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Generation Z Pre-service Science Teacher Artificial Intelligence Competence Self-Efficacy (AICS): A Survey Study

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Abstrak

Penelitian ini mengkaji hubungan antar enam sub-konstruk (*AI Knowledge (AIK), AI Pedagogy (AIP), AI Assessment (AIA), AI Ethics (AIE), Human-Centred Education (HCE), and Professional Engagement (PEN)?* dari *Artificial Intelligence Competence Self-Efficacy (AICS).* Selain itu, penelitian ini juga mengeksplorasi pengaruh gender dan spesialisasi (kimia, fisika, biologi, dan sains) terhadap AICS. Penelitian ini menggunakan metode survei kuantitatif untuk menilai AICS pada 318 mahasiswa calon guru sains. Data dikumpulkan menggunakan instrumen yang telah divalidasi dan disesuaikan, mencakup enam sub-konstruk terkait AI. Analisis data dilakukan menggunakan SPSS versi 25, meliputi analisis korelasi, perbandingan gender dengan uji t independen, dan perbedaan spesialisasi menggunakan uji ANOVA satu arah dengan uji lanjutan LSD. Hasil deskriptif dan korelasi menunjukkan bahwa AI Knowledge dan AI Assessment adalah area yang paling dikuasai oleh peserta, dengan hubungan positif yang kuat di seluruh sub-konstruk. Perbandingan berdasarkan gender menunjukkan tidak ada perbedaan signifikan, yang mengindikasikan tingkat self-efficacy AI yang seimbang antara peserta laki-laki dan perempuan. Namun, analisis berdasarkan spesialisasi menunjukkan perbedaan signifikan pada AI Pedagogy dan AI Assessment, di mana mahasiswa jurusan Pendidikan Kimia dan Pendidikan Fisika menunjukkan kepercayaan diri yang lebih tinggi dibandingkan dengan jurusan pendidikan sains. Temuan ini menegaskan pentingnya pengembangan program pelatihan AI yang disesuaikan, spesifik sesuai disiplin ilmu, dan inklusif dalam pendidikan calon guru.

Kata Kunci

Artificial Intelligence, Calon Guru IPA, Teknologi Pendidikan, Self-Efficacy, Penelitian Survei

Abstract

This study examined the correlations among six sub-constructs (AI Knowledge (AIK), AI Pedagogy (AIP), AI Assessment (AIA), AI Ethics (AIE), Human-Centred Education (HCE), and Professional Engagement (PEN)?) of Artificial Intelligence Competence Self-Efficacy (AICS). It also explored the influence of gender and specialization (chemistry, physics, biology, general science) on AICS. This study employed a quantitative survey method to assess the Artificial Intelligence Competence Self-Efficacy (AICS) of 318 pre-service science teachers. Data were collected using a validated, culturally adapted instrument covering six AI-related sub-constructs. Analyses were conducted using SPSS version 25, including correlation analysis, gender comparisons via independent t-tests, and specialization differences through one-way ANOVA with

LSD post-hoc tests. Descriptive and correlation analyses show that AI Knowledge and AI Assessment are the areas where participants feel most confident, with strong positive relationships across all sub-constructs. Gender comparisons reveal no significant differences, suggesting balanced AI self-efficacy between male and female participants. However, specialization-based analysis shows significant differences in AI Pedagogy and AI Assessment, where Chemistry and Physics majors demonstrate higher confidence than General Science majors. These findings highlight the need for tailored, discipline-specific, and inclusive AI training programs in teacher education.

Keywords
Artificial Intelligence, Educational Technology, Pre-Service Science Teacher, Self-Efficacy, Survey Study

INTRODUCTION

The rapid advancement of Artificial Intelligence (AI) over the past decades has significantly transformed various sectors, including healthcare, industry, communication, and especially education. The integration of AI into the learning process presents both remarkable opportunities and complex challenges that educators must be prepared to face in the 21st century. In science education, AI offers the potential to revolutionize traditional teaching methods by enabling more personalized, adaptive, and technology-supported learning environments. Tools such as virtual laboratories, AI-assisted assessments, intelligent tutoring systems, and automated feedback platforms are increasingly being used to support student learning in a more interactive and individualized way (Wang & Huang, 2025).

