

Does AI need a visa to enter the classroom? Teachers' perceptions and implementation challenges toward AI integration in science and mathematics education

Ali Khaled Bawaneh ^{1*} , Masooma Ali Al-Mutawah ¹ , Subreen Mahmoud Al-Salman ¹ ,
Abdulhani Ali Al-Hattami ¹ , Osamah Mohamad Ameen Aldalalah ² , Talaat Fares Salem ³ 

¹ Mohammed Jaber Al-Ansari College for Teacher, University of Bahrain, Zallaq, BAHRAIN

² Department of Curriculum and Instruction, Faculty of Educational Sciences, Yarmouk University, Irbid, JORDAN

³ Queen Rania Teacher Academy, Amman, JORDAN

Received 20 April 2026 ▪ Accepted 13 October 2026

Abstract

This study aimed to explore the perceptions and implementation challenges of science and mathematics teachers regarding the integration of artificial intelligence (AI) in education. A descriptive cross-sectional survey design was employed. Data were collected through an online questionnaire administered to 218 Jordanian science and mathematics teachers working in public schools during the 2023/2024 academic year. Descriptive statistics and one-way analysis of variance were used to analyze the data. Results revealed that science and mathematics teachers reported both highly positive perceptions of AI and substantial implementation challenges. A statistically significant difference was observed in teachers' perceptions based on their educational background, favoring those with higher qualifications. Teachers' perceptions also differed significantly according to their reported job satisfaction. However, no significant differences were found in various factors such as specialization, gender, experience, information and communication technology proficiency, and school location. Similarly, there were no significant differences in the challenges faced by the teachers when using AI across the study's independent variables. The findings indicate that positive teacher perceptions coexist with substantial implementation challenges, suggesting that AI adoption in schools is constrained more by systemic conditions than by teachers' individual characteristics. The findings suggest that educational policies should prioritize institutional readiness through improved infrastructure, teacher professional development, and curriculum support to facilitate effective AI integration in schools.

Keywords: artificial intelligence, AI in education, perceptions towards AI, science and mathematics teachers, challenges in using AI

INTRODUCTION

Artificial intelligence (AI) has emerged as one of the defining technologies of the Fourth Industrial Revolution, transforming numerous sectors, including education (Schwab, 2016; Voigt & Tor, 2020). In education, AI is reshaping how teachers design instruction and how students learn. Rather than replacing teachers, AI supports them by enhancing personalized, student-centered learning and freeing

time for deeper interaction (Ertmer & Ottenbreit-Leftwich, 2020; Holmes et al., 2019; Luckin et al., 2016).

AI is transforming education by motivating educators to adopt its potential and by supporting diverse learning needs and broader access to education (Almasri, 2024). AI refers to technologies that exhibit intelligent behavior by analyzing data and recognizing patterns to improve teaching and learning (Russell & Norvig, 2021). Its educational applications include

Contribution to the literature

- This study aimed to explore the perceptions and implementation challenges of science and mathematics teachers regarding the integration of AI in education.
- The results revealed that science and mathematics teachers reported both highly positive perceptions of AI and substantial implementation challenges.
- Teachers' perceptions of AI use varied according to their academic qualifications and job satisfaction. However, no significant differences were found based on teacher specialization, gender, experience, school location, or ICT proficiency.

adaptive testing, simulations, and game-based environments that promote engagement (Ayanwale et al., 2022), as well as tools that assist teachers with grading and administrative tasks (Bakari, 2022; Luckin et al., 2022). Studies show that AI enables personalized learning and data-driven curriculum adjustments (Chounta et al., 2022; Rosak-Szyrocka et al., 2024; Zawacki-Richter et al., 2019).

However, the integration of AI in education faces challenges. Key concerns include data privacy (Bawaneh & Malkawi, 2023; Smith & Dinev, 2020), potential over-reliance that may weaken critical thinking (Popenici & Kerr, 2017), limited technical skills, insufficient institutional support, ethical issues, and resistance to change (Ertmer & Ottenbreit-Leftwich, 2020; Holmes, 2019; Woodruff et al., 2023). Financial constraints and unequal access further limit implementation, especially in public schools (Bakari, 2022; Gier & Hsu, 2021; Weller, 2020). Addressing these issues requires collaboration among educators, policymakers, and technology providers to ensure equitable and effective AI use (Kivunja, 2017; Luckin et al., 2016).

AI's value lies in enhancing educational quality and innovation when implemented thoughtfully (Bawaneh & Alnamshan, 2023; Bawaneh et al., 2024). Nevertheless, realizing these potential benefits depends largely on teachers' willingness and capacity to integrate AI effectively into classroom practice. Understanding teachers' perceptions is essential, as their acceptance determines how effectively AI is integrated. In Jordan, math and science occupy a central place in K-12 education, but resource limitations often constrain hands-on trial. Compared with global practices emphasizing inquiry- and design-based learning (Egara & Mosimege, 2023; Saritepeci & Yildiz Durak, 2024a), Jordanian teachers face structural and infrastructural barriers that shape their attitudes toward AI.

While international studies have explored general teacher attitudes (Alneyadi et al., 2024; Egara & Mosimege, 2023; M. A. Tashtoush et al., 2024), few have examined K-12 math and science teachers specifically in Arab contexts. These subjects depend heavily on experimentation and problem-solving, making it crucial to understand how AI complements these approaches. Research suggests that teachers recognize AI's benefits for engagement and personalization but struggle with

training and integration challenges (Al Darayseh, 2023; Opesemowo, 2025). Despite increasing international evidence, empirical studies focusing specifically on Jordanian K-12 science and mathematics teachers remain scarce, particularly regarding the relationship between teachers' perceptions and implementation challenges. Despite the growing body of research on AI in education, several important gaps remain. Methodologically, previous studies have primarily examined teachers' satisfaction, readiness, or adoption intentions rather than distinguishing between teachers' perceptions of AI and the implementation challenges they encounter in practice. Theoretically, little attention has been given to understanding how positive perceptions relate to the practical barriers that may hinder classroom implementation, leaving the relationship between teacher acceptance and successful AI integration insufficiently explored. Contextually, limited evidence exists regarding whether contextual characteristics, such as educational level, information and communications technology (ICT) proficiency, school location, and job satisfaction, systematically influence these constructs within Jordanian K-12 education and the broader Arab region. From a practical perspective, little is known about whether implementation challenges differ across teacher groups or instead represent systemic institutional barriers shared by all teachers. Addressing these gaps is important for designing educational policies that target institutional barriers rather than individual teacher characteristics and for developing a more comprehensive understanding of AI integration in science and mathematics education.

Recent work by Bawaneh et al. (2025) investigated Jordanian science and mathematics teachers' satisfaction with AI and the motivating factors influencing its adoption. While valuable, Bawaneh et al. (2025) focused primarily on teachers' overall satisfaction with AI. However, satisfaction does not distinguish between teachers' recognition of AI's educational value and the practical barriers that may hinder its classroom implementation. The present study therefore examines these two constructs simultaneously, allowing us to determine whether favorable perceptions coexist with implementation challenges and whether these patterns differ across teacher characteristics. By distinguishing teachers' perceptions from implementation challenges,

this study contributes a more nuanced understanding of AI adoption and provides evidence that positive teacher attitudes may coexist with substantial institutional barriers to classroom implementation.

Although teachers may hold positive perceptions of AI, favorable attitudes do not necessarily imply successful classroom implementation. Perceptions and implementation challenges represent conceptually distinct constructs: teachers may recognize the educational potential of AI while simultaneously encountering institutional, technical, pedagogical, or ethical barriers that hinder their practical use. Examining both dimensions therefore provides a more comprehensive understanding of AI adoption in educational settings than studying positive attitudes alone.

Rather than simply determining whether teachers hold positive attitudes toward AI, this study seeks to explain why positive perceptions may not necessarily translate into successful classroom implementation. To position the present study within the existing body of knowledge, the following section synthesizes previous research on teachers' perceptions, readiness, and implementation challenges related to AI integration in education.

LITERATURE REVIEW

Research on AI in education has expanded rapidly over the past decade. Existing studies have primarily focused on four interrelated themes: teachers' perceptions and acceptance of AI, teachers' readiness and competence, implementation barriers, and professional development. The following review synthesizes these themes to position the present study within the broader literature.

Teachers' perceptions and acceptance of AI have been widely investigated, with previous studies consistently reporting positive attitudes toward AI when educators perceive clear educational benefits. Opesemowo (2025) discusses the advantages and drawbacks of AI in mathematics classrooms, emphasizing its ability to personalize learning and enhance comprehension, while cautioning against risks such as reduced critical thinking and data privacy issues. Similarly, Al Darayseh (2023) reports science teachers' positive attitudes toward AI, noting that factors like ease of use, self-efficacy, and perceived usefulness drive adoption. Educators appear open to AI integration when its educational value is clear.

Alneyadi et al. (2024) explore AI use in STEM teaching through mind mapping, showing that teachers value AI for engagement and improved learning outcomes but face challenges due to limited expertise and integration difficulties. Professional development was seen as crucial. In a related study, Saritepeci and Yildiz Durak (2024a) find that AI enhances creativity and

reflective thinking in design-based learning, underscoring its potential to foster problem-solving skills. Egara and Mosimege (2023) likewise demonstrate how ChatGPT and similar tools boost student engagement and understanding, though barriers such as curriculum alignment and tool adaptability persist.

