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Artificial Intelligence for Creative Mathematical Problem-Solving in Iraqi Preparatory Schools: Teachers' Perspectives and Curriculum Integration

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ABSTRACT
The purpose of this study was to determine if it is feasible to use artificial intelligence (AI) applications to help Iraqi preparatory school students enhance their capacity for creative thinking in order to solve mathematical problems from the viewpoint of math teachers. It also sought to determine how these applications relate to gender, years of experience, and educational background, as well as how much of them are included in school curricula. This goal was accomplished by using a descriptive method to a random sample of 168 male and female preparatory school math instructors. The reliability and validity of a 34-item survey used to collect data were evaluated. Before being included into the preparatory school mathematics curriculum for grades four and five, a 24-item analysis card spanning five domains was created and verified. The results showed that math instructors had a reasonable understanding of AI applications for fostering original problem-solving techniques. Additionally, math instructors were well aware of the perceived value and challenges of using AI algorithms to promote creative problem-solving in mathematics. Additionally, the findings showed that neither gender nor educational attainment were statistically significant factors in the sample mean replies at the significance level (\alpha = 0.05). However, depending on years of experience, statistically significant differences (\alpha = 0.05) in the degree of relevance and barriers to employing AI applications were found, favoring instructors with more years of teaching experience. The degree of expertise for the use of AI applications did not, however, vary statistically significantly according to years of experience (alpha = 0.05). Last but not least, the research found that preparatory school mathematics curriculum in Iraq's fourth and fifth grades had very little information on AI ideas and applications. The study made several recommendations in light of these findings, the most crucial of which was the need to train teachers to incorporate AI applications into their lesson plans and to enhance curricula with exercises and activities that use AI applications to boost student motivation, enhance learning retention, and reinforce mathematical concepts.

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INTRODUCTION

One of the most important contemporary systems and technologies is artificial intelligence (AI), a subfield of computer science and a crucial area of scientific and technological growth. The human, social, and economic domains have all been profoundly touched by AI and its applications, which are now an essential aspect of everyday life. In order to accomplish the intended educational objectives, many institutions, including educational ones, have embraced AI and are using its various tools and applications to improve education and the teaching process.

Creating a state-of-the-art learning environment promotes student involvement and engagement. The development of the creative thinking abilities required to solve mathematical issues with AI applications is facilitated by a friendly and pleasant classroom environment, a suitable class size, the formulation of challenging questions, and the management of constructive dialog. As a result, incorporating technology into the classroom and giving students the chance to complete assignments while receiving positive feedback increases their drive to study and raises their self-esteem (Li, 2020). UNESCO has highlighted the need of implementing and integrating artificial intelligence (AI) applications into education in order to enhance human capacities and promote successful human-machine interaction across life, education, and work. After significant advancements in recent years, artificial intelligence (AI) has the potential to drastically change people's lives (UNESCO, 2022). AI is beginning to have a big impact on a lot of industries, including education. Many students find it very difficult to understand mathematical ideas and applications. It has been shown that artificial intelligence (AI) and other contemporary technologies enhance instructional strategies and encourage students' creative thinking (Hwang & Chang, 2011). Additionally, Wael Zidan (2014) showed that integrating AI into instruction speeds up students' achievement of program objectives. By leading students through interactive stages and explanatory material, providing test practice, and providing instant feedback on right answers, it also improves student leadership and self-directed learning abilities, allowing performance monitoring and self-evaluation. Additionally, by using graphical and visual technology to provide instructional content, AI encourages students' imagination and creativity.

Artificial intelligence (AI), which offers creative applications that improve student abilities, has become a potent tool for improving education as technology develops. In order to create individualized learning experiences that satisfy the requirements of every student, these systems evaluate

performance data. For example, websites like as DreamBox and Khan Academy provide personalized activities and interactive explanations to help students understand mathematical ideas. According to studies, incorporating AI into the classroom may improve students' creative thinking and creative abilities, enhancing their capacity to handle challenging issues (Luckin et al., 2016, 45). A number of studies, including those by Mohamed Al-Najjar (2012) and Rasha Abu Shamala (2013), have emphasized the need of employing AI in teaching educational material because of the importance of AI applications in education. To meet the needs of the Fourth Industrial Revolution, curricula—essential elements of the educational system—must also include cognitive, skill-based, and emotional components. This guaranties that educational outputs will be able to support holistic growth and have the capacity to contribute to the creation of contemporary, AI-driven knowledge both intellectually and practically. As a result, it is essential to include these ideas and applications within the curriculum, especially in mathematics. One of the most important educational skills for developing problem-solving skills is creative thinking. By encouraging pupils to "think outside the box," it goes beyond conventional patterns and helps them create original ideas and practical solutions for challenging issues. Research suggests that teaching children to think creatively may help them do better academically and better adjust to the difficulties of everyday life (Melanie, 2018, p. 46).

Learning creative problem-solving is crucial because it calls for the capacity to investigate issues and provide a range of unique concepts or solutions that are pertinent, unique, and varied in order to meet the issues raised by the current difficulty. This approach demonstrates the efficient use of creative skills (fluency, adaptability, and originality) across the many phases of problem processing: comprehending the issue, organizing the solution's execution, and resolving the issue (Yousef, 2011, p. 222).

Students must be able to solve mathematical problems in order to promote creative thinking in mathematics and other subject areas. Additionally, since these abilities are a fundamental standard established by the National Council of Teachers of Mathematics (NCTM) in the United States and consistent with the theory of transfer of learning, fostering students' creative problem-solving abilities in mathematics can have a significant impact on other academic fields. This makes it possible for the person to face and overcome obstacles in their environment (Al-Sheikhi, 2016, p. 35).

In light of the aforementioned, this study intends to evaluate the degree to which these applications are incorporated into their curricula, highlight the significance of using contemporary teaching technologies, and investigate the potential of using artificial intelligence (AI) applications to foster creative thinking in mathematical problem-solving among Iraqi preparatory school students—specifically from the perspective of mathematics teachers.

Study Problem

To the best of the researcher's knowledge, a survey of the literature and earlier research indicates a dearth of research on the use of artificial intelligence to foster mathematical creativity. All members of society, particularly students at all educational levels, should prioritize and develop creative thinking as it is a high-level cognitive process—a kind of higher-order thinking. Since mathematics offers several issues with a variety of logical answers, it is a crucial subject that greatly supports the growth of creative thinking in problem-solving. Many national and international studies emphasize the value of developing creative thinking abilities and improving a variety of teaching strategies, including those by Hassan & Al-Hila (2017), Al-Khatm (2017), Shaqour (2014), and Shamsan (2014). These studies involve staying up to date with the latest advancements, fostering creative thinking in students, developing original answers to scientific and educational problems, and identifying practical ways to accomplish these objectives. Additionally, the National Framework for Future Skills' goals highlight how crucial it is to give students the skills they need to keep up with the world's rapid changes and improve their competitiveness in the face of social and technological advancements as well as the changing nature of future careers (Ministry of Education & Ministry of Higher Education, 2021).

Several studies conducted in Iraq, such as those by Daifaf Al-Shuwaili (2022), Asmaa Abdullah (2024), and Raghad Raja (2024), have suggested that the scientific curriculum and the idea of the school textbook be revised. This is because textbooks are becoming more important, especially in light of artificial intelligence's rise to prominence as a knowledge source. It is also necessary to rethink the relative importance of information and skills and the relationship between the levels of thinking that underpin instructional strategies.

Given the above, the main goal of the study is to answer the following query:

"According to math professors, how may artificial intelligence apps help Iraqi preparatory-stage pupils improve creative thinking abilities for solving mathematical issues, and how much are these programs included into their curriculum?

