THE READINESS TO USE AI IN TEACHING SCIENCE: SCIENCE TEACHERS' PERSPECTIVE

Sameera Alshorman

Abstract. *This study aimed to assess the readiness of Jordanian science teachers for integrating Artificial Intelligence (AI) in science education, focusing on their perceptions, challenges, and training needs. A quantitative survey methodology was employed, using a 35-item questionnaire distributed to 136 science teachers in urban Jordan. The questionnaire, developed and refined through expert peer review and a pilot study, encompassed demographics, attitudes towards AI, perceived benefits and challenges of AI in science teaching, self-efficacy in using AI, and behavioural intentions regarding its use. The results indicated varying teacher readiness levels, influenced by gender, educational background, and concerns over data privacy and security. While there was a general sense of optimism about the potential of AI, significant challenges related to limited resource access and insufficient professional development were identified. These results emphasized the need for targeted policy initiatives and training programs to enhance teachers' readiness for AI adoption. The study's insights contributed to understanding the facilitators and barriers to AI integration in science education, highlighting the critical role of teacher readiness in the effective utilization of AI in educational contexts.*
Keywords: *science education, artificial intelligence, AI readiness, science teachers' perspectives, quantitative survey*

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Introduction

Artificial Intelligence (AI), a groundbreaking advancement in computer systems, has the unique capability to perform tasks that traditionally require human intelligence, such as learning, reasoning, problem-solving, and decision-making (IBM, 2023). This technological progression, noted by Sætra (2021), is opening up new opportunities across various sectors, with education being one of the most significantly impacted areas. Thus, the potential of AI to transform educational methodologies and pedagogical strategies is immense, promising a significant shift in how teaching and learning processes are conceived and implemented (Alkanaan, 2022).

In the realm of science education, the effective integration of AI is contingent upon the readiness and preparedness of science teachers. Čipková and Karolčík (2018) underscore this necessity, highlighting science teachers as crucial implementers of educational technology in the classroom. Their perceptions, willingness, and competence in utilising AI tools are pivotal in determining the efficacy and success of this integration (Sallam et al., 2023). Their role is integral in adopting and applying AI in science education and in recognising and navigating the challenges and opportunities accompanying this technological integration (Barsoum et al., 2022).

The increasing integration of AI in education has garnered widespread attention, emphasising its potential to revolutionise traditional teaching and learning processes (Barsoum et al., 2022; Sallam et al., 2023). This trend is characterised by an emphasis on utilising AI to enhance students' understanding of scientific concepts and develop their 21st-century skills (Chiu & Chai, 2020). The potential for AI to transform traditional educational methodologies into more engaging, personalised, and outcome-focused experiences is well-recognised in the field (Sætra, 2021). However, the realisation of these advancements heavily depends on the readiness and acceptance of educators, particularly in the field of science education, where the impact of AI can be substantial (Ayanwale et al., 2022; Lindner et al., 2019).

Several factors need to be considered to understand better the readiness of science teachers to implement AI in the classroom. These factors include teachers' attitudes towards AI, their perceived self-efficacy in using AI tools, their expectations regarding the benefits of AI integration, and their access to resources and training in AI education (Ayanwale et al., 2022). Additionally, the feasibility of integrating AI into science teaching must be evaluated within the context of school environments. Teachers' perspectives are critical in determining the readiness to use AI in teaching science (Chiu & Chai, 2020; Su et al., 2022), as they are vital in assessing the value and feasibility of AI

implementation. Equipping teachers with the necessary training and resources is crucial for effectively integrating AI into their science classrooms. Moreover, it is essential to address science teachers' challenges in adopting AI in the classroom. Only then can the successful integration of AI technology into science education be ensured, enhancing students' learning experiences (Lin, 2020).

The significance of this study lies in its exploration of science teachers' readiness to use AI in teaching science, a critical factor in the successful implementation of AI in education. It delves into teachers' attitudes, beliefs, and concerns about AI integration, offering insights into the challenges and opportunities of incorporating AI into science education. Focusing on science teachers' perspectives, this research contributes to the existing literature on AI in education, emphasising its importance in preparing students for the 21st century. Furthermore, with its distinct educational and technological landscape, this study's focus on Jordan provides a critical perspective that contributes to the global discourse on AI in education. The perspectives of science teachers in Jordan are crucial in determining the readiness and acceptance of using AI, highlighting universal themes and region-specific challenges and opportunities in AI integration.

Research Aims

This study aims to explore science teachers' perspectives regarding their readiness and willingness to use AI in teaching science. Integrating AI technology in science teaching can revolutionise education and greatly enhance students' learning experiences (Barsoum et al., 2022). Science teachers' perspectives are essential in determining the readiness to use AI in teaching science. Science teachers are critical in assessing and adopting AI in science education. Effectively incorporating AI into science education necessitates an understanding of the readiness of science teachers to teach this emerging subject (Ayanwale et al., 2022).

By understanding their attitudes, self-efficacy, expectations, access to resources and training, and the feasibility of their school environments, strategies can be developed to support and empower science teachers in integrating AI into their teaching practices.

Research Questions

1. To what extent do Jordanian science teachers perceive themselves as ready to integrate artificial intelligence (AI) into their pedagogical practices, and is this self-perceived readiness reflected in their adoption of AI tools in the classroom?
2. Is there a statistically significant difference at (α = .05) in the readiness to use AI between male and female science teachers, as evidenced by a t-test revealing gender-based disparities?
3. What are the perceived barriers and challenges to the adoption of AI in teaching science among Jordanian educators, and do these perceptions statistically correlate with a lower readiness to employ AI technologies, as indicated by the mean scores and standard deviations?
4. Are there statistically significant differences at (α = .05) in the readiness to use AI across different levels of educational attainment among science teachers, and how does this variability in readiness align with the reported availability and efficacy of professional development programs?

