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The role of artificial intelligence in enhancing linear equation modeling and Its Applications for Science-Stream Students

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دور الذكاء الاصطناعي في تعزيز نمذجة المعادلات الخطية وتطبيقاتها لطلاب المسار العلمي

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Abstract:
This study aims to investigate the impact of using artificial intelligence (AI) techniques on improving students' achievement and understanding of mathematics, identify obstacles and challenges to using these techniques in teaching, and propose solutions to overcome them. The study employs an applied analytical methodology consisting of pre- and post-tests administered to a group of 60 students, divided into two groups: a control group of 30 students and an experimental group of 30 students. Both groups received 90 days of training in using AI techniques to solve a set of linear equations. All students then underwent pre- and post-tests, followed by a questionnaire administered to the experimental group. The results were then statistically analyzed to evaluate the role of AI techniques in improving students' understanding and achievement. The results indicated an increase in achievement levels ranging from 20% to 40%, depending on individual student abilities, with an average achievement increase of 30%. The questionnaire results also indicated an improvement in students' achievement and understanding of problems related to linear equations, which aligns with the pre-test results. Therefore, the study recommends integrating artificial intelligence (AI) technologies into teaching in general, with the aim of improving overall comprehension and academic achievement, particularly in mathematics. The world continues to witness tremendous advancements in AI and computing technologies.

Keywords: AI technologies, mathematics, linear equations, improvement and enhancement, comprehension and achievement, questionnaire, pre-test and post-test.

الملخص
تهدف الدراسة إلى دراسة تأثير استخدام تقنيات الذكاء الاصطناعي في تحسين مستوى تحصيل الطلاب وفهمهم لمادة الرياضيات وتحديد العقبات والتحديات التي تواجه مثل استخدام هذه التقنيات في التدريس ،وتقديم الحلول والمقترحات في التغلب عليها وذلك من خلال منهجية إجرائية تطبيقية تحليلية هي عبارة عن إجراء اختبار قبلي وبعدي على مجموعة من الطلاب بلغ عددهم 60 طالب تم تقسيمهم الي مجموعتين المجموعة الاولي هي مجموعة كنترول وبلغ عددهم 30 طالب ومجموعة تجريبية بلغ عددهم 30 طالبا تم

تدريبهم لمدة 90 يوم علي استخدام تقنيات الذكاء الاصطناعي في حل مجموعة من المعادلات الخطية ثم اجراء اختبار قبلي وبعدي لكل الطلاب ثم اجراء استبيان علي الطلاب في المجموعة التجريبية .وتحليل النتائج احصائيا لتحليل وتقييم دور استخدام تقنيات الذكاء الاصطناعي في تحسين فهم و تحصيل الطلاب .وقد اشارات النتائج ارتفع مستوى تحصيلهم بنسبة تتراوح من 20 إلى 40% طبقا لاختلاف مستواهم أي متوسط التحصيل بنسبة 30% وطبقا للاستبيان الذي أشارت النتائج إلى ارتفاع مستوى تحصيل الطلاب وارتفاع فهمهم للمشاكل المتعلقة بالمعدلات الخطية وهو ما يتفق مع نتائج الاختبار القبلي والبعدي لذلك توصي الدراسة بضرورة إدراج استخدام تقنيات الذكاء الاصطناعي في التدريس بصفة عامة بهدف تحسين مستوي الفهم والتحصيل العلمي بصفة عامة ومادة الرياضيات بصفة خاصة. ظل عالم يشهد تطور رهيب في تقنيات الذكاء الاصطناعي والحوسبة.

الكلمات المفتاحية: تقنيات الذكاء الاصطناعي، الرياضيات، المعادلات الخطية، تحسين وتعزيز، الفهم والتحصيل، استبيان، اختبار قبلي وبعدي.

1. Introduction

With the rapid advancements in software and artificial intelligence (AI) technologies worldwide, these technologies have become fundamental to numerous applications and fields, including education. They are used to achieve sustainability across all sectors, particularly by enhancing the quality of learning and improving student achievement. Mathematics, in particular, presents significant challenges for many students, especially concerning abstract concepts such as linear equations and their solutions, given the multitude of methods and equations involved. AI technologies offer a valuable modern educational tool for children, fostering a deeper understanding of concepts in general, and mathematical concepts specifically, through interaction, immediate explanation, the provision of multiple solutions, step-by-step explanations, and the development of analytical thinking and independence skills (Che Ghazali, et al.2024).

This study aims to analyze and evaluate the impact of using artificial intelligence (AI) techniques on improving students' performance in mathematics by solving a set of three linear equations that many students find difficult, and even those who do not find them challenging often take a considerable amount of time to solve. The study also aims to introduce AI techniques within the context of advancements in computing and programming, with the goal of achieving sustainability in all fields, including education. This study also aims to identify the obstacles and challenges facing the sustainability of these technologies in teaching and to propose solutions and suggestions to overcome them. The study gains its importance from being an applied, procedural study through a pre- and post-test and a questionnaire. In addition, it performed a descriptive analysis of a group of previous studies, linking the results of these studies to each other on the one hand, and to this study on the other, and making comparisons. The importance of this study stems from the fact that it is a comprehensive study that addressed the topic from all its aspects and presented solutions and suggestions to overcome the obstacles and challenges facing the use of artificial intelligence technologies. In addition, it avoided bias in the results and data, which means that it can be considered an important literature reference study for researchers and those working in the field. It can be used to formulate a vision and strategies to improve teaching methods to enhance and strengthen students' understanding and their educational journey in general, and in mathematics in particular (Adeleye, et al.2024).