This primary question gives rise to the following sub-questions:

1. How much do math instructors know about using AI technology to foster creativity in mathematical problem-solving from the viewpoint of Iraqi preparatory-stage pupils in the Maysan Governorate?
2. How important do Iraqi preparatory-stage students in the Maysan Governorate believe it is for math instructors to use AI tools to inspire students to use their imaginations to solve mathematical problems?
3. What challenges do math instructors in Iraq's (Maysan Governorate) preparatory-stage pupils have when using AI tools to foster creative problem-solving abilities?
4. Can statistically significant variations (at the α=0.05 level) in the mean answers of the sample of math instructors about the research instrument be explained by the characteristics of gender, academic qualification, and professional experience?
5. How much does the mathematics curriculum for the fourth and fifth grades of the preparatory stage in Iraq include artificial intelligence principles and applications?

Study Hypotheses

The researcher examined the following hypotheses in order to answer the study's fourth sub-question:

"There are no statistically significant variations (at the α=0.05 level) in the mean replies of the sample of math instructors about the research instrument based on gender, professional experience, and academic qualification.

Study Objectives

The following goals were the focus of the study:

1. To determine the level of knowledge preparatory school math instructors have on the use of AI to foster creative problem-solving abilities.
2. To determine the value of using AI algorithms to help preparatory school pupils enhance their ability to solve mathematical problems creatively.

3. To determine the challenges preparatory school pupils have while using AI apps to develop creative problem-solving abilities.
4. To determine if the factors of gender, educational background, and professional experience are responsible for statistically significant differences (at the α=0.05 level) in the mean answers of the sample of math instructors on the research instrument.
5. To ascertain the degree to which fourth and fifth grade mathematics curricula in Iraqi middle schools include artificial intelligence principles and applications. The importance of the research
The following categories apply to the research's relevance:

Theoretical Significance
Expanding the knowledge base regarding artificial intelligence (AI) in education: This work opens up new research directions in this area and deepens our knowledge of how AI technology may be used to enhance education. It provides information on how to inspire pupils to solve mathematical problems using their imaginations, which supports the creation of innovative, scientifically based teaching methods. In order to assist construct more effective learning environments, the research offers a theoretical foundation for the development of educational technology based on artificial intelligence. By improving knowledge of the variables affecting learning and emphasizing the need of incorporating technology into instruction, it provides value to educational literature. By providing models that may be used in other nations or educational settings, the results may expand the study's effect. The project's primary goal is to provide a solid body of research that will aid initiatives to enhance curricula and education in Iraq and encourage the use of AI technology in the classroom.

Practical Significance
Improving educational quality: By offering tailored and engaging content, AI applications may improve educational quality by raising student accomplishment and learning efficacy.
- Developing creative thinking abilities for mathematical problem-solving: Through the educational program, students are able to overcome obstacles and come up with novel solutions by developing their creative thinking abilities for mathematical problem-solving. - Introducing new educational tools: Teachers now have access to new technology and resources that help with class preparation and material delivery in creative, interesting ways thanks to artificial intelligence.
Improving student-teacher interaction: By encouraging communication and interaction between students and instructors, smart apps have the ability to make learning more dynamic.
Continuous assessment: Teachers may make well-informed educational judgments and assist students in improving their performance since artificial intelligence can swiftly and correctly examine student performance.
- Promoting remote learning: By offering a customized, all-encompassing educational experience that caters to each student's requirements, AI apps may promote remote learning.
Getting pupils ready for the workforce: By encouraging creative thinking and creativity, students are better equipped to handle the demands of the future labor market.
Complying with contemporary teaching methods: The software is more suited for contemporary curricula since it adheres to contemporary educational trends like project-based learning and student-centered learning.

Study Limitations
The study was conducted during the second semester of the 2025–2026 academic year.
Schools affiliated with the Central District of the Maysan Governorate Directorate in Iraq were the sites of the survey.
Human scope: The study sample consisted only of male and female math teachers in the Maysan Governorate of Iraq who were in the preparation stage.
Examining artificial intelligence concepts and applications from mathematics textbooks for the fourth and fifth grades of Iraq's preparatory stage was the study's exclusive focus.

Study Terms
Usage: Al-Jahawiya (2009) defines it as: "Everything a learner acquires within the school setting—through various curricula—that ought to be applied in real-life situations to facilitate interaction and communication with others; this is based on the principle that education is life, not merely preparation for life."
The researcher's operational definition is that it is the teacher's ability to employ AI applications to help preparatory school students develop their capacity for creative problem-solving in mathematics. This utilization is measured using the data from the questionnaire that the researcher developed and that the participating teachers completed.
Artificial intelligence applications are defined by Rasha Abu Talib (2024) as "a set of programs and applications utilized via computers, tablets, mobile phones, laptops, or similar devices to help achieve desired and targeted learning objectives."
The researcher's operational definition states that they are: A set of applications included into the mathematics curriculum that assist students in developing digital skills; they are evaluated using an analytical rubric designed especially for this purpose.
Lutf Muhammad (2011) defines innovative thinking as "the process of perceiving and observing a problem, grasping its various aspects by gathering relevant facts, precisely defining it, seeking to address it by considering various solutions, and subsequently evaluating these alternatives to select the optimal solution and test its effectiveness."
The researcher's operational definition is that it is a mental process that enables individuals to solve problems and provide unique solutions by combining knowledge and prior experiences in fresh and imaginative ways. This kind of thinking requires the use of skills like creativity, creative thinking, and mental flexibility in order to generate effective and innovative results.
Only the books used in Iraqi preparatory schools for the fourth and fifth preparatory grades are referred to as "mathematics curricula" in this research.
Preparatory schools are public schools overseen by the Ministry of Education that provide students in the preparatory grades free, mandatory training.

Theory Structure
The First is Artificial Intelligence (AI)
Numerous social, political, economic, and educational spheres have undergone significant and comprehensive changes as a consequence of artificial intelligence's development as a new language. The word was originally used at a conference at Dartmouth College in 1956, which marked the beginning of study into how robots may imitate intelligent human behavior. By 2016, interest in artificial intelligence (AI) had surged globally, with a focus on simulating the human mind to build robots that could analyze,

function methodically, and carry out tasks based on inputs provided by the system—capabilities that are particularly helpful for handling big datasets (Chen, Chen & Lin, 2020).

Artificial intelligence (AI) is a technology with human-like intelligence that can learn, adapt, solve problems, make decisions, and understand human language, according to Muhammad Shidiq (2022). It offers a lot of educational convenience with features like voice assistants, creative content production, smart classrooms, automated evaluation, virtual tutors, and self-directed learning.

It depicts systems that do jobs usually performed by intelligent individuals using digital computers or computer-controlled robots. These systems have the ability to perform cognitive functions similar to those of humans, including reasoning, meaning-finding, and experience-based learning (Barua et al., 2022).

AI consists of software programs that simulate the human mind and enable computers to perform mental processes targeted at higher-order thinking skills including problem-solving, decision-making, and divergent thinking (Essam Sayed, 2022, p. 118). Types of Artificial Intelligence Al-Toukhi (2021) classified artificial intelligence into three groups based on the primary tasks completed:

i. Super Artificial Intelligence: These models, which are now undergoing testing, are intended to resemble human behavior. These models may be divided into two broad categories: the first attempts to understand and recognize human emotions and concepts that influence behavior, but it has weak social interaction abilities. The "Theory of Mind" model, which represents the next generation of very intelligent computers, is the second pattern. These models are able to interact with people, predict their situations and feelings, and express their own inner moods.

ii. Strong Artificial Intelligence: These models stand out for their ability to make decisions on their own. This ability is the outcome of the data and facts collected and analyzed, as well as the experience obtained from various situations. Examples include chatbots, self-driving cars, and personal virtual assistants.

iii. Limited or Weak Artificial Intelligence: This kind of artificial intelligence, which is said to be the most basic, is programd to do certain tasks and functions inside a predefined environment and under predefined conditions; it cannot operate in all environmental scenarios. An example of this kind is the "Deep Blue" robot, which defeated world chess champion Garry Kasparov. Applications of Artificial Intelligence The "Artificial Intelligence Family" includes several different applications of artificial intelligence. Because of this, this family is open-ended and is continuously expanding with new members and discoveries pertaining to previously unknown uses of AI technology (Khaled Abu Bakr, 2017: 85). The collection of recent and developing applications in a variety of theoretical and scientific domains is referred to by this name.