Through AI, science educators can design learning experiences that are tailored to students' specific needs, pacing, and progress levels, which can significantly improve learning outcomes (Saddia, Yanti, & Qudratuddarsi, 2025). For example, virtual laboratories can simulate complex scientific experiments that might otherwise be too dangerous, expensive, or inaccessible in physical classrooms (Qudratuddarsi, Fauziah, Agung & Yanti, 2025). AI-powered assessment systems can also help teachers efficiently track student understanding and provide real-time feedback to support students' growth. In addition, intelligent learning platforms can offer dynamic content based on students’ performance, making the learning process more student-centered and effective (Giri, 2025).

However, despite these promising developments, the successful integration of AI in education is not solely dependent on technological advancements or infrastructure availability (Yanti & Astiti, 2024). More crucially, it relies on the readiness, competence, and confidence of teachers in using these AI tools meaningfully within their instructional practices (Dewi, Qudratuddarsi, Ningthias, & Cinthami, 2024; Yanti, Rahayu, & Rabbani, 2024). Without adequate teacher preparedness, the potential benefits of AI in education may remain underutilized or even misapplied, potentially widening educational gaps or creating ethical dilemmas related to privacy (Hava & Babayiğit, 2025).

In this regard, teachers' self-efficacy in AI integration plays a pivotal role. Self-efficacy, as defined by Bandura (1997), refers to an individual's belief in their capability to execute tasks and achieve goals in specific contexts (Oran, 2023). When applied to AI, it reflects how confident teachers feel in their ability to understand, apply, and manage AI tools in their teaching. Pre-service teachers, in particular, represent a critical population to study because their current perceptions of AI competence will directly influence how they approach technology integration in their future classrooms (Yao & Wang, 2024).

Building high levels of Artificial Intelligence Competence Self-Efficacy (AICS) among pre-service teachers is essential to prepare them for the demands of modern teaching. If future educators lack confidence in their AI competencies, they may resist adopting these technologies, or they may use them in ways that are superficial rather than pedagogically sound. Conversely, when teachers believe in their ability to effectively apply AI in education, they are more likely to innovate, engage students actively, and use AI tools to support deeper, more meaningful learning (Bergdahl & Sjöberg, 2025; Yang, Tseng & Lai, 2024).

Therefore, teacher education programs must not only introduce the technical aspects of AI but must also actively foster teachers' self-efficacy across key dimensions, such as AI knowledge, pedagogy, assessment, ethics, human-centered approaches, and professional development. Understanding how confident pre-service science teachers feel in these areas, and what factors may influence their self-efficacy—such as gender or specialization—is essential for shaping effective, inclusive, and targeted AI training programs (Chou, Shen, Shen & Shen, 2024).

When investigating teachers' AI competencies, it is crucial to view AICS as a multi-dimensional construct. According to Chiu, Ahmad, and Çoban (2024), AICS consists of six interrelated sub-constructs: AI Knowledge (AIK), AI Pedagogy (AIP), AI Assessment (AIA), AI Ethics (AIE), Human-Centred Education (HCE), and Professional Engagement (PEN). Each of these sub-constructs reflects distinct but connected competencies, including understanding basic AI concepts, implementing AI-supported pedagogical strategies, using AI for assessment purposes, being aware of ethical considerations, maintaining a student-centred approach, and demonstrating continuous professional development related to AI. Investigating the correlations among these sub-constructs is important to gain a comprehensive understanding of how they interact and contribute to pre-service teachers' overall AI competence.