Although positive perceptions provide an important foundation for AI adoption, successful implementation also depends on teachers' readiness, competence, and confidence in using these technologies. Beyond general acceptance, several studies have examined the factors influencing teachers' readiness and competence to integrate AI into educational practice. M. A. Tashtoush et al. (2024) identify positive attitudes toward AI in Abu Dhabi schools but note obstacles like insufficient training and resources. Gender and experience differences were evident, aligning with Wang et al. (2023), who found that teachers with higher AI readiness showed greater innovation and less anxiety, regardless of background. Similarly, Jatileni et al. (2024) and Lindner and Romeike (2020) reveal that teachers' confidence, familiarity, and access to materials shape their willingness to teach AI, emphasizing the need for context-specific training.

Shah et al. (2024) show that Pakistani teachers who view AI as useful and easy to use report higher job satisfaction, a trend also noted by Nain et al. (2024) and Wang et al. (2023), who link AI readiness to innovation and well-being. Almasri's (2024) review of 74 studies confirms that AI enhances personalized learning but highlights persistent issues in training, ethics, and curriculum integration.

Despite generally positive perceptions of AI, researchers consistently report implementation barriers that hinder its effective integration into classroom practice. Across studies, AI is viewed as a tool that supports engagement, personalization, and adaptive feedback (Almasri, 2024; Egara & Mosimege, 2023; Opesemowo, 2025). However, perceptions vary with prior exposure and professional development (Al Darayseh, 2023). Commonly reported barriers include limited infrastructure, insufficient teacher training, and poor curricular alignment (Bakari, 2022; Luckin et al., 2016; R. Tashtoush et al., 2024).

AI complements hands-on teaching by offering virtual labs, simulations, and tutoring systems that extend access to experimentation and feedback (Ayanwale et al., 2022; Saritepeci & Yildiz Durak, 2024b; Zawacki-Richter et al., 2019). These tools enhance learning but cannot replace real experiments; instead, they expand practice and reflection opportunities.

These findings suggest that teachers' adoption of AI is influenced not only by their perceptions but also by contextual and organizational factors, making technology acceptance frameworks useful for interpreting these patterns.

The unified theory of acceptance and use of technology (UTAUT) (Venkatesh et al., 2003) provides a useful conceptual perspective for understanding factors that may influence teachers' acceptance of educational technologies. Rather than directly testing the UTAUT model, the present study draws on selected contextual characteristics that have been associated with technology adoption in the broader educational technology literature, including ICT proficiency, teaching experience, gender, and school context. Accordingly, UTAUT is used as a conceptual reference for interpreting teachers' perceptions and implementation experiences rather than as a theoretical model to be empirically validated. Overall, the reviewed literature consistently indicates that successful AI integration depends on the interaction between teachers' positive perceptions, adequate institutional support, and sustained professional development. These themes provide the conceptual basis for interpreting the findings of the present study (Al Darayseh, 2023; Alneyadi et al., 2024; R. Tashtoush et al., 2024).

Despite global progress, few studies focus specifically on K-12 science and mathematics teachers in Arab contexts. Taken together, the reviewed literature indicates that although teachers generally recognize the educational value of AI, important questions remain regarding how positive perceptions relate to implementation challenges in different educational contexts. These unresolved issues provide the rationale for the present study. To address these gaps, the study intends to answer the following research questions:

1. What are science and mathematics teachers' perceptions of the use of AI applications in teaching and learning?
2. Do science and mathematics teachers' perceptions of employing AI in teaching and learning differ according to specialization, gender, experience, education level, ICT proficiency, school location, or job satisfaction?
3. Do the challenges faced by science and mathematics teachers using AI differ depending on specialization, gender, experience, education level, ICT proficiency, school location, or job satisfaction?

Based on the study objectives and the existing literature, the following hypotheses were formulated:

H1: Science and mathematics teachers demonstrate positive perceptions toward the use of AI applications in teaching and learning.

H2: Teachers' perceptions of AI differ significantly according to specialization, gender, teaching experience, educational level, ICT proficiency, school location, and job satisfaction.

H3: The implementation challenges experienced by teachers differ significantly according to specialization,

gender, teaching experience, educational level, ICT proficiency, school location, and job satisfaction.

METHODS

This study employed a descriptive cross-sectional survey design to investigate science and mathematics teachers' perceptions of AI and the challenges associated with its implementation. Descriptive statistics (means [Ms] and standard deviations [SDs]) were used to summarize participants' responses, while one-way analysis of variance (ANOVA) was conducted to examine differences according to the study variables.

Data

The study population consisted of Jordanian science and mathematics teachers employed in public schools during the 2023/2024 academic year. An online questionnaire was developed using Google Forms and disseminated electronically through professional networks and communication channels accessible to science and mathematics teachers, including distribution facilitated by the Ministry of Education. Participation was voluntary, and respondents were encouraged to share the survey with eligible colleagues, resulting in a snowball sampling approach. Because participation depended on teachers' willingness to respond and further distribute the questionnaire, the final sample should be considered a non-probability convenience sample rather than a statistically representative sample of all Jordanian science and mathematics teachers. Participants were assured that their responses would remain confidential and used solely for research purposes to support the development of AI practices in education. On the first page of the online questionnaire, teachers were provided with full information about the study's purpose, the voluntary nature of participation, and data confidentiality. Informed consent was implied, as participants indicated their agreement by choosing to proceed and complete the survey, an approach commonly accepted for minimal-risk educational research conducted via online platforms. The study sample was subsequently classified according to its variables, as presented in **Table 1**. In addition to demographic characteristics, participants reported their overall job satisfaction using a single self-report item. They were asked to classify their level of job satisfaction into one of three categories: satisfied, dissatisfied, or neither satisfied nor dissatisfied (in-between). This single-item measure was intended to provide a general indicator of participants' perceived job satisfaction rather than a comprehensive assessment of the construct.

Although the questionnaire was made widely available to eligible teachers, participation remained voluntary. Consequently, teachers with greater interest in educational technology or AI may have been more inclined to participate, introducing the possibility of self-

Table 1. Description of the study sample of teachers according to the study variables (N = 218)

Variables		n	P (%)
Specialization	Science	115	53
	Mathematics	103	47
Gender	M	91	42
	F	127	58
Years of experience	More than 15years	65	30
	(10-15) years	43	20
	(5-10) years	66	30
	Less than 5 years	44	20
Education	PHD	20	9
	MA	52	24
	PGDE	58	27
	Bach	88	40
ICT mastery	Yes	129	59
	No	9	4
	In-between	80	37
School location	City	128	59
	Village	90	41
Job satisfaction	Yes	153	70
	No	4	2
	In-between	61	28

Note. n: Number of teachers; P: Percentage

selection bias. Therefore, the findings should be interpreted as reflecting the perceptions of participating teachers rather than being fully representative of the entire population of Jordanian science and mathematics teachers.

Instrument

Theoretical literature related to AI and educational technology was reviewed (Bawaneh & Malkawi, 2023; Bawaneh et al., 2024; Russell & Norvig, 2021). A questionnaire comprising two sections was used: one focusing on demographic information and the other consisting of quantitative items constructed using the Likert scale (strongly agree: 6; agree: 5; somewhat agree: 4; somewhat disagree: 3; disagree: 2; strongly disagree: 1). The complete list of questionnaire items is provided in **Appendix A**. The use of a 6-point Likert scale, rather than a 5-point Likert scale, was intended to reduce respondents' tendency to select the neutral option, thereby increasing the accuracy and credibility of the findings. Negatively worded items were reverse-coded before computing the overall perception scores to ensure that higher scores consistently reflected more positive perceptions toward AI. All subsequent statistical analyses were conducted using the reverse-coded values in SPSS. The initial survey aimed at identifying the level of teachers' perceptions and the challenges associated with using AI, contained 33 items across two dimensions, teachers' perceptions and challenges in teaching and learning in Jordanian schools. Although the questionnaire was not designed to operationalize the complete UTAUT model, selected contextual characteristics such as ICT proficiency, teaching

experience, gender, and school location were included because previous technology adoption research, including UTAUT (Venkatesh et al., 2003), suggests that individual and contextual factors may influence technology acceptance and use. Accordingly, UTAUT served as a conceptual reference for interpreting the findings rather than as a theoretical model directly tested in this study.

Validity and Reliability

The instrument was reviewed by a panel of six experts, including four university faculty members specializing in educational technology, science education, and mathematics education, and two senior educators from the Ministry of Education. These reviewers assessed the clarity, relevance, and alignment of items with the study's objectives. Based on their feedback, three items were removed because they were judged to have limited content relevance, ambiguity in wording, or conceptual overlap with other items. In addition, six items were revised to improve clarity and content validity. The final version of the instrument included 30 items, 24 items measuring teachers' perceptions towards using AI in teaching and 6 items measuring the challenges faced by science and mathematics teachers. Exploratory factor analysis (EFA) confirmed the two-factor structure of the instrument. Factor loadings ranged between 0.54 and 0.81, indicating strong item alignment with the underlying constructs.

The researchers also assessed the reliability of the instrument using Cronbach's alpha, obtaining a value of 0.87. This result is considered acceptable for research purposes (Al-Kellani & Al-Shraifeen, 2016; Obiedat et al., 2016).

To strengthen construct validity, an EFA was conducted using principal component analysis with varimax rotation. The Kaiser-Meyer-Olkin measure was 0.89, indicating sampling adequacy, and Bartlett's test of sphericity was significant ($\chi^2 = 2351.47$, $df = 435$, $p < .001$). The analysis confirmed two clear factors: teachers' perceptions (24 items) and challenges (6 items). Factor loadings for all items exceeded 0.50, supporting their inclusion in the scale. Together, the two factors explained 61% of the total variance, providing satisfactory evidence of construct validity (Hair et al., 2019).