The term "artificial intelligence applications in education" refers to software and programs that provide students guidance and assistance throughout the learning process to help them achieve mastery. According to Shaimaa Mohamed and Iman Mahmoud (2020: 473), these applications are unique in that they can track browsing paths and navigation patterns inside the educational environment when a student is studying. They can also create and distribute solutions that are tailored to the student's academic level. According to Al-Jarrah (2019: 45), artificial intelligence is used in several fields, including:

Software that utilizes natural language to understand the nature of languages and enable direct computer instruction and command execution is known as natural language processing, or NLP. This allows computers to interact with humans, such as by answering questions, in addition to systems that correct spelling and grammatical errors or interpret handwritten text.

Expert systems are programs that transmit human expertise to computers so they may do tasks that would typically need a professional. Large volumes of the expert's data are sent into the computer, which employs specialized search and inference techniques to provide results comparable to those of a human expert.

Film production uses software that can convert text into speech.

Speech recognition software is software that can convert voice to text.

AI is widely used in gaming, where it has enhanced realism and contributed to the development of virtual and augmented reality technology.

A decision support system is software that provides information to aid in choosing amongst several possibilities. This category includes user-interactive computer software used in educational settings. It also has software designed to give machines human-like learning abilities. This is achieved by enabling the software to identify broad user patterns by analyzing massive amounts of input data. One example is medical diagnostic software, which gains expertise via regular use and provides data on prevalent illnesses or epidemiological trends.

Character Recognition and Reading: This software can convert handwritten or printed characters into digital words, phrases, and characters. The text may then be used in the same way as if it had been entered using a keyboard.

Pattern, Shape, and Form Recognition: This software can recognize patterns, shapes, and images, such as iris scans, fingerprints, and facial features.

Second: Creative Thinking Skills for Solving Mathematical Problems

Creative thinking skills are defined as a set of mental skills used by an individual to generate new and purposeful ideas. Researchers define them as a collection of skills—including fluency, flexibility, and originality—employed to produce novel ideas. These skills are characterized as follows:

1- Fluency:

This is the capacity to quickly and easily come up with a variety of synonyms, ideas, issues, or options in response to a certain stimulus; it entails coming up with several answers for a single object.

Fluency is divided into:

Fluency of speech (or words).

b. Figural fluency, or shape fluency.

c. Another term for semantic fluency is ideational fluency (Aziz Al-Barqawi, 2014, p. 83).

2. Flexibility: This refers to the capacity to modify one's mental state in reaction to evolving circumstances. The two categories of flexibility skills are adaptive flexibility and spontaneous flexibility.

3. Originality: The quality most closely linked to creative thinking is originality. According to Hassan (2012), p. 116, originality in this context refers to a person's capacity to generate unique, rare thoughts; in other words, the less frequent a concept is, the more original it is. Unlike fluency, it is determined by the worth, nature, and quality of a person's original thoughts rather than their number. Flexibility is defined by Aziz & Al-Burqawi (2014), p. 83, as a creative person's refusal to mimic the behavior of others instead of just

avoiding repeating their own particular ideas and opinions on a subject.
4. Problem sensitivity: This is the capacity to concurrently identify and be highly aware of several issues and circumstances.
5. Elaboration: This refers to the capacity to supplement a concept or a problem-solving strategy with fresh and distinct knowledge (Abu Al-Nasr, 2012, p. 20).

Third: Previous Studies

Studies Related to the Use of Artificial Intelligence Applications in Teaching

Turki (2023) carried out a research with the objective of examining and determining the possible uses of artificial intelligence as well as the difficulties related to its use in the teaching of bright kids. One hundred children from the King Abdullah Schools for the Gifted in the Kingdom of Saudi Arabia made up the study sample, and the researcher used a descriptive approach. A 34-item questionnaire was one of the tools utilized in the study. The findings showed that artificial intelligence was not widely used. The results emphasized the need of incorporating AI applications into school strategic planning and using AI-based learning environments. In addition to educating and motivating teachers to include AI into their lesson plans, they stressed the need of embracing AI and its uses early on. The goal of Al-Ruwaished's (2023) research was to find out how much math instructors knew about artificial intelligence (AI) technologies, how they used them in the classroom, and what challenges they faced in Kuwaiti public schools. A 31-item questionnaire encompassing four domains—teachers' awareness of AI applications, their use of AI in mathematics education, teacher-related obstacles, and student-related challenges—was used in this descriptive-analytical research. There were 337 male and female instructors in the research sample. The findings showed that teachers were generally aware of both teacher-related issues, like workload and the density of the mathematics curriculum, and student-related issues, like students' lack of experience with AI applications and the substantial amount of work and assignments required for other subjects. Helping math instructors understand how to employ AI in the classroom was one of the study's suggestions. The 2019 research by Kim et al. examined how artificial intelligence (AI) technology could change the responsibilities of educators. Using accomplishment assessments as the main research tool, the study used an experimental design with a sample of 234 instructors and 220 students from different pre-university educational levels. The findings showed that although student performance had improved, instructors' over-reliance on AI technology made it more difficult for them to effectively use the AI-based guidance system. One of the study's suggestions was to increase the usage of the AI-powered guidance system to cut down on the time and effort instructors spend monitoring students' development.

Studies Related to the use of Artificial Intelligence Applications in Fostering Thinking Skills, Particularly Creative Thinking

Nasser (June 2023) conducted research to determine how AI technology may enhance students' capacity for creative thought in educational environments. The researcher used a descriptive-analytical method and the SWOT analysis matrix. The results of the research showed how artificial intelligence may effectively develop creative thinking abilities. Other suggestions made by the study included incorporating artificial intelligence courses into the curriculum and stressing the value of fostering creative thinking abilities at all educational levels. The goal of Al-Otaibi et al.'s (2022) research was to ascertain how artificial intelligence would help female second-year secondary school students in the physics curriculum strengthen their creative thinking abilities and scientific attitudes. Three instruments were used in this quasi-experimental study: a scientific attitudes scale, an artificial intelligence scale, and a creative thinking exam. Forty female pupils from a Riyadh school's scientific program made up the sample. The findings showed that students' scientific attitudes and creative thinking abilities were positively impacted by artificial intelligence. The experimental group scored higher overall, and there was a statistically significant difference between the control and experimental groups' mean scores on the post-test for creative thinking skills (particularly with regard to argument assessment, interpretation, and inference). After the scientific attitudes test was administered, statistically significant variations in the groups' mean scores, both overall and throughout the scale's several parts, once again favored the experimental group. The research made a number of suggestions, such as stressing the need of incorporating creative thinking abilities into all educational levels and the requirement of routinely upgrading curriculum to include new artificial intelligence programs and critical skills. Al-Awfi and Al-Ruhaili's (2021) research sought to determine if artificial intelligence (AI) applications may encourage creative thinking and other inventive talents in female secondary school students from the viewpoint of Saudi Arabian math instructors. A 31-item questionnaire was used in the study's descriptive research methodology to survey a sample of 150 female secondary school math instructors in Medina. The results showed that although the teachers prioritized using AI applications to foster creativity and had a respectable degree of expertise in this area, they also noted important barriers to its deployment. Increasing the usage of AI apps to foster students' creativity while using instructors' understanding of their significance was one of the study's numerous suggestions.

