



SCIENCE TEACHERS' PERCEPTIONS OF THE ARTIFICIAL INTELLIGENCE IN SCIENCE EDUCATION: CHALLENGES, READINESS, BENEFITS, AND IMPACT ON STUDENT LEARNING

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Abstract. Recent developments in AI technology have the potential to affect science education. Understanding science teachers' perceptions of AI is essential for developing strategies that support effective and morally responsible integration of AI in science learning environments. This research focuses on science teachers' perceptions of AI in science classes by considering the challenges, preparedness, advantages, and its effect on student learning. A total of 383 science teachers participated in the study. Science teachers' perceptions of AI scale were used for data collection. The data were analysed through descriptive statistics, MANOVA, and multiple regression. Data analysis disclosed that the participants viewed lack of adequate training and data privacy concerns as the most prominent barriers for integrating AI in science classes. Familiarity significantly affects AI Readiness and AI-Supported Assessment & Feedback, while Teaching experience has a significant effect on Barriers to AI Adoption, emphasizing the significance of familiarity with AI and teaching experience on these outcomes. AI Readiness and Adoption significantly predicted AI's Impact on Learning, while the likely Benefits of AI were the strongest predictor of AI's Impact on Student Learning. Fostering AI readiness, emphasizing AI's educational advantages, and reducing structural barriers to AI adoption are among the recommendations.

Keywords: AI adoption, science teachers' perceptions, AI readiness, AI benefits, AI challenges

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Introduction

The advancement in artificial intelligence (AI) in recent years harbours a big potential to affect many areas, including the education sector, by transforming traditional teaching methods, enhancing personalized learning experiences, and enabling more efficient administrative processes within educational institutions (Ayanwale et al., 2024; Wu et al., 2024). This assertion holds significant validity within the realm of science education, as the discipline of science inherently encompasses the investigation of intricate concepts and phenomena that can be more effectively comprehended through the utilization of interactive simulations, data analytical instruments, and sophisticated learning systems specifically designed to address the distinct requirements of each learner (Erduran & Levrini, 2024). This potential has already started to manifest in classrooms around the world, where educators are increasingly integrating AI-driven technologies to foster engagement and improve student outcomes through tailored educational strategies (Mnguni et al., 2024; Zhang et al., 2025). The processes through which science educators modify their educational approaches to integrate these advanced tools are essential for optimizing the advantages of technological innovations within the educational framework (Zhang et al., 2025). Research focused on AI integration in science classes, highlighted various approaches that teachers are employing in order to increase learning experiences and enable a more profound comprehension of intricate scientific concepts (Almasri, 2024; Demir & Güraksın, 2022; Mnguni et al., 2024). Science teachers' readiness and willingness to embrace these advancements serve as a main pillar in the successful implementation of AI tools, as their attitudes can significantly influence both educational practices and student engagement levels.



AI Integration and Science Teachers' Perceptions

The examined literature indicated that educators in the field of science typically demonstrate an optimistic perspective regarding the potential of artificial intelligence to enhance the educational experience in science. AI is widely regarded as an instrument for customizing learning experiences, streamlining administrative tasks, and supporting student engagement (Ali & Okon, 2024; Almasri, 2024). For instance, AI-powered tools are seen as beneficial for creating interactive simulations, evaluating student progress, and delivering instant feedback (Almasri, 2024; Azari et al., 2024). These tools are built for individual student's distinct learning speed and approach, allowing for a more tailored educational experience that can significantly improve learning outcomes (Heeg & Avraamidou, 2023; Shi et al., 2024; Yilmaz, 2024). AI-enabled teacher dashboards, in this respect, provide real-time analytics that enable timely interventions and targeted instruction, which are crucial for meeting the varied learning requirements of students in an educational environment (Kim & Kim, 2022; Zhang et al., 2025). Similarly, Inq-ITS facilitate real-time feedback and intervention, helping teachers track student progress effectively and address gaps in understanding. This instant response is crucial for creating a learning atmosphere where students can learn from their errors and continuously improve their skills. Additionally, automated systems for scientific writing and assessment not only reduce teacher workloads but also offer consistent and immediate feedback (Kim & Kim, 2022). This effectiveness enables teachers to devote more attention to instructional quality rather than administrative tasks, ultimately benefiting student learning. These technologies enable students to interact with intricate scientific concepts through experiential learning, enhancing their ability to grasp abstract ideas through visualization and interaction. For example, VR simulations enable students to conduct experiments in controlled environments, fostering curiosity and innovation without the constraints of physical resources (Ayanwale et al., 2024; Makransky & Lilleholt, 2018). These perceptions are particularly strong among teachers who have higher levels of AI understanding and self-efficacy (Viberg et al., 2023).

However, not all teachers share the same level of enthusiasm. Some express apprehensions regarding the moral consequences of AI, including data privacy and the possible reduction of personal interaction in teaching (Ali & Okon, 2024; Morze et al., 2024). These concerns emphasize the importance of balanced approaches to AI integration that prioritize ethical considerations.

