teaching practices, continuous professional development, and collaboration and support. The overall performance of preservice teachers was rated as satisfactory (M = 3.17, SD = 0.70), and among the specific indicators, cooperation and support recorded the highest mean (M = 3.19, SD = 0.68), followed closely by adaptive teaching practices (M = 3.18, SD = 0.69) and continuous professional development (M = 3.17, SD = 0.70). Lesson planning received the lowest mean score (M = 3.14, SD = 0.72) but still fell within the “satisfactory” range.

Preservice teachers generally meet performance expectations, particularly in collaboration and support, indicating effective engagement with peers and the school community. The lower mean in lesson planning suggests a need for improvement in designing coherent instructional plans that meet diverse student needs. While adaptive teaching practices show promise, there is potential for enhancing professional development to achieve higher satisfaction levels.

Flores (2019) noted preservice teachers excel in collaborative environments, linked to strong mentoring and peer interactions, aligning with the current study's findings. Greenberg et al. (2014) observed that student teachers exhibit increased flexibility in classroom management as they gain experience, reinforcing the positive performance in this area. Conversely, El-Annan & Hassoun (2025) highlighted lesson planning as a persistent weakness among preservice teachers, reflecting challenges in content-objective alignment. Grima-Farrell (2015) noted that while preservice teachers are eager

about professional development, their engagement lacks depth, underscoring the need for comprehensive programs. Collectively, these studies validate the current results and emphasize the importance of structured support in lesson planning and ongoing professional learning for enhancing internship performance.

Despite strengths in collaboration, targeted support for lesson planning improvement is essential, potentially through model-based instruction, guided workshops, or peer critiques. Additionally, institutionalized opportunities for adaptive teaching practices, such as simulations or differentiated strategies, could enhance classroom flexibility. Enhancing professional development sessions and reflective activities may foster a proactive growth mindset among preservice teachers.

Constructs	M	SD	Descriptive Level
Lesson Planning	3.14	0.72	Very High
Adaptive Teaching Practices	3.18	0.69	Very High
Continuous Professional Development	3.17	0.70	Very High
Collaboration And Support	3.19	0.68	Very High
Overall Performance	3.17	0.70	Very High

Scale: 3.25-4.0 (Very Satisfactory); 2.50-3.24 (Satisfactory); 1.75-2.49 (Fair); 1.0-1.74 (Poor)

*Table 4. Performance of Preservice Teachers in their Teaching Internship*

Table 5 delineates a robust positive correlation between pedagogical competence and the performance of preservice educators, with all correlations reaching significance at  $p < .05$ . Subject knowledge exhibits a moderate association with overall performance and critical domains, including lesson planning, adaptive teaching, professional development, and collaboration, thereby emphasizing the significance of content mastery. Instructional design reveals stronger connections to performance, particularly in the spheres of adaptive teaching and professional development, underscoring the importance of systematically organized lesson frameworks. Knowledge of instructional strategies manifests even stronger correlations across all performance domains, thereby reinforcing the critical role of effective pedagogical techniques. Differentiation and adaptation emerge as the most potent predictors, with the highest correlations with overall performance, lesson planning, adaptive teaching, professional development, and collaboration, thereby underscoring the impact of responsive instruction tailored for diverse learners. Pedagogical competence is strongly correlated with preservice performance and its constituent components, thereby affirming its pivotal role in bolstering teaching readiness, instructional effectiveness, ongoing professional development, and collaborative practice among prospective educators.

Pedagogical content knowledge is essential for effective lesson planning and adaptive instruction (Jacob et al., 2020). Instructional strategies empower preservice teachers to make pedagogical decisions that enhance engagement and achievement (Verma, 2024). Pedagogical knowledge correlates positively with teaching readiness and classroom effectiveness (König et al., 2014), while differentiated instruction significantly influences performance and professional development (Valiandes, 2015). Effective mentoring and feedback enhance collaboration and reflective practices during internships (Calamlam & Mokshein, 2019). These results underscore the necessity for teacher education programs and partner schools to improve internship training through instructional design workshops, differentiation-centered mentoring, and specific feedback, thereby facilitating responsive coaching that supports pedagogical advancement, reflective practices, and enduring teaching effectiveness.