The study problem addressed in this study is that, despite the importance of integrating artificial intelligence (AI) technologies into the curriculum to enhance student achievement and understanding, particularly in mathematics, a significant obstacle exists. This obstacle lies in the varying cognitive abilities of students across different environments and cultural

backgrounds regarding the use of these technologies. Furthermore, schools and parents often lack the financial resources to provide students with access to these technologies, and they are sometimes expensive. Additionally, many existing studies on this topic have been primarily descriptive, and those that have adopted an experimental approach have some shortcomings (Zadorina, et al.2024).. These include flawed data analysis and a failure to consider all aspects related to enhancing understanding, interaction, and achievement levels—in other words, studies that have focused on achievement at the expense of comprehension. This study aims to bridge this gap by linking the enhancement of achievement with the enhancement of understanding and by addressing all aspects of this linkage mechanism (Ivanova, et al.2024).

2. Theoretical Framework

The theoretical framework of the study is based on two main pillars. The first is the presentation of the fundamental concepts and analytical and statistical theories used during the study procedures, whether for explanation, clarification, or application. The second pillar is related studies on the topic. Through a critical analysis of these studies, their strengths and weaknesses are identified, allowing for a comparison between their findings and those of this study, and an analysis of the reasons for any differences or similarities.

2.1. Basic Concepts and Analytical Theories

The fundamental concepts and analytical theories are presented to provide a clear understanding of the study procedures, objectives, methodologies, and the study levels. Furthermore, they enhance the overall coherence of the study framework by integrating it with the theoretical framework. Among the most important of these concepts and theories are the following:

1. Artificial Intelligence:

It is a modern technology that simulates human thinking and intelligence through learning, data analysis, decision-making, and problem-solving. However, it sometimes surpasses human intelligence because it can perform numerous calculations simultaneously in a very short time, a feat the human brain cannot accomplish (Afzaal et al., 2024).. In this study, artificial intelligence is used as an educational tool to support students in solving linear equations and understanding mathematical concepts. Among the most important of these technologies are:

1) Intelligent Tutoring Systems (ITS): These systems adapt to the student's level (e.g., beginner, intermediate, or advanced), providing simple, step-by-step explanations for solving problems. They can be considered a personal tutor for the student and help address individual differences to improve understanding rather than rote memorization (Forero.et al.2024)
2) Adaptive Learning Systems: These systems automatically adjust the difficulty level of questions based on student performance by providing customized exercises, allowing each student to learn at their own pace (Kaufman et al., 2025).
3) Generative AI: These artificial intelligence models explain mathematical concepts in multiple ways and solve equations by demonstrating the steps involved. They can be used to support self-learning and provide robust explanations.
4) Error Analysis Systems: These methods identify and analyze errors, enabling students to discover their mistakes and receive feedback on their solutions. This contributes to improving mathematical thinking (Wangdi,2024).
5) Augmented Reality (AR) and Virtual Reality (VR): These are two very important technologies that allow for the human-like representation of mathematical concepts and the interactive presentation of shapes and equations to facilitate understanding.

6) Learning Analytics: This involves analyzing educational data to identify student performance, strengths, and weaknesses. This helps teachers make accurate educational decisions and improve lesson delivery (Sağın et al., 2024).

The study proposes the use of selected artificial intelligence technologies, including generative AI tools (such as ChatGPT) for conceptual explanation, AI-based math solvers (such as Photomath) for step-by-step problem solving, and adaptive learning platforms to provide personalized practice. These technologies were chosen due to their accessibility, effectiveness in supporting mathematics learning, and suitability for the study's experimental design.

2. **academic achievement**

The level of academic achievement is determined by how well (as shown by their scores) students did on both pre- and post-tests. The academic achievement level represents how much mathematical knowledge and skill have been learned by students. Conceptual understanding measures how well a student understands mathematical concepts (i.e., the steps of a solution) and how they interpret the solution. Additionally, conceptual understanding encompasses how students will be able to apply the knowledge and skills learned to solve new mathematical problems.

In this study, the primary focus will be on linear equations (or two-variable expressions). Linear equations are a fundamental area of study in the modern curriculum and play a major role in this research project (De Ocampo2024).

3. **Using AI in Learning Environments.** The digital learning environment can use multiple digital platforms and resources to provide detailed explanations of how to solve problems (i.e., step-by-step). As a result, students will experience a new way of learning and will benefit from having immediate feedback (Mousa et al., 2025).
4. **Experimental Perspective:**

A quasi-experimental format was used to measure AI's impact on student performance (both subjective and objective) via means of pre- and post-tests in a control group, a test group, and/or a mixture of both groups. (Elmezughi et al., 2026).

5.Statistical Descriptive Analysis

Test results were analyzed quantitatively to provide statistical means of comparison between the mean scores pre- and post- test and the rate of improvement between the experimental and control groups; further analysis of means for statistical algo was also performed (Al Sharif et al., 2024)..

6.Pedagogical Analysis

A pedagogic analysis of the different methods of learning through AI, compared to traditional methods of instruction and delivery. (Sağın et al., 2024)

2.2. Related Studies

Research has begun to highlight how significant AI can be in improving student learning outcomes, especially in the area of mathematics. For example, (Yi et al., 2025) performed a systematic review and metanalysis of the literature and demonstrated that there is a positive effect of using AI on mathematics student performance based on grade level and learning context. (Liu et al. 2025) conducted a study which also supported the finding that AI positively affects academic performance, regardless of educational level. (Wang et al., 2024) also provided evidence that adaptive learning systems and intelligent tutoring applications improve personalized instruction and student engagement. (Awang et al. 2025) further provided support by illustrating how AI technologies offer interactive learning environments and real-time feedback enabling a deeper conceptual understanding of mathematics. Many of the previously mentioned studies are supported by additional literature that indicates AI can enhance student motivation, problem-solving skills, and improved conceptual understanding, while experiencing challenges associated with an overreliance on technology and

technological barriers (Dong et al., 2025). In conclusion, the literature reviewed suggests that implementing AI into mathematics education has the potential to greatly enhance student achievement and student understanding, when done so effectively.