Benefits of AI in Science Classes

Different advantages of AI in science classes are reported in the literature review. AI contributes to science teaching by developing engagement and interactive educational settings, simplifying complex scientific concepts for students (Almasri, 2024; Azari et al., 2024). Similarly, AI can customize educational experiences to suit each student's unique requirements, helping to address diverse learning styles and abilities (Ali & Okon, 2024; Seo et al., 2024). It has the potential to help nurture skills including critical thinking, creativity, and problem-solving (Ayanwale et al., 2024; Luckin, 2018; Wu et al., 2024) as well as helping with grading and other administrative duties, enabling educators to dedicate more time to teaching activities (Ali & Okon, 2024; Echave et al., 2024). Studies also suggest that AI can assist students in conducting scientific research, analysing data, and generating hypotheses in science classes (Almasri, 2024; Park et al., 2023). These benefits are more evident in scientific writings, where AI can provide scaffolding for students and help them develop critical thinking skills (Kim & Kim, 2022).

Challenges in AI Integration

Despite the benefits of AI in science teaching, some potential challenges are also reported in the related literature. Limited access to AI tools and resources, particularly in underserved regions, is one of the important challenges (Arvin et al., 2023; Azari et al., 2024). Similarly, studies revealed that teachers often feel unprepared to use AI effectively due to insufficient training and support (Morze et al., 2024). Data security, the potential for excessive dependence on technology (Ali & Okon, 2024), and the difficulties of integration of AI into existing science curricula, as it requires careful alignment with educational goals (Park et al., 2023; Williams et al., 2021), are other major challenges of AI in science classes.

The Role of Professional Development

Studies demonstrate that teaching professionals who participate in focused training and instructional guidance are more predisposed to embrace artificial intelligence technologies and appreciate their merits (Williams et al., 2021). For instance, initiatives aimed at enhancing professional development that focus on artificial intelligence competence, ethical implications, and practical applications in real-world settings are likely to increase teachers' confidence and readiness to implement this new technology in science classes (Jatileni et al., 2024; Morze et al., 2024). In this respect, primary school teachers may require training on using AI for basic tasks, while secondary school teachers may need more advanced training on integrating AI into complex scientific inquiries (Dúo et al., 2023; Park et al., 2023). Professional development programs leveraging frameworks like TPACK (Technological Pedagogical Content Knowledge) improve teachers' competency and belief in applying AI tools effectively (Sun et al., 2023). Such training is crucial for educators to manage the challenges of incorporating AI into their curricula.

Ethical Issues

The incorporation of artificial intelligence within the domain of science education engenders considerable ethical dilemmas, particularly with regard to the necessity of maintaining transparency in the decision-making processes of AI systems and the imperative to confront potential biases inherent in AI algorithms (Ali & Okon, 2024; Kim & Kim, 2022). Educators must navigate these concerns while ensuring that they are using technology responsibly and transparently (Erduran & Levrini, 2024; Guo et al., 2024). Furthermore, disparities in digital literacy and resource availability exacerbate challenges, particularly in developing regions where educators may lack access to necessary tools and training (Mnguni et al., 2024).

Understanding science teachers' perceptions on AI is essential for developing strategies that support effective and morally responsible integration of AI in science learning environments. The following research questions were formulated to find out:

1. How do science teachers perceive AI integration in science education in terms of barriers to AI adoption, AI readiness, AI-driven learning enhancements, and AI-supported assessment and feedback?
2. How do science teachers' familiarity with AI, teaching experience, age, education level, and the science subject they teach affect barriers to AI adoption, AI readiness, AI-driven learning enhancements, and AI-supported assessment & feedback?
3. Are barriers to AI adoption, AI readiness, and AI-supported assessment & feedback predictors of AI-driven learning enhancements?

Research Methodology*General Background*

The study employed a quantitative approach that explored the participant science teachers' perceptions through a questionnaire. Questionnaires are helpful for data collection instruments as they enable researchers to gather data from a large group of participants efficiently, allowing for a more comprehensive analysis of trends and patterns. They are economically advantageous, reliable, valid, and easy to administer, making them a preferred choice for many researchers in the field (Cohen et. al., 2017). They can effectively capture the participant teachers' perceptions towards the integration of AI in education, providing valuable insights into their experiences and challenges. Thus, questionnaires are suitable for this research that aimed to find out science teachers' perceptions of the use of AI in science classes in terms of AI adoption, AI readiness, AI-driven learning enhancements, and AI-supported assessment and feedback. Since the reliability and validity of questionnaires are relatively easy to maintain through careful design and implementation, they allow the researcher to generalize study findings if sampling is properly selected.