Variables		Lesson Planning	Adaptive Teaching Practices	Adaptive Teaching Practices	Collaboration And Support	Overall Performance
Subject Knowledge	<i>r</i>	0.236***	0.240***	0.247***	0.211***	0.246
	<i>p</i>	<.001	<.001	<.001	0.001	<.001
Instructional Design	<i>r</i>	0.292***	0.337***	0.354***	0.288***	0.334
	<i>p</i>	<.001	<.001	<.001	<.001	<.001
Instructional Strategies	<i>r</i>	0.348***	0.381***	0.397***	0.323***	0.381
	<i>p</i>	<.001	<.001	<.001	<.001	<.001
Differentiation and Adaptation		0.406***	0.413***	0.434***	0.363	0.425
		<.001	<.001	<.001	<.001	<.001
Overall Competence	<i>r</i>	0.358***	0.383***	0.400***	0.330	0.387
	<i>p</i>	0.236	<.001	<.001	<.001	<.001

*P* value Scale: \*\*\*  $p < .001$  (Highly Significant); \*\*  $p < 0.01$  (Highly Significant); \*  $p < 0.05$  (Significant);  $p > 0.05$  (Not significant)

*Table 5. Significant Relationship between pedagogical competence and preservice teachers' performance*

Table 6 reveals a significant correlation between the utilization of artificial intelligence and preservice teachers' performance across various domains. All AI-related factors demonstrated significant positive correlations with performance ( $p$ -values  $< 0.05$ ), providing strong associative evidence. Data indicate that preservice teachers who use emerging technologies excel in lesson planning, adaptive teaching, professional development, and collaboration, as evidenced by significant correlation coefficients. Moreover, those who demonstrate innovation and adaptability with AI show favorable performance trends, as reflected in a strong correlation with overall performance. Technological pedagogical knowledge is found to significantly improve preservice teachers' performance by enhancing the integration of content and digital tools in instruction.

Additionally, while digital citizenship and ethics exhibit lower correlation coefficients, they remain significantly associated with performance factors, which emphasizes the value of ethical AI use in teacher preparation. The aggregate score for AI usage shows a positive correlation with preservice teachers' performance, illustrating the importance of technological proficiency in teacher education. These findings advocate for the inclusion of AI technologies in educational practices as vital for developing proficient and effective educators.

Integrating AI in teacher training improves lesson planning and enhances student engagement (Sabri et al., 2024). Preservice teachers with robust technological, pedagogical, and content knowledge can better design adaptable lessons using AI tools (Oved & Alt, 2025), aligning with the TPACK framework's integration of content, pedagogy, and digital skills (Belda-Medina & Calvo-Ferrer, 2022). AI-supported training fosters reflective practice and professional collaboration (Zhang, nd), while promoting ethical teaching through AI literacy and digital citizenship (Yingsoon et al., 2025). Thus, teacher education programs should incorporate structured technology training and ethical instruction to equip preservice teachers for innovative teaching in modern classrooms.

Variables		Lesson Planning	Adaptive Teaching Practices	Adaptive Teaching Practices	Collaboration And Support	Overall Performance
AI skills	$r$	0.319	0.367	0.353	0.372	0.370
	$p$	<.001	<.001	<.001	<.001	<.001
Integration into Instructions	$r$	0.310	0.311	0.321	0.316	0.331
	$p$	<.001	<.001	<.001	<.001	<.001
Adaptability and Innovation	$r$	0.323	0.360	0.349	0.356	0.365
	$p$	<.001	<.001	<.001	<.001	<.001
Pedagogical Knowledge	$r$	0.307	0.296	0.325	0.325	0.330
	$p$	<.001	<.001	<.001	<.001	<.001
Digital Citizenship	$r$	0.172	0.191	0.237	0.237	0.220
	$p$	0.009	0.004	<.001	<.001	<.001
Overall Extent of AI Use		0.326	0.347	0.361	0.366	0.368
		<.001	<.001	<.001	<.001	<.001

*P value Scale: \*\*\*  $p < .001$  (Highly Significant); \*\*  $p < 0.01$  (Highly Significant); \*  $p < 0.05$  (Significant);  $p > 0.05$  (Not significant)*

*Table 6. Significant Relationship between the extent of use of artificial intelligence and preservice teachers' performance*

Table 7 reveals a notable correlation between ethical intelligence and preservice teachers' performance across domains, including lesson planning and collaboration, with varying strength of association. Ethical awareness is strongly associated with performance across all areas, indicating that preservice teachers with high ethical awareness are better at teaching and collaborating with others.