Literature Review

AI's Transformative Potential in Science Classrooms

Artificial Intelligence (AI) holds remarkable potential in revolutionising science education. AI can offer personalised learning experiences and adaptive assessments, enhancing student engagement and outcomes (Toncic, 2021). By automating tasks such as grading and lesson planning, AI allows educators to focus more on personalised teaching and student engagement (AlKanaan, 2022). However, the effective integration of AI in science classrooms heavily depends on teachers' readiness and acceptance, emphasising the need for them to be well-equipped with the necessary knowledge and skills for AI utilisation (Kamalov & Gurrib, 2023).

Lin et al. (2022) highlighted the importance of utilising AI models to support teachers in creating educational activities and overcoming implementation challenges. For instance, AI can assist in developing lesson plans, evaluating student performance, and providing customised learning materials, which can significantly reduce the workload of teachers and enhance the learning experience for students (Lin et al., 2022).

Similarly, Su (2022) conducted a study focusing on integrating innovative AI cognitions with problem-based learning (PBL) tasks to enhance students' performance in science. The research involved participants from Hungkuo Delin University of Technology in Taiwan, who engaged in problem-solving and group cooperation activities. The study revealed that incorporating AI concepts, including face recognition and self-driving technology, into PBL activities improved students' scientific cognitive skills and fostered positive attitudes towards cross-disciplinary PBL and AI knowledge application. These findings underscore AI's potential to stimulate innovation and enhance learning outcomes in educational environments (Su, 2022).

Kamalov and Gurrib (2023) further elaborated on the multifaceted impact of AI in education, identifying applications such as intelligent tutoring systems, automated assessment, and teacher-student collaboration. They emphasised that AI's scalability and ability to provide real-time feedback can personalise learning experiences, thereby improving learning outcomes and promoting a more inclusive educational environment (Kamalov & Gurrib, 2023).

The Critical Role of Teachers in AI-Driven Science Education

Teachers play a crucial role in integrating AI technology into science education and significantly enhancing students' learning experiences. However, science teachers' readiness to use AI in teaching science varies. While some teachers have a strong interest in and knowledge of AI, others may feel overwhelmed or uncertain about its implementation in their classrooms (Zhao et al., 2022). The lack of formal training in AI education exacerbates these challenges, making it essential to provide teachers with the necessary support and resources (Chiu & Chai, 2020). Additionally, students' perceptions of AI influence teachers' readiness for AI integration in classrooms (Demir & Güraksın, 2022).

The increasing interest in integrating AI into science education highlights the need for science teachers' readiness to implement this technology, which remains a significant challenge (AlKanaan, 2022; Pečiuliauskienė et al., 2022). Several studies suggested that while teachers generally have a positive attitude towards using AI in teaching science, they face challenges such as limited knowledge and access to AI resources, concerns about job security, and the need for training and support. Despite these challenges, it is crucial to provide teachers with the necessary training and resources to effectively integrate AI into their science classrooms (Ayanwale et al., 2022; Zhao et al., 2022; Vazhayil et al., 2019).

Teacher Perceptions and the Effectiveness of AI in Classrooms

Teachers' perceptions of the usefulness of AI applications in the classroom can significantly influence their readiness to adopt and incorporate AI into their teaching practice. If teachers perceive AI applications as beneficial in enhancing student learning outcomes, they are more likely to be motivated and ready to use AI in their science curriculum (Demir & Güraksın, 2022). Teachers' willingness to adopt AI in science education is also influenced by their perceptions of its utility and effectiveness in enhancing students' critical thinking and problem-solving skills. Their attitudes and readiness to use AI are shaped by personal experiences with AI tools and their impact on student learning (Alswilem, 2019).

Integrating AI into education effectively fosters enriched learning environments and underscores the pivotal role of educators' readiness to embrace novel educational technologies, highlighting the imperative of cultivating 21st-century competencies among learners and instructors (Flogie & Aberšek, 2015). Training and professional development are vital for increasing teachers' understanding and practical skills in AI applications. Awareness of both AI's benefits and potential drawbacks in education can further influence their readiness to integrate AI into teaching. Teacher readiness for AI in science classrooms is thus a multifaceted issue affected by perceptions of AI's usefulness, effectiveness, personal attitudes, self-efficacy, and access to training (Dec et al., 2022; Zhao et al., 2022).

Teachers' attitudes towards AI are pivotal in their readiness for its adoption in science teaching (Ayanwale et al., 2022). Addressing concerns and resistance is crucial, as apprehensions about AI's impact on teaching responsibilities and ethical issues in education can affect their willingness to use AI (Sætra, 2021). According to Toncic (2021), a lack of awareness or knowledge about AI's benefits in science education can hinder its integration. Positive attitudes and a willingness to explore AI's potential are essential. Therefore, teacher education and development programmes must focus on informing teachers about AI and equipping them with the necessary skills for integration.

Broader Impacts: Social, Cultural, and Ethical Considerations in AI Adoption

Social, cultural, and ethical factors deeply influence AI adoption in science education. Teachers' attitudes towards AI are shaped by societal beliefs and cultural norms within education (Songkram & Osuwan, 2022; Wong & Li, 2011). Ethical considerations like privacy and inclusivity are vital (Jiang, 2022; Otero et al., 2023; Williams et al., 2020). Additionally, teachers need training and support to enhance their understanding and readiness for AI integration. Despite a generally positive attitude, challenges like limited knowledge, resource access, and job security concerns exist among teachers (Zhao et al., 2022).