Participants

A total of 383 science teachers specializing in biology, physics, chemistry, and middle school science participated in the study during the 2024-25 academic year (Table 1). All science teachers volunteered to participate in the

study. The participants were selected based on the condition that they have access to the internet in their schools and have means such as smartboards, tablets that enabled them to integrate AI in their classrooms for science classes; therefore, a purposive sampling (Cohen et al., 2017) was adopted. The study was approved by the social sciences ethical committee, and permission from the national ministry of education was gained to administer the scales to science teachers in person and online, for science teachers who were not possible to reach in person. In total, 397 teachers participated, but 14 questionnaires were left out as they were incomplete. The remaining 383 questionnaires from science teachers (Table 1) working in different parts of Turkey were used as the data source. The science teacher population is around 85.000 in Turkey, and the required sample size for this population is 383 (Cohen et al., 2017).

Table 1
Participant Teachers' Subjects

Subject	N	%
Biology	83	21.7
Secondary science	232	60.6
Physics	31	8.1
Chemistry	37	9.7
Total	383	100.0

Instrument and Procedures

The data were gathered through "Science teachers' perceptions of the artificial intelligence in science education scale," developed for the purpose of the study. The elements delineated from the related literature underwent analysis through exploratory factor analysis. A Principal Component Analysis (PCA) employing Varimax rotation was executed to discern the distinct factors that exert influence on the integration of artificial intelligence in pedagogical practices. Prior to the execution of the factor analysis, the adequacy of the sample was evaluated utilizing the Kaiser-Meyer-Olkin (KMO) test alongside Bartlett's Test of Sphericity. The KMO statistic yielded a value of .912, signifying excellent sampling adequacy, while Bartlett's Test of Sphericity revealed a chi-square value of $X^2_{(496)}: 12261.317, p < .001$, thereby substantiating the factorability of the correlation matrix. Factors were retained based on Eigenvalues > 1 and the scree plot. Four factors were identified, accounting for 73.25% of the total variance (Table 2).

Table 2
Summary of Factor Extraction

Component	Initial Eigenvalues	% of Variance	Cumulative %
1	10.067	31.46	31.46
2	5.623	17.57	49.03
3	4.534	14.17	63.20
4	3.217	10.05	73.25

Based on the items in each factor, the factors were named as *Barriers to AI Adoption*, *AI Readiness*, *AI-Driven Learning Enhancements*, and *AI-Supported Assessment and Feedback*. The results demonstrated excellent internal consistency across all factors: *Barriers to AI Adoption* ($\alpha = .943$, 8 items), *AI Readiness* ($\alpha = .935$, 8 items), *AI-Driven Learning Enhancements* ($\alpha = .956$, 8 items), and *AI-Supported Assessment and Feedback* ($\alpha = .942$, 8 items). The stratified alpha for the overall reliability of the scale was .968. These findings indicate that the scale (Appendix) used to assess science teachers' views on the AI integration in science education is highly reliable.

Data Analysis

Data were analysed by using SPSS 29. A MANOVA was conducted to determine whether the independent variables (age, education level, teaching experience, subject area, and familiarity with AI collectively influenced the dependent variables (*Barriers to AI Adoption*, *AI Readiness*, *AI-Driven Learning Enhancements*, and *AI-Supported Assessment & Feedback*). A multiple linear regression analysis was conducted to examine how barriers to AI integration, AI readiness and adoption, and the potential benefits predict AI's impact on student learning. Descriptive statistics for each factor are also provided

Research Results*Barriers to AI Adoption in Science Classes*

The participant science teachers' responses to the questionnaire items for barriers to AI adoption are provided in Table 3. The data analysis shows that the participant science teachers see all items related to barriers to AI adoption as important when the mean values are considered.

Table 3
Results for Science Teachers' Responses related to Barriers to AI Adoption

Items	N	Min.	Max.	M	SD
Lack of adequate training is a major barrier to using AI in teaching.	383	1	5	3.56	1.02
I am concerned about data privacy when using AI tools.	383	1	5	3.50	1.09
There is limited access to AI tools in my school.	383	1	5	3.36	1.07
AI tools are too complex for regular classroom use	383	1	5	3.49	1.02
I face resistance from colleagues or the administration when adopting AI	383	1	5	3.36	1.04
AI tools may increase the workload due to technical issues	383	1	5	3.29	1.00
Students may misuse AI tools if not monitored properly	383	1	5	3.10	1.11
There is a lack of reliable information about the effectiveness of AI in science education	383	1	5	3.34	0.99

The findings (Table 3) revealed that among the items related to the barriers to AI adoption in science classes the participant science teachers saw the lack of adequate training as the most prominent barrier ($M = 3.56$, $SD = 1.02$) followed by concerns regarding data privacy ($M = 3.50$, $SD = 1.09$). *Students may misuse AI tools if not monitored properly*, which was responded as the least prominent ($M = 3.10$, $SD = 1.11$) when barriers to AI adoption were considered.

AI Readiness in Science Classes

Table 4 presents descriptive statistics for the participant science teachers' *AI Readiness* in their science teaching activities.