Professional integrity has positive but weaker correlations with teacher performance, notably in professional development and collaboration, yet exhibits non-significant associations with lesson planning and adaptive practices. Empathetic engagement presents the weakest correlations, indicating limited predictive value for preservice performance in this domain.

Reflective practice is identified as the most influential contributor to performance, showing substantial correlations across all areas, suggesting that self-assessment enhances teaching effectiveness. In conclusion, ethical intelligence significantly correlates with preservice teacher performance, particularly in professional development and collaboration, illustrating the value of ethical dispositions in educator effectiveness.

Fostering ethical sensibilities enhances instructional decision-making and classroom engagement, particularly through reflective practice (Nasir et al., 2024). Ethical awareness and professional integrity form a moral basis for adaptive teaching and collaboration (Kumar, 2024), while empathy and fairness foster thoughtful teaching behaviors over time (Meyers et al.,

2019). Ethical sensitivity, particularly awareness, correlates positively with professional values and reflective practice, enhancing preservice performance (Chen et al., 2025). Nonetheless, ethical character does not consistently predict short-term performance unless ethical development is intentionally incorporated into training (Wells & Schminke, 2001). Its impact becomes more reliable when integrated via case-based learning, mentoring, and feedback (Warnick & Silverman, 2011; Thiel et al., 2013). Therefore, teacher education must systematically include ethical discussions, reflection, and practicum guidance to cultivate competent, morally grounded, and professionally responsible educators.

Variables		Lesson Planning	Adaptive Teaching Practices	Adaptive Teaching Practices	Collaboration And Support	Overall Performance
Ethical Awareness	<i>R</i>	0.214	0.203	0.243	0.222	0.232
	<i>P</i>	0.001	0.002	<.001	<.001	<.001
Professional Integrity	<i>R</i>	0.125	0.122	0.159	0.146	0.145
	<i>P</i>	0.058	0.064	0.016	0.026	0.027
Empathetic Engagement	<i>R</i>	0.082	0.102	0.135	0.109	0.112
	<i>P</i>	0.217	0.122	0.040	0.099	0.089
Reflective Practice	<i>R</i>	0.202	0.257	0.285	0.267	0.265
	<i>P</i>	0.002	<.001	<.001	<.001	<.001
Overall Ethical Intelligence	<i>R</i>	0.170	0.187	0.224	0.203	0.206
	<i>P</i>	0.010	0.004	<.001	0.002	0.002

*P* value Scale: \*\*\* *p* < .001 (Highly Significant); \*\**p* < 0.01 (Highly Significant); \**p* < 0.05 (Significant); *p* > 0.05 (Not significant)

Table 7. Significant Relationship between the extent of use of Ethical Intelligence and preservice teachers' performance

Table 8 indicates a significant relationship between pedagogical competence and artificial intelligence across various dimensions. Subject knowledge correlates well with AI integration and adaptability, suggesting mastery aids technology application. Instructional design shows a strong connection to AI competencies, implying that effective planners leverage digital tools for learning enhancement. Knowledge of instructional strategies is closely tied to AI integration and innovation, emphasizing the impact of effective teaching methods on technology use. Differentiation and adaptation are strongly associated with all AI indicators, underscoring the need for flexible teaching to support technology implementation. In summary, pedagogical competence is highly correlated with artificial intelligence, especially in adaptability, innovation, and instructional integration, reinforcing that strong pedagogical foundations facilitate effective and ethical AI application in education. Pedagogical content knowledge is paramount for the effective integration of artificial intelligence, ensuring alignment with educational objectives and learners' needs (Yue et al., 2025). Educators with robust instructional design capabilities are more likely to implement AI within student-centered pedagogical frameworks, in line with research linking instructional design and differentiation to AI competencies such as adaptability and innovation (Ginting et al., 2024). Educators demonstrating pedagogical proficiency also leverage AI to facilitate differentiated instruction and provide personalized feedback (Zhang & Yang, 2023; Oladele, 2024). Nonetheless, resistance persists due to ethical dilemmas, concerns about data privacy, and inadequate institutional support (Miao et al., 2020; Farooqi et al., 2024). Consequently, while pedagogical expertise promotes the utilization of AI, systemic factors continue to exert a significant influence. Teacher education programs should incorporate AI into pedagogical training and professional development (Alyammahi, 2020) to equip educators to create equitable, innovative, and future-oriented learning environments.