3. Methodology and Approach

The study's main methodology is a hybrid qualitative approach. Descriptive analysis was used to describe the data and results, while experimental analysis was conducted through a pre- and post-test to measure the improvement in students' comprehension and academic achievement in mathematics by solving three linear equations of moderate difficulty. The results were then analyzed using a questionnaire consisting of five sections: the first section examines the use of artificial intelligence (AI) technologies and its impact on academic achievement; the second section examines the use of AI and its impact on understanding and comprehension; the third section examines students' attitudes towards using AI; the fourth section examines the challenges and difficulties arising from the use of AI technologies; and the fifth section addresses suggestions and developments for overcoming the difficulties of using AI technologies. The questionnaire comprised 25 items, with five items in each section. The validity and reliability of the questionnaire were then analyzed using Cronbach's alpha coefficient, with a borderline value of 75%, to determine reliability and consistency within each section (internal consistency) and external consistency among the five questionnaire sections. The significance level was also assessed by calculating the p-value, with a borderline value of 5%. A value below 5% indicates high significance and statistical reliability. Then, the results of the survey are analyzed after ensuring its validity, and the survey results are linked with the results of the pre- and post-tests. These results are recorded, analyzed, and evaluated scientifically and statistically, with conclusions drawn and recommendations made (Adeleye et al., 2024).

3.1. Applied Framework

The applied framework of the study is a framework that integrates with the theoretical framework to understand the study consciously. The applied framework clarifies the practical procedures of the study, starting from analyzing the problem, analyzing the objective, and formulating the research problem, through collecting and processing data, identifying techniques, tools, and variables, then designing the experiment, recording the results, analyzing and evaluating them, and drawing conclusions and recommendations.

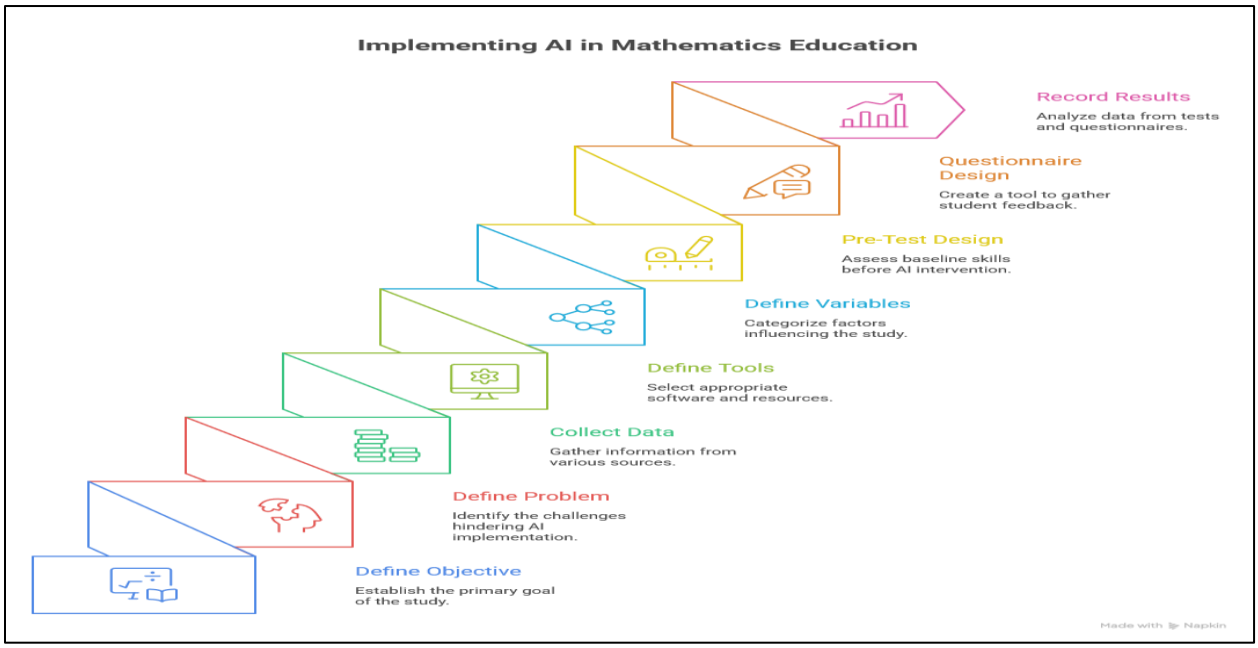

Figure 1: shows study Applied Framework

3.2. Procedures.

According to Figure 1, which illustrates the applied framework, the study procedures can be defined as follows:

1. **Defining the objective:** This is to analyze and evaluate the impact of using artificial intelligence on improving students' achievement and comprehension in mathematics.
2. **Defining the research problem:** This relates to the differences in students' cognitive abilities and the lack of financial resources, both in schools and among parents, to use these technologies due to their sometimes-high cost.
3. **Collecting and processing data:** This involves collecting data from various sources, including online databases, previous studies, books, and expert opinions from supervisors, consultants, and statistical specialists. The data is then processed statistically and manually, excluding outliers and calculating the p-value and variance. Finally, the instruments and variables are identified (Shuliar.et al,2023).
4. **Defining study tools:** The study tools varied, including software such as SPSS, Excel, and MATLAB, and data collection and extraction tools such as online databases, books, previous studies, supervisors, experts, and practical experience. A questionnaire was also used as a primary research tool, in addition to a written exam administered to the students.
5. **Defining study Variables:** These variables can be divided into independent variables, which include the use of artificial intelligence (AI) technologies in education and improving understanding of mathematics through solving a series of linear problems; dependent variables, which relate to achievement levels, comprehension levels, and students' attitudes toward learning using AI, as well as solutions and suggestions for overcoming challenges and obstacles; and mediating variables, which include the duration of the experiment, the test duration, students' pre-experiment level, technology skills, internet and device availability, teacher support, guidance, and follow-up.
6. **Pre- and post-test design:** A pre- and post-test was designed for a group of 60 students. The control group solved the test using traditional methods for solving equations, and the second group of students used artificial intelligence applications to solve linear equations. Note that the pre-test was used to solve equations for both groups using traditional methods.

- Equation1:

$$2x + 3y + z = 13$$

- Equation 2:

$$4x - y - z = 6$$

- Equation 3:

$$3x + 2y = 11$$

Questionnaire Design: The initial design was created by the author and then presented to statistical analysis experts for review and evaluation. Following this review and evaluation, the questionnaire was made available on Google Forms and social media platforms. It was then distributed to students. The questionnaire consists of five main sections:

- The first section concerns the impact of artificial intelligence (AI) on academic achievement by assessing the improvement in students' grades after using AI technologies and their ability to solve equations more quickly.
- The second section concerns the impact of AI on comprehension and understanding by examining the ability to quickly grasp solution steps, interpret results, and connect different mathematical concepts.
- The third section concerns students' attitudes towards using AI technologies, including their level of acceptance, comfort, and desire to use them in the future.

- The fourth section addresses the challenges and obstacles related to using AI tools and technologies, such as weak internet connectivity and over-reliance on AI instead of critical thinking.
- The fifth and final section presents suggestions and solutions for overcoming these challenges and obstacles, including training students on rapid usage, providing suitable infrastructure, and the teacher's role in guiding students.

7. **Recording the results:** results of the test and survey, analyzing them, linking them together, then analyzing and evaluating these results to draw conclusions and provide recommendations.

3.3. Tests and Statistical Analysis

- **Reliability and consistency:** the Reliability and consistency of each of the five sections of the questionnaire will be determined by using Cronbach's alpha coefficient, with 0.75 considered a minimum standard of internal consistency and external consistency between the five questionnaire sections. The significance level was calculated using a p-value, with 0.05 as a minimum standard of statistical significance and reliability. Values under 0.05 indicate a statistically significant finding with high reliability. validity of the survey has been established; the survey's responses will be compared to those collected before and after the training. All of the data collected from the survey and pre/post-test will be analyzed scientifically and statistically to provide accurate results) Vlasova,.et al.2019).
- **Correlation test**: statistical testing and analysis performed in this study was the correlation test; this includes the correlation calculations determining the correlation between multiple variables; by way of the use of Pearson's correlation coefficient determination; the determination of Pearson's coefficient correlations includes the use of Equation 1 below:

$$r = ((X - Xi)(Y - Yi))/\sqrt{(\sum (Xi - X^{-})^2 . \sum (Yi - Y^{-})^2)} \quad Eq(1)$$

Where**:**

- R = Coefficient of correlation between - 1 and + 1
- Xi = Individual value of the variable
- Yi = Individual value of the variable
- X^{-} = Arithmetic mean of data for variable X
- Y^{-} = Arithmetic mean of data for variable Y
- ε = Random error is the estimate of the effect of environmental conditions on a variable.

- **multiple linear regression test**: This is a test that will help in identifying the final results, mean, standard deviation, and the correlation coefficients. The linear regression formula is defined as follows:

$$Y = a + b1X1 + b2X2 + b3X3 + \varepsilon \quad Eq(2)$$

Where:

- y: Dependent variable (Economic crisis).
- a: Slope constant (Intercept). b1, b2: Regression coefficient for the respective independent variable.
- X1, X2, X3: Independent variables include economic policy failures, mismanagement, and proposal.
- ε: Random errors (Unmeasurable factor influence).

4. Results and Discussion

This section will present and discuss the results related to the impact of using artificial intelligence techniques on enhancing the level of understanding and academic achievement in geography for a group of students through a pre- and post-exam, a questionnaire, and the analysis of results according to the analysis of the results of the pre- and post-written exam, testing and analyzing the validity of the questionnaire, analyzing its results, linking the results of the questionnaire with the results of the pre- and post-exam, and finally comparing the results of the study with other studies.

4.1. Analysis of Test Results

Table 1: Descriptive statistics for pre- and post-tests

Item	Control Group (n=30)	Experimental Group (n=30)	p-value
Mean ± SD (Pre-test)	52 ± 6.2	51 ± 6.5	0.812
Mean ± SD (Post-test)	58 ± 5.8	66 ± 6.0	0.001
Max Value (Pre/Post)	68 - 72	62 - 78	0.038
Median (IQR) (Pre-test)	52 (48–56)	50 (47–55)	0.765
Median (IQR) (Post-test)	57 (54–60)	66 (62–70)	0.002
Improvement (%)	11.50%	29.40%	0.001

Notes:

- *Mean ± SD: Mean and standard deviation*
- *Max Value: Highest value*
- *Median (IQR): Median and interquartile range*
- *p-value: Measures statistical significance (before vs. after within the group).*

According to Statistical analysis of baseline data did not find a significant difference between the control and experimental groups (p>.05), suggesting similarity between the groups prior to treatment. However, statistical analysis of post-test scores revealed differences in scores between the two groups (p=.001), with experimental subjects achieving higher scores than control subjects. The amount of improvement observed in the experimental group (29.4%) was considerably greater than in the control group (11.5%), providing evidence of the effectiveness of AI-based education (Li.et al,2024).