Table 4
Results for Science Teachers' AI Readiness

Items	N	Min.	Max.	M	SD
I feel confident using AI tools in the classroom.	383	1	5	3.37	0.93
My students respond positively to the use of AI in lessons	383	1	5	3.35	0.97
AI tools align well with the curriculum I teach	383	1	5	3.30	0.92
I regularly integrate AI tools into my science teaching	383	1	5	3.28	0.96
I collaborate with colleagues on using AI in teaching	383	1	5	3.28	1.01

Items	N	Min.	Max.	M	SD
I actively seek out new AI tools for teaching purposes	383	1	5	3.27	1.04
I have attended training sessions on the use of AI in education	383	1	5	3.26	1.04
My school provides sufficient resources for incorporating AI into teaching.	383	1	5	3.19	1.02

The results indicate a moderate level of AI integration ($M = 3.28$, $SD = 0.96$) and confidence ($M = 3.37$, $SD = 0.93$) in using AI tools. While teachers generally find AI tools aligned with the curriculum ($M = 3.30$, $SD = 0.92$) and report positive student responses ($M = 3.35$, $SD = 0.97$), institutional support for AI implementation varies ($M = 3.19$, $SD = 1.02$). Many participants have attended AI-related training sessions ($M = 3.26$, $SD = 1.04$), actively seek new AI tools ($M = 3.27$, $SD = 1.04$), and collaborate with colleagues ($M = 3.28$, $SD = 1.01$).

AI-Supported Assessment and Feedback in Science Learning

The descriptive analysis of participant science teachers' views on AI-supported assessment and feedback in science learning is provided in Table 5. The findings revealed that mean scores for all items of the scale indicate a generally positive perception of AI's role in science education.

Table 5
AI-Supported Assessment and Feedback in Science Learning

Items	N	Min.	Max.	M	SD
In the future, AI will play a critical role in curriculum development.	383	1	5	3.84	0.98
AI can enhance virtual and augmented reality applications for science education	383	1	5	3.80	0.89
AI will create opportunities for more collaborative learning experiences	383	1	5	3.73	0.85
AI has the potential to revolutionize science education	383	1	5	3.72	0.87
AI has the potential to provide insights into students' learning behaviours and needs	383	1	5	3.71	0.85
AI will improve the accuracy of student assessments and feedback	383	1	5	3.70	0.85
AI can bridge learning gaps in underprivileged communities	383	1	5	3.62	0.87
AI will support science teachers by automating routine tasks	383	1	5	3.60	0.84

The highest mean score ($M = 3.84$, $SD = 0.98$) suggests that teachers strongly believe AI has an important potential for curriculum development. Similarly, teachers recognize AI's potential in enhancing virtual and augmented reality applications ($M = 3.80$, $SD = 0.89$) and facilitating collaborative learning experiences ($M = 3.73$, $SD = 0.85$). The lowest-rated statement ($M = 3.60$, $SD = 0.84$) relates to AI automating routine tasks, though it still reflects considerable agreement. The findings, in general, suggest that science teachers acknowledge AI's transformative potential in education, particularly in curriculum development, assessment accuracy, and innovative learning opportunities.

AI-Driven Learning Enhancements in Science Classes

The analysis of sub-scale items related to participant science teachers' perceptions of AI-driven learning enhancements is presented in Table 6. The table shows that the participant teachers exhibit an overall positive stance when the mean scores are considered.

Table 6
Results for AI-Driven Learning Enhancement in Science Classes

Items	N	Min.	Max.	M	SD
AI can foster innovation and creativity in science projects	383	1	5	3.93	0.85
Using AI in teaching saves time and effort.	383	1	5	3.90	0.80



Items	N	Min.	Max.	M	SD
AI tools make science more accessible for students with diverse learning needs	383	1	5	3.87	0.84
AI can personalize learning experiences for students.	383	1	5	3.87	0.77
AI tools enhance students' engagement in science lessons	383	1	5	3.82	0.82
AI facilitates deeper understanding of complex scientific concepts	383	1	5	3.80	0.77
AI can help students develop critical thinking and problem-solving skills	383	1	5	3.80	0.86
AI helps in providing real-time feedback to students	383	1	5	3.79	0.82

The highest-rated aspect ($M = 3.93$, $SD = 0.85$) indicates the influence of AI on nurturing creativity and driving innovation in science projects. Similarly, teachers recognize AI's effectiveness in personalizing learning ($M = 3.87$, $SD = 0.77$) and improving accessibility for diverse learners ($M = 3.87$, $SD = 0.84$). While AI's ability to provide real-time feedback ($M = 3.79$, $SD = 0.82$) received the lowest mean score, it still reflects a strong level of agreement. These findings reveal that teachers consider AI as an important instrument for increasing student engagement, simplifying instructional tasks, and deepening conceptual understanding in science education.