Variables		Lesson Planning	Adaptive Teaching Practices	Adaptive Teaching Practices	Collaboration And Support	Overall Extent of AI Use
Subject Knowledge	<i>r</i>	0.398	0.473	0.549	0.511	0.505
	<i>p</i>	<.001	<.001	<.001	<.001	<.001
Instructional Design	<i>r</i>	0.340	0.451	0.475	0.419	0.394
	<i>p</i>	<.001	<.001	<.001	<.001	<.001
Instructional Strategies	<i>r</i>	0.406	0.509	0.522	0.468	0.459
	<i>p</i>	<.001	<.001	<.001	<.001	<.001
Differentiation and Adaptation	<i>r</i>	0.379	0.521	0.514	0.482	0.481
		<.001	<.001	<.001	<.001	<.001
Overall Competence	<i>r</i>	0.422	0.542	0.570	0.520	0.509
	<i>p</i>	<.001	<.001	<.001	<.001	<.001

*P* value Scale: \*\*\* *p* < .001 (Highly Significant); \*\**p* < 0.01 (Highly Significant); \**p* < 0.05 (Significant); *p* > 0.05 (Not significant)

Table 8. Significant Relationship Between Pedagogical Competence and Extent of Artificial Intelligence

Table 9 indicates a significant correlation between pedagogical competence and ethical intelligence across all factors. Subject knowledge shows the strongest correlations with professional integrity and moral awareness, suggesting that mastery enhances ethical reasoning. Instructional design correlates strongly with ethical intelligence and awareness, indicating that well-planned lessons enhance ethical sensitivity. Knowledge of instructional strategies is closely linked to reflective practice and empathetic engagement, underscoring the ethical aspects of effective teaching. Reflective practice and overall ethical intelligence are closely related to differentiation and adaptation, underscoring the moral imperative to address diverse learners. Pedagogical competence is significantly associated with ethical intelligence, particularly in reflective practice and professional integrity, emphasizing the role of teaching expertise in fostering ethical and reflective educators.

Ethical sensitivity and moral reasoning are integral to teacher professionalism and closely linked to pedagogical expertise (Campbell, 2014). Teachers with strong content knowledge and instructional mastery tend to demonstrate higher ethical awareness and professional integrity, consistent with findings showing subject knowledge as a key correlate of ethical engagement. Ethical intelligence, marked by empathy and reflective thinking, flourishes when supported by sound instructional design and adaptive teaching practices (Smolina et al., 2023; Tomlinson et al., 2023). However, pedagogical skill alone does not ensure ethical conduct, as moral reasoning requires intentional development (Holland et al., 2012). Thus, pedagogical competence and ethical intelligence are mutually reinforcing. Integrating ethics-focused modules into teacher education strengthens both instructional quality and moral accountability (Gulevska & Atanasoska, 2015), preparing future educators to navigate complex classroom realities with integrity and compassion.

Variables		Ethical Awareness	Professional Integrity	Empathetic Engagement	Reflective Practice	Overall Level of Ethical Intelligence
Subject Knowledge	<i>r</i>	0.584	0.614	0.557	0.575	0.635
	<i>p</i>	<.001	<.001	<.001	<.001	<.001
Instructional Design	<i>r</i>	0.457	0.522	0.534	0.549	0.562
	<i>p</i>	<.001	<.001	<.001	<.001	<.001
Instructional Strategies	<i>r</i>	0.528	0.507	0.530	0.582	0.585
	<i>p</i>	<.001	<.001	<.001	<.001	<.001
Differentiation and Adaptation	<i>r</i>	0.531	0.554	0.566	0.623	0.620
	<i>p</i>	<.001	<.001	<.001	<.001	<.001
Overall Competence	<i>r</i>	0.580	0.607	0.606	0.646	0.664
	<i>p</i>	<.001	<.001	<.001	<.001	<.001

*P* value Scale: \*\*\* *p* < .001 (Highly Significant); \*\**p* < 0.01 (Highly Significant); \**p* < 0.05 (Significant); *p* > 0.05 (Not significant)

*Table 9. Significant Relationship between pedagogical competence and ethical intelligence*