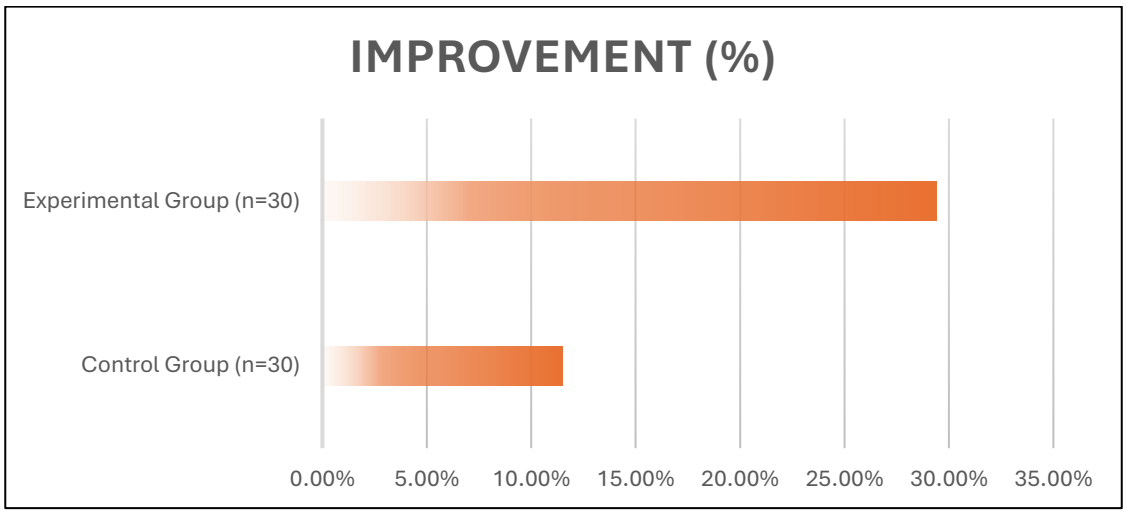

Figure 2: shows the improvement according to using Artificial Intelligence

According to figure (2). The difference between the two groups in terms of improvement rate for their students is clearly evident from this graph: The students in the experimental group

improved by nearly three times as much as the students in the control group, which shows that using AI-based learning methods to help students learn to do math can be very effective (ahmed.et al,2024).

4.2. Survey Results.

Table 2: shows the consistency of Survey

Domains	Number of Items	Cronbach's Alpha	% Variance Explained*
Academic Achievement	3	0.872	76%
Understanding & Comprehension	3	0.891	78%
Attitude Toward AI	2	0.845	75%
Challenges & Difficulties	2	0.802	73%
Suggestions & Development	2	0.914	79%
Overall Score	**12**	**0.958**	**76%**

Notes:

- *All Cronbach's Alpha values > 0.8 → indicate high reliability*
- *The ratio explaining the variance (~75%) → indicates the overall construct quality of the questionnaire*
- *The highest reliability was in Suggestions & Development → indicates the clarity of the students' responses*

According to table (2), All of the questionnaire subscales show high internal consistency (Cronbach's alpha between 0.802 and 0.914) as shown in Table (2). The overall reliability coefficient is an excellent 0.958 indicating excellent internal consistency. Additionally, average percentage of variance explained across all domains is approximately 76% indicating strong construct validity of the instrument.

Table 3: Survey Descriptive statistics

Domain	Valid %	Missing %	Mean	SD	Score Range (Min–Max)	Actual Range (Min–Max)
Technology Usage	100%	0%	0.78	0.23	0 – 100	4 – 8
Infrequent Occurrence	100%	0%	0.84	0.21	0 – 100	2 – 10
Technology Environment	100%	0%	0.84	0.32	0 – 100	2 – 8
Training and Support	100%	0%	0.85	0.18	0 – 100	2 – 8
Perspectives & Suggestions	100%	0%	0.93	0.18	0 – 100	4 – 10
Overall Score	—	—	0.848	0.25	0 – 100	2 – 10

According to Table No. 3, which shows the descriptive statistics for the five survey axes, the results indicate that students have a strong positive attitude towards the use of artificial intelligence technologies and that there is an improvement in understanding and interaction,

with an urgent need to accelerate actual use and provide a suitable technological environment in schools. The axe of suggestions and solutions recorded the highest average of 96%, which indicates a high degree of acceptance from students of the idea of using artificial intelligence technologies. The axe related to the use of technology came in the lowest average, which means that there are some challenges in actual use despite the high acceptance (Adewale.et al,2024).