Multivariate Tests (MANOVA)

The participant science teachers' familiarity with AI, their teaching experience, age, education level, and subject were used as the independent variables. A MANOVA test was used to determine the independent variables on the dependent variables.

Table 7
Multivariate Test for Independent Variables

Effect	Wilks' Lambda	F	Hypothesis df	Error	p	Partial η^2
Familiarity	.739	3.464	16	532.216	< .001	0.073
Teaching experience	.811	1.883	20	578.043	.012	0.051
Age	.911	.824	20	578.043	.685	0.023
Education level	.926	1.129	12	460.652	.334	0.025
Subject	.941	.887	12	460.652	.560	0.020

Wilks' Lambda values (Table 7) indicate that *Familiarity* and *Teaching experience* show significant effects ($p < .05$) on the combined dependent variables. The effect size for *familiarity* is medium (η^2 : 0.073) and small for *teaching experience* (η^2 : 0.051).

Table 8 presents the results of separate univariate ANOVAs for each dependent variable. *Familiarity* significantly affects *AI Readiness* and *AI-Supported Assessment & Feedback*, while *Teaching experience* has a significant effect on *Barriers to AI Adoption*, reinforcing the importance of familiarity with AI and teaching experience on these outcomes.

Table 8
Univariate ANOVA Results

Independent Variable	Dependent Variable	F	df	p	Partial η^2
Familiarity	AI Readiness	8.524	4	.001	0.162
Familiarity	AI-Supported Assessment & Feedback	2.565	4	.04	0.055
Teaching experience	Barriers to AI Adoption	3.277	5	.01	0.085

A post hoc analysis was carried out to determine the source of these differences (Table 9).



Table 9*Tukey HSD Test Results*

Familiarity with AI (AI readiness)	<i>MD</i>	<i>SE</i>	<i>p</i>
Low vs. Medium	-0.62	0.15	.001
Low vs. High	-0.86	0.16	.001
Medium vs. High	-0.24	0.13	.09
Familiarity with AI (AI-Supported Assessment & Feedback)	<i>MD</i>	<i>SE</i>	<i>p</i>
Low vs. Medium	-0.41	0.14	.02
Low vs. High	-0.62	0.15	.01
Medium vs. High	-0.21	0.13	.10
Teaching Experience	<i>MD</i>	<i>SE</i>	<i>p</i>
1–2 Years vs. 3–5 Years	-0.35	0.15	.03
1–2 Years vs. 6–10 Years	-0.48	0.17	.01
3–5 Years vs. 6–10 Years	-0.13	0.14	.38

The results indicate that individuals with low familiarity scored significantly lower than those with medium or high familiarity for the participant teachers' *AI readiness*. The post hoc analysis for *AI-Supported Assessment & Feedback* reveals significant differences between familiarity levels (Table 8). Participants with low familiarity scored lower than those in the medium and high groups. The table also displays the post hoc analysis for teaching experience on *Barriers to AI Adoption*. The results indicate that individuals with fewer years of experience scored significantly lower compared to those with more years of experience. The results suggest that familiarity with AI and teaching experience significantly impact science teachers' views on *AI Readiness* and *AI-Supported Assessment & Feedback*. Post hoc analysis confirmed that participants with lower familiarity with AI scored significantly lower in *AI Readiness* and *AI-Supported Assessment & Feedback* compared to those with medium or high familiarity. Similarly, teaching experience showed a significant difference in *Barriers to AI Adoption*, with those having 1–2 years of experience scoring lower than those with more experience. However, age, education, and subject area did not have a statistically significant impact on the dependent variables.

Regression Analysis

A multiple linear regression analysis was conducted to examine how barriers to AI integration, AI readiness and adoption, and the potential benefits predict the participants' perceived AI's impact on learning. After the outliers were taken out, a total of 357 participants' responses on four key variables: AI's influence on Learning (dependent variable), Barriers to AI Integration, AI Readiness and Adoption, and Potential Benefits of AI in Science Education (independent variables) were analysed. Descriptive statistics, correlation analysis, and multiple linear regression were used to analyse the data.

Table 10*Descriptive Results*

Variables	<i>N</i>	<i>M</i>	<i>SD</i>
AI's Influence on Learning	357	3.90	0.51
Barriers to AI Integration	357	3.41	0.87
AI Readiness and Adoption	357	3.29	0.83
Potential Benefits of AI	357	3.80	0.64

Descriptive results (Table 10) showed that the mean scores for the variables were as follows: AI's influence on Learning ($M = 3.90$, $SD = 0.51$), Barriers to AI Integration ($M = 3.41$, $SD = 0.87$), AI Readiness and Adoption ($M = 3.29$, $SD = 0.83$), and Potential Benefits of AI ($M = 3.80$, $SD = 0.64$).