In addition to exploring the correlations among sub-constructs, this study also examines the influence of gender on AICS. Gender is frequently identified as a variable that may influence confidence levels in using technology. In AI-related research, there is still limited evidence regarding gender-based differences in self-efficacy, particularly among pre-service teachers (Elezi & Bamber, 2021). Understanding whether gender influences AICS is critical to ensuring that educational interventions and AI training programs are inclusive and do not unintentionally favour one gender over another. Another important consideration in this study is the specialization of the participants. In science teacher education programs, students typically pursue specific fields such as chemistry, physics, biology, or general science. Each specialization may offer different levels of exposure to AI tools and concepts. For example, pre-service physics teachers may have more opportunities to engage with AI simulations and virtual experiments, while pre-service biology teachers might rely more on hands-on, observational learning methods. These disciplinary differences could influence their confidence and perceived competence in using AI. Therefore, it is essential to investigate whether specialization plays a role in shaping AICS among pre-service science teachers. Identifying such differences can help tailor AI training programs to better suit the specific needs of each discipline (Filiz, Kaya & Adiguzel, 2025).

This study is especially relevant given the current global emphasis on preparing teachers for the digital era, where AI is becoming increasingly integrated into classroom instruction, assessment, and educational management (Lu, Zheng, Gong & Xu, 2024). Understanding pre-service teachers' self-efficacy regarding AI competence is key to designing effective, targeted training that addresses specific gaps, whether they are related to knowledge, pedagogy, ethics, or professional development. Moreover, mapping out the correlations between sub-constructs, identifying potential gender differences, and comparing self-efficacy across specializations will offer valuable insights for policymakers and teacher education institutions to support a more equitable and discipline-sensitive approach to AI integration.

Specifically, this study seeks to answer the following research questions:

1. Is there any correlation among AI Knowledge (AIK), AI Pedagogy (AIP), AI Assessment (AIA), AI Ethics (AIE), Human-Centred Education (HCE), and Professional Engagement (PEN)?
2. Is there any influence of gender (male and female) on Artificial Intelligence Competence Self-Efficacy (AICS)?
3. Is there any difference in Artificial Intelligence Competence Self-Efficacy (AICS) based on specialization (chemistry, physics, biology, general science)?

METHOD

This study employed a quantitative survey method, focusing on gathering and analyzing numerical data derived from structured responses provided by participants. As a survey-based investigation, it sought to evaluate pre-service science teachers' self-efficacy regarding Artificial Intelligence Competence (AICS) at a particular moment in time, without introducing interventions or manipulating the participant group (Ramadhana & Qudratuddarsi, 2024). The researchers applied a cross-sectional design, which allowed them to capture participants' self-efficacy in a single snapshot, thus avoiding typical challenges associated with longitudinal studies, such as participant attrition or changing external factors that may influence perceptions over time (Wang & Cheng, 2020). The use of quantitative analysis ensured objectivity and data reliability, enabling statistical exploration of trends and response patterns. This method was particularly appropriate for the study's goal of producing generalizable insights that can support the broader integration of virtual laboratories in science teacher education programs (Qudratuddarsi, Meivawati & Saputra, 2024).

Subject of the study

A total of 318 Generation Z pre-service science teachers participated in this study. They were selected through convenience sampling, which provided quick and accessible participant recruitment, although it may slightly limit the generalizability of the findings (Qudratuddarsi, Ramadhana, Indriyanti & Ismail, 2024). Despite this, the sample was highly relevant, as all participants were in their third year of study, making them sufficiently experienced to provide meaningful input on their AI competence self-efficacy.

Table 1 presents the demographic distribution of the study participants. A total of 318 pre-service science teachers took part in the research. Based on gender, 28.30% were male and 71.70% were female, indicating that the majority of the participants were female. In terms of specialization, 27.99% of participants specialized in chemistry, 20.75% in physics, 22.96% in biology, and 28.30% in general science. This distribution shows a balanced representation across the different science disciplines, which provides diverse perspectives relevant to the study's focus.