The growing influence of AI in educational settings, as discussed by Šorgo (2020), highlights the critical need for teachers to be integrally involved in both the design and implementation of these technologies. Šorgo elaborates on the rising adoption of automated assessment tools, noting their advantages and the accompanying challenges. Although these systems can enhance efficiency in grading and offer constructive feedback to students, concerns about the standardization of testing formats and possibilities for cheating emphasize the need to explore teachers' readiness and their attitudes towards AI integration in education.

Finally, there may be potential differences in the readiness to use AI in teaching science based on gender. The research of Beekhuyzen et al. (2003) and Chan et al. (2013) has indicated that gender differences in technology adoption and usage are significant, with studies demonstrating that males often exhibit a higher level of comfort and confidence in using technology compared to females. Similarly, Undar and Madrigal (2021) and Chou et al. (2022) suggest that these gender differences in technology adoption and usage could extend to teachers' readiness to use AI in teaching science. It is crucial to acknowledge and address these disparities to ensure equal access and opportunities in science education for all students.

Identifying and Overcoming Barriers to AI Integration

Teachers face various challenges in adopting AI, including limited access to technology, inadequate training, and concerns about job security (Chiu & Chai, 2020; Zhao et al., 2022). Access to diverse AI resources is crucial for teachers' confidence in implementing AI in science lessons (Chou et al., 2022; Yin Albert et al., 2022). Professional development and training are essential for enhancing teachers' AI literacy and understanding the benefits of AI in science education (Song et al., 2022; Zhang, 2022). Addressing potential resistance and concerns is critical for effective AI implementation in science education (Dec et al., 2022; Lin et al., 2022; Sanz et al., 2019; Song et al., 2022).

Access to diverse AI resources significantly influences teachers' readiness for integrating AI into science education. Teachers with ample AI tools, curricula, and learning materials tend to feel more prepared and confident in implementing AI in their teaching. Such resources allow for exploring AI applications, enhancing their ability to effectively use them in science lessons (Chou et al., 2022). Additionally, a varied resource pool aids teachers in tailoring instruction to student needs, thereby improving engagement and learning outcomes (Yin Albert et al., 2022).

Professional development and training are crucial in teachers' readiness to incorporate AI into science education. Teachers who receive specific training and professional development opportunities related to AI are more likely to feel prepared and confident in incorporating it into their teaching practices (Song et al., 2022). They have the necessary knowledge and skills to use AI technologies effectively, understand their potential applications in science education, and address any challenges that may arise. They are also more likely to have a network of support and collaboration with other educators who can share best practices and provide ongoing guidance (Zhang, 2022).

The challenges of integrating AI in science education extend beyond just technological considerations. It also involves addressing teachers' attitudes, concerns, and fears regarding using AI in the classroom. Therefore, it is essential to provide comprehensive professional development programs and support for science teachers to increase their awareness and readiness to utilise AI in science teaching (Elmali & Kiyici, 2022).

Research Methodology

Sample Selection

This study involved collecting data from 136 science teachers in Irbid and Amman, the principal cities of Jordan, using convenience sampling. This method was selected for its practicality in a developing country like Jordan, where reaching a broad spectrum of participants across varied geographic areas could pose significant challenges. The choice of this sample size, though smaller than the typical benchmarks for simple random samples, was deliberate

and aligned with the exploratory nature of the research. The emphasis on urban areas, known for better access to technological resources, was crucial in addressing the study's objective to understand the readiness for AI integration in science education in a developing country. Focusing on the major cities of Irbid and Amman was a strategic decision. Given the notable disparities in technology access between urban and rural areas in Jordan, targeting participants from these urban centres was essential to examine AI readiness among teachers with regular access to technology and AI exposure. This targeted approach was expected to yield insights into digital competencies and the potential for AI integration in urban educational contexts.

However, the reliance on convenience sampling and the concentration on urban areas had to be considered when interpreting the findings. The AI readiness levels and perspectives of teachers in these major cities might have only partially represented those in Jordan's rural or less technologically advanced regions. While the descriptive statistical analysis of the sample offered valuable insights, the extrapolation of these findings to the broader population of Jordanian science teachers should be approached with caution.

Research Instrument

A comprehensive quantitative survey was conducted to evaluate the readiness of science teachers to integrate artificial intelligence (AI) into science education. The questionnaire, specifically designed to align with the study's goals and grounded in pertinent literature, encompassed a range of variables, including demographic information, attitudes towards AI, perceived benefits and challenges of AI in science teaching, self-efficacy in utilising AI tools, and behavioural intentions regarding AI use. It incorporated Likert-scale items, inviting respondents to express their level of agreement with various statements related to AI in science education.

Instrument Development

The initial version of the questionnaire contained 52 items. A pilot study was conducted with 16 participants to evaluate this preliminary version. The participants included a diverse group of science teachers with varying levels of teaching experience and prior exposure to educational technology. During the pilot study, it was observed that the "Perceived Competence in AI" section initially showed a lower reliability with a Cronbach's alpha of 0.70. This indicated potential issues in the uniformity of participants' interpretations of the questions. To address this, specific terms were clarified, and certain questions were rephrased or made more specific to enhance clarity and directness, particularly to better match the real-world experiences of teachers with AI technologies.

The findings from this pilot study were summarised in Table 1. Notably, the average completion time for the survey was 18 minutes, which was deemed acceptable and indicated that the survey was not overly burdensome for participants. However, the initial overall Cronbach's alpha for the survey was 0.78, which, while generally indicative of good internal consistency, revealed room for improvement in specific sections. The lower reliability score (Cronbach's alpha = 0.70) for the "Perceived Competence in AI" section indicated that some questions might not have been uniformly interpreted by all participants. As a result, ambiguous terms were clarified or removed, and some items were rephrased to ensure they more accurately measured the intended constructs.