Table 11
Correlation Analysis

Pearson Correlation	AI's Influence on Learning	Barriers to AI Integration	AI Readiness and Adoption	Potential Benefits of AI
AI's Influence on Learning	1.000	.215	.355	.644
Barriers to AI Integration	.215	1.000	.075	.218
AI Readiness and Adoption	.355	.075	1.000	.214
Potential Benefits of AI	.644	.218	.214	1.000

A Pearson correlation analysis (Table 11) revealed that AI's influence on Learning was significantly correlated with Barriers to AI Integration ($r = .215, p < .001$), AI Readiness and Adoption ($r = .355, p < .001$), and Potential Benefits of AI ($r = .644, p < .001$).

Table 12
A Model Summary of Regression Analysis

Model	R	R ²	Adjusted R ²	SE	DW
1	.685a	.469	.465	.38	2.032

a. Predictors: (Constant), Potential Benefits of AI, AI Readiness and Adoption, Barriers to AI Integration, b. Dependent Variable: AI's Influence on Learning

The overall model was significant, $F_{(3, 353)} = 104.030, p < .001$, explaining 46.9% of the variance in AI's Impact on Student Learning ($R^2 = .469$, Adjusted $R^2 = .465$). The Durbin-Watson statistic was 2.032, indicating no significant autocorrelation (Table 12).

Table 13
Regression Coefficients of the Independent Variables on AI's Impact on Student Learning

Variables	Unstandardized Coefficients		Standardized Coefficients	<i>t</i>	<i>p</i>	Collinearity Statistics	
	<i>B</i>	<i>SE</i>	<i>Beta</i>			<i>Tolerance</i>	<i>VIF</i>
(Constant)	1.509	.143		10.58	.001		
Barriers to AI Integration	.042	.023	.072	1.81	.07	.951	1.051
AI Readiness and Adoption	.141	.025	.226	5.69	.001	.954	1.049
Potential Benefits of AI	.470	.033	.580	14.29	.001	.913	1.095

Table 13 displays that *Barriers to AI Integration* ($B = .042, SE = .023, \beta = .072, t = 1.81, p = .07$) did not significantly predict AI's Impact on Student Learning. But, *AI Readiness and Adoption* ($B = .141, SE = .025, \beta = .226, t = 5.69, p = .001$) significantly predicted AI's Impact on Student Learning while *Potential Benefits of AI* ($B = .470, SE = .033, \beta = .580, t = 14.29, p = .001$) was the strongest predictor of AI's Impact on Student Learning.

The regression equation for predicting perceived AI's influence on Learning is as follows:

$$Y = 1.509 + 0.042X_1 + 0.141X_2 + 0.470X_3$$

where:

Y = AI's Influence on Learning

X_1 = Barriers to AI Integration

X_2 = AI Readiness and Adoption

X_3 = Potential Benefits of AI

Discussion

This study focused on science teachers' perceptions related to their AI in science classes. The participant teachers saw the lack of adequate training, concerns regarding data privacy, limited access to AI tools, resistance from colleagues or administration, and the perceived complexity of AI tools as the main barriers to integrating AI into their classrooms. These findings are in line with previous research indicating that apprehensions about student data security in digital learning environments (Al Darayseh, 2023; Gueo et al., 2025) and insufficient professional development hinder the effective use of AI in education (Alshorman, 2024; Mnguni, 2024). Furthermore, limited access to AI tools and resistance from colleagues or administration suggest that institutional support is crucial for the successful implementation of AI (Wu et al., 2024). Additionally, the perceived complexity of AI tools highlights the need for user-friendly AI applications tailored for classroom use (Erduran & Levrini, 2024; Woodruff et al., 2023).

Teachers' readiness to incorporate AI into science teaching showed moderate levels of confidence and engagement. While teachers expressed some confidence in using AI tools and actively sought new AI applications, their integration of AI into instruction and school-provided resources remained at medium levels. These results suggest that while teachers recognize AI's potential, additional institutional support and professional development opportunities are necessary to enhance AI readiness (Alshorman, 2024). Research on AI literacy in education emphasizes that a strong foundation in AI-related skills is required for teachers to effectively implement AI-driven instructional strategies (Kim & Kim, 2024; Mnguni et al., 2024).

The study also explored teachers' perspectives on AI's role in assessment and feedback. The highest-rated item, *AI will play a critical role in curriculum development*, underlines AI's potential in shaping future educational practices (Ayala-Pazmiño, 2023; Nadimpalli, 2017). Teachers also acknowledged AI's ability to enhance virtual and augmented reality applications and its potential to improve assessment accuracy. These findings align with prior research emphasizing AI's transformative role in providing personalized learning experiences and automating routine tasks (Guo et al., 2024; Shi et al., 2024; Zhang et al., 2025).

Teachers largely agreed that AI enhances student engagement and fosters personalized learning. The highest-rated item, *AI can foster innovation and creativity in science projects*, highlights AI's ability to facilitate exploratory learning and problem-solving (Woodruff et al., 2023). AI's role in real-time feedback and supporting students with diverse learning needs further reinforces its potential to improve equity in education (Park et al., 2023).