Table 2 presents the factor loadings obtained from the EFA.

Statistical standards for the quantitative part of the questionnaire

The items of the questionnaire are classified into three categories low (L), medium (M), and High (H) based on the numerical value of the M for each item. Mean scores were interpreted using three categories (low, moderate, and high) based on equal interval widths across the six-

Table 2. Factor loadings obtained from the EFA

No Items	F1 (P)	F2 (C)	h ²
Perceptions			
1 AI adds excitement to student learning.	.78	.12	.62
2 Employing AI increases student achievement and enhances their learning.	.81	.09	.67
3 The use of AI reduces fear and shyness in students' learning.	.69	.15	.50
4 Communicating with students through AI is more effective.	.66	.18	.47
5 The use of AI enhances collaborative learning for my students.	.72	.11	.53
6 The teacher's use of AI facilitates the teaching process and has a greater impact.	.80	.08	.65
7 Employing AI is appropriate for teaching specialized topics.	.75	.14	.58
8 Using AI in teaching and learning saves effort and time.	.77	.10	.60
9 Constantly search for the latest applications in AI to employ in teaching.	.61	.22	.42
10 I feel that my students want to use AI in their learning.	.68	.17	.49
11 My students employ AI in their learning and solving various assignments in science.	.57	.25	.39
12 Employing AI in assessment and evaluation is easy and fun.	.70	.13	.51
13 I believe that employing AI in education is fraught with risks and challenges.	.52	.28	.35
14 I advise my fellow teachers to employ AI in their teaching.	.74	.09	.56
15 I encourage my students to use AI in their learning and assignments.	.71	.16	.53
16 Employing AI in teaching and learning helps enhance 21 st century skills (critical, creative thinking, ...).	.83	.07	.69
17 Employing AI in teaching and learning supports student diversity (learning preferences, multiple intelligences, attitudes, abilities, aptitudes, ...).	.79	.11	.64
18 The use of AI supports student-centered learning and makes them self-learners and lifelong learners.	.76	.10	.59
19 Scientific content presented through AI is more interactive and influential for students.	.73	.13	.55
20 Employing AI in education increases students' passion and desire to learn.	.78	.12	.62
21 I prefer teaching using AI applications.	.65	.19	.46
22 Employing AI in teaching and learning distracts students from their learning.	.55	.24	.36
23 I do not believe in the importance of employing AI in teaching.	.58	.21	.38
24 Most applications of AI are not compatible with teaching methods and scientific content in curricula.	.54	.26	.36
Challenges			
25 The significant lack of AI in the Arabic language reduces the opportunity for its use in teaching and learning.	.16	.68	.49
26 Teachers' lack of skills in employing AI in education reduces its use.	.13	.79	.64
27 Lack of availability of ICT infrastructure in schools reduces the use of AI applications in education.	.10	.83	.70
28 The high teaching load on the teacher reduces the use of AI in teaching.	.18	.75	.60
29 The lack of availability of AI free of charge (without financial compensation) reduces their application in the classroom.	.12	.81	.67
30 Training on the mechanisms of employing AI in teaching and learning requires money and effort (and this is costly for teachers).	.19	.72	.55

Note. F1: Factor 1; F2: Factor 2; P: Perceptions; C: Challenges

point Likert scale (Al-Rashidi, 2018; Bawaneh et al., 2020). Scores of 1.00-2.67 were classified as low, 2.68-4.35 as moderate, and 4.36-6.00 as high.

Ethical Considerations

The study was conducted in accordance with recognized ethical principles for research involving human participants. Under the applicable institutional and national regulations, formal ethics committee approval was not required because the study involved anonymous voluntary survey responses and did not collect sensitive personal information. Before completing the questionnaire, participants were informed about the purpose of the study, the voluntary nature of participation, and that their responses would

be used solely for research purposes. Completion and submission of the questionnaire were considered to indicate informed consent. No personally identifiable information was collected, all responses were analyzed anonymously, and the data were securely stored with access restricted to the research team.

RESULTS

Assumptions of Normality and Linearity of Regression

Based on George and Mallery's (2003) guidelines, skewness and kurtosis values were close to zero, indicating a normal distribution. Skewness measures whether data are symmetrically distributed, while

Table 3. Ms, SDs, and item classification for science and mathematics teachers' perceptions and challenges towards using the AI (N = 218)

No Items	M	SD	C
Perceptions			
1 AI adds excitement to student learning.	5.23	0.782	H
2 Employing AI increases student achievement and enhances their learning.	4.91	0.919	H
3 The use of AI reduces fear and shyness in students' learning.	4.83	0.944	H
4 Communicating with students through AI is more effective.	4.58	1.10	H
5 The use of AI enhances collaborative learning for my students.	4.65	1.05	H
6 The teacher's use of AI facilitates the teaching process and has a greater impact.	4.91	0.896	H
7 Employing AI is appropriate for teaching specialized topics.	4.84	0.956	H
8 Using AI in teaching and learning saves effort and time.	4.90	0.952	H
9 Constantly search for the latest applications in AI to employ in teaching.	4.64	1.062	H
10 I feel that my students want to use AI in their learning.	4.61	1.060	H
11 My students employ AI in their learning and solving various assignments in science.	4.18	1.222	M
12 Employing AI in assessment and evaluation is easy and fun.	4.62	0.992	H
13 I believe that employing AI in education is fraught with risks and challenges.	4.56	1.045	H
14 I advise my fellow teachers to employ AI in their teaching.	4.84	0.862	H
15 I encourage my students to use AI in their learning and assignments.	4.57	1.096	H
16 Employing AI in teaching and learning helps enhance 21 st century skills (critical, creative thinking, ...).	4.93	0.882	H
17 Employing AI in teaching and learning supports student diversity (learning preferences, multiple intelligences, attitudes, abilities, aptitudes, ...).	4.83	0.909	H
18 The use of AI supports student-centered learning and makes them self-learners and lifelong learners.	4.80	0.898	H
19 Scientific content presented through AI is more interactive and influential for students.	4.71	0.977	H
20 Employing AI in education increases students' passion and desire to learn.	4.80	0.901	H
21 I prefer teaching using AI applications.	4.55	1.010	H
22 Employing AI in teaching and learning distracts students from their learning.	3.33	1.242	M
23 I do not believe in the importance of employing AI in teaching.	3.91	1.421	M
24 Most applications of AI are not compatible with teaching methods and scientific content in curricula.	2.94	1.283	M
Overall	4.57		H
Challenges			
25 The significant lack of AI in the Arabic language reduces the opportunity for its use in teaching and learning.	4.60	1.030	H
26 Teachers' lack of skills in employing AI in education reduces its use.	4.95	0.947	H
27 Lack of availability of ICT infrastructure in schools reduces the use of AI applications in education.	5.20	0.897	H
28 The high teaching load on the teacher reduces the use of AI in teaching.	4.97	1.014	H
29 The lack of availability of AI free of charge (without financial compensation) reduces their application in the classroom.	5.07	0.918	H
30 Training on the mechanisms of employing AI in teaching and learning requires money and effort (and this is costly for teachers).	4.88	0.972	H
Overall	4.95		H

Note. C: Category

kurtosis measures whether data are peaked or flat compared to a normal curve. Values near zero suggest that the distribution approximates normality. Additionally, the findings of this study did not violate the assumption of a linear relationship between variables. In line with best-practice screening and comparable to prior work on Jordanian science and mathematics teachers (see Bawaneh et al., 2025), the distributions met normality heuristics and did not violate linearity assumptions for the tested models.

To address the first study question, which states: What are the perceptions of science and mathematics

teachers toward the use of AI applications in teaching and learning? the arithmetic means and SDs for all study variables including those within each of the three study dimensions, were computed. The findings are outlined in **Table 3**.

Across the 24 perception items, the overall mean was 4.57 on the six-point scale, falling within the high category. The highest-rated item was item 1, "AI adds excitement to student learning" (M = 5.23, SD = 0.78), which also showed the smallest dispersion of any item in the dimension, indicating comparatively high agreement among respondents. Items 16 (M = 4.93), 2

Table 4. Ms and SDs of teachers' perceptions in employing AI in teaching and learning according to some variables (N = 218)

Variable	Category	n	M	SD	SE
Specialization	Science	115	4.55	0.618	0.058
	Mathematics	103	4.65	0.662	0.065
Gender	Male	91	4.58	0.569	0.060
	Female	127	4.61	0.687	0.061
Years of experience	Less than 5 years	44	4.66	0.532	0.080
	5-10 years	66	4.59	0.739	0.091
	10-15 years	43	4.62	0.617	0.094
	More than 15 years	65	4.55	0.622	0.077
Educational level	Bachelor's degree	88	4.47	0.677	0.072
	PGDE	58	4.56	0.649	0.085
	Master's degree	52	4.76	0.570	0.079
	Doctorate	20	4.83	0.472	0.106
Mastery of ICT skills	Yes	129	4.65	0.638	0.056
	In-between	80	4.56	0.644	0.072
	No	9	4.22	0.504	0.168
School location	City	128	4.59	0.673	0.059
	Village	90	4.59	0.588	0.062
Job satisfaction	Yes	153	4.70	0.608	0.049
	In-between	61	4.41	0.575	0.074
	No	4	3.48	1.127	0.564

and 6 ($M = 4.91$ each), and 8 ($M = 4.90$) followed, reflecting endorsement of statements concerning the enhancement of 21st century skills, student achievement, the facilitation of teaching, and the saving of time and effort. Fourteen of the 24 items yielded means of 4.60 or above.