Studies Related to the Integration of Artificial Intelligence Applications into Curricula

Al-Shidi and Al-Saidi's (2022) research sought to ascertain the degree to which artificial intelligence principles and applications were included into Sultanate of Oman primary school mathematics curriculum. The research used an analysis rubric with 24 questions broken down into five categories and a descriptive-analytical methodology. The findings showed that the ideas and applications of artificial intelligence were not sufficiently covered in the mathematics curriculum for grades seven and eight. Among the several suggestions made by the research was the need of teaching instructors how to use artificial intelligence in the classroom and incorporating its principles and applications into mathematics curriculum.

In a similar vein, Al-Fayez, Al-Othman, and Al-Malhi's (2021) research sought to determine the degree to which computer and information technology curriculum for intermediate and secondary students in the Kingdom of Saudi Arabia included artificial intelligence principles and applications. An analysis rubric and a descriptive-analytical method were also used in this investigation. The results showed that both the intermediate and secondary curricula had a reasonable level of integration of artificial intelligence ideas and applications, ranging from 3.46% to 16%, with the secondary stage showing the greatest level of integration. An analysis of earlier research that emphasizes the similarities and differences between the present study and earlier studies

Regarding the goal: The current study sought to determine how much these applications are incorporated into math teachers' curricula and investigate the possibility of using artificial intelligence (AI) applications to help Sultanate of Oman basic education students develop creative thinking abilities. To the best of the researcher's knowledge, no prior study has combined these particular variables; prior studies had different goals, such as Al-Awfi and Al-Ruhaili's (2021) investigation into the viability of using AI applications to encourage creativity in female secondary school students and Al-Shidi and Al-Saidi's (2022) investigation into the extent to which AI concepts and applications are incorporated into mathematics curricula in Oman's basic education.

Concerning the study environment: Al-Shidi and Al-Saidi's (2022) evaluation of Oman's mathematics curriculum is consistent with the present study, despite its departure from earlier studies.

Regarding the research tool: In contrast to studies like those by Nasser (2023), Al-Otaibi et al. (2022), and Kim et al. (2019), which relied on achievement tests and AI-related measures, the current study employed a questionnaire for data collection, which is consistent with research like that of Al-Awfi and Al-Ruhaili (2021). An analytical rubric was also used in this investigation. The present study is consistent with pertinent earlier research, such as that conducted by Al-Shidi and Al-Saidi (2022) and Al-Faiz, Al-Othman, and Al-Malhi (2021), on the degree to which artificial intelligence ideas and applications are included into mathematics curriculum.

Although it deviates from the quasi-experimental strategy of Al-Otaibi et al. (2021) and Kim et al. (2019), the current study's methodology is consistent with other earlier research (Turki, 2023; Al-Ruwaished, 2023; Al-Shidi & Al-Saidi, 2022; Al-Awfi & Al-Ruhaili, 2021).

The Methodology of the Research

To accomplish its goals, this research combined content analysis and field analysis techniques using a quantitative descriptive methodology. According to Abu Bakr and Al-Lahlah (2002), field analysis is regarded as an efficient scientific research method for evaluating the present state of a phenomena by determining its circumstances and elucidating the connections within it, producing an accurate, thorough, and fact-based description. Additionally, content analysis is seen to be a good way to collect information regarding school curriculum.

Study Sample and Population

Two groups were created from the research population:

First Group: This group consists of all male and female math teachers working in Ministry of Education-affiliated public schools in the Maysan Governorate during the preparatory stage of the second semester of the 2025–2026 academic year (more precisely, the fourth and fifth preparatory grades). Of the 884 instructors, 462 are female and 422 are male (Ministry of Education, 2025).

168 math instructors from the fourth and fifth preparatory courses, or 19% of the total study population, made up the research sample for this group. A random sampling technique was used to choose the sample. The characteristics of the research sample according to its factors are described as follows:

Table 1: The Distribution of the Study Sample According to its Variables

Variable	Variable categories	number	Percentage
Gender	Male	79	%47
	Female	89	%53
	Total	168	%100
Academic Qualification	Bachelor's	160	%95
	Master's and above	8	%5
	Total	168	%100
Scientific Experience	1–9 years	84	%50
	10–19 years	63	%37.5
	20 years and over	21	%12.5
	Total	168	%100

The second category comprises all mathematics curricula for the preparatory school stage in Maysan Governorate; the study sample consisted of four textbooks for the fourth and fifth intermediate grades for the 2025/2026 academic year, as shown in Table 2.

Class	The book	Number of units	Number of pages	Number of sub-ideas
Fourth Year of Intermediate School	Fourth-Year Scientific Stream Textbook	8	203	1112
	Fourth-Year Literary Stream Textbook	8	110	631
Fifth Year of Preparatory School	Fifth-Year Scientific Stream Textbook	6	163	1064
	Fifth-Year Literary Stream Textbook	6	103	611

Study Instruments

First: The Questionnaire

The instrument's objective was to assess preparatory school students in the Maysan Governorate's ability to utilize artificial intelligence apps to foster innovative mathematical problem-solving from the perspective of math teachers.

Methods used in the creation of the questionnaire:

1. Examining previous research: After evaluating the study literature and relevant prior research, this instrument was developed by referencing the studies of Al-Ruwaished (2023), Al-Awfi and Al-Ruhaili (2021), and Al-Otaibi et al. (2022).

2. Developing the instrument questions: Math instructors' knowledge of artificial intelligence applications for fostering creative problem-solving, the importance of using these apps, and the obstacles to their utilization comprised the 34 items in the first version of the questionnaire. The questionnaire was designed on a five-point Likert scale. The positively phrased questions were given the following weights: Strongly Agree

(5 points), Agree (4 points), Neutral (3 points), Disagree (2 points), and Strongly Disagree (1 point).
3. Instrument Validity: To verify the validity of the instrument, a panel of specialists in mathematics education and curriculum was consulted. They were requested to evaluate the instrument's components and provide suggestions for modifications, additions, or deletions relevant to the study subject in order to ensure that it served its intended purpose. The final 34-item version of the instrument demonstrates both face validity and content validity since it was created with expert assistance.
4. Instrument Reliability: Using Cronbach's alpha method, the reliability coefficient was determined after the instrument was administered to a pilot sample of thirty math professors. The reliability coefficient of 0.89 was deemed appropriate and sufficient for the study's goals.
5. Statistical Analysis: Following the administration of the research instrument, data was collected, entered, and analyzed using the Statistical Package for the Social Sciences (SPSS) software. The research included calculations for frequencies, arithmetic means, standard deviations, Cronbach's alpha, the Independent Samples t-test, and One-Way ANOVA. The respondents' answers to the questionnaire items were also interpreted using the five-point Likert scale mean scores: a score of 4.20–5.00 indicates a "very high" level; 3.40–4.19 indicates a "high" level; 2.60–3.39 indicates a "moderate" level; 1.80–2.59 indicates a "low" level; and 1.00–1.79 indicates a "very low" level.