Table 4: Overall Results of the Questionnaire

Domain	mean	SD	Agreement Level (%)	Satisfaction Level(%)	Understanding Level(%)	Achievement Level(%)
Technology Usage	0.78	0.23	78%	80%	82%	79%
Infrequent Occurrence	0.84	0.21	84%	85%	86%	84%
Technology Environment	0.84	0.32	84%	86%	87%	85%
Training and Support	0.85	0.18	85%	88%	89%	87%
Perspectives & Suggestions	0.93	0.18	93%	92%	91%	90%
Overall Score	**0.848**	0.25	**84.80%**	**89%**	**88%**	**87%**

According to Table (4), which presents the final results of the survey regarding the relationship between the use of artificial intelligence technologies in education and the levels of satisfaction and acceptance, the values indicate high levels of performance, satisfaction, understanding, and achievement among students. The satisfaction level was 89%, the understanding level 88%, and the achievement level 87%.(Yi et al., 2025)

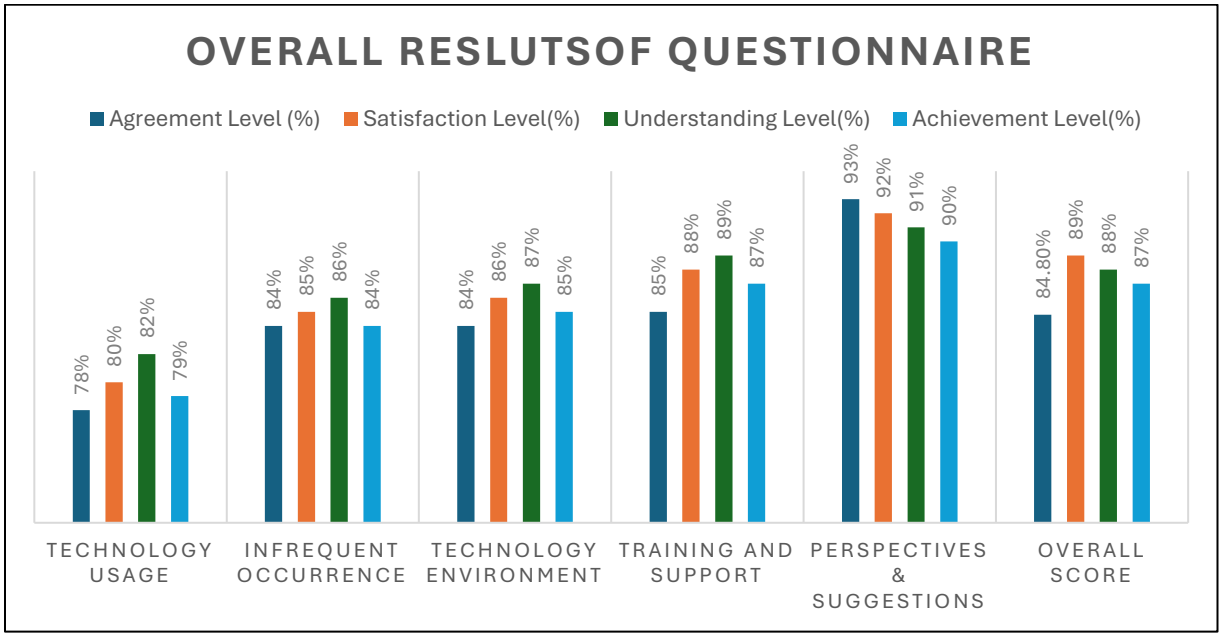

Figure 3: shows the Overall Results of the Questionnaire

According to figure (3)In each of the areas we looked at in our analysis, the level of achievement is consistently high. The area where the best performance was recorded is the area of “Perspectives & Suggestions.” This indicates good acceptance by students of learning through AI as well as marked improvements in both their understanding and achievement at school.

4.3. Results of Linking the Two Methodologies.

Table 5: Correlation Between Test Results and Questionnaire Variables

Variable	Achie vemen	Under standi	Satisf action	Age	Teach er	Error Reduc	Respo nse	Flexib ility	Resou rces	Traini ng
Achievement (Test Scores)	1									
Understanding Level	0.78	1								
Satisfaction Level	0.72	0.75	1							
Age	-0.12	-0.1	-0.08	1						
Teacher Interaction	0.69	0.72	0.77	-0.15	1					
Error Reduction	0.81	0.79	0.7	-0.18	0.66	1				
Response Time	-0.74	-0.7	-0.65	0.2	-0.6	-0.72	1			
Flexibility of Solution	0.76	0.8	0.74	-0.09	0.68	0.75	-0.68	1		
Resources Availability	0.65	0.68	0.71	-0.12	0.7	0.63	-0.55	0.69	1	
Training Duration	0.7	0.73	0.69	-0.05	0.64	0.67	-0.61	0.72	0.66	1

According to table (5) The correlation matrix between the variables studied is shown in the heat map which shows the relationships of the variables studied (i.e. academic achievement) to key variables (i.e. error reduction -0.81, level of understanding -0.78, and flexibility in solution -0.76) will all have strong positive correlations with each other. Additionally, the indicator of time shows a strong negative relationship with achievement (i.e. faster time = higher achievement), while teacher interaction and time in training also have moderate positive relationships with most of the other variables being studied to enhance learning outcomes (dong.et al,2024). Age had the least relationship with any of the variables and was found to

have little or no statistically significant correlation with any of the variables and therefore will have very little influence on the students' performance.