Table 1
Summary of Pilot Study Results

Metric	Value
Average completion time	18 minutes
Overall Cronbach's Alpha	0.78
Cronbach's Alpha (Competence in AI)	0.70
Items frequently skipped	2 items in 'Access to Resources'

Based on the pilot study feedback, the questionnaire was refined, reducing the number of items from 52 to 35. This revision process, supported by a pilot study, not only validated the content and internal consistency of the survey but also optimised its length to avoid respondent fatigue and ensure comprehensive coverage with-

out overwhelming participants. Each section of the survey was standardised to contain seven items to maintain uniformity, which facilitates comparative analysis and ensures that no key aspect of readiness is overlooked, thus enabling a detailed and effective measure of science teachers' readiness to deploy AI in their teaching practices.

Instrument Design

The questionnaire design was based on the foundational principles of the Technology Acceptance Model (TAM) as proposed by Davis (1989). TAM is extensively utilised to assess the acceptance and use of technology, positing that perceived usefulness (PU) and perceived ease of use (PEOU) are crucial determinants of technology adoption.

1. **Perceived Usefulness (PU):** TAM defines PU as the degree to which an individual believes that using a particular technology will enhance their job performance. Relevant sections of the questionnaire included:
    -   Attitudes Towards AI in Education: This section explores teachers' beliefs about AI's potential to improve educational outcomes, reflecting the concept of PU.
    -   Barriers and Challenges: This section identifies potential impediments to PU, such as concerns regarding data privacy and the ethical implications of AI.
2. **Perceived Ease of Use (PEOU):** According to TAM, PEOU is the degree to which an individual believes that using a technology will be effortless. This aspect was examined in the questionnaire through:
    -   Perceived Competence in AI: Assesses teachers' self-efficacy in using AI tools, directly linked to their perceived ease of use.
    -   Professional Development and Training: Evaluates the training and support provided to teachers, which can significantly influence their perceptions of ease of use by simplifying the operation of AI tools.
3. **External Variables:** TAM acknowledges that external variables can influence PU and PEOU. In this study, these were examined through:
    -   Access to Resources: Measures the availability of essential technological resources, impacting both PU and PEOU.

Each section was designed to measure both the psychological and practical aspects affecting AI adoption among teachers, providing a holistic perspective on the factors that promote or inhibit the effective integration of AI technologies in educational settings.

Validity and Reliability

To ensure the validity and reliability of the data collection, several measures were taken. The pilot study helped refine the questionnaire, ensuring clarity and relevance of the items. Cronbach's alpha was used for reliability analysis, ensuring internal consistency among the questionnaire items.

$$\alpha = k / (k-1) * (1 - \sum \sigma^2_i / \sigma^2_t)$$

The overall Cronbach's alpha for the refined survey was found to be 0.843, indicating a high internal consistency level. This suggests that the questionnaire items accurately measured the participants' perceptions of their digital competencies.

Table 2
Percentage Scale of Teachers' Responses to Questionnaire Items

Less than 59	Very low
60 - 69	Low
70 - 79	Medium
80 - 89	High
90 - 100	Very high

Table 2 presents the classification system used to categorize teachers' responses to the questionnaire items regarding their readiness to integrate AI into teaching practices. The responses are distributed across a percentage scale from 'Very Low' to 'Very High'. This classification aids in assessing the level of readiness among teachers, with 'Very Low' indicating less than 59% readiness and 'Very High' reflecting scores from 90% to 100%.

Data Collection and Analysis

The survey deployment via an online platform was chosen to maintain participant anonymity and confidentiality, elements deemed essential in educational research. The data gathered was analysed through quantitative methods, enabling the identification of themes, patterns, and trends in science teachers' perspectives regarding their readiness for AI in science teaching. Means and standard deviations were computed based on responses to a 5-point Likert scale, with options ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). This method assesses the centrality and dispersion of responses for each item, providing a quantitative measure of participants' attitudes across different sections of the questionnaire.

The notion 'Total' in the following tables refers to the aggregate score obtained by summing the responses to all items within each specific section of the questionnaire. This cumulative score was utilised to evaluate the overall stance or proficiency of participants concerning the section's thematic content. The insights from this analysis offered a comprehensive overview of the current state of readiness among these educators. This valuable information is instrumental in developing targeted interventions and support mechanisms to bolster science teachers' confidence and readiness in integrating AI into their instructional methodologies.

Research Results

The quantitative analysis of science teachers' readiness to integrate AI into their teaching practices revealed varied engagement and competence levels. The following tables summarise the responses to the questionnaire items, providing a detailed understanding of the teachers' perceptions and the challenges they face.

Perceived Competence in AI

The perceived competence of Jordanian science teachers in using AI tools in their teaching practices was explored. Table 3 below summarises teachers' self-assessed abilities and confidence levels.

Table 3
Perceived Competence in AI

Items	M	SD	Availability Ratio, %	Awareness Level	Rank
1. I understand the basic concepts of AI relevant to education.	4.00	3.46	80	High	5
2. I am confident in my ability to use AI tools for teaching science subjects.	4.60	1.56	92	Very high	1
3. I can easily learn new AI tools that are introduced for educational purposes.	4.50	2.50	90	Very high	2
4. I feel prepared to troubleshoot minor issues with AI technology in the classroom.	3.51	5.30	70.20	Medium	7
5. I am able to evaluate the effectiveness of AI tools in enhancing science learning.	3.52	2.50	70.4	Medium	6
6. I am comfortable explaining the benefits and limitations of AI to my students.	4.05	2.33	81	High	4
7. I can integrate AI teaching tools with traditional teaching methods effectively.	4.20	1.78	84	High	3
Total	4.05	4.81	81	High	

Table 3 shows Jordanian science teachers' self-perceived AI competencies, highlighting their confidence in AI tools ($M = 4.60$) and adaptability in integrating AI with conventional teaching methods ($M = 4.20$). However, lower scores in 'Preparedness to Troubleshoot Issues' and 'Ability to Evaluate AI Effectiveness' (3.51 and 3.52, respectively) suggest technical support and evaluation skills gaps.