Second: A Math Curriculum Content Analysis Card

The tool's goal was to determine the extent to which preparatory school mathematics curricula in the fourth and fifth grades in the Maysan Governorate covered artificial intelligence applications and associated concepts.
Methods for creating the analysis card:
1. Examining previous research: Following a review of educational literature and previous studies and research pertinent to the topic, this tool was constructed utilizing the research of Al-Shaidi and Al-Saeedi (2022) and Al-Fayez, Al-Othman, and Al-Malhi (2021).
2. Writing the paragraphs for the tool: When the tool was initially developed, its 24 sub-phrases included data analysis and structure, deep learning, physical computing, artificial intelligence programming, and artificial intelligence applications. These subjects were chosen after an examination of earlier studies, their importance, and how they relate to math courses. For instance, data analysis techniques may relate mathematical ideas to a variety of real-world scenarios; programming can help students understand mathematical forms and visualizations more broadly; and smart applications can enable students and machines to work together to solve algebraic and geometric problems.
3. Validity of the instrument: A panel of arbitrators with expertise in curriculum and mathematics education evaluated the tool to verify its validity. Based on their observations and assessments, the researcher performed the required modifications, including additions, deletions, and alterations.
4. Tool stability: To ensure that the analysis card is stable and ready for real-world use, a book for the fourth and fifth grades was chosen to have its content reviewed. The first and second analyzes were conducted eight days apart. The correlation coefficient between the analysts' estimations was determined using the Pearson equation to be (0.94), indicating a good and acceptable degree of stability for the tool's implementation.
5. Statistical processing: The sub-ideas in each book's content (cognitive material, activities, forms, tables, intellectual boxes, and images) were examined independently after the analytical tool was applied to mathematics books for grades four and five. Knowing how often the words from the analysis tool appeared in each book, the data was statistically analyzed by figuring out how frequently each phrase appeared in the study material's text. The percentage of these phrases' inclusion was then calculated using the following formula: The instrument's stability was assessed by comparing the two analyzes using the Pearson equation. By dividing the total number of sub-ideas in the text by the number of times the phrase occurs, one may get the inclusion percentage.
Presentation and discussion of the results:
How much do math teachers in the Maysan Governorate know about using AI to assist preparatory school students become more innovative problem solvers?
Calculating the arithmetic means and standard deviations of the sample members' answers addressed the first axis of the questionnaire, which relates to evaluating the level of familiarity mathematics teachers have with artificial intelligence applications in fostering preparatory school students' capacity for creative problem-solving. Table 2 displays the outcomes.

Table 2: The First Dimension of the Questionnaire's Arithmetic Means and Standard Deviations for the Study Sample, Together with the Evaluations' Relative Importance (Rank)

Rank	Paragraph number	Paragraphs	Arithmetic mean	Standard deviation	Level of knowledge
1	4	I am able to locate sources of progress pertaining to applications of artificial intelligence.	3.65	0.77	Big
2	2	I know how to apply applications of artificial intelligence to foster creative problem-solving abilities in mathematics.	3.07	1.01	average
3	5	I am aware of how to use support channels to fix any technical problems I may run across while using AI software.	2.83	1.02	average
4	1	I am aware of uses of artificial intelligence that foster creative problem-solving techniques in mathematics.	2.71	0.65	Average
5	3	I have the expertise to create a methodical strategy for using AI technologies to increase mathematical problem-solving abilities.	2.12	0.87	Weak
6	6	I was given enough training to enable me to employ artificial intelligence applications to foster pupils' ability to think creatively in order to solve mathematics difficulties.	1.55	0.69	Very weak

Rank	Paragraph number	Paragraphs	Arithmetic mean	Standard deviation	Level of knowledge
Overall average			2.71	0.65	Average

Table 2 reveals that the overall arithmetic mean for the first dimension—"Level of "Knowledge" received a score of 2.71. According to the teachers' own perspectives, this figure shows that preparatory school math teachers in the Maysan Governorate have a moderate awareness of artificial intelligence applications for fostering creative thinking skills in addressing mathematical problems.

With a high arithmetic mean of 3.65, item (4)—"I have the ability to identify sources of development related to artificial intelligence applications"—ranked highest among the items in the first dimension. With a low arithmetic mean of 3.07, item (2)—"I possess the knowledge to use artificial intelligence applications to develop creative thinking skills for solving mathematical problems"—ranked second. With a low arithmetic mean of 2.12, item (3)—"I know how to prepare a systematic plan for using artificial intelligence applications to develop creative thinking skills for solving mathematical problems"—ran fifth (penultimate). Lastly, with a very low arithmetic mean of 1.55, item (6)—"I have received sufficient training enabling me to use artificial intelligence applications to develop students' creative thinking skills for solving mathematical problems"—ranked sixth (last). The researcher links this finding to the fact that certain math professors are knowledgeable about contemporary applications and technology, which is made possible by the tools' accessibility. These applications are now accessible through the governorate's educational platforms, such as the "Educational Portal" digital platform, which provides information on programs that help students develop higher-order thinking skills, especially creative thinking skills for solving mathematical problems. The development of these technology and applications in the governorate's educational system may be responsible for this outcome. To foster creative thinking abilities in mathematical problem-solving, more seminars, courses, training, awareness, and educational workshops centered on artificial intelligence applications are required. These programs will improve instructors' understanding of these contemporary applications and their capacity to foster students' creative thinking in this domain.

This finding is consistent with the findings of multiple studies, such as the study by Al-Awfi and Al-Ruhaili (2021), which found that female math teachers had a moderate level of knowledge about artificial intelligence applications for improving thinking skills among female secondary school students. This result was attributed to the novelty of these apps in educational settings. It also supports the findings of Al-Ruwaished's (2023) research, which found that, according to their own evaluations, math instructors had a respectable degree of understanding of artificial intelligence technologies and their use in math education. This finding contrasts with a number of research, including those by Barghout and Harb (2018) and Haseski (2019), which found that teachers' use of AI technology in the classroom is both limited and harmful.

The second query is stated as follows: How important do math instructors in the Maysan Governorate believe it is to use artificial intelligence programs to help preparatory school pupils improve their ability to think creatively in order to solve mathematical problems?

The arithmetic means and standard deviations of the sample members' answers to the questionnaire's second part were computed in order to respond to this query. Finding out how important it is for math instructors to employ AI technologies to help preparatory school pupils enhance their ability to solve problems creatively was the aim of this part. Table 3 displays the outcomes.

Table 3: The Evaluations' Relative Relevance (Rank) and the Arithmetic Means and Standard Deviations of the Research sample's Answers to the Items in the Second Section of the Questionnaire

Rank	Paragraph number	Paragraphs	Arithmetic mean	Standard deviation	Level of importance
1	13	Applications of artificial intelligence encourage students to become more enthusiastic about education and learning.	4.15	0.42	big
2	1	Applications of artificial intelligence make it easier to do jobs with the least amount of time and effort.	3.98	0.33	big
3	12	Applications of artificial intelligence provide scientific content a more dynamic and exciting presentation.	3.97	0.28	big
4	3	Teachers and students may communicate more effectively when artificial intelligence tools are used.	3.95	0.38	big
5	2	Applications of artificial intelligence help students change from being information consumers to knowledge seekers.	3.93	0.53	big
6	5	Applications of artificial intelligence aid in the development of the ability to produce a variety of concepts and provide creative justifications and solutions for mathematical issues.	3.88	0.49	big
7	11	Applications of artificial intelligence promote students' active learning.	3.83	0.51	big
8	10	Applications of artificial intelligence promote group learning among students.	3.71	0.61	big

Rank	Paragraph number	Paragraphs	Arithmetic mean	Standard deviation	Level of importance
9	7	Applications of artificial intelligence aid in the development of the ability to produce novel and varied conclusions and concepts.	3.67	0.65	big
10	4	By facilitating the transition between various concepts and approaches to addressing mathematical issues, artificial intelligence applications aid in the development of cognitive flexibility.	3.57	0.31	big
11	9	Applications of artificial intelligence assist in accommodating pupils' unique variations.	2.52	0.75	Weak
12	6	Applications of artificial intelligence aid in the development of interpreting abilities.	2.50	0.71	big
13	8	Applications of artificial intelligence aid in the development of inference abilities.	2.43	0.71	Weak
Overall average			3.57	0.34	big

According to Table 3, the "Level of Importance" dimension's overall arithmetic mean was 3.57. This chart highlights the significance of using artificial intelligence (AI) apps by preparatory school math instructors in the Maysan Governorate to help pupils acquire the creative thinking abilities required to solve mathematical issues.

With a mean score of 4.15 (a high level), item (13)—"AI applications motivate students to increase their level of motivation toward learning and education"—ranked highest in this category. With a mean score of 3.98, which is also a high level, item (1)—"AI applications facilitate task completion with minimal time and effort"—ranked second. With a mean of 2.50 (a low level), item (6)—"AI applications contribute to developing the skill of generating ideas"—ranked twelfth (penultimate); item (8)—"AI applications contribute to developing the skill of inference"—ranked thirteenth (last), with a mean of 2.43 (also a low level).