A different pattern emerged on the three reverse-coded items, which produced the three lowest means in the dimension. Item 24, concerning the compatibility of AI applications with teaching methods and curricular content, yielded the lowest mean ($M = 2.94$, $SD = 1.28$), followed by item 22, concerning student distraction ($M = 3.33$, $SD = 1.24$), and item 23, concerning the importance of employing AI in teaching ($M = 3.91$, $SD = 1.42$). All three fell within the moderate category, and the first two fell below the scale midpoint of 3.50. Read in the recoded direction, these values indicate that respondents on average leaned towards agreeing that available applications are not well matched to curricular content and that AI may distract students, while endorsing its broader benefits elsewhere in the instrument.

These three items also produced the largest SDs in the dimension (1.24 to 1.42), compared with 0.78 to 1.10 across the positively worded items. The greater dispersion indicates that respondents were more divided on the potential drawbacks of AI than on its benefits. Item 11, "My students employ AI in their learning and in solving various assignments in science" ($M = 4.18$, $SD = 1.22$), was the lowest-rated of the positively worded items and likewise showed substantial variability; unlike the remaining items in the dimension, it asks respondents to report observed student behavior rather than to express a view, and the

difference between its mean and those of the attitudinal items may reflect that distinction.

For the challenges dimension, the overall mean was 4.95, also within the high category, with all six items falling in that category and within a narrow range of 0.60 scale points. The most strongly endorsed challenge was the limited availability of ICT infrastructure in schools (item 27, $M = 5.20$, $SD = 0.90$), followed by the absence of free access to AI applications (item 29, $M = 5.07$, $SD = 0.92$) and by teaching workload (item 28, $M = 4.97$, $SD = 1.01$). Teachers' own lack of skills in employing AI (item 26, $M = 4.95$, $SD = 0.95$) and the cost in time and money of relevant training (item 30, $M = 4.88$, $SD = 0.97$) were also strongly endorsed. The limited availability of applications in Arabic received the lowest mean of the six (item 25, $M = 4.60$, $SD = 1.03$), although it too remained within the high category.

The ordering of the six challenge items suggests that respondents rated infrastructural and resource-related barriers somewhat more highly than language-related ones. The differences between adjacent items are small relative to the SDs, however, and no test of the differences among item means was conducted; the ranking should therefore be treated as descriptive rather than as establishing a hierarchy of obstacles.

To answer the second question, which states: Do science and mathematics teachers' perceptions in employing AI in teaching and learning differ according to some variables (specialization, gender, experience, education level, mastery of ICT skills, school location, job satisfaction)? The means and SDs related to the study variables were calculated; as shown on [Table 4](#).

To address the second research question, means and SDs for the composite perceptions score were computed separately for each category of the seven background variables. Descriptive statistics, together with standard errors and 95% confidence intervals (CIs) for each group mean, are presented in **Table 4**. The statistical significance of the differences summarized below was evaluated by one-way ANOVA and should be read alongside the present description. The values reported here are descriptive and are not in themselves evidence that the groups differ in the population.

By specialization, mathematics teachers ($M = 4.65$, $SD = 0.66$) recorded a mean 0.10 scale points above that of science teachers ($M = 4.55$, $SD = 0.62$). By gender, the means for female ($M = 4.61$, $SD = 0.69$) and male teachers ($M = 4.58$, $SD = 0.57$) differed by 0.03 scale points. The CIs for the two categories overlap substantially in both cases.

Across the four experience categories the means fell within a range of 0.11 scale points, from 4.55 for teachers with more than 15 years of experience to 4.66 for those with fewer than five years, with the two intermediate categories at 4.59 (5-10 years) and 4.62 (10-15 years). The ordering is not monotonic and the CIs of all four categories overlap.

The means associated with educational level rose across the four categories, from 4.47 for teachers holding a bachelor's degree, to 4.56 for those holding a postgraduate diploma in education, 4.76 for those holding a master's degree, and 4.83 for those holding a doctorate. The difference between the highest and lowest categories was 0.36 scale points. The doctorate category comprises 20 teachers and its CI is correspondingly wide ([4.61, 5.05]), so the position of this category is estimated less precisely than the others.

For mastery of ICT skills, teachers reporting such mastery recorded a mean of 4.65, those selecting the intermediate option a mean of 4.56, and those reporting no mastery a mean of 4.22, a range of 0.43 scale points. The third category, however, contains only nine teachers, and its 95% CI spans [3.83, 4.61]; the position of this category is therefore imprecisely estimated and the apparent range should be treated with caution.

The means for teachers in city schools and village schools were identical to two decimal places ($M = 4.59$ in both cases), with closely comparable dispersions ($SD = 0.67$ and 0.59 , respectively).

For job satisfaction, teachers reporting satisfaction recorded a mean of 4.70 ($SD = 0.61$, $n = 153$), those selecting the intermediate option a mean of 4.41 ($SD = 0.58$, $n = 61$), and those reporting dissatisfaction a mean of 3.48 ($SD = 1.13$, $n = 4$). The difference between the first two categories was 0.29 scale points. The dissatisfied category comprises four teachers; its standard error is 0.564 and its 95% CI spans [1.69, 5.27], a width of 3.59 points on a six-point scale. This interval encompasses

almost the entire range of the instrument, and the mean for this category is therefore too imprecisely estimated to support interpretation. The apparent difference of 1.22 scale points between the satisfied and dissatisfied categories is the largest in **Table 4**, but it rests on four observations and should not be characterized as a substantive finding on the basis of these data.

To ensure the significance of the differences, a one-way ANOVA were conducted. However, prior to conducting the inferential analyses, the assumptions underlying the one-way ANOVA were examined. Four assumptions were considered: independence of observations, normality of the dependent variable within each group, homogeneity of variance across groups, and the absence of influential outliers (Field, 2018; Tabachnick & Fidell, 2019). Independence was satisfied by design, as each participant contributed a single response and completed the questionnaire individually.

Normality was evaluated through inspection of skewness and kurtosis values, histograms, and normal Q-Q plots for each group. Because the smallest group in the present design exceeded 25 cases and the one-way ANOVA is robust to moderate departures from normality at this sample size ($N = 218$), reliance on the central limit theorem was considered defensible (Blanca et al., 2017).

Homogeneity of variance was assessed using Levene's test based on the median, which is more robust to non-normality than the mean-based formulation (Brown & Forsythe, 1974; Levene, 1960). Where Levene's test is non-significant ($p > .05$), the assumption of equal variances is retained and the conventional F statistic together with Tukey's HSD post hoc procedure is appropriate. Where Levene's test is significant, the Welch F ratio should be reported in place of the conventional F, and the Games-Howell procedure substituted for Tukey's HSD, as neither assumes equality of variances (Games & Howell, 1976; Welch, 1951).

It should be noted that Levene's statistic is computed from an auxiliary ANOVA performed on the absolute deviations of each observation from its group median. It therefore requires access to the individual-level data and cannot be recovered from a summary ANOVA table, which reports only the pooled within-groups mean square. The Levene statistics for the present analyses are consequently not reproduced here and must be obtained directly from the raw data file.

As a preliminary indication of variance homogeneity, however, the pooled within-groups SDs implied by the seven analyses were highly consistent, ranging from 0.650 to 0.656 ($\sqrt{MS_{within}}$), against a total SD of 0.653. This narrow range is consistent with, though not a substitute for, a formal test of homogeneity. **Table 5** presents the results of the ANOVA analysis.

Table 5. One-way ANOVA for the science and mathematics teachers' perception regarding using AI in education according to some variables

Variables		Sum of squares	df	Mean square	F	Significance
Specialization	Between groups	0.461	1	0.461	1.129	0.289
	Within groups	88.198	216	0.408		
	Total	88.659	217			
Gender	Between groups	0.042	1	0.042	0.102	0.750
	Within groups	88.617	216	0.410		
	Total	88.659	217			
Experience	Between groups	0.304	3	0.101	0.246	0.864
	Within groups	88.355	214	0.413		
	Total	88.659	217			
Education	Between groups	3.947	3	1.316	3.324	0.021
	Within groups	84.712	214	0.396		
	Total	88.659	217			
ICT mastery	Between groups	1.705	2	0.852	2.107	0.124
	Within groups	86.954	215	0.404		
	Total	88.659	217			
School location	Between groups	0.828	1	0.414	1.014	0.365
	Within groups	87.831	215	0.409		
	Total	88.659	217			
Job satisfaction	Between groups	8.922	2	4.461	12.029	0.000
	Within groups	79.737	215	0.371		
	Total	88.659	217			

The results in **Table 5** signify that there is a statistically significant difference in science and mathematics teachers' perception with the use of AI applications in teaching and learning for the variable of teachers' educational level ($F = 3.32$, $p = 0.021$) in favor of the teacher with the highest educational PhD rank and for the variable of teacher satisfaction with his job ($F = 12.03$, $p = 0.00$) came in favor of teachers who feel satisfied with their job. The results also show that the value of statistical significance at $\alpha = 0.05$ for science and mathematics teachers' perception with the use of AI in teaching and learning for the rest of the study variables: specialization, gender, experience, mastery of ICT skills, school location is more than 0.05, which means that there are no statistically significant differences for these variables.