Table 10 presents a mediation analysis assessing the mediating role of artificial intelligence use in the relationship between pedagogical competence and preservice teachers' performance. The total effect of pedagogical competence on performance was significant ( $B = 0.65, p < .001$ ), underscoring its predictive strength. The direct effect remained significant after adjusting for AI use ( $B = 0.44, p < .001$ ), while the indirect effect via AI was also significant ( $B = 0.21, p = .005$ ), suggesting partial mediation. Approximately 32.5% of the total effect was mediated through AI, with 67.5% remaining as a direct effect. Path estimates indicated that pedagogical competence was a significant predictor of AI use ( $B = 0.66, p < .001$ ), and AI use was a significant predictor of performance ( $B = 0.32, p = .003$ ). These findings illustrate that AI notably enhances the connection between pedagogical competence and preservice teaching performance.

The findings suggest that artificial intelligence serves as a partial mediator in the nexus between pedagogical competence and preservice teaching efficacy, indicating that competence affects performance both directly and indirectly through the adept utilization of AI technologies. This partial mediation underscores the enhancement of robust pedagogical foundations when they are synergistically integrated with deliberate technological applications. Preservice educators exhibiting elevated pedagogical competence demonstrate a greater propensity to effectively adopt and implement AI tools, thereby augmenting lesson delivery, differentiation, and student engagement (Almuhanna, 2024; Choi et al., 2023). These results resonate with the TPACK framework (Koehler & Mishra, 2009), which emphasizes the interrelationships among pedagogy, content, and technology in effective teaching, and corroborate the notion that AI facilitates reflective practice and data-driven decision-making (Wang, 2021).

Nevertheless, the mediation remains only partial, as pedagogical competence continues to account for the majority of performance variance. Researchers caution against an overreliance on AI in the absence of a robust pedagogical foundation, as this may engender superficial teaching practices and undermine authentic interactions between educators and students

(da Silva, 2024; Knox, 2020), thereby reinforcing the argument that AI cannot supplant professional judgment, ethical discernment, or instructional profundity (Khreisat et al., 2024). These findings highlight the imperative for teacher education programs to incorporate AI training into pedagogical frameworks, augmented by faculty demonstrations of effective instructional design and technological proficiency. Ultimately, preservice performance optimization occurs when pedagogical competence and digital literacy evolve concurrently within a cohesive, practice-centered paradigm.

Effect	Label Estimate	SE	95% Confidence Interval		Z	P	% Mediation	
			Lower	Upper				
Indirect	a x b	0.211	0.0746	0.0652	0.358	2.83	0.005	32.5
Direct	c	0.439	0.1233	0.1970	0.681	3.56	<.001	67.5
Total	c+a x b	0.650	0.1020	0.4503	0.850	6.38	<.001	100.0
<b>Path Estimates</b>								
Pedagogical Competence	→ AI Use	a	0.655	0.0599	0.538	0.773	10.93	<.001
AI Use	→ Performance	b	0.323	0.1099	0.107	0.538	2.94	0.003
Pedagogical Competence	→ Performance	c	0.439	0.1233	0.197	0.681	3.56	<.001

*Table 10. Mediation Analysis on the extent to which artificial intelligence mediates the relationship between pedagogical competence and preservice teachers' performance*

Table 11 presents a mediation analysis of ethical intelligence's role in the relationship between pedagogical competence and preservice teachers' performance. Pedagogical competence exerted a significant effect on performance ( $B = 0.65, p < .001$ ), underscoring its pivotal influence on educational outcomes. The direct effect remained significant when ethical intelligence was controlled ( $B = 0.75, p < .001$ ), whereas the indirect effect via ethical intelligence was insignificant ( $B = -0.10, p = .261$ ). Pedagogical competence was a strong predictor of ethical intelligence ( $B = 0.76, p < .001$ ), yet ethical intelligence did not significantly predict performance ( $B = -0.13, p = .259$ ). Mediation accounted for only 11.9% of the total effect, with 88.1% stemming from the direct effect, illustrating that pedagogical competence is the primary driver of preservice teaching performance independent of ethical intelligence.

The results suggest that while pedagogical proficiency serves as a robust predictor of preservice educators' performance, ethical intelligence does not significantly moderate this association. Despite the considerable influence of pedagogical competence on ethical intelligence, this effect fails to translate into measurable improvements in teaching efficacy, suggesting either a weak or non-linear relationship. One possible rationale for this observation is that assessments for preservice educators predominantly emphasize instructional delivery, classroom management, and technical skills, thereby affording minimal opportunity to evaluate ethical awareness, empathy, or reflective practices.