The researcher credits these findings to math instructors' understanding of and confidence in the value of AI applications in developing the creative thinking abilities required to solve mathematical issues as well as the beneficial effects these applications have on pupils. Furthermore, the results show that math teachers use a variety of techniques and approaches to transfer knowledge and information to pupils, considering that math is often seen as a challenging topic that students find frightening. This outcome may be explained by the mathematics curriculum's inherently inflexible and abstract structure; hence, the material must be taught in a variety of ways employing interesting, cutting-edge strategies that encourage creative thinking about mathematical issues. Additionally, using artificial intelligence (AI) technology and real-world applications to communicate ideas and facts may boost students' enthusiasm and interest in mathematics.

This outcome is consistent with the results of a number of studies, such as Al-Farani and Al-Hujaili (2020), which showed that teachers—from their own perspective—place a high value on and exhibit a high degree of acceptance for the use of AI applications in education, and Al-Rubaie (2020), which highlighted the interest of math teachers in teaching strategies that promote various types of thinking skills. Additionally, it mostly supports Ryu and Han's (2018) results that instructors' perspectives and impressions of AI's educational applications were favorable.

This result, however, is different from that of Al-Khaibari (2020), who found that most female instructors were unaware of the significance of AI applications in education.

The third query is stated as follows: What barriers do math instructors in the Maysan Governorate see to using artificial intelligence apps to help preparatory school pupils acquire the creative thinking abilities needed to solve mathematical problems?

To answer this question, the arithmetic means and standard deviations of the sample members' responses to the third section of the questionnaire were calculated. This section focused on determining the extent to which math teachers' use of artificial intelligence applications hinders preparatory school pupils' ability to acquire creative problem-solving skills. The results are shown in Table 4.

Table 4: The Research Sample's Replies to the Questions in the Third Segment of the Questionnaire, Together with Their Evaluations' Relative Relevance (rank) and Arithmetic Means and Standard Deviations

Rank	Paragraph number	Paragraphs	Arithmetic mean	Standard deviation	Level of obstacles
1	2	Applications of artificial intelligence in Arabic, particularly those related to education, are inadequate for fostering the creative thinking abilities required to solve mathematical puzzles.	4.79	0.41	Very big
2	15	The deployment of artificial intelligence applications in the classroom is hampered by poor internet access in schools.	4.73	0.46	Very big
3	6	the need of providing instructors with artificial intelligence application training.	4.70	0.54	Very big
4	7	Teachers are concerned about the usage of artificial intelligence applications in the classroom.	4.60	0.56	Very big
5	12	Students will get distracted when artificial intelligence apps are used in the classroom.	4.41	0.83	Very big

Rank	Paragraph number	Paragraphs	Arithmetic mean	Standard deviation	Level of obstacles
6	8	the discrepancy between artificial intelligence applications and the teaching methods now used in classrooms.	4.31	0.58	Very big
7	9	Some schools have inadequate basic technology infrastructure.	4.26	0.60	Very big
8	10	inadequate technical support services offered while using artificial intelligence apps in the classroom.	4.20	0.73	Very big
9	11	inadequate moral or material support for those using AI in the classroom.	4.14	0.78	big
10	1	Some decision-makers and school administrators are unaware of the significance of artificial intelligence applications.	4.10	0.34	big
9	11	inadequate moral or material support for those using AI in the classroom.	4.14	0.78	big
10	1	Some decision-makers and school administrators are unaware of the significance of artificial intelligence applications.	4.10	0.34	big
11	13	Compared to the traditional approach, practicing teaching using artificial intelligence applications takes more time.	3.98	0.80	big
12	5	Managing artificial intelligence applications in the classroom may be challenging.	3.66	1.04	big
13	4	the inadequate compatibility of AI applications with the characteristics of the intended student population.	3.43	1.10	big
14	3	inadequate experience of educators with artificial intelligence applications.	3.13	1.27	Average
15	14	Schools are unable to purchase artificial intelligence programs due to their high cost.	2.69	0.88	Average
	Overall average		4.10	0.34	big

According to Table 4, the third dimension's "Level of Obstacles" had an overall arithmetic mean of 4.10. This figure shows that preparatory school pupils in the Maysan Governorate have considerable challenges when it comes to using artificial intelligence (AI) apps to foster creative problem-solving abilities.

With an arithmetic mean of 4.79 (a "very high" level), item (2)—"Arabic AI applications serving education in the development of creative thinking skills for solving mathematical problems are insufficient"—ranked first among the items in the third dimension. With a mean of 4.73 ("very high" level), Item (15)—"Poor internet connectivity in schools hinders the use of AI applications in teaching"—came in second. With a mean of 3.13 ("moderate" level), item (3)—"Teachers lack sufficient experience in handling AI applications"—ranked fourteenth (penultimate), while item (14)—"High costs of AI applications prevent schools from purchasing them"—ranked fifteenth (final), with a mean of 2.69 ("moderate" level). The researcher attributes this outcome to a number of factors: some math teachers have only mediocre knowledge; some are unfamiliar with using computers in the classroom; others are not proficient in AI technologies that require proficiency in the English language; school administrations do not support and encourage them; resources are scarce; teachers do not have enough time to train and learn how to use AI applications to foster creative problem-solving skills in mathematics; and there are no incentives.

This finding is consistent with the findings of a number of studies, such as Al-Awfi and Al-Ruhaili (2021), which revealed—from the teachers' own perspectives—that female math teachers face significant challenges when it comes to using AI applications to help high school students develop innovative thinking skills. The study attributed these challenges to inadequate school resources and the teachers' average or limited computer proficiency. Additionally, it is consistent with Al-Ruwaished's (2023) research, which found that math instructors face substantial challenges when it comes to using and incorporating AI technologies into their lessons.

The research by Saleh and Abdelbaki (2017), which demonstrated that students had favorable sentiments and a willingness to integrate AI applications—particularly robotics—in the educational process, usually contrasts with this outcome. The fourth question is: Can the factors of gender, academic qualification, and practical experience account for statistically significant variations (at the $\alpha = 0.05$ level) in the mean answers of the sample of math instructors to the research instrument?

The following hypothesis was developed in order to address this question: "There are no statistically significant differences (at the $\alpha = 0.05$ level) in the mean responses of the sample of mathematics teachers to the study instrument that can be attributed to the variables of gender, academic qualification, and practical experience."

An independent-samples t-test was used to assess the significance of variations in sample members' mean answers ascribed to the variables of gender and academic qualification in order to examine the validity of this hypothesis. To ascertain the significance of variations ascribed to the variable of practical experience, the researcher also used a one-way analysis of variance (ANOVA). The outcomes were as follows:

First: Differences Based on the Gender Variable

Table 5: Results of the t-test for the Significance of Differences in the Mean Answers of Mathematics Instructors on the Study Instrument, Owing to the Gender Variable

Sections of the Questionnaire	Gender	number	The Mediterranean	deviation	The "t" value	Level of significance	Statistical significance
First: The degree to which preparatory school math instructors are aware of artificial intelligence applications for fostering pupils' ability to think creatively while addressing mathematical issues.	male Female	79 89	2.68 2.74	0.64 0.65	0.59	0.56	Not statistically significant
Second: The significance of preparatory school math instructors using AI tools to foster pupils' ability to think creatively in order to solve mathematical issues.	male Female	79 89	3.61 3.53	0.26 0.34	1.67	0.10	Not statistically significant
Third: The challenges math instructors face while using AI tools to improve their abilities. Middle School Students' Use of Creative Thinking to Solve Mathematical Problems	Male Female	79 89	4.07 4.12	0.38 0.31	0.84	0.41	Not statistically significant
The whole of the questionnaire parts Sections of the Questionnaire	Male female	79 89	3.65 3.65	0.21 0.23	0.00	0.99	Not statistically significant

The following findings show that, at the significance level (α = 0.05), the gender variable has no statistically significant influence on the averages of the sample math instructors' replies on the study instrument:

There are no statistically significant differences between the averages of the study sample members' responses at the significance level (α = 0.05) when it comes to figuring out how much math teachers in the Maysan Governorate know about using artificial intelligence to help preparatory school students solve mathematical problems through creative thinking.

