KeAi
CHINESE ROOTS
GLOBAL IMPACT

International Journal of Innovation Studies

THE EFFECTIVENESS OF USING A PROPOSED STRATEGY BASED ON ARTIFICIAL INTELLIGENCE APPLICATIONS IN DEVELOPING PHYSICS PROBLEM – SOLVING SKILLS AMONG FIFTH – GRADE FEMALE STUDENTS IN PHYSICS

Hind Hadi Rayed
Master's Degree in General Science Teaching Methods, Sidrat Al-Muntaha for Girls Research and Studies Division, General Directorate of Education, Diyala, Ministry of Education, Republic of Iraq
hiha3011@gmail.com

Abstract
The current study aimed to propose a strategy based on artificial intelligence applications and then test its effectiveness in developing physics problem-solving skills among a group of fifth-grade science students in physics. To achieve the research objective, the researcher used a quasi-experimental approach based on two groups: the first was the experimental group (33 students) and the second was the control group (33 students). The experimental group was taught using the proposed model, while the control group was taught using the traditional method. The measurement tool used in the research was the Physics Problem-Solving Skills Test. After ensuring the validity and reliability of the tool, it was administered before and after completing the research procedures. Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS), and the research results showed the following:

1. There were no statistically significant differences at a significance level of (0.05) between the mean scores of the pre-test of physics problem-solving skills between the experimental and control groups.
2. There were statistically significant differences at the significance level of (0.05) between the mean scores of the post-test of physics problem-solving skills between the experimental and control groups, in favor of the group with the higher mean, the experimental group.

In light of these results, the researcher recommended using the proposed model to train female students to solve physics problems. She also recommended continued work on developing artificial intelligence applications in line with Iraqi curricula, supporting the educational environment in schools with artificial intelligence components, and employing them in lesson planning and implementation. She also suggested employing artificial intelligence programs to achieve other objectives of teaching physics, such as conducting experiments and developing scientific thinking.

Keywords: Artificial intelligence applications, Physics problem – solving skills, fifth – grade physics

Introduction

Research Problem

Solving physics problems is one of the most important goals of teaching physics. This requires students to be experienced in mathematical methods for solving problems. Training students to solve physics problems is one of the most difficult challenges facing physics teachers in the classroom. This leads some to describe it as a complex and dry subject. Among the reasons why students make mistakes when solving a math problem are believing the problem is difficult, not remembering how to solve it, or lacking motivation (Al-Qassim, 2015: 109). In this regard, numerous studies have been conducted to identify the difficulties students face in solving physics problems, including a study by Sarheed (2019). This study concluded that difficulties solving physics problems among middle school students are due to two factors:

1. Student internal factors, including difficulty reading, understanding, and representing the problem, planning to solve the problem, implementing the solution, and verifying the correctness of the solution.
2. The nature of the physics problem, including (weak linguistic formulation of some problems, and some problems containing redundant information for the solution).
3. Another major challenge facing physics teaching, as indicated by Al-Alwani's study (2018), is the weak mathematical background students need to study physics. This weakness will manifest at the end of the academic year, with teachers unable to address this problem due to time constraints and the dense curriculum.

Everyone agrees that a student will not be able to solve any physics problem without a solid mathematical foundation. Therefore, students must master the skills of solving mathematical equations to be able to solve physics problems. Al-Jumaili's study also indicated the need to focus on diversifying teaching methods to provide students with greater opportunities to solve physics problems, as well as intensifying problem-solving by students, while providing diverse examples of solutions (Al-Jumaili, 2023).

Artificial intelligence is one of the most prominent outcomes of the contemporary technological revolution, which can be leveraged and invested in developing many aspects of the educational process and facilitating many tasks, particularly within curricula and educational units. Cries have been raised here and there demanding a revision of educational content to enable students—at all levels—to maximize the benefits of modern technology in academic achievement and acquire knowledge and skills that are compatible with the nature of the era in which we live. (Al-Hayla, 2014: 229)

The reliance of any educational system on modern educational technologies, including artificial intelligence, has become a necessity for the success of such systems. With the increasing need to design electronic learning environments, it has become imperative to explore the impact of these environments on the educational process. The use of artificial intelligence applications means transforming content into interactive electronic activities, where the student is both an actor and an analyst in these environments. The teacher's role is to facilitate and guide students toward self-learning. (Al-Mutairi, 2022: 147).

The current research problem is highlighted in the following aspects:

1. Solving physics problems is considered one of the most important activities that help students understand and comprehend physics concepts. Therefore, continuous research is required to find the best ways to improve students' physics problem-solving skills.