Furthermore, limitations in measurement may obscure the ethical impacts, as short-term, controlled teaching experiences seldom capture the long-term effects of moral dispositions. Ethical considerations arguably contribute more significantly to teacher identity and professional development than to immediate performance indicators (Tirri & Kuusisto, 2022), and assessment frameworks tend to prioritize pedagogical execution over moral reasoning (Karp & Woods, 2008). Nonetheless, certain studies contend that ethical behaviors promote inclusive environments and foster improved interpersonal relationships within the classroom (Borich, 2014; Miller, 2024), as well as enhance decision-making capabilities in complex scenarios (Kumar, 2024; Tirri, 2019). In conclusion, although pedagogical competence is essential, teacher education programs must intentionally integrate ethical reasoning with practical teaching methods through simulations, case-based learning, and reflective practices.

Effect	Label Estimate	SE	95% Confidence Interval		Z	p	% Mediation	
			Lower	Upper				
Indirect	a x b	-0.102	0.0907	-0.280	0.0757	-1.13	0.261	11.9
Direct	c	0.752	0.1361	0.486	1.0189	5.53	<.001	88.1
Total	c+a x b	0.650	0.1020	0.450	0.8501	6.38	<.001	100.0
<b>Path Estimates</b>								

Pedagogical Competence	→ Ethical Int.	a	0.760	0.0562	0.650	0.8700	13.51	<.001
Ethical Int	→ Performance	b	-0.134	0.1190	-0.368	0.0989	-1.13	0.259
Pedagogical Competence	→ Performance	c	0.752	0.1361	0.486	1.0189	5.53	<.001

*Table 11. Mediation analysis on the role of ethical intelligence on the relationship between pedagogical competence and preservice teachers' performance*

Table 12 presents a GLM mediation analysis examining the influence of pedagogical competence on preservice teachers' performance, with artificial intelligence and ethical intelligence as mediators (N = 231). A significant direct effect of pedagogical competence on performance was found ( $\beta = 0.375, p < .001$ ), signifying a moderate independent effect. Three indirect pathways were identified. The pathway through ethical intelligence alone exhibited a significant negative effect, suggesting a suppression effect in which heightened ethical intelligence was associated with diminished performance. Conversely, the pathway through artificial intelligence was both positive and significant, indicating that pedagogical competence facilitated AI utilization, which strongly correlated with enhanced performance. A sequential pathway incorporating both ethical and artificial intelligence produced favorable outcomes, indicating that ethical considerations enhanced AI integration and led to improved results. In summary, pedagogical competence remained a robust predictor of performance ( $\beta = 0.387, p < .001$ ). The incorporation of mediators augmented model fit, enhancing explained variance from 15% to 21.6%, underscoring the synergistic roles of technology and ethics in teacher preparation. Pedagogical competence is a significant predictor of the incorporation of artificial intelligence in educational contexts, indicating that educators with robust skills in instructional planning and classroom management are more likely to integrate AI-driven tools into their teaching methodologies (Zhang & Zhang, 2024). Supporting this assertion, educators with a high degree of technological proficiency and a solid understanding of pedagogy are inclined to use AI to augment personalization and operational efficiency, thereby contributing to improved student performance (Alam & Mohanty, 2023). The sequential mediation framework, in which ethical intelligence facilitates the use of AI and subsequently enhances performance outcomes, is consistent with the findings of Olan et al. (2022), who posited that educators with heightened awareness of ethical considerations tend to adopt emerging technologies with greater intentionality, resulting in improved pedagogical effectiveness. In a similar vein, Marín & Tur (2024) underscored the significance of value-oriented digital competence, demonstrating that ethical considerations shape responsible technology usage and amplify educational outcomes. Conversely, the detrimental mediating role of ethical intelligence between pedagogical competence and performance departs from prevailing scholarly discourse. Tirri (2019) posited that an elevated sense of ethical sensitivity may prompt educators to reevaluate their decisions or confront moral dilemmas, temporarily undermining their confidence or delaying their actions. Additionally, Tirri and Husu (2013) noted that an increase in ethical engagement can exacerbate self-reflection and caution, potentially hindering prompt decision-making. Hence, while pedagogical competence remains a pivotal element, the relevance of AI accentuates the necessity for technological literacy; thus, teacher education programs ought to incorporate ethical reasoning alongside digital pedagogy to enhance instructional efficacy.