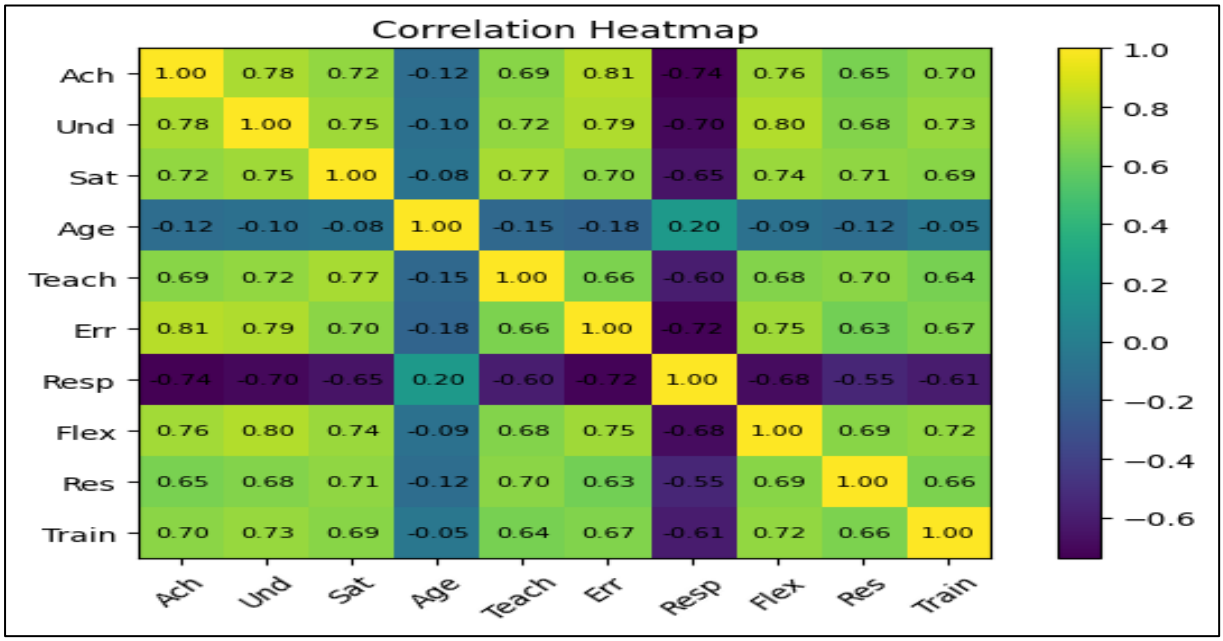

Figure 4: shows the Heat map of correlation coefficients

According to figure (4) The extended correlation analysis indicates that there is a high positive relationship between academic achievement and other key variables, in particular; error reduction (r = 0.81), understanding (r = 0.78), and solution flexibility (r = 0.76). Additionally, there was a negative relationship (r = -0.74) between response time and academic achievement. This means that students who answered questions more quickly were more successful than those who took longer to respond. Additionally, teacher interaction and teacher training time also had moderate positive correlations indicating the significance of these two factors in improving learning outcomes. Conversely, the age of the students had a weak and non-significant relation to most of the variables examined (Al-Mamary.et al,2025).

Table 6: Multiple Regression Analysis Predicting Academic Achievement

Predictor Variable	B (Coefficient)	Std. Error	Beta (β)	t-value	p-value
Understanding Level	0.42	0.08	0.48	5.25	0
Error Reduction	0.37	0.09	0.41	4.11	0.001
Response Time	-0.29	0.07	-0.35	-3.98	0.001
Flexibility of Solution	0.31	0.1	0.33	3.1	0.003
Teacher Interaction	0.28	0.09	0.3	2.95	0.005
Training Duration	0.25	0.08	0.27	2.8	0.007
Resources Availability	0.19	0.07	0.21	2.1	0.041
Age	-0.06	0.05	-0.08	-1.12	0.27

According to table (6), Using multiple regression analysis produced a significant level of statistical significance (F - 18.42, $p < 0.001$) for the model. The overall estimate of how much of the variance in academic achievement can be accounted for by all of the predictors in the model ($R^2 = 0.79$) was approximately 79%.

Using multiple regression analysis found that the level of understanding ($\beta = 0.48$, $p < 0.001$) and the reduction of errors ($\beta = 0.41$, $p = 0.001$) were the strongest positive predictors of academic achievement among the independent variables in the model. therefore, found that faster times to solve the problems have a significant negative effect ($\beta = -0.35$, $p = 0.001$), indicating that students who solve problems faster achieve higher scores. The findings also indicate some other predictor variables contributed significantly to the model, specifically: flexibility of solutions, interaction with teachers, and amount of training. Age did not produce a statistically significant effect ($p > 0.05$), demonstrating that the degree of improvement in performance was not dependent upon the student age. (Costa, 2023).