The results also suggest that familiarity with AI plays a crucial role in shaping teachers' readiness to adopt AI-based tools and methods. This finding aligns with prior research emphasizing that digital competence and prior exposure to AI technologies positively influence teachers' willingness to integrate AI into their pedagogical practices (Guo et al., 2025; Kim & Kim, 2022; Wu et al., 2024). Moreover, the implications of teachers' familiarity with AI extend beyond mere readiness; they also influence the overall effectiveness of AI integration within educational settings. Teachers who possess a higher degree of familiarity not only exhibit greater confidence in utilizing AI tools but are also more likely to recognize their potential for enhancing student engagement and learning outcomes (Celik, 2023). This is particularly relevant as studies indicate that educators' perceptions of AI's utility significantly shape their willingness to adopt these technologies in classroom instruction (Demir & Guraksin, 2022). Furthermore, addressing concerns about AI's ethical implications and its impact on traditional teaching roles can further mitigate resistance among less familiar educators, fostering an environment conducive to innovation and collaboration (Saetra, 2021; Wang et al., 2023).

Teaching experience also emerged as a significant factor influencing teachers' views on AI adoption barriers. These findings are consistent with existing literature suggesting that novice teachers often encounter more challenges in implementing emerging technologies due to limited practical experience and pedagogical adaptability (Ertmer & Ottenbreit-Leftwich, 2013; Howard & Mozejko, 2015). Research indicates that comprehensive support structures can significantly enhance teachers' readiness to embrace technology, thus mitigating resistance stemming from both intrinsic factors, like anxiety, and extrinsic factors such as inadequate resources (Elmali & Kiyici, 2022).

Contrary to expectations, age, education level, and subject area did not yield significant effects on AI readiness, AI-supported assessment and feedback, or barriers to AI adoption. These findings suggest that AI adoption and related pedagogical attitudes may be more dependent on experiential factors such as familiarity and years of teaching rather than demographic variables. Prior studies have also indicated that professional development and hands-on exposure to technology are stronger predictors of technology integration than general demographic characteristics (Drent & Meelissen, 2008; Voogt et al., 2013).

The substantial predictive capacity of artificial intelligence readiness and adoption serves a pivotal function in the preparedness necessary for the effective utilization of AI within educational contexts. This observation cor-

relates with prior research indicating that educators possessing elevated levels of AI literacy and familiarity are more inclined to incorporate AI into their pedagogical methodologies. For example, Chiu and Chai (2020) suggested that the sustainable development of curricula for AI education necessitates a robust foundation of AI literacy amongst instructors. In a similar vein, Hwang et al. (2020) discovered that educators' self-efficacy regarding the application of AI tools significantly affects their propensity to integrate AI within classroom environments. Educators who exhibit confidence in their competence to utilize AI tools are more adept at implementing them effectively, thus contributing positively to student learning outcomes.

The perceived benefits of artificial intelligence in the realm of science education have emerged as a significant predictor, suggesting that educators who recognize AI's capacity to augment student engagement, assessment, and personalized learning are more inclined to regard it as a valuable pedagogical tool. This observation is consistent with prior studies, which indicate that affirmative attitudes towards the utility of AI facilitate higher rates of adoption. Hwang et al. (2020) discovered that when educators perceive AI as advantageous, they exhibit increased motivation to integrate it into their instructional methodologies. These findings underscore the importance of professional development initiatives that highlight the tangible benefits of AI for both educators and learners. Workshops, experiential training sessions, and practical case analyses could assist educators in better comprehending and valuing AI's potential advantages.

Interestingly, barriers to AI integration did not significantly predict teachers' perceptions of AI's impact on student learning. This result suggests that while teachers may acknowledge challenges such as lack of resources, technical difficulties, and resistance to change, these factors do not necessarily prevent them from perceiving AI as beneficial for student learning. Prior research suggests that overcoming such barriers may depend on institutional support, training, and policy frameworks rather than individual perceptions alone. Ertmer and Ottenbreit-Leftwich (2010) highlighted that removing obstacles to technology adoption requires systemic changes, including providing adequate infrastructure and ongoing professional development. Policymakers and educational administrators should focus on minimizing these barriers by offering sufficient resources, technical support, and incentives for AI adoption.

Conclusions and Implications

This research examined views of artificial intelligence within science curricula, drawing insights from the perspectives of participating science educators who reflected upon their experiences with AI. The results demonstrate that although science educators acknowledge the advantages of AI, considerable obstacles, including insufficient training, concerns regarding privacy, and restricted access, continue to exist. Tackling these impediments through focused professional development, institutional financial support, and comprehensive policy frameworks can significantly facilitate the integration of AI in science education. Furthermore, the study disclosed that familiarity with AI notably influences both AI readiness and AI-supported assessment and feedback, while teaching experience markedly impacts the barriers to AI adoption, thereby underscoring the critical role of familiarity with AI and teaching experience in shaping these outcomes. This research revealed that AI readiness and perceived benefits are substantial predictors of educators' perceptions regarding AI's influence on student learning, whereas barriers to AI integration do not exert a significant impact. These findings accentuate the necessity of fostering AI literacy, highlighting the educational benefits of AI, and mitigating structural impediments to the adoption of AI. Subsequent studies should delve into longitudinal shifts in educators' perceptions and assess the enduring effects of AI adoption on student learning outcomes.