Type	Effect	Estimate	SE	95% C.I. (a)		$\beta$	z	p
				Lower	Upper			
Indirect	PEDAGOGICAL COMPETENCIES ⇒ ETHICAL INTELLIGENCE ⇒ PERFORMANCE	-0.1323	0.0417	-0.2141	-0.0505	-0.1993	-3.17	0.002
	PEDAGOGICAL COMPETENCIES ⇒ ARTIFICIAL INTELLIGENCE ⇒ PERFORMANCE	0.0483	0.0184	0.0122	0.0844	0.0728	2.62	0.009
	PEDAGOGICAL COMPETENCIES ⇒ ETHICAL INTELLIGENCE ⇒ ARTIFICIAL INTELLIGENCE ⇒ PERFORMANCE	0.0920	0.0246	0.0439	0.1401	0.1386	3.75	<.001
Component	PEDAGOGICAL COMPETENCIES ⇒ ETHICAL INTELLIGENCE	0.3001	0.0222	0.2566	0.3437	0.6644	13.51	<.001
	ETHICAL INTELLIGENCE ⇒ PERFORMANCE	-0.4408	0.1351	-0.7057	-0.1760	-0.2999	-3.26	0.001
	PEDAGOGICAL COMPETENCIES ⇒ ARTIFICIAL INTELLIGENCE	0.0891	0.0268	0.0365	0.1418	0.2011	3.32	<.001
	ARTIFICIAL INTELLIGENCE ⇒ PERFORMANCE	0.5421	0.1268	0.2936	0.7906	0.3619	4.28	<.001
	ETHICAL INTELLIGENCE ⇒ ARTIFICIAL INTELLIGENCE	0.5654	0.0594	0.4489	0.6819	0.5762	9.51	<.001
Direct	PEDAGOGICAL COMPETENCIES ⇒ PERFORMANCE	0.2488	0.0530	0.1450	0.3526	0.3748	4.70	<.001
Total	PEDAGOGICAL COMPETENCIES ⇒ PERFORMANCE	0.2568	0.0404	0.1777	0.3359	0.3869	6.36	<.001

*Table 12. Mediation Analysis on the Role of Artificial Intelligence and Ethical Intelligence of the Relationship Between Pedagogical Competence and Performance Among Preservice Teachers*

## Conclusion and Implications

Preservice teachers exhibit high levels of pedagogical competence, effectively integrate emerging technology in their instructional practices, and demonstrate strong ethical intelligence, particularly in terms of empathetic engagement and professional integrity. These competencies positively influence their teaching performance, with significant relationships observed between pedagogical competence, the use of emerging technology, ethical intelligence, and performance. The use of emerging technology serves as a partial mediator between pedagogical competence and preservice teachers' performance, whereas ethical intelligence does not significantly mediate this relationship. Pedagogical competence stands out as a strong predictor of preservice teachers' performance, and the indirect influence of both emerging technology and ethical intelligence further enhances its direct impact. These findings underscore the importance of fostering pedagogical skills, integrating technology, and promoting ethical values to improve the overall performance of preservice teachers.

## Recommendations

Teacher education programs can enhance ethical intelligence through workshops and case studies that facilitate preservice teachers' analysis of ethical challenges. To improve technology integration, training on emerging educational tools should be provided by program coordinators and IT specialists. Pedagogical competence can be advanced via expanded internships and mentorships that offer authentic teaching experiences and feedback. Further research is essential to elucidate the role of ethical intelligence and the effective integration of ethical reasoning into teaching practices. Additionally, continuous professional development should be emphasized through regular workshops, peer collaboration, and networking. These initiatives support preservice teachers in staying abreast of educational trends and developing essential skills for 21st-century classrooms.

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## Competing Interests Statement

The authors declare that there are no competing interests related to the conduct and publication of this study. The research was carried out independently and objectively, and no personal, financial, or institutional relationships influenced the design, data collection, analysis, interpretation, or reporting of the findings presented in this manuscript.

## Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request. Access to the dataset may be provided for academic and research purposes while ensuring the confidentiality and anonymity of the participants. Any shared data will comply with ethical and data protection guidelines.

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## Appendices

No appendices are included in this article