The highest rank in Table 3 was assigned to "I am confident in my ability to use AI tools for teaching science subjects," indicating a strong self-perception of ability among teachers in this aspect. Conversely, the lowest rank was given to "I feel prepared to troubleshoot minor issues with AI technology in the classroom," suggesting an area where teachers felt less competent and may have required additional training and support. These findings point to enhanced training and support, balancing teachers' eagerness for AI integration with the necessary competencies for effective implementation and evaluation.

Interpretation: The results indicate that Jordanian science teachers generally feel confident in their ability to use AI tools, with the highest mean score (4.60) for confidence in using AI tools for teaching. However, there are areas where teachers feel less competent, such as troubleshooting minor issues with AI technology.

Access to Resources

The availability and accessibility of resources necessary for integrating AI into science teaching were analysed. The results are presented in Table 4.

Table 4
Access to Resources

Items	M	SD	Availability Ratio, %	Awareness Level	Rank
8. I have access to adequate AI resources for teaching science.	3.55	3.85	71	Medium	2
9. My school provides sufficient hardware for utilising AI in the classroom.	3.50	4.70	70	Medium	4
10. I have access to a variety of AI software and applications designed for education.	3.50	1.80	70	Medium	3
11. My school provides the necessary technical support for using AI tools.	3.10	2.55	62	Low	5
12. I have a reliable internet connection in the classroom to support AI activities.	3.08	3.88	61.6	Low	1
13. The AI teaching resources available to me are up-to-date and relevant.	3.05	1.95	61	Low	7
14. I have the necessary instructional materials to complement AI tools in science teaching.	3.00	4.5	60	Low	6
Total	3.25	5.26	65	Low	

Table 4 reveals Jordanian science teachers' views on resource access for AI implementation in education. Scores for 'Access to Adequate AI Resources' and 'Sufficient Hardware' (3.55 and 3.50, respectively) suggest moderate access, but high standard deviations indicate uneven distribution across institutions. Crucial deficits are noted in 'Reliable Internet Connection' and 'Up-to-date AI Resources' (mean scores of 3.08 and 3.05), signalling critical areas for improvement.

The highest rank for resource accessibility in Table 4 was for "I have access to a reliable internet connection in the classroom to support AI activities," highlighting this as a relatively well-supported area. The lowest rank was assigned to "The AI teaching resources available to me are up-to-date and relevant," pointing to a significant gap in the quality and relevance of AI resources, which could hinder effective AI integration. These findings highlight the need for policy action to bridge resource gaps, especially in internet connectivity and current AI materials, to support effective AI integration in science education.

Interpretation: The data suggest that while there is moderate access to AI resources, significant gaps exist

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in technical support, reliable internet connectivity, and up-to-date AI resources, which may hinder effective AI integration in classrooms.

Professional Development and Training

The availability and adequacy of professional development and training for AI integration were explored. The results are presented in Table 5.

Table 5
Professional Development and Training

Items	*M*	*SD*	Availability Ratio, %	Awareness Level	Rank
15. I have received training on how to use AI in teaching.	2.60	4.75	52	Very Low	5
16. Ongoing professional development in AI is available to me.	3.55	3.34	71	Medium	2
17. I am encouraged by my school to attend workshops or conferences about AI in education.	3.50	1.95	70	Medium	3
18. The professional development I receive is tailored to my subject area and grade level.	3.10	5.35	62	Low	4
19. I am satisfied with the level of training provided for AI integration into the curriculum.	2.45	2.54	49	Very Low	7
20. I actively seek out new learning opportunities related to AI.	4.00	1.45	80	High	1
21. The training I received has been practical and applicable to my teaching context.	2.50	2.67	50	Very Low	6
Total	3.1	1.95	62	Low	

Table 5 assesses Jordanian science teachers' views on professional development for AI integration. Teachers show high self-motivation to learn about AI ($M = 4.00$) yet express low satisfaction with the provided training ($M = 2.45$), indicating a gap between their desire for professional growth and the quality of current training. The means for training received, its practicality, and subject-specific tailoring (2.60, 2.50, and 3.10, respectively) suggest inadequacies in development programs, with high standard deviations highlighting varied experiences. Less than three-quarters of teachers report accessible AI professional development, indicating a need for more strategic and structured training aligned with modern teaching demands.

The item "I actively sought out new learning opportunities related to AI" received the highest rank in Table 5, reflecting a proactive attitude among teachers towards enhancing their AI skills. The lowest ranked item, "I am satisfied with the level of training provided for AI integration into the curriculum," indicated dissatisfaction with current training programs, suggesting a need for more robust and tailored professional development initiatives.

Interpretation: The findings indicate a high level of self-motivation among teachers to learn about AI ($M = 4.00$), but a low satisfaction with the training provided ($M = 2.45$), suggesting the need for more practical and relevant professional development programmes.

Attitudes Towards AI in Education

Teachers' attitudes towards the use of AI in education and its potential benefits and challenges were explored. The results are presented in Table 6.