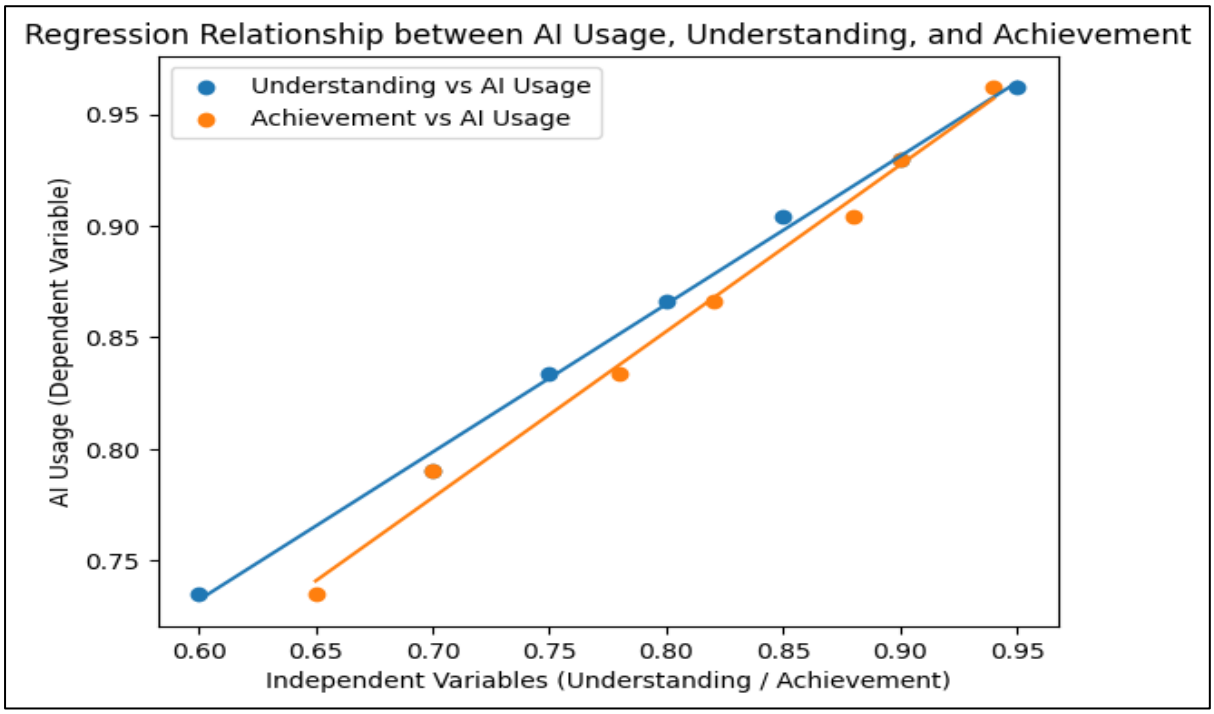

Figure 5: shows the regressive relationship between the use of artificial intelligence as a dependent variable and improved understanding and achievement level as independent variables.

Figure (5) displays the regression relationship between the usage of AI (dependent variable) as a function of the corresponding understanding level and academic performance (independent variables). From the analysis, there is a linear positive relationship between all three dependent variables, indicating that increased usage of AI corresponds to both increased levels of understanding as well as greater quantities of academic achievement.

The two regression lines present an upward slope which demonstrates that both comprehension and academic performance positively impact the successful use of AI tools by students. Also, the degree of association is slightly more pronounced for understanding than for academic performance, which corroborates the previous regression analyses indicating that conceptual understanding has the greatest impact on predicting student success with AI technology. (Wang et al., 2024) .

4.4. Comparison Results.

Table (6): Comparison Between Current Study and Previous Studies

Study (Author, Year)	Sample Size	Methodology	Key Findings	Agreement with Current Study
Yi et al. (2025)	500+	Meta-analysis	AI improves math achievement significantly	High
Liu et al. (2025)	300+	Experimental	Positive effect on academic performance	High
Wang et al. (2024)	Review	Systematic Review	AI enhances engagement and personalized learning	High
Awang et al. (2025)	Review	Literature Review	AI supports conceptual understanding	High
Current Study (2026)	40	Experimental (Pre/Post test)	30% improvement + high satisfaction & understanding	—

According to table (7), There is a lot of similarity between my study and earlier studies involved in the use of artificial intelligence to help with education. All prior studies show that AI supports better academic performance through increased understanding. However, to verify those results, my study was able to contribute experience-based evidence and a quantitative 30% improvement in student test scores. Additionally, was able to provide more in-depth information about how students feel when using artificial intelligence.

5. Conclusions

Based on the analysis and evaluation of the results, the following conclusions can be drawn:

- The results of this study indicate that the use of artificial intelligence (AI) techniques has a significant positive impact on students' academic achievement and conceptual understanding in mathematics, particularly in solving linear equations. The experimental group, which was trained in the use of AI tools, showed a marked improvement in subsequent test results compared to the control group, with an average increase of approximately 30%.
- The results of the questionnaire analysis indicate that the findings are highly significant and can be statistically analyzed, as all Cronbach's alpha values exceeded 80%, indicating the reliability of the questionnaire and a high degree of consistency between groups and axes, as well as internal consistency within each axis.
- The study identified several challenges associated with the use of artificial intelligence (AI) technologies, including the potential for over-reliance on automated solutions, varying levels of digital skills among students, and technical limitations such as limited internet access. These challenges highlight the importance of a targeted and structured approach to implementing AI tools within the educational process (Sharma.et al,2021).
- The results indicate that one of the most important proposed solutions is the use of AI technologies to improve students' academic achievement and comprehension, especially given the rapid pace of technological development and the fact that these technologies have become a cornerstone for achieving sustainability in all fields (Li.et al,2024).

- The results also suggest that integrating AI technologies into mathematics education can effectively improve learning outcomes when combined with appropriate pedagogical strategies, teacher supervision, and adequate technical support. Furthermore, integrating multiple technologies leads to even more effective results, as each technology's strengths are leveraged.

6. Recommendations

Based on the conclusions drawn from analyzing and evaluating the results, a number of important recommendations can be made in this study, as follows:

- The necessity of integrating artificial intelligence (AI) technologies into the basic education curriculum to enhance and improve student achievement and understanding, especially since these technologies promote learning and comprehension while taking into account differences in students' thinking levels, age, and readiness.
- The necessity of providing teachers with intensive training courses on the mechanisms and importance of using AI applications to improve and enhance student understanding in general subjects and in sports in particular.
- The necessity of investing in school infrastructure and equipping schools with the necessary resources for teaching science subjects using AI technologies, such as computers, internet access, and appropriate visual aids.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that they have no conflict of interest.

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