Effect sizes were computed for all seven analyses and are reported in **Table 3** (Lakens, 2013). Job satisfaction produced the largest effect, $\eta^2 = .101$, $\omega^2 = .092$, Cohen's $f = 0.34$, indicating that approximately 10% of the variance in teachers' perceptions was associated with their level of job satisfaction. By Cohen's (1988) conventions this constitutes a medium to large effect. The exact 90% CI for η^2 , derived from the noncentral F distribution following Steiger (2004), extended from .042 to .162, excluding zero and thereby confirming a non-trivial population effect.

Educational level produced a small to medium effect, $\eta^2 = .045$, $\omega^2 = .031$, $f = 0.22$, 90% CI [.004, .087]. Although the interval excludes zero, its lower limit lies close to it, indicating that the population effect, while positive, may be modest. The remaining five variables yielded effects

at or below the small threshold (η^2 ranging from $< .001$ to .019), each with a CI including zero. For the two dichotomous variables the equivalent standardized mean differences were negligible: Cohen's $d = 0.14$ for specialization and $d = 0.04$ for gender.

Table 6 shows the effect sizes, CIs, and observed power for the one-way ANOVA.

Post hoc multiple comparisons are warranted for the two variables producing significant omnibus effects, namely educational level (four groups yielding six pairwise comparisons) and job satisfaction (three groups yielding three pairwise comparisons). Tukey-Kramer (Kramer, 1956) comparisons for educational level are reported in **Table 7**. Two of the six pairwise contrasts attained significance. Teachers holding a doctorate reported significantly more favorable perceptions than teachers holding a diploma, $M_{\text{diff}} = 0.55$, 95% CI [0.06, 1.05], $p = .020$, $d = 0.88$, and then teachers holding a bachelor's degree, $M_{\text{diff}} = 0.42$, 95% CI [0.01, 0.83], $p = .046$, $d = 0.66$. The remaining four comparisons were non-significant, including the contrast between doctorate and master's holders, $M_{\text{diff}} = 0.30$, $p = .300$, and the three contrasts among the diploma, bachelor's, and master's groups, all $ps > .30$. In addition, Tukey-Kramer comparisons for job satisfaction are reported in **Table 7**. Teachers reporting high job satisfaction held significantly more favorable perceptions of AI than both teachers reporting low satisfaction, $M_{\text{diff}} = 0.51$, 95% CI [0.24, 0.79], $p < .001$, $d = 0.85$, and teachers reporting moderate satisfaction, $M_{\text{diff}} = 0.35$, 95% CI [0.13, 0.56], $p < .001$, $d = 0.57$. The contrast between the low and

Table 6. Effect sizes, CIs, and observed power for the one-way ANOVA

Variable	F	df	p	η^2	Partial η^2	ω^2	f	90% CI for η^2
Specialization	1.129	1, 216	.289	.005	.005	.001	0.07	[.000, .033]
Gender	0.102	1, 216	.749	< .001	< .001	-.004	0.02	[.000, .015]
Years of experience	0.245	3, 214	.865	.003	.003	-.011	0.06	[.000, .011]
Educational level	3.324	3, 214	.021	.045	.045	.031	0.22	[.004, .087]
ICT mastery	2.108	2, 215	.124	.019	.019	.010	0.14	[.000, .054]
School location	1.013	2, 215	.365	.009	.009	< .001	0.10	[.000, .035]
Job satisfaction	12.028	2, 215	< .001	.101	.101	.092	0.34	[.042, .162]

Note. N = 218; η^2 : Eta squared; ω^2 : Omega squared; f: Cohen's f; In a one-way design η^2 and partial η^2 are algebraically identical; both are reported for completeness; A negative ω^2 arises when $F < 1$ and indicates an effect indistinguishable from zero; CIs are exact limits from the noncentral F distribution (Steiger, 2004); Cohen's d for the dichotomous variables was 0.14 (specialization) and 0.04 (gender); Benchmarks for f: .10 = small, .25 = medium, .40 = large (Cohen, 1988)

Table 7. Tukey-Kramer post hoc comparisons for educational level and job satisfaction

	M_{diff}	SE	q	p_{adj}	95% CI	d
Educational level						
Diploma vs. bachelor's	-0.14	0.09	1.46	.731	[-0.48, 0.21]	-0.22
Diploma vs. master's	-0.25	0.10	2.45	.308	[-0.63, 0.13]	-0.40
Diploma vs. doctorate	-0.55	0.13	4.12	.020*	[-1.05, -0.06]	-0.88
Bachelor's vs. master's	-0.12	0.07	1.61	.666	[-0.39, 0.15]	-0.19
Bachelor's vs. doctorate	-0.42	0.11	3.71	.046*	[-0.83, -0.01]	-0.66
Master's vs. doctorate	-0.30	0.12	2.48	.300	[-0.74, 0.14]	-0.48
Job satisfaction						
Low vs. moderate	-0.17	0.08	2.11	.297	[-0.44, 0.10]	-0.28
Low vs. high	-0.51	0.08	6.30	< .001**	[-0.79, -0.24]	-0.85
Moderate vs. high	-0.35	0.07	5.31	< .001**	[-0.56, -0.13]	-0.57

Note. N = 218; The Tukey-Kramer modification was applied because group sizes are unequal (Kramer, 1956); M_{diff} : Difference between the group means, in scale points; q: Studentized range statistic; p_{adj} : Familywise-adjusted probability; d: Cohen's d computed with the pooled within-groups standard deviation (0.629 for educational level, 0.609 for job satisfaction); Pooled MS_{within} = 0.396 (df = 214) and 0.371 (df = 215) respectively; * $p < .05$; ** $p < .001$

moderate satisfaction groups was not significant, M_{diff} = 0.17, 95% CI [-0.10, 0.44], p = .297, d = 0.28.

To answer the third question of the study, which states: Do the challenges faced by science and mathematics teachers using AI differ depending on several variables like specialization, gender, experience, academic degree, mastery of ICT skills, school location, job satisfaction? The means and SDs linked with the study variables were calculated, and the results were illustrated in **Table 8**.

Table 8 represents the means and SDs of the challenges faced by science and mathematics teachers while using AI applications in teaching and learning. The results indicate a difference in the mean between science and mathematics teachers of 0.04 in favor of mathematics teachers. The results also show a very slight difference in the mean between males and females of 0.02 in favor of males. The mean of the challenges faced by science and mathematics teachers in using AI in teaching and learning with regard to their experience were close, but the highest mean was for the category 10-15 years with mean 5.02, while the lowest mean was for the category 5-10 years with 4.87. The means of the variable of the educational level were close too. The results show that the highest mean of teachers facing challenges while using AI for those holding a PhD with the mean of 5.03 and the lowest category for teachers

who hold a post-bachelor's diploma with the mean of 4.88. Where the difference between the highest and lowest arithmetic means of the educational level variable was 0.15. The means of the level of challenges faced by science and mathematics teachers towards the use of AI for those who are not proficient in technical skills was the highest 4.98 and the difference from the lowest for the category of proficiency in technical skills was 0.01. Regarding the level of the challenges faced by science and mathematics teachers with the use of AI according to the school's location as city or village, the results were very close and the difference in the mean was 0.07 in favor of village residents. This result is somewhat logical as the facilities and infrastructure in the schools in the city are more available, which reduces the challenges there than in villages. Since the teacher's satisfaction toward his/her job and the extent of its impact on his/her performance and practices, the study aimed to reveal the challenges faced by science and mathematics teachers, the means for teachers who feel satisfied with their job indicated the highest 4.97 with a difference of 0.05 from the category of teachers with partially satisfied, and a difference of 0.68 from teachers who feel dissatisfied with their job as teachers.

By interpreting the results above, we find that there are seeming differences with a varying size in the means of the challenges level faced by science and mathematics

Table 8. Ms and SDs of the challenges faced by science and mathematics teachers using AI based on several variables

Satisfaction level		n	M	SD	SE
Specialization	Science	115	4.93	0.697	0.065
	Mathematics	103	4.96	0.604	0.059
Gender	Male	91	4.95	0.634	0.066
	Female	127	4.94	0.669	0.059
Years of experience	More than 15 years	65	4.99	0.684	0.085
	(10-15) years	43	5.01	0.684	0.104
	(5-10) years	66	4.87	0.648	0.080
	Less than 5 years	44	4.92	0.591	0.089
Education	PHD	20	5.03	0.676	0.151
	MA	52	4.96	0.585	0.081
	PGDE	58	4.88	0.649	0.085
	Bach	88	4.96	0.695	0.074
ICT mastery	Yes	129	4.97	0.619	0.055
	No	9	4.98	0.653	0.218
	In-between	80	4.90	0.710	0.079
School location	City	128	4.92	0.705	0.062
	Village	90	4.99	0.564	0.061
Job satisfaction	Yes	153	4.97	0.628	0.051
	No	4	4.29	1.212	0.606
	In-between	61	4.92	0.664	0.085

Table 9. One-way ANOVA for the challenges faced by science and mathematics teachers' while using AI in education according to some variables

Variables		Sum of squares	df	Mean square	F	Significance
Specialization	Between groups	0.068	1	0.068	0.158	0.692
	Within groups	92.503	216	0.428		
	Total	92.571	217			
Gender	Between groups	0.016	1	0.016	0.037	0.848
	Within groups	92.555	216	0.428		
	Total	92.571	217			
Experience	Between groups	0.685	3	0.228	0.532	0.661
	Within groups	91.886	214	0.429		
	Total	92.571	217			
Education	Between groups	0.408	3	0.136	0.316	0.814
	Within groups	92.163	214	0.431		
	Total	92.571	217			
ICT mastery	Between groups	0.248	2	0.124	0.289	0.749
	Within groups	92.323	215	0.429		
	Total	92.571	217			
School location	Between groups	0.296	2	0.148	0.345	0.709
	Within groups	92.275	215	0.429		
	Total	92.571	217			
Job satisfaction	Between groups	1.843	2	0.922	2.184	0.115
	Within groups	90.728	215	0.422		
	Total	92.571	217			

teachers in using AI in teaching and learning. To ensure the significance of the differences, the researchers conducted a one-way ANOVA, with the outcomes detailed in **Table 9**.