This study contributes to the field by simultaneously analysing barriers, readiness, and perceived benefits of AI adoption in science teaching—providing a holistic model that has been underexplored in prior research. It revealed that familiarity with AI notably influences both AI readiness and AI-supported assessment and feedback, while teaching experience markedly impacts the barriers to AI adoption. These insights suggest that both experiential and perceptual variables play a critical role in effective AI implementation. As AI technologies rapidly evolve and enter the classroom, understanding teachers' perceptions is important. The outcomes of this study can directly inform professional development programs, help design school policies supporting AI infrastructure, and guide national education strategies toward future-ready teaching. The results demonstrate that although science educators acknowledge the advantages of AI, considerable obstacles, including insufficient training, concerns regarding privacy, and restricted access, continue to exist. Tackling these impediments through focused professional development, institutional financial support, and comprehensive policy frameworks can significantly facilitate the integration of AI in science education.



Declaration of Interest

The authors declare no competing interest.

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Appendix: Questionnaire for Measuring Science Teachers' Perception of AI in Science Teaching

Section 1: Demographic Information

1. What is your age? (Open-ended)
2. What is your highest level of education?
 - Bachelor's Degree
 - Master's Degree
 - Doctorate
 - Other (please specify)
3. How many years of teaching experience do you have? (Open-ended)
4. Have you used any AI tools in your teaching practice? (Yes/No)
5. If yes, which AI tools have you used? (Open-ended)
6. What is the primary subject area you teach? (Open-ended)
7. How would you rate your familiarity with AI technologies? (Scale: 1-Not Familiar to 5-Very Familiar)



Section 2: Perceptions on Current Practice

Scale: Strongly Disagree (1) to Strongly Agree (5)

Please choose the number that is the most suitable for you

Item	Strongly Disagree	Disagree	I have no idea	Agree	Strongly Agree
1. I regularly integrate AI tools into my science teaching.	1	2	3	4	5
2. AI tools enhance students' engagement in science lessons.	1	2	3	4	5
3. Lack of adequate training is a major barrier to using AI in teaching.	1	2	3	4	5
4. AI has the potential to revolutionize science education.	1	2	3	4	5
5. I feel confident using AI tools in the classroom.	1	2	3	4	5
6. AI can personalize learning experiences for students.	1	2	3	4	5
7. I am concerned about data privacy when using AI tools.	1	2	3	4	5
8. In the future, AI will play a critical role in curriculum development.	1	2	3	4	5
9. My school provides sufficient resources for incorporating AI into teaching.	1	2	3	4	5
10. Using AI in teaching saves time and effort.	1	2	3	4	5
11. There is limited access to AI tools in my school.	1	2	3	4	5
12. AI can bridge learning gaps in underprivileged communities.	1	2	3	4	5
13. I have attended training sessions on the use of AI in education.	1	2	3	4	5
14. AI helps in providing real-time feedback to students.	1	2	3	4	5
15. AI tools are too complex for regular classroom use.	1	2	3	4	5
16. AI will support teachers by automating routine tasks.	1	2	3	4	5
17. AI tools align well with the curriculum I teach.	1	2	3	4	5
18. AI facilitates deeper understanding of complex scientific concepts.	1	2	3	4	5
19. I face resistance from colleagues or administration when adopting AI.	1	2	3	4	5
20. AI will create opportunities for more collaborative learning experiences.	1	2	3	4	5
21. I actively seek out new AI tools for teaching purposes.	1	2	3	4	5
22. AI can help students develop critical thinking and problem-solving skills.	1	2	3	4	5
23. AI tools may increase the workload due to technical issues.	1	2	3	4	5



Item	Strongly Disagree	Disagree	I have no idea	Agree	Strongly Agree
24. AI can enhance virtual and augmented reality applications for science education.	1	2	3	4	5
25. My students respond positively to the use of AI in lessons.	1	2	3	4	5
26. AI tools make science more accessible for students with diverse learning needs.	1	2	3	4	5
27. Students may misuse AI tools if not monitored properly.	1	2	3	4	5
28. AI will improve the accuracy of student assessments and feedback.	1	2	3	4	5
29. I collaborate with colleagues on using AI in teaching.	1	2	3	4	5
30. ai can foster innovation and creativity in science projects.	1	2	3	4	5
31. There is a lack of reliable information about the effectiveness of AI in education.	1	2	3	4	5
32. AI has the potential to provide insights into students' learning behaviors and needs.	1	2	3	4	5

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