Table 1. Sample of the study

Sample	N	Percentage
Gender		
Male	90	28.30%
Female	228	71.70%
Specialization		
Chemistry	89	27.99%
Physics	66	20.75%
Biology	73	22.96%
Science	90	28.30%
Total	318	100 %

Instrument

The measurement tool used in this research was adapted from Chiu, Ahmad, and Çoban (2024), who originally developed and validated the Artificial Intelligence Competence Self-Efficacy (AICS) scale. The original instrument, written in English and published in a high-impact journal, was carefully translated into Bahasa Indonesia to ensure it was both linguistically accurate and culturally appropriate. To achieve this, a rigorous back-translation process was conducted, involving bilingual experts who translated the instrument into Bahasa Indonesia and then back into English to verify consistency and accuracy. This method helped to preserve the meaning and cultural relevance of each item while minimizing misinterpretation or bias (Behr, 2017). The decision to adopt this instrument was based on its alignment with the objectives of the current study, which aimed to examine pre-service science teachers' self-efficacy in integrating AI into their teaching practices.

Using an established and psychometrically sound instrument enabled the researchers to focus on its contextual adaptation and further validation using the SPSS to count Reliability coefficient, ensuring the tool remained reliable and valid within the study's specific educational context. Table 2 shows the reliability coefficients for each sub-construct within the Artificial Intelligence Competence Self-Efficacy (AICS) scale. All sub-constructs demonstrate acceptable to excellent reliability, indicating that the instrument consistently measures the intended aspects of AI competence. The reliability values range from 0.756 to 0.919 across the sub-constructs, with the overall scale showing a very high reliability of 0.965. This suggests that the AICS instrument is a dependable tool for assessing pre-service science teachers' self-efficacy in integrating AI into their educational practices.

The final version of the instrument covered six major constructs of AICS: 1) AI Knowledge (AIK): Measures confidence in understanding essential AI concepts relevant to science education. 2) AI Pedagogy (AIP): Assesses the ability to design and apply AI-supported teaching methods. 3) AI Assessment (AIA): Evaluates confidence in using AI tools for student assessments and feedback. 4) AI Ethics (AIE): Examines awareness of ethical considerations, including data privacy and fairness in AI applications. 5) Human-Centered Education (HCE): Focuses on maintaining a student-centered approach while integrating AI. 6) Professional Engagement (PEN): Reflects the commitment to ongoing professional development related to AI. Together, these dimensions provided a comprehensive understanding of how pre-service science teachers perceive their ability to integrate AI effectively and responsibly in their future classrooms.

Table 2. Reliability of Artificial Intelligence Competence Self-Efficacy (AICS)

No	Sub-construct	Realibility Coefficient
1	AI Knowledge (AIK)	0.880
2	AI Pedagogy (AIP)	0.756
3	AI Assessment (AIA)	0.849
4	AI Ethics (AIE)	0.857
5	Human-Centred Education (HCE)	0.919
6	Professional Engagement (PEN)	0.910
7	Artificial Intelligence Competence Self-Efficacy (AICS)	0.965

Data Collection

Data collection was conducted through Google Forms, supporting sustainable, paperless research practices while also improving efficiency and minimizing data entry errors (Hidayat, Imami, Liu, Qudratuddarsi, & Saad, 2024). The digital format allowed for real-time access to responses. To further ensure clarity and accurate understanding of the survey items, the researcher was present during data collection, offering immediate assistance to participants if needed. This presence also helped create a supportive environment that encouraged participants to respond sincerely. Participation in the study was voluntary, with clear assurances that their responses would remain confidential and would not influence their academic evaluations (Ahmad et al., 2019). These ethical safeguards were crucial in maintaining the credibility and integrity of the collected data.

Data Analysis

After data collection, participants' responses were systematically organized using Microsoft Excel 2019 to facilitate accurate processing and preparation for further analysis. The statistical analyses were conducted using SPSS version 25 to ensure rigorous data handling and reliable interpretation. A correlation analysis was performed to examine the relationships among the six sub-constructs within Artificial Intelligence