Table 6
Attitudes Towards AI in Education

Items	M	SD	Availability Ratio, %	Awareness Level	Rank
22. I believe that AI can enhance the quality of science education.	4.55	2.75	91	Very high	1
23. I am excited about the potential of AI to personalise learning for my students.	3.90	4.34	78	Medium	4
24. I think that AI can help me to be a more effective teacher.	3.85	3.95	77	Medium	5
25. I am open to experimenting with AI in my teaching practice.	3.78	5.35	75.6	Medium	7
26. I believe that AI can support critical thinking and problem-solving skills in science.	3.80	3.54	76	Medium	6
27. I feel that AI will become an essential part of education in the future.	4.45	1.90	89	High	2
28. I am concerned about AI replacing human elements in teaching	4.43	3.87	88.6	High	3
Total	4.10	3.90	82	High	

Table 6 shows that Jordanian science teachers anticipate AI's significant role in future education. Teachers view AI as beneficial, with a high mean score of 4.55 for enhancing science education quality, backed by a 91% 'Availability Ratio', indicating broad recognition of AI's transformative potential. However, the varied degrees of conviction (standard deviation of 2.75) suggest diverse experiences with AI.

Teachers exhibited the highest optimism for "AI can enhance the quality of science education," as evidenced by its top rank, signalling a strong belief in the potential benefits of AI. The lowest rank was associated with "I am open to experimenting with AI in my teaching practice," indicating reluctance and potential resistance to adopting AI tools, which may have required targeted change management strategies.

Despite optimism, there is a notable concern about AI replacing the human element in teaching (mean score of 4.43) with a wide range of views (standard deviation of 3.87). This highlights a balance between embracing AI's capabilities and apprehensions about its impact on traditional teaching. The consensus on AI becoming integral to future education (mean score of 4.45) demonstrates a readiness for innovation, albeit with caution towards maintaining pedagogical standards.

Interpretation: The results show that teachers are generally optimistic about the potential of AI to enhance education, particularly in improving the quality of science education ($M = 4.55$). However, there are concerns about AI replacing human elements in teaching ($M = 4.43$).

Barriers and Challenges

The perceived barriers and challenges to integrating AI into science education were identified. The results are presented in Table 7.

Table 7
Barriers and Challenges

Items	M	SD	Availability Ratio, %	Awareness Level	Rank
29. I am concerned about data privacy and security issues related to using AI in the classroom.	4.70	4.53	94	Very high	1
30. I perceive a lack of clarity in my school's policy on AI use in education.	4.45	3.59	89	High	6

Items	M	SD	Availability Ratio, %	Awareness Level	Rank
31. I believe there is insufficient time during the school day to integrate AI effectively.	4.65	3.65	93	Very high	2
32. I am worried about the ethical implications of AI in education.	4.55	4.20	91	Very high	3
33. I think that AI could potentially widen the gap between different groups of students.	4.10	5.12	82	High	7
34. I find it challenging to keep up with the rapid development of AI technologies.	4.45	2.85	89	High	5
35. I am concerned about the reliability of AI assessments in understanding student progress.	4.60	1.79	92	Very high	4
Total	4.50	1.95	90	Very high	

Table 7 reveals Jordanian science teachers' perceived barriers to using AI in education, with data privacy and security emerging as top concerns (mean score of 4.70). High 'Availability Ratio' (94%) and 'Awareness Level' ('Very high') show teachers' acute awareness of data management risks, emphasising their focus on the ethical aspects of educational technology. The most significant concern, ranked highest, was "I am concerned about data privacy and security issues related to using AI in the classroom," underscoring the need for robust security measures and policies. The lowest rank was attributed to "AI could potentially widen the gap between different groups of students," suggesting a lesser but still important concern about the equity of AI implementation in education.

Challenges such as insufficient time for AI integration within the school day (mean score of 4.65) and concerns over ethical implications and AI assessment reliability (mean scores of 4.55 and 4.60) highlight teachers' practical and moral complexities. The uniformity in concerns about AI assessment reliability (standard deviation of 1.79) indicates a common worry about AI's alignment with genuine student progress. These findings suggest a teaching cohort keenly aware of AI's challenges but equally committed to integrating it effectively into modern pedagogy.

Interpretation: Data privacy and security concerns are the most significant barriers ($M = 4.70$), followed by insufficient time for AI integration during the school day ($M = 4.65$). These findings highlight the need for clear policies and adequate time allocation for AI activities.

Gender Impact on Teachers' AI Readiness

The impact of gender on AI readiness among science teachers was measured. The results are presented in Table 8.

Table 8
Gender Impact on Teachers' AI Readiness: Means, SDs, and t-Test

Gender	N	M	SD	t	F. D	p
Male	70	4.45	0.59	2.5	134	0.014*
Female	66	4.05	0.55			

Table 8 shows a gender-based disparity in science teachers' readiness to use AI, with male teachers reporting higher readiness ($M = 4.45$) than females ($M = 4.05$). A *t*-test reveals this difference as statistically significant (t-value = 2.5, *p*-value = .014, degrees of freedom = 134), falling below the α = .05 threshold.

While statistically significant, the close mean scores suggest a modest effect size. This highlights the need for further research into the reasons behind this gender gap, such as varying technology exposure, AI attitudes, or professional development opportunities. Addressing these disparities is crucial for equitable AI resource and training access, ensuring all teachers can effectively use AI in their teaching.

Interpretation: The analysis shows a significant gender disparity in AI readiness, with male teachers reporting higher readiness ($M = 4.45$) compared to female teachers ($M = 4.05$). This suggests the need for targeted interventions to support female teachers in AI integration.

Readiness of Science Teachers to Use AI: Analysis by Educational Level

The differences in AI readiness among science teachers based on their educational attainment were identified. The results are presented in Table 9.