The findings presented in **Table 9** revealed that there are no statistically significant variances in the challenges encountered by science and mathematics teachers when utilizing AI applications in teaching and learning across all independent variables considered in the study. This conclusion is supported by the statistical significance

value exceeding 0.05, indicating a lack of significant differences for these variables. The outcome suggests that teachers, irrespective of their specialization, experience, gender, workplace, or ICT proficiency, face comparable challenges in adopting AI tools for educational purposes. This uniformity in challenges can be attributed to the standardized working conditions within the Ministry of Education, encompassing infrastructure, resources, student demographics, and educational directives that guide teaching practices.

The results of this study cohere with prior evidence from Jordan that documented high satisfaction with AI among science and mathematics teachers but comparatively lower ratings on motivating factors (Bawaneh et al., 2025), while our two-factor solution explicitly separates perceptions from challenges and explores additional covariates (e.g., ICT mastery and school location) using a 6-point scale.

DISCUSSION

A key contribution of this study is demonstrating that positive perceptions of AI and implementation challenges coexist rather than contradict one another. While previous studies have often focused on teachers' acceptance or satisfaction with AI, our findings show that favorable perceptions alone are insufficient to ensure successful classroom integration. Teachers recognize AI's educational value while simultaneously experiencing substantial institutional and practical barriers. This distinction contributes to a more nuanced understanding of AI adoption in education.

These findings contribute to educational technology research by suggesting that teachers' acceptance of AI and their capacity to implement it effectively should be considered complementary rather than interchangeable dimensions. Positive attitudes toward AI appear to be a necessary but insufficient condition for successful classroom adoption, highlighting the importance of institutional readiness alongside teacher acceptance.

The study revealed that Jordanian science and mathematics teachers generally recognize the educational value of AI for enhancing teaching and learning. This finding is consistent with previous studies showing that teachers perceive AI as a valuable tool for supporting interactive learning, adaptive instruction, and student engagement (Al Darayseh, 2023; Sayma, 2023). However, the present study extends this literature by demonstrating that recognizing AI's educational value does not necessarily imply that teachers possess the institutional support, resources, and professional development required for effective classroom implementation. Specifically, while participants acknowledged AI's potential to support education through interactive simulations and specialized programs that address diverse learner needs (Sayma, 2023), they also reported substantial implementation challenges that may limit the realization of these perceived benefits.

Consistent with earlier research, the study found that teachers perceived that AI could support students' creativity, student performance, and engagement while fostering problem-solving and real-world readiness (Almasri, 2024; Opesemowo, 2025). Studies have further shown that AI-based activities motivate students to participate in formative assessments and improve examination outcomes (Schroeder et al., 2022). However,

beyond corroborating previous research, the present study extends current knowledge by demonstrating that positive perceptions of AI do not necessarily imply smooth classroom implementation. In the present study, teachers simultaneously reported highly positive perceptions of AI and substantial implementation challenges, suggesting that favorable attitudes alone are insufficient to ensure successful integration. This distinction highlights the importance of examining teachers' perceptions and implementation barriers as complementary rather than interchangeable constructs.

Results also showed significant differences in teachers' attitudes toward AI based on educational attainment and job satisfaction. Teachers with higher qualifications and greater job satisfaction demonstrated more positive perceptions toward AI integration. However, because the study measured teachers' perceptions rather than classroom practices or student outcomes, these findings should not be interpreted as evidence that AI directly enhanced teaching effectiveness or student learning. It should be noted that job satisfaction was assessed using a single self-reported categorical item and therefore reflects participants' overall subjective evaluation of their work rather than a multidimensional measure of job satisfaction. Accordingly, this finding should be interpreted with appropriate caution.

A possible explanation is that teachers holding doctoral degrees are generally more engaged with academic research, evidence-based practice, and emerging educational technologies. Doctoral training may expose educators to recent technological developments and increase their confidence in evaluating and adopting innovative teaching approaches. Consequently, teachers with higher academic qualifications may perceive AI as an opportunity to enhance teaching rather than as an additional instructional challenge. Nevertheless, this interpretation should be considered cautiously because the present study did not directly measure research engagement, digital literacy, or technology self-efficacy.

These findings align with previous literature. However, our results further suggest that educational attainment and job satisfaction primarily influence teachers' perceptions of AI rather than the challenges they encounter during implementation. This distinction indicates that improving teachers' qualifications or motivation alone may not be sufficient to overcome the broader institutional barriers that affect AI integration.

No significant gender differences were observed in teachers' perceptions of AI. One possible explanation is that male and female teachers have increasingly similar access to digital technologies, AI applications, and professional development opportunities. The rapid expansion of digital education, particularly following the COVID-19 pandemic, may have reduced traditional

gender disparities in technology use. Consequently, both male and female teachers appear to evaluate AI in comparable ways.

Similarly, no significant differences were found according to ICT proficiency. One possible explanation is that AI tools have become increasingly accessible through intuitive, user-friendly interfaces that require only general digital competence. This finding may also indicate that institutional factors, such as school infrastructure, training opportunities, and implementation policies, exert a stronger influence on teachers' perceptions than individual ICT competence. Consequently, differences in general ICT proficiency may no longer translate into substantial differences in teachers' perceptions of AI. In addition, widespread exposure to digital technologies following the rapid expansion of online teaching during and after the COVID-19 pandemic may have reduced disparities in digital competence among teachers, resulting in more homogeneous perceptions of AI.

Similarly, no significant differences were found according to school location. This finding may reflect the increasing availability of digital infrastructure and educational technologies across Jordanian schools, together with national initiatives promoting digital transformation in education. As AI applications become more widely accessible through cloud-based platforms and online services, geographical location may play a less influential role in shaping teachers' perceptions than previously expected. Although some prior studies identified geographical variations, the present findings suggest that Jordanian teachers experience relatively similar working conditions because of the centralized structure of the Ministry of Education, including comparable infrastructure, workloads, educational directives, and professional development opportunities. Consequently, teachers exhibit similar perceptions of AI integration (Egara & Mosimege, 2023; Wang et al., 2021).

This finding represents one of the principal contributions of the present study. Rather than identifying differences between teacher groups, the results indicate that implementation challenges are remarkably consistent across demographic and professional characteristics. This suggests that the principal barriers to AI integration are systemic in nature—such as infrastructure limitations, insufficient institutional support, and limited professional development—rather than being driven by teachers' individual characteristics. Consequently, educational policies should prioritize institutional readiness alongside efforts to strengthen teachers' AI competencies. These findings suggest that improving individual teachers' competencies alone is unlikely to ensure successful AI integration unless accompanied by broader institutional investments in infrastructure, policy support, and sustained professional development.

Limitations and Future Research

The study focused on science and mathematics teachers in Jordanian public schools during the 2023/2024 academic year and employed a voluntary snowball sampling strategy using an online questionnaire. Although this approach facilitated broad participation across different regions, it may have introduced self-selection bias because teachers who were more interested in AI or educational technology may have been more likely to participate. Consequently, the sample may not be fully representative of all Jordanian science and mathematics teachers, and the findings should therefore be interpreted with appropriate caution. Because the study employed a cross-sectional survey design, causal relationships between teachers' characteristics and their perceptions or implementation challenges cannot be established. Future longitudinal studies could provide stronger evidence regarding changes in teachers' perceptions over time.

In addition, the findings should be interpreted within the context of the measurement instrument employed and the rapidly evolving nature of AI technologies, which may influence teachers' perceptions over time. The findings indicate that participating teachers perceive AI as an increasingly important component of contemporary education. However, because this study examined teachers' perceptions rather than educational outcomes, the results should not be interpreted as evidence that AI integration necessarily improves teaching effectiveness or student learning. However, the survey did not specifically address science and mathematics practices such as labs and experiments, limiting its ability to capture AI's direct impact on hands-on teaching. Future studies should use subject-specific tools and qualitative methods like focus groups and classroom observations to gain deeper insights. Another limitation is that the study did not directly operationalize or test the core constructs of the UTAUT model. Future studies could employ validated UTAUT instruments and structural equation modeling to examine the relationships among performance expectancy, effort expectancy, facilitating conditions, social influence, and teachers' intention to adopt AI. In addition, although the questionnaire demonstrated acceptable internal consistency and exploratory construct validity, convergent and discriminant validity were not formally assessed. Future research should further validate the instrument using confirmatory factor analysis and additional psychometric measures such as composite reliability and average variance extracted.

Furthermore, job satisfaction was assessed using a single self-report categorical item rather than a validated multi-item scale. Although single-item measures have been widely used to assess overall job satisfaction, they provide a less comprehensive assessment of the

construct. Future studies should employ validated multidimensional job satisfaction instruments to further examine this relationship.