Competence Self-Efficacy (AICS), namely AI Knowledge (AIK), AI Pedagogy (AIP), AI Assessment (AIA), AI Ethics (AIE), Human-Centred Education (HCE), and Professional Engagement (PEN). This step was essential to explore the interconnectedness of AI competencies and to identify whether improvements in one area may support growth in others. Additionally, to assess potential gender-based differences, an independent samples t-test was conducted for each sub-construct, which is crucial for ensuring inclusivity and verifying whether perceptions of AI competence vary across genders. Furthermore, a one-way ANOVA was applied to test for differences among four specializations—Chemistry, Physics, Biology, and General Science—to determine whether discipline-specific gaps in AI competence exist. When significant differences were found in the ANOVA, Least Significant Difference (LSD) post-hoc tests were conducted to pinpoint the specific groups where those differences occurred. This layered approach strengthens the reliability and depth of the analysis, ensuring that the results can meaningfully guide targeted interventions in teacher education.

RESULT AND DISCUSSION

Correlation Analysis

Table 3 presents the descriptive statistics of the six sub-constructs measured in this study, which collectively represent Artificial Intelligence Competence Self-Efficacy (AICS) among pre-service science teachers. The sub-constructs include AI Knowledge (AIK), AI Pedagogy (AIP), AI Assessment (AIA), AI Ethics (AIE), Human-Centred Education (HCE), and Professional Engagement (PEN). These statistics offer an initial overview of the participants' self-perceptions in relation to their AI competence across various teaching dimensions. The table reports key indicators such as the mean, standard deviation, skewness, and kurtosis for each sub-construct. The mean values provide insight into the average levels of self-efficacy in each area, while the standard deviation indicates the variability of responses. Skewness and kurtosis values help assess the distribution characteristics of the data, determining whether the responses align with the assumption of normality. This descriptive overview is essential for understanding the overall trends and preparing for further inferential statistical analyses.

Table 3. Descriptive statistics

	Mean	Std. Deviation	Skewness		Kurtosis	
Sub Construct	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
AI Knowledge (AIK)	3.4418	.89742	-.167	.137	-.334	.273
AI Pedagogy (AIP)	3.0094	.80583	.072	.137	.412	.273
AI Assessment (AIA)	3.3302	.81310	-.107	.137	.059	.273
AI Ethics (AIE)	3.0047	.86987	.244	.137	.016	.273
Human-Centred Education (HCE)	2.8734	.94417	.403	.137	-.277	.273
Professional Engagement (PEN)	2.9536	.94590	.246	.137	-.262	.273

The descriptive results show that among the six sub-constructs, AI Knowledge (mean = 3.44) and AI Assessment (mean = 3.33) received the highest average scores, suggesting that pre-service science teachers feel most confident in their AI understanding and in applying AI tools for assessment purposes. On the other hand, Human-Centred Education (mean = 2.87) and Professional Engagement (mean = 2.95) were rated lowest, indicating less confidence in maintaining student-centered practices and in pursuing continuous AI-related professional development. The skewness values across all sub-constructs range from -0.167 to 0.403, indicating that the data are approximately symmetrical and free from extreme skew. Similarly, kurtosis values fall between -0.334 and 0.412, suggesting that the distributions are neither overly flat nor overly peaked. The moderate standard deviations (ranging from 0.80 to 0.94) show that participant responses varied but remained within a reasonable range. Overall, the data distributions appear normal and suitable for further statistical testing.

Table 4 presents the results of the correlation analysis among the six sub-constructs of Artificial Intelligence Competence Self-Efficacy (AICS): AI Knowledge (AIK), AI Pedagogy (AIP), AI Assessment (AIA), AI Ethics (AIE), Human-Centred Education (HCE), and Professional Engagement (PEN). The purpose of this analysis is to examine the relationships between each of these domains to determine how closely they are associated. Correlation coefficients (r-values) provide insights into the strength and direction of these relationships, while the significance level at 0.01 indicates that the correlations are statistically meaningful. Identifying these interrelationships is crucial in understanding whether self-efficacy in one area of AI competence may influence confidence in other areas. This analysis offers a deeper view of how these aspects of AI integration are connected within the perceptions of pre-service science teachers, supporting a more comprehensive understanding of their overall readiness to incorporate AI in education.