Table 9
Readiness of Science Teachers to Use AI: Analysis by Educational Level

Education Level	N	M	SD
Bachelor's	85	3.27	0.46
Higher Diploma	28	3.58	0.65
Master's	17	4.03	0.42
Ph.D.	6	4.34	0.57

The data presented in Table 9 indicates a correlation between higher educational levels and increased readiness to use AI in teaching science. Bachelor's degree holders showed the lowest readiness ($M = 3.27$), while PhD holders had the highest ($M = 4.34$), suggesting that advanced academic qualifications may enhance understanding and acceptance of AI in teaching. This trend implies that higher education, particularly at the Master's and Ph.D. levels, equips teachers with the necessary knowledge and confidence for effective AI integration. An ANOVA test could further validate the significance of these educational differences in AI readiness.

Interpretation: The data indicates a positive correlation between higher educational levels and increased AI readiness. Teachers with higher degrees, such as Master's and PhD, report higher readiness, suggesting that advanced academic training contributes to greater competence in AI integration.

ANOVA: Education Level's Effect on Teachers' AI Readiness

An ANOVA analysis to determine the significance of educational levels on AI readiness was carried out. The results are presented in Table 10.

Table 10
ANOVA: Education Level's Effect on Teachers' AI Readiness

Source	SS	df	MS	F	p
Between groups	26.88	3	13.44	54.93	< .001
Within groups	83.70	342	0.245		
Total	110.18	344			

Table 10's one-way ANOVA analysis reveals a significant correlation between the educational levels of science teachers and their readiness to use AI (F-value = 54.93, $p < .001$). This indicates that differences in AI readiness across educational levels are statistically significant, not just due to chance.

The substantial variance in readiness associated with educational level is highlighted by comparing the sum of squares between groups, 26.88, and the total sum of squares, 110.18. Furthermore, the mean squares between groups, calculated at 13.44, significantly exceed those within groups, at 0.245. This indicates a more significant variability in readiness across different educational levels than within each group. The p-value less than .001 establishes educational attainment as a critical factor in teachers' readiness to integrate AI. These results emphasise the importance of professional development programs tailored to teachers' varying educational backgrounds, ensuring a uniformly high readiness level for AI integration across all levels of educational attainment.

Interpretation: The ANOVA analysis shows a significant effect of educational levels on AI readiness (F-value = 54.93, $p < .001$), indicating that differences in educational attainment significantly impact teachers' readiness to integrate AI.

Post Hoc Analysis: Education Level and AI Readiness

A post hoc analysis to explore further the differences in AI readiness among teachers with varying educational levels was performed. The results are presented in Table 11.

Table 11
Post Hoc Analysis: Education Level and AI Readiness

Education Level	M	Bachelor's	Higher Diploma	Master's	Ph.D.
Bachelor's	3.27				
Higher Diploma	3.58	0.31*			
Master's	4.03	0.76*	0.45*		
Ph.D.	4.34	1.07*	0.76*	0.31*	

As shown in Table 11, the post hoc analysis reveals significant differences in AI readiness among science teachers based on their educational levels. Teachers with higher qualifications, such as Master's and PhD degrees, demonstrated significantly higher readiness scores compared to those with Bachelor's degrees and Higher Diplomas. This suggests that advanced academic training enhances teachers' readiness to integrate AI into teaching practices. The differences between Bachelor's degree holders and those with Higher Diplomas (0.31*), Master's degrees (0.76*), and PhDs (1.07*), as well as between other levels, were all statistically significant, underscoring the need for targeted professional development programmes tailored to teachers' varying educational backgrounds.

These findings highlight the importance of providing comprehensive training programmes that cover both technical aspects of AI and pedagogical strategies for effective integration. Such programmes should bridge the gap between different educational levels, ensuring all teachers have the necessary support and resources to implement AI successfully in their classrooms. Continued investment in professional development and training is essential to enhance teachers' confidence and competence in using AI, ultimately preparing them to harness its potential to enhance science education. Addressing these disparities will contribute to a more equitable and technologically adept teaching environment.

Interpretation: The post hoc analysis confirms significant differences in AI readiness across educational levels. Higher educational attainment correlates with greater AI readiness, emphasising the need for advanced training to support effective AI integration in teaching practices.

Discussion

This study delved into the factors affecting science teachers in Jordan and their readiness to implement Artificial Intelligence (AI) in science education. Echoing global educational technology trends, the research revealed that teachers' self-efficacy and resource accessibility are pivotal to their readiness for AI adoption, consistent with the observations made by Zhao et al. (2022). These aspects find parallels in the study by Folgie and Aberšek (2015), where a transdisciplinary approach in STEM education emphasised the need for teachers' self-efficacy in technology integration and the accessibility of resources as critical determinants of successful technology integration in education.

The analysis presented in Tables 3 and 4 disclosed a high degree of self-reported confidence among educators regarding their AI capabilities, reflecting a baseline optimism similar to sentiments identified in the research by Vazhayil et al. (2019). However, the considerable variability in readiness, as indicated by standard deviations, mirrors the diverse experiences of educators noted in the work of Čipková and Karolčík (2018). This variability suggests that while many teachers feel confident, a significant number still require additional support and training to fully integrate AI into their teaching practices.

The integration of AI in science education faces significant hurdles, particularly the scarcity of essential resources such as AI tools and reliable internet connectivity, as detailed in Table 4 of this study. These challenges, which mirror broader issues identified by Ayanwale et al. (2022), demonstrate their prevalence across diverse educational settings. Furthermore, there is a substantial gap between the strong interest of educators in AI-focused professional development and the actual quality of the training programmes currently available, a concern echoed by Lin et al. (2022). This discrepancy is highlighted in Table 5, where it is noted that Jordanian science teachers exhibit a high

motivation to learn about AI (*M*= 4.00) but report low satisfaction with the provided training (*M* = 2.45). The data underscore the need for improved professional development offerings that are strategically structured and tailored to meet educators' needs. Addressing these dual challenges—resource scarcity and inadequate training—is crucial for the effective and successful adoption of AI in science teaching.