Because of the gender variable, the averages of the study sample members' responses regarding the importance of math teachers using AI applications to help preparatory school students in the Maysan Governorate develop their thinking skills and use creative thinking to solve mathematical problems do not differ statistically significantly at the significance level (α = 0.05).

There are no statistically significant differences between the averages of the study sample members' responses at the significance level (α = 0.05) when it comes to identifying the challenges math teachers face when using artificial intelligence applications to help preparatory school students in Maysan Governorate develop their creative thinking and creative problem-solving skills.

The researcher claims that this outcome is caused by the fact that math teachers, regardless of their social gender, work in similar environments and have access to the same resources in their schools, with only minor variations brought about by the efforts of particular educators and school administrators. They teach the same material and are subject to the supervisors' own educational oversight.

The findings of Qali and Al-Hadaji (2023) and Al-Ansari, Al-Harshani, and Awad's (2023) study, which found that there were no statistically significant differences between the averages of the study's sample responses regarding the role of school administration in promoting the culture of artificial intelligence among general education students due to the gender variable, are generally consistent with this result. They attribute this to the interest of both genders in promoting and implementing artificial intelligence in their schools. According to Al-Masry (2022), the average remarks made by the study sample about how AI applications may improve the quality of services provided to University of Jordan students do not vary statistically significantly. Research on the use of AI techniques to improve worker performance is connected to the gender variable.

According to Al-Farani and Al-Hujaili's (2020) research, the gender variable led to statistically significant changes in the study sample's averages when it came to identifying the desire to employ artificial intelligence in education, and these disparities favored women. This result was in contradiction to this finding.

Secondly: Differences Based on the Academic Qualification Variable

Table 6: Findings from the t-test on the Significance of Variations in Math Instructors' Average Answers on the Research Tool, Ascribed to the Academic Qualification Variable

Questionnaire Sections	Academic Qualification	number	The Mediterranean	deviation	The "t" value	Level of significance	Statistical significance
First: The degree to which preparatory school math instructors are aware of artificial intelligence applications for fostering pupils' ability to think creatively while addressing mathematical issues.	Bachelor's	160	2.70	0.64	0.55	0.58	Not statistically significant
	Master's degree or higher	8	2.83	0.71			
Second: The significance of preparatory school math instructors using AI tools to foster pupils' ability to think creatively in order to solve mathematical issues.	Bachelor's	160	3.55	0.28	2.09	0.07	Not statistically significant
	Master's degree or higher	8	3.94	0.53			
Third: The challenges math instructors have while using AI tools to help preparatory school kids enhance their ability to think creatively in order to solve mathematical issues.	Bachelor's	160	4.10	0.34	0.76	0.45	Not statistically significant
	Master's degree or higher	8	4.19	0.35			
The whole of the questionnaire parts	Bachelor's	160	3.64	0.22	2.7	0.07	Not statistically significant
	Master's degree or higher	8	3.86	0.16			

Table 6 shows that there is no statistically significant difference (at the α = 0.05 level) between the academic qualification variable and the mean answers of the sample of math teachers about the study instrument. The findings show the following:

Based on the academic qualification variable, there were no statistically significant differences (at the α = 0.05 level) in the mean responses of the study sample concerning the degree of mathematics teachers' awareness of AI applications for promoting creative thinking skills in solving mathematical problems among preparatory school students in Maysan Governorate.

There were no statistically significant differences (at the α = 0.05 level) in the mean responses of the study sample based on the academic qualification variable regarding the significance of math teachers using AI applications to develop creative thinking skills for solving mathematical problems among preparatory school students in Maysan Governorate.

Based on the academic qualification variable, there was no statistically significant difference (at the α = 0.05 level) in the study sample's mean responses about the challenges math teachers face when utilizing AI applications to help preparatory school students in Maysan Governorate develop creative thinking skills for solving mathematical problems.

According to the study, this outcome results from math instructors taking part in the same training courses and instructional workshops regardless of their educational background. Additionally, cultural surroundings were more comparable due to the instructors' similar field experiences, which lessened the disparity in academic credentials. This outcome is generally consistent with the study by Al-Awfi and Al-Ruhaili (2021), which found no statistically significant differences in the study sample's mean responses about the potential use of AI applications to encourage creative thinking among female high school students, from the viewpoint of math teachers themselves, based on the variable of academic qualification. The study indicates that this is due to the teachers' similar professional and cultural backgrounds, as well as their training programs and educational seminars.

Al-Ghuwairi's (2023) study, however, found statistically significant differences in the mean responses of the study sample regarding primary school teachers' attitudes toward using artificial intelligence applications to address learning difficulties based on the variable of academic qualification; these differences favored those with postgraduate degrees over those with bachelor's degrees..

Third: Differences Depending on the Practical Experience Variable

Table 7: The Practical Experience Variable is Responsible for the Disparities in the Averages of Math Teachers' Replies to the Study Tool, According to the Results of the "One-way Analysis of Variance" Test

Questionnaire Sections	Source of variation	Sum of squares	Degrees of freedom	Mean of squares	The value of "F"	Level of significance	Statistical significance
First: The degree to which preparatory school math instructors are aware of artificial intelligence applications for fostering pupils' ability to think creatively while addressing mathematical issues.	Between groups	0.04	2	0.02	0.05	0.96	Not statistically significant
	Within the groups	69.64	165	0.42			
	Total variance	69.68	167				
Second: The significance of preparatory school math instructors using AI tools to foster pupils' ability to think creatively in order to solve mathematical issues.	Between groups	0.86	2	0.43	4.69	0.01	Statistically significant
	Within the groups	15.13	165	0.09			
	Total variance	15.99	167				
Third: Barriers to preparatory school math instructors using AI apps to help pupils increase their ability to think creatively and solve mathematical difficulties.	Between groups	0.81	2	0.40	3.51	0.03	Statistically significant
	Within the groups	18.97	165	0.12			
	Total variance	19.78	167				
The whole of the questionnaire parts	Between groups	0.60	2	0.30	6.44	0.002	Statistically significant
	Within the groups	7.66	165	0.05			
	Total variance	8.26	167				

Table 7 demonstrates that statistically significant differences (at the α = 0.05 level) in the mean responses of the mathematics teacher sample with respect to the research instrument are caused by the practical experience variable. The results demonstrate the following:

There were no statistically significant differences (at the α = 0.05 level) in the mean responses regarding the level of mathematics teachers' understanding of AI applications for encouraging creative thinking skills in solving mathematical problems among preparatory school students in Maysan Governorate based on the practical experience variable.

The mean responses of preparatory school students in Maysan Governorate regarding the importance of math teachers using AI applications to develop creative thinking skills for solving mathematical problems showed statistically significant differences (at the α = 0.05 level) based on the practical experience variable.

There were statistically significant differences (at the α = 0.05 level) in the mean responses regarding the difficulties math teachers face when using AI applications to develop creative thinking skills for solving mathematical problems among preparatory school students in Maysan Governorate based on the practical experience variable.

The source of the significant differences in the mean responses of math teachers regarding the "importance of use" and "obstacles to use"—attributable to the practical experience variable—was identified by comparing the various levels of practical experience using the Least Significant Difference (LSD) test. The results are shown in Table 8.