Table 4. Correlation Analysis result

	AIK	AIP	AIA	AIE	HCE	PEN
AI Knowledge (AIK)	1	.639**	.812**	.730**	.611**	.665**
AI Pedagogy (AIP)	.639**	1	.700**	.712**	.679**	.695**
AI Assessment (AIA)	.812**	.700**	1	.784**	.655**	.710**
AI Ethics (AIE)	.730**	.712**	.784**	1	.806**	.822**
Human-Centred Education (HCE)	.611**	.679**	.655**	.806**	1	.877**
Professional Engagement (PEN)	.665**	.695**	.710**	.822**	.877**	1

**. Correlation is significant at the 0.01 level (2-tailed).

The correlation results reveal strong and positive relationships among all the sub-constructs of Artificial Intelligence Competence Self-Efficacy (AICS). The strongest correlation appears between Human-Centred Education (HCE) and Professional Engagement (PEN) (r = .877), suggesting that participants who are committed to continuous AI-related professional development also tend to prioritize maintaining student-centered teaching when using AI. Additionally, AI Ethics (AIE) shows consistently high correlations with other sub-constructs, particularly with AI Assessment (AIA) (r = .784), HCE (r = .806), and PEN (r = .822), indicating that ethical awareness is strongly linked to effective assessment practices and professional attitudes. All correlation coefficients are significant at the 0.01 level, confirming that the observed relationships are unlikely to occur by chance. These findings suggest that as pre-service teachers feel more competent in one AI-related domain, they are also likely to feel more confident in other interconnected areas.

The use of correlation analysis in this study is essential to understand the interconnectedness between the various dimensions of Artificial Intelligence Competence Self-Efficacy (AICS). Examining the relationships among the sub-constructs helps to reveal whether the development of one competence area may support growth in others, which is valuable for designing integrated training programs. The statistically significant correlations at the 0.01 level indicate that the relationships observed are both strong and reliable. Without this analysis, the study would lack a detailed explanation of how these competencies interact within the participants' self-efficacy framework. Additionally, the strength of the correlations justifies the assumption that AI competence is a multi-dimensional but interrelated construct, where improvements in one aspect, such as ethics or assessment, could positively impact other areas like pedagogy or professional engagement. Thus, correlation analysis not only validates the internal consistency of the instrument but also informs potential holistic approaches to AI competence development in teacher education.

Comparison Based on Gender

Table 5 presents the results of an independent samples t-test conducted to examine whether there are significant differences in Artificial Intelligence Competence Self-Efficacy (AICS) and its sub-constructs based on gender. This comparison aims to determine if male and female pre-service science teachers perceive their AI-related self-efficacy differently across areas such as AI Knowledge, AI Pedagogy, AI Assessment, AI Ethics, Human-Centred Education, and Professional Engagement. By analyzing the t-values and significance levels (p-values), the study seeks to explore potential gender-based disparities, which can provide meaningful insights for tailoring educational interventions to support equitable AI competence development.

Table 5. Result of t-test

No	Sub-construct	t	sig
1	AI Knowledge (AIK)	0.487	0.627
2	AI Pedagogy (AIP)	0.865	0.388
3	AI Assessment (AIA)	0.645	0.519
4	AI Ethics (AIE)	0.892	0.322
5	Human-Centred Education (HCE)	0.909	0.243
6	Professional Engagement (PEN)	0.597	0.206
7	Artificial Intelligence Competence Self-Efficacy (AICS)	0.965	0.317

The comparison results show that none of the sub-constructs exhibit statistically significant differences based on gender, as all p-values are greater than 0.05. For instance, the p-value for AI Knowledge is 0.627, and for AI Pedagogy, it is 0.388, both indicating no significant variation between male and female participants. Even the overall Artificial Intelligence Competence Self-Efficacy (AICS) shows no significant difference ($p = 0.317$). These findings suggest that both male and female pre-service science teachers generally perceive their AI competence at similar levels, indicating a balanced level of confidence in integrating AI into their educational practices across genders.