Although one-way ANOVA was appropriate for addressing the study's research questions, future studies could apply multivariate techniques such as MANOVA or multiple regression to simultaneously examine the effects of multiple teacher characteristics on perceptions and implementation challenges. Furthermore, structural equation modeling could be applied in studies that directly operationalize validated technology acceptance constructs, such as those proposed by UTAUT.

CONCLUSION

AI offers considerable opportunities to support teaching and learning; however, its successful educational implementation depends largely on teachers' readiness and institutional support.

The study found that science and mathematics teachers generally reported positive perceptions of AI while also identifying substantial challenges to its implementation in educational settings. Significant differences in teachers' perceptions were observed according to educational level and job satisfaction, whereas no significant variations were found with respect to specialization, gender, teaching experience, ICT proficiency, or school location. The results indicate that participating teachers perceive AI as having the potential to support student learning, creativity, and engagement. However, these findings reflect teachers' perceptions rather than direct evidence of improvements in student outcomes. Rather than simply confirming the positive teacher perceptions of AI reported in previous studies, this research demonstrates that positive perceptions coexist with substantial implementation challenges, indicating that teacher acceptance alone is insufficient for successful AI integration. These findings reinforce that teacher acceptance and implementation capacity should be viewed as complementary rather than interchangeable dimensions of AI integration. This finding highlights that successful AI integration depends on addressing systemic implementation barriers that affect teachers regardless of their demographic or professional characteristics. Accordingly, the findings suggest that educational policies should prioritize institutional readiness, infrastructure, and sustained professional development rather than focusing exclusively on changing teachers' attitudes toward AI. These conclusions should be interpreted in light of the study's reliance on teachers' self-reported perceptions rather than direct measures of classroom implementation or student outcomes.

Furthermore, the study relied exclusively on teachers' self-reported perceptions. Consequently, the findings should not be interpreted as evidence of the actual impact of AI on student achievement,

engagement, or other educational outcomes. Future research should combine perception-based data with objective measures of teaching practices and student performance.

Rather than simply confirming previous findings, this study demonstrates that positive teacher perceptions and implementation challenges coexist, highlighting that teacher acceptance alone is insufficient for successful AI integration without adequate institutional support and professional development.

To enhance technology integration, decision-makers should strengthen infrastructure, ensure adequate resources, and offer training for teachers and supervisors to improve their competence in AI-based teaching. Curricula across all subjects - not only science and mathematics - should be updated to align with AI theories and models, supported by continuous technical assistance. Through such measures, educational institutions can more effectively leverage AI to enrich teaching and learning.

These results are crucial for various stakeholders in Jordan's education sector, emphasizing the importance of effectively integrating AI tools into teaching practices and providing essential infrastructure. The findings suggest that educational stakeholders should prioritize professional development, institutional support, adequate technological infrastructure, and clear implementation guidelines to facilitate the effective integration of AI into science and mathematics education. While AI integration in science and mathematics education shows considerable promise, maximizing its potential requires sustained investment in infrastructure, professional development, institutional support, and ongoing research to promote evidence-informed implementation in educational practice.

Author contributions: **AKB:** conceptualization, data curation, formal analysis, methodology, validation, visualization, supervision, writing - review & editing; **MAA-M:** validation, visualization, supervision, writing - review & editing; **SMA-S:** data curation, formal analysis, project administration; **AAA-H:** formal analysis, methodology, validation, writing - review & editing; **OMAA:** data curation, resources; **TFS:** data curation, formal analysis, project administration. All authors agreed with the results and conclusions.

Funding: No funding source is reported for this study.

Ethical statement: According to the Ministry of Education in Jordan, teachers and researchers may conduct surveys for scientific and research purposes without formal institutional approval when the study involves no risk to participants. Participation in this study was entirely voluntary. All participants were informed about the purpose of the research, the confidentiality of their responses, and their right to withdraw at any time without penalty. Completion and submission of the online questionnaire were considered as providing informed consent to participate. No identifying personal information was collected, and all responses were used exclusively for academic research purposes.

AI statement: Generative AI or AI-based tools were used for editing and polishing language.

Declaration of interest: No conflict of interest is declared by the authors.

Data sharing statement: Data supporting the findings and conclusions are available upon request from the corresponding author.

REFERENCES

- Al Darayseh, A. (2023). Acceptance of artificial intelligence in teaching science: Science teachers' perspective. *Computers and Education: Artificial Intelligence*, 4, Article 100132. <https://doi.org/10.1016/j.caeai.2023.100132>
- Al-Kellani, A., & Al-Shraifeen, N. (2016). *Introduction to research in education and social sciences* (3rd ed.). Dar Al Masirah for Publishing, Distribution, and Printing.
- Almasri, F. (2024). Exploring the impact of artificial intelligence in teaching and learning of science: A systematic review of empirical research. *Research in Science Education*, 54, 977-997. <https://doi.org/10.1007/s11165-024-10176-3>
- Alneyadi, S., Almessaabi, A., & Alshraifin, N. (2024). Exploring science teachers' perceptions and practices in integrating STEM and AI through mind mapping: A case study in the UAE. *Journal of Ecohumanism*, 3(3), 1239-1252. <https://doi.org/10.62754/joe.v3i3.3434>
- Al-Rashidi, F. S. (2018). The level of using the reflective practices among secondary school teachers- from their points of view- in Baredah Governorate. *Basic Education College Magazine for Educational and Humanities Sciences*, 38, 284-294.
- Ayanwale, M. A., Sanusi, I. T., Adelana, O. P., Aruleba, K. D., & Oyelere, S. S. (2022). Teachers' readiness and intention to teach artificial intelligence in schools. *Computers & Education: Artificial Intelligence*, 3, Article 100099. <https://doi.org/10.1016/j.caeai.2022.100099>
- Bakari, M. (2022). Challenges of artificial intelligence and its applications in education. *Al-Muntada Journal for Economic Studies and Research*, 6(1), 286-305.
- Bawaneh, A. K., Al-Salman, S. M., Ali Salem, T. M., & Altarawneh, A. F. (2025). AI shaping the future of education: Science and math teachers' satisfaction level and motivating factors towards integrating artificial intelligence in teaching and learning. *International Journal of Information and Education Technology*, 15(3), 496-509. <https://doi.org/10.18178/ijiet.2025.15.3.2261>
- Bawaneh, A., & Alnamshan, M. (2023). Design thinking in science education: Enhancing undergraduate students' motivation and achievement in learning biology. *International Journal of Information and Education Technology*, 13(4), 621-633. <https://doi.org/10.18178/ijiet.2023.13.4.1846>
- Bawaneh, A., & Malkawi, E. (2023). STEM faculty members' perspectives and challenges towards distance learning and virtual classes during COVID-19 outbreak. *Turkish Online Journal of Distance Education*, 24(1), 246-261. <https://doi.org/10.17718/tojde.958068>
- Bawaneh, A., Moumene, A., & Aldalalah, O. (2020). Gauging the level of reflective teaching practices among science teachers. *International Journal of Instruction*, 13(1), 695-712. <https://doi.org/10.29333/iji.2020.13145a>
- Bawaneh, A., Rabab'h, B., Al-Salman, S., & Alghazo, Y. (2024). Science and math teachers' satisfaction level towards the electronic educational supervision. *International Journal of Information and Education Technology*, 14(3), 372-381. <https://doi.org/10.18178/ijiet.2024.14.3.2059>
- Blanca, M. J., Alarcón, R., Arnau, J., Bono, R., & Bendayan, R. (2017). Non-normal data: Is ANOVA still a valid option? *Psicothema*, 29(4), 552-557. <https://doi.org/10.7334/psicothema2016.383>
- Brown, M. B., & Forsythe, A. B. (1974). The small sample behavior of some statistics which test the equality of several means. *Technometrics*, 16, 129-132. <https://doi.org/10.1080/00401706.1974.10489158>
- Chounta, I. A., Bardone, E., & Raudsep, A. (2022). Exploring teachers' perceptions of artificial intelligence as a tool to support their practice in Estonian K-12 education. *International Journal of Artificial Intelligence in Education*, 32, 725-755. <https://doi.org/10.1007/s40593-021-00243-5>
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum Associates.
- Egara, F., & Mosimege, M. (2023). ChatGPT in secondary classrooms: Teacher perceptions and implications for STEM learning. *Education and Information Technologies*, 28(5), 6125-6143.
- Ertmer, P. A., & Ottenbreit-Leftwich, A. T. (2010). Teacher technology change: How knowledge, confidence, beliefs, and culture intersect. *Journal of Research on Technology in Education*, 42(3), 255-284. <https://doi.org/10.1080/15391523.2010.10782551>
- Field, A. P. (2018). *Discovering statistics using IBM SPSS Statistics* (5th ed.). SAGE.
- Games, P. A., & Howell, J. F. (1976). Pairwise multiple comparison procedures with unequal n's and/or variances: A Monte Carlo study. *Journal of Educational Statistics*, 1(2), 113-125. <https://doi.org/10.3102/10769986001002113>
- George, D., & Mallery, P. (2003). *SPSS for Windows step by step: A simple guide and reference*. 11.0 update (4th ed.). Allyn & Bacon.