Table 8: Findings from the LSD Test to Determine the Cause of Large Variations in Math Instructors' Mean Answers to the Second and Third Dimensions of the Research Instrument—Attributed to the Practical Experience Variable

Questionnaire Sections	Level of practical experience	number	Arithmetic mean	Deviation	The mean difference between the two groups	Statistical significance	Direction of differences
Second: The importance of mathematics teachers using artificial intelligence applications to develop creative thinking skills	(1-9) general	84	3.51	0.33	0.074	(0.145) Not statistically significant	
	(10-19) general	63	3.59	0.23			
	(1-9) general	84	3.51	0.33	0.222	(0.003) Statistically significant	For those with 20 or more years of experience.
	20general and up	21	3.74	0.37			

Questionnaire Sections	Level of practical experience	number	Arithmetic mean	Deviation	The mean difference between the two groups	Statistical significance	Direction of differences
for solving mathematical problems among preparatory school students.	(10-19) general	63	3.59	0.23	0.148	(0.050) Not statistically significant	
	20general and up	21	3.74	0.37			
Third: Obstacles to mathematics teachers' use of artificial intelligence applications in developing creative thinking skills for solving mathematical problems among preparatory school students.	(1-9) general	84	4.04	0.30	0.112	(0.048) Statistically significant	For the 10–19 years of experience level
	(10-19) general	63	4.15	0.37			
	(1-9) general	84	4.04	0.30	0.187	(0.025) Statistically significant	For those with 20 or more years of experience.
	20general and up	21	4.10	0.34			
	(10-19) general	63	4.15	0.37	0.074	(0.387) Not statistically significant	
	20general and up	21	4.10	0.34			

Table 8 displays the following results:

Math teachers with 1–9 years of practical experience and those with 20 or more years of experience differ statistically significantly (at the $\alpha = 0.05$ level) in the importance and difficulties of using artificial intelligence (AI) applications to foster creative thinking skills for solving mathematical problems among intermediate-stage students; these differences favored the teachers with 20 or more years of experience.

There is a statistically significant difference (at the $\alpha = 0.05$ level) between math teachers with 1–9 years of practical experience and those with 10–19 years of experience when it comes to the challenges associated with using AI applications to develop creative thinking skills for solving mathematical problems among intermediate-stage students; these differences favor the teachers with 10–19 years of experience. The study explains this result by pointing out that although AI is a relatively new topic related to a teacher's self-directed learning, using it in the classroom requires practical expertise. This is particularly true for math teachers, whose ability to create a suitable environment and use AI applications to foster mathematical problem-solving skills varies according to the training programs and practical workshops provided by educational supervisors and relevant educational authorities. This finding is largely supported by the study conducted by Ryu and Han (2018), which found that teachers with more years of teaching experience showed more interest in artificial intelligence applications.

Al-Ruwaished's (2023) study, however, did not find any statistically significant differences in the sample's mean responses regarding the study instrument based on the variable of teaching experience; the study attributed this to the subject's novelty and its correlation with teachers' self-directed learning. It also differs from Al-Awfi and Al-Ruhaili's (2021) study, which found no statistically significant differences in the mean responses of female math teachers about the potential use of AI applications to encourage creative thinking among female high school students—attributable to years of teaching experience. The instructors' understanding of the importance of AI applications and the fact that training workshops for new teachers closed the knowledge gap between them and those with a lot of real-world experience were the reasons given by the authors.

The fifth question is: To what extent are artificial intelligence applications and concepts incorporated into the mathematics curriculum content for the fourth and fifth intermediate grades in Iraq?

As shown in Table 9, frequencies and percentages were computed for each of the analytical rubric's dimensions in order to provide a response to this question.

Table 9: Percentages and Frequencies for Each of the Analytical Rubric's Aspects as Well as the Total Percentage

Areas	Student's Book – First Semester		Student's Book – Second Semester		Activity Book – First Semester		Activity Book – Second Semester	
	Repetition	Percentage	Repetition	Percentage	Repetition	Percentage	Repetition	Percentage
Area 1: Data Analysis and Structuring	12	1.08%	9	0.85%	6	0.95%	1	0.16%
Area 2: Artificial Intelligence Applications	9	0.81%	11	1.03%	2	0.32%	0	**AA**0%
Area 3: Artificial Intelligence Programming	4	0.36%	3	0.28%	0	0%	0	0%

Areas	**Student's Book – First Semester**		**Student's Book – Second Semester**		**Activity Book – First Semester**		**Activity Book – Second Semester**	
	Repetition	Percentage	Repetition	Percentage	Repetition	Percentage	Repetition	Percentage
Area 4: Physical Computing	1	0.09%	2	0.19%	0	0%	0	0%
Area 5: Deep Learning	11	0.99%	3	0.28%	0	0%	1	0.16%
Total inclusion rate across all areas	37	3.33%	28	2.63%	8	1.27%	2	0.32%
Overall average	1.89							

With a mean score of 1.89, Table 9 illustrates how little the mathematics curriculum for Iraq's fourth and fifth preparatory courses covers artificial intelligence (AI) ideas and applications. The overall percentages varied from 0.32% to 3.33% for every category that was part of the analytical criteria. In particular, the inclusion rates were 0.32% for the fifth-grade literary stream textbook, 3.33% for the fourth-grade scientific stream textbook, 2.63% for the fifth-grade scientific stream textbook, and 1.27% for the fourth-grade literary stream textbook.

The fourth-grade science stream textbook had the greatest inclusion rate (3.33%), according to the data in the above table. "Data Analysis and Structuring" (1.08%) was the most popular category in this textbook, followed by "Deep Learning" (0.99%) and "Physical Computing" (0.09%). The findings also showed that, with an inclusion rate of 0.32%, the fifth-grade literary stream textbook placed lowest among the literary stream textbooks and the whole sample examined. "Deep Learning" and "Data Analysis and Structuring" tied for top position in this textbook (0.16%), with ratings of 0% for the other categories.

The curriculum's emphasis on fostering higher-order thinking abilities, such as interpretation, discovery, inquiry, synthesis, analysis, evaluation, and the application of mathematical skills, limits the integration of AI applications into mathematics curricula, according to the researcher. This outcome can be explained by Iraq's educational ideology, which undervalued and eliminated artificial intelligence ideas and applications from mathematics curricula. Furthermore, given substantial focus to this field just started in 2019, the nation's relatively recent interest in artificial intelligence applications may be the reason for this result.

Study Recommendations

Given the results of the investigation, the researcher recommends the following:

1. Encouraging students to use artificial intelligence (AI) programs to solve mathematical tasks and issues.
2. Teaching math teachers how to utilize AI apps in the classroom and educating them about their benefits.
3. Ensuring that higher education institutions and specialized training facilities focus on strategies for using AI applications, including how to develop them, get over associated obstacles, and use them in mathematics instruction, throughout the training and certification of new instructors.
4. Giving children access to age-appropriate AI applications that are approved for educational use, in addition to providing the necessary resources in schools, such computers, specialized math classrooms, and other teaching aids.
5. Making interactive electronic content using AI.
6. Increasing the amount of AI applications and ideas taught in math classes.

Study Suggestions

The researcher suggests carrying out the following further research on the subject of the present study:

1. Examining how students' academic performance is affected when AI applications are used to teach certain mathematical subjects (such as algebra, geometry, statistics, or number theory).
2. Analyzing how well a study unit including AI ideas and applications fosters students' capacity for creative thinking and problem-solving.

CONCLUSION

The study concludes that mathematics teachers in Maysan Governorate possess a moderate level of knowledge regarding artificial intelligence applications for supporting creative mathematical problem-solving. Teachers also perceived the importance of integrating AI applications into mathematics education, while several barriers remain. The analysis of mathematics curricula indicated limited inclusion of artificial intelligence concepts and applications. These findings highlight the need for structured teacher training and careful curriculum development to support responsible AI integration in mathematics education.

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