The influence of demographic variables on AI readiness, specifically gender and educational background, is highlighted in Tables 8, 9, and 11. The observed gender disparity is akin to findings by Beekhuyzen et al. (2003), suggesting broader societal influences on gender and technology interaction. This indicates that male teachers generally feel more prepared to integrate AI into their teaching practices than their female counterparts, which may be influenced by societal norms and access to technology. Moreover, the positive correlation between advanced educational qualifications and higher AI readiness complements the perspectives offered by Lin et al. (2022), which acknowledge the empowering effect of advanced degrees on educators' technological competencies. This observation is supported by research findings similar to those of Šorgo (2020), who discussed the influence of societal factors on technology interaction, indicating a common theme across different educational systems.

The implications of these findings are manifold. First, the identification of a gender gap in AI readiness suggests an urgent need for targeted interventions aimed at enhancing access and confidence among female science teachers. Second, the variation in readiness according to educational level calls for restructuring professional development programmes to better meet the needs of teachers across all educational backgrounds. Such efforts could include integrating AI education into initial teacher training curricula and providing ongoing specialised training for in-service educators.

Conclusions and Implications

This study provided concrete empirical insights into the factors influencing Jordanian science teachers' readiness to integrate Artificial Intelligence (AI) into their pedagogical practices.

The majority of teachers displayed a positive disposition towards AI, indicating foundational readiness for integrating AI technologies into their pedagogical strategies. However, this readiness varied significantly, with some teachers feeling less confident in their ability to troubleshoot and evaluate AI tools. This mixed readiness was reflected in their varied adoption of AI tools in the classroom.

The analysis revealed a significant gender disparity in AI readiness, with male teachers reporting higher readiness compared to female teachers. This suggested the need for targeted interventions to support female teachers in AI integration.

Teachers faced significant barriers, including the scarcity of AI tools, reliable internet connectivity, and concerns over data privacy and security. These challenges correlated with lower readiness to employ AI technologies, as reflected in lower mean scores for resource access and professional development satisfaction.

There were statistically significant differences in AI readiness across educational levels, with higher educational attainment correlating with greater readiness (e.g., PhD holders reported the highest readiness with a mean of 4.34). This trend underscored the need for professional development programmes that catered to the specific needs of teachers at different educational stages.

The findings of this study on the readiness of Jordanian science teachers to integrate Artificial Intelligence (AI) into their teaching practices carry significant implications for educational theory, practice, and policy development:

1. **Targeted Interventions:** The identification of a gender gap in AI readiness suggests an urgent need for targeted interventions aimed at enhancing access and confidence among female science teachers.

2. **Professional Development:** The variation in readiness according to educational level calls for restructuring professional development programmes to better meet the needs of teachers across all educational backgrounds. Integrating AI education into initial teacher training curricula and providing ongoing specialised training for in-service educators are critical steps.

3. **Resource Allocation:** Addressing the scarcity of AI tools and reliable internet connectivity is crucial. Policymakers should focus on improving infrastructure and ensuring equitable access to technological resources.

4. **Ethical Considerations:** Exploring the ethical dimensions of AI in education will be essential as this technological frontier continues to expand. Ensuring data privacy and security must be prioritised to build trust and facilitate the adoption of AI technologies in educational settings.

Future research should focus on longitudinal studies to track the evolution of teachers' attitudes towards AI and investigate the long-term impacts of AI integration on educational outcomes.

Recommendations

Based on the comprehensive findings of this study, the following strategic recommendations are proposed:

- **Development of Targeted Training Programmes:** It is essential for educational authorities to develop and deploy comprehensive AI training programmes that are pedagogically sound and tailored to the specific needs of science educators.
- **Upgrading Educational Infrastructure:** Schools must enhance their technological infrastructure to support the seamless integration of AI tools, ensuring that educators and students can maximise the benefits of AI in learning environments.
- **Establishing Supportive Policies:** Policymakers should formulate and enforce policies that foster an environment conducive to the ethical use of AI in education. This includes frameworks for data protection, privacy, and the promotion of equitable access to AI resources.
- **Encouragement of Further Research:** Further empirical research is required to track the long-term effectiveness of AI integration strategies and to explore innovative ways to overcome the barriers identified in this study.

By implementing these recommendations, Jordan can make significant strides toward effectively enhancing science teachers' readiness to use AI in education. These efforts will contribute to a more equitable, informed, and technologically adept teaching environment, ultimately benefiting the educational landscape of Jordan and similar developing contexts.

Limitations of the Study

This research, while comprehensive in its approach to understanding the readiness of Jordanian science teachers to use AI in their teaching practice, is subject to several limitations:

1. **Sample Scope:** The findings are based on 136 teachers, which may only partially represent the diverse experiences across Jordan, particularly in more remote areas.
2. **Self-Report Bias:** Data was self-reported, potentially leading to biases such as overestimating AI readiness.
3. **Temporal Limitation:** A cross-sectional study captures a specific moment and might not reflect ongoing changes in attitudes or AI technology.
4. **Implementation Gap:** The study did not measure the actual implementation of AI in classrooms, focusing instead on perceived readiness.
5. **Generalizability:** Specific to Jordanian science teachers, the results may only sometimes apply to different educational or cultural contexts.

Recognising these limitations is crucial for interpreting the study's findings accurately. They also suggest future research avenues, including studies incorporating longitudinal designs or broader, more diverse sampling techniques. Such research could build upon the current study's insights, offering a more detailed and dynamic understanding of the readiness of science teachers to integrate AI into their educational practices. Future research should aim for a more diverse sample to address these limitations. Utilising various sampling methods that include teachers from different geographical areas would provide a more comprehensive view of AI readiness in Jordanian science education, effectively capturing urban and rural educator perspectives.

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