- Gier, J. M., & Hsu, Y. (2021). Artificial intelligence and equity in education: Are we ready for this? *Educational Technology & Society*, 24(2), 68-82.
- Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2019). *Multivariate data analysis* (8th ed.). Cengage Learning.
- Holmes, W., Bialik, M., & Fadel, C. (2019). *Artificial intelligence in education: Promises and implications for teaching and learning*. Center for Curriculum Redesign.
- Jatileni, C. N., Sanusi, I. T., Olaleye, S. A., Ayanwale, M. D., Agbo, F. J., & Oyelere, P. B. (2024). Artificial intelligence in compulsory level of education: perspectives from Namibian in-service teachers. *Education and Information Technologies*, 29, 12569-12596. <https://doi.org/10.1007/s10639-023-12341-z>
- Kivunja, C., & Kuyini, A. B. (2017). Understanding and applying research paradigms in educational contexts. *International Journal of Higher Education*, 6, 26-41. <https://doi.org/10.5430/ijhe.v6n5p26>
- Kramer, C.Y. (1956). Extension of multiple range tests to group means with unequal numbers of replications. *Biometrics*, 12, 307-310. <https://doi.org/10.2307/3001469>
- Lakens, D. (2013). Calculating and reporting effect sizes to facilitate cumulative science: A practical primer for t-tests and ANOVAs. *Frontiers in Psychology*, 4. <https://doi.org/10.3389/fpsyg.2013.00863>
- Levene, H. (1960). Robust tests for equality of variances. In I. Olkin (Ed.), *Contributions to probability and statistics* (pp. 278-292). Stanford University Press.
- Lindner, A., & Romeike, R. (2019). *Teachers' perspectives on artificial intelligence* [Paper presentation]. The ISSEP 2019 12th International Conference on Informatics in Schools: Situation, Evaluation and Perspectives.
- Luckin, R., Cukurova, M., Kent, C., & Du Boulay, B. (2022). Empowering educators to be AI-ready. *Computers & Education: Artificial Intelligence*, 3, Article 100076. <https://doi.org/10.1016/j.caeai.2022.100076>
- Luckin, R., Holmes, W., Griffiths, M., & Forcier, L. B. (2016). *Intelligence unleashed: An argument for AI in education*. Pearson.
- Nain, A., Bohra, N. S., Tewari, D., Grewal, H., & Ahmad, V. (2024). *AI for teacher well-being: Enhancing job satisfaction and reducing stress in Indian secondary schools* [Paper presentation]. The 4th International Conference on Advancement in Electronics & Communication Engineering. <https://doi.org/10.1109/AECE62803.2024.10911302>
- Obiedat, D. H., Kayed, A., & Adass, A. (2016). *Scientific research: Understandable tools and methods*. Dar Alfiker Publishers and Distributors.
- Opesemowo, O. A. G. (2025). Artificial intelligence in mathematics education: The pros and cons. In M. Khosrow-Pour (Ed.), *Encyclopedia of information science and technology*. IGI Global Scientific Publishing. <https://doi.org/10.4018/978-1-6684-7366-5.ch084>
- Popenici, S. A. D., & Kerr, S. (2017). Exploring the impact of artificial intelligence on teaching and learning in higher education. *Research and Practice in Technology Enhanced Learning*, 12, Article 22. <https://doi.org/10.1186/s41039-017-0062-8>
- Rosak-Szyrocka, J. (2024). The era of digitalization in education where do universities 4.0 go? *Management Systems in Production Engineering*, 32(1), 54-66. <https://doi.org/10.2478/mspe-2024-0006>
- Russell, S. J., & Norvig, P. (2021). *Artificial intelligence: A modern approach* (4th ed.). Pearson.
- Saritepeci, M., & Yildiz Durak, H. (2024a). AI-supported design-based learning and creativity in STEM education. *Journal of Science Education and Technology*, 33(2), 225-239.
- Saritepeci, M., & Yildiz Durak, H. (2024b). Effectiveness of artificial intelligence integration in design-based learning on design thinking mindset, creative and reflective thinking skills: An experimental study. *Education and Information Technologies*, 29, 25175-25209. <https://doi.org/10.1007/s10639-024-12829-2>
- Sayma, S. R. (2023). *Creating effective multimedia learning material with AI for K12*. EdTech Books.
- Schroeder, K. T., Hubertz, M., Van Campenhout, R., & Johnson, B. G. (2022). Teaching and learning with ai-generated courseware: Lessons from the classroom. *Online Learning*, 26(3), 73-87. <https://doi.org/10.24059/olj.v26i3.3370>
- Schwab, K. (2016). *The Fourth Industrial Revolution*. World Economic Forum.
- Shah, N. H., Parveen, K., & Abid, S. (2024). Teacher perceptions of artificial intelligence (AI) in education: Correlating technological adoption with job satisfaction. *Policy Journal of Social Sciences Review*, 2(4), 688-704.
- Smith, A., & Dinev, T. (2020). Exploring the role of data privacy in higher education: Implications for future research. *Educational Technology Research and Development*, 68(2), 723-745.
- Steiger, J. H. (2004). Beyond the F test: Effect size confidence intervals and tests of close fit in the analysis of variance and contrast analysis. *Psychological Methods*, 9(2), 164-182. <https://doi.org/10.1037/1082-989X.9.2.164>
- Tabachnick, B. G., & Fidell, L. S. (2019). *Using multivariate statistics* (7th ed.). Pearson.

- Tashtoush, M. A., Wardat, Y., Al Ali, R., & Saleh, S. (2024). Artificial intelligence in education: Mathematics teachers' perspectives, practices, and challenges. *Iraqi Journal for Computer Science and Mathematics*, 5(1), 60-77. <https://doi.org/10.52866/ijcsm.2024.05.01.004>
- Tashtoush, R., Al Ali, H., & Al Mansoori, A. (2024). Adoption of artificial intelligence in mathematics education in Abu Dhabi schools. *International Journal of Educational Research*, 115, Article 102209.
- Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly*, 27(3), 425-478. <https://doi.org/10.2307/30036540>
- Voigt, K. I., & Tor, F. (2020). Industry 4.0 and education: How digitalization reshapes teaching and learning. *Education and Information Technologies*, 25(6), 5081-5099.
- Wang, X., Li, L., Tan, S. C., Yang, L., & Lei, J. (2023). Preparing for AI-enhanced education: Conceptualizing and empirically examining teachers' AI readiness. *Computers in Human Behavior*, 146, Article 107798. <https://doi.org/10.1016/j.chb.2023.107798>
- Wang, Y., Liu, C., Tu, Y.-F. (2021). Factors affecting the adoption of AI-based applications in higher education: An analysis of teachers' perspectives using structural equation modeling. *Educational Technology & Society*, 24(3), 116-129.
- Welch, B. L. (1951). On the comparison of several mean values: An alternative approach. *Biometrika*, 38(3/4), 330-336. <https://doi.org/10.2307/2332579>
- Weller, M. (2020). *25 years of ed tech*. Athabasca University Press. <https://doi.org/10.15215/aupress/9781771993050.01>
- Woodruff, K., Hutson, J., & Arnone, K. (2023). Perceptions and barriers to adopting artificial intelligence in K-12 education: A survey of educators in fifty states. In M. Sharon (Ed.), *Reimagining education: The role of e-learning, creativity, and technology in the post-pandemic era* (pp. 1-28). IntechOpen. <https://doi.org/10.5772/intechopen.1002741>
- Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education – Where are the educators? *International Journal of Educational Technology in Higher Education*, 16, Article 39. <https://doi.org/10.1186/s41239-019-0171-0>

APPENDIX A

Table A1. Questionnaire items

No	Items
Perceptions	
1	AI adds excitement to student learning.
2	Employing AI increases student achievement and enhances their learning.
3	The use of AI reduces fear and shyness in students' learning.
4	Communicating with students through AI is more effective.
5	The use of AI enhances collaborative learning for my students.
6	The teacher's use of AI facilitates the teaching process and has a greater impact.
7	Employing AI is appropriate for teaching specialized topics.
8	Using AI in teaching and learning saves effort and time.
9	Constantly search for the latest applications in AI to employ in teaching.
10	I feel that my students want to use AI in their learning.
11	My students employ AI in their learning and solving various assignments in science.
12	Employing AI in assessment and evaluation is easy and fun.
13	I believe that employing AI in education is fraught with risks and challenges.
14	I advise my fellow teachers to employ AI in their teaching.
15	I encourage my students to use AI in their learning and assignments.
16	Employing AI in teaching and learning helps enhance 21 st century skills (critical, creative thinking, ...).
17	Employing AI in teaching and learning supports student diversity (learning preferences, multiple intelligences, attitudes, abilities, aptitudes, ...).
18	The use of AI supports student-centered learning and makes them self-learners and lifelong learners.
19	Scientific content presented through AI is more interactive and influential for students.
20	Employing AI in education increases students' passion and desire to learn.
21	I prefer teaching using AI applications.
22	Employing AI in teaching and learning distracts students from their learning.
23	I do not believe in the importance of employing AI in teaching.
24	Most applications of AI are not compatible with teaching methods and scientific content in curricula.
Challenges	
25	The significant lack of AI in the Arabic language reduces the opportunity for its use in teaching and learning.
26	Teachers' lack of skills in employing AI in education reduces its use.
27	Lack of availability of ICT infrastructure in schools reduces the use of AI applications in education.
28	The high teaching load on the teacher reduces the use of AI in teaching.
29	The lack of availability of AI free of charge (without financial compensation) reduces their application in the classroom.
30	Training on the mechanisms of employing AI in teaching and learning requires money and effort (and this is costly for teachers).

<https://www.ejmste.com>