Conducting a gender-based comparison is important to ensure fairness and inclusivity in educational research, especially in technology-related studies where gender gaps are often reported. The absence of significant differences in this study is valuable because it highlights that both male and female pre-service teachers perceive similar levels of AI self-efficacy, suggesting that gender may not be a determining factor in AI competence development within this group. This justifies the design of gender-neutral AI training programs, focusing on the individual's needs rather than gender-based assumptions. The statistical results support the reliability of the study in demonstrating equitable AI self-efficacy perceptions.

Comparison Based on Specialization

Table 6 presents the results of a one-way ANOVA test used to compare Artificial Intelligence Competence Self-Efficacy (AICS) across different science specializations: Chemistry, Physics, Biology, and General Science. This analysis aims to determine whether pre-service teachers from various disciplines have significantly different perceptions of their AI competence. The ANOVA test focuses on the six AICS sub-constructs and the overall self-efficacy score. Identifying whether specialization influences AI competence is crucial for understanding potential gaps in AI integration readiness across subject areas, which can inform more tailored and discipline-specific training approaches.

Table 6. one-way ANOVA test result

No	Sub-construct	F	sig
1	AI Knowledge (AIK)	2.079	0.103
2	AI Pedagogy (AIP)	2.716	0.045*
3	AI Assessment (AIA)	3.302	0.012*
4	AI Ethics (AIE)	1.220	0.302
5	Human-Centred Education (HCE)	1.060	0.366
6	Professional Engagement (PEN)	1.554	0.201
7	Artificial Intelligence Competence Self-Efficacy (AICS)	2.306	0.077

The ANOVA results indicate significant differences in AI Pedagogy (AIP) (p = 0.045) and AI Assessment (AIA) (p = 0.012) across science specializations, while the other sub-constructs, including AI Knowledge, AI Ethics, Human-Centred Education, and Professional Engagement, show no significant differences. This suggests that participants' confidence in applying AI in teaching and assessment varies depending on their field of study. The LSD post-hoc test reveals that for AI Pedagogy, significant differences exist between Chemistry and Science (Confidence Interval: 0.0661–0.5364) and between Physics and Science (Confidence Interval: 0.0439–0.5536). Similarly, in AI Assessment, significant differences are found between Chemistry and Science (Confidence Interval: 0.0485–0.5216) and between Physics and Science (Confidence Interval: 0.1241–0.6370). These results indicate that students majoring in Chemistry and Physics tend to have higher self-efficacy in AI Pedagogy and Assessment than those in the General Science group, possibly due to different levels of exposure to AI-related content.

The use of one-way ANOVA is appropriate for this study as it allows for comparison among multiple specialization groups to identify significant differences in AI competence self-efficacy. The finding of significant differences in specific sub-constructs, particularly AI Pedagogy and AI Assessment, highlights the importance of addressing specialization-specific gaps in AI training. Without this analysis, potential discipline-based disparities could be overlooked, which may hinder the design of effective, equitable AI education programs. The LSD post-hoc test further strengthens the results by pinpointing which specific groups differ, providing clear direction for targeted instructional improvements to enhance AI competence across all science disciplines.

CONCLUSION

This study provides comprehensive insights into the Artificial Intelligence Competence Self-Efficacy (AICS) of pre-service science teachers, focusing on the relationships among key AI-related competencies and examining differences based on gender and specialization. The descriptive and correlation analyses revealed that pre-service teachers generally possess moderate to high self-efficacy, particularly in AI Knowledge and AI Assessment. Strong, positive, and significant correlations among all sub-constructs suggest that AI competence is an interrelated, multi-dimensional construct, where improvement in one area may support growth in others. The gender comparison results indicated no significant differences across all sub-constructs, demonstrating that both male and female pre-service teachers perceive their AI competence similarly. However, the specialization-based analysis identified significant differences in AI Pedagogy and AI Assessment, where Chemistry and Physics majors exhibited higher confidence than those in General Science. These findings emphasize the need for targeted, specialization-specific AI training while supporting the development of inclusive, gender-neutral AI competence programs within teacher education.

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