2. Through the researcher's experience teaching physics, she observed that students' level of problem-solving in physics remains below the desired level. This is due to several reasons, the most important of which is their inability to represent the problem or draw a diagram of it. Students also often seek ready-made solutions, which are widely available in textbooks, the internet, and social media. Furthermore, students complain and grumble when the question's concept is changed.
3. Physicists believe that students should rely entirely on their own skills when solving problems, and some even object to the use of a calculator. In this research, the researcher attempts to present a new perspective, namely that it is possible to learn physics problem-solving skills by relying on artificial intelligence applications, which possess tremendous potential for representing and analyzing problem data. Their use is limited to activities, not (a final assessment). 4 - With the daily expansion of artificial intelligence technology and its applications, educational systems are attempting to adapt to this reality by preparing students for the age of artificial intelligence, selecting what is beneficial and directing it toward the public good.

Importance of the Research:

The field of education is a dynamic one that constantly adapts to new developments in technology. Abu Jamal believes that one of the advantages of using modern technology in the educational process is developing positive attitudes among students toward subjects they find difficult and complex (Abu Jamal, 2015: 199). Artificial intelligence applications are currently an emerging field in educational technology. Despite their existence for 30 years, it is still unclear to teachers and instructors how to utilize them on a large scale or understand how they can effectively impact the learning process (Bin Ibrahim, 1443: 21).

Artificial intelligence applications have received widespread attention and widespread popularity in recent years, prompting educational researchers to find the most appropriate ways to leverage these applications to achieve educational goals. In order for students to maximize the benefits of this technology, we, educational researchers and teachers, must define the rules of the game by developing modern strategies that seek to integrate these applications into the educational process inside and outside the classroom, regardless of our comfort level with them.

This study seeks to keep pace with contemporary global trends. The Beijing Meeting on Artificial Intelligence and Education included a series of recommendations and considerations, including ensuring that AI enhances high-quality teaching and learning opportunities for all, regardless of gender, socioeconomic status, or ethnic background (UNESCO, 2023: 7). Several studies have demonstrated the need to include AI applications in education, including a study by Al-Shabl (2021). This study indicated that the use of AI applications to integrate sound, image, and motion contributes to facilitating the learning of mathematical skills and making them more enjoyable and engaging by representing knowledge for learners, from the perspective of mathematics teachers. Al-Otaibi's study (2022) also recommended the use of various AI programs as an important means of achieving science teaching goals, including developing critical thinking and scientific orientations. The study (Ukoh, 2022) also recommended that governments and responsible authorities provide the necessary requirements of artificial intelligence tools and applications needed for effective physics teaching and encourage teachers to use them.

To understand the impact of artificial intelligence in education, Mohaghegh (2020) indicated that this technology will, in the future, develop intelligent systems capable of adapting to the capabilities of each individual student. It will also develop interactive learning systems that utilize virtual reality and augmented reality technologies, which will play a significant role in solving the challenges facing the education system in the future. (Al-Ghamdi, 2024: 37)
Developed countries are seeking to introduce artificial intelligence programs into primary and secondary schools through a set of measures. UNESCO, in a publication, outlined a set of these measures, including:
1 - In 2016, the United States launched the "National Strategic Plan for Research and Development of Artificial Intelligence." Among the proposals in this plan are how to implement artificial intelligence in education (learning using artificial intelligence).
2 - In 2017, China launched a plan to develop a new generation of artificial intelligence through "smart learning." This plan includes a set of measures, including promoting smart and interactive learning, developing a comprehensive three-dimensional teaching methodology and a smart online education platform based on big data, and achieving personalized education for each learner.
3 - In 2019, Malta launched the "Towards an Artificial Intelligence Strategy" initiative. This initiative stipulates that the country's education system must adapt to the requirements of the Fourth Industrial Revolution. This initiative is based on the premise that a high percentage of young children interact with electronic devices before they can speak. These devices have become an integral part of their lives, and they have never known a world without the constant flow of personalized content to an always-connected mobile device. Therefore, it is necessary to expand the curricula themselves and better prepare children for a future workplace where decisions will be made through the application of artificial intelligence (AI). (UNESCO, 2021: 34) The importance of the current research lies in the following aspects:
1. Through this research, the researcher attempts to present a proposed vision for employing artificial intelligence technologies, given their characteristics and capabilities in teaching physics that may not be available in the classroom.
2. Modern technologies and artificial intelligence robots are an integral part of students' lives, interacting with them daily at home. Therefore, through this research, we attempt to support the teaching process by providing access to rich repositories of big data.
3. Direct the attention of officials toward the use of artificial intelligence applications in the educational process.
4. Arouse the interest of researchers and teachers alike in designing educational environments using artificial intelligence applications in various science subjects to raise students' academic achievement.

Research objective:

The current research aims to measure the effectiveness of a proposed strategy based on artificial intelligence applications in developing the physics problem-solving skills of fifth-grade science students.

Research hypotheses:

There are no statistically significant differences at the significance level (0.05) between the average scores of the students in the experimental and control groups on the pretest of physics problem-solving skills.

There are no statistically significant differences at a significance level of (0.05) between the average scores of the students in the experimental and control groups in the post-test of physics problem-solving skills.

Research Limits:

The current research is defined as follows:

1. Fifth-grade science students at Sidrat Al-Muntaha Girls' Intermediate School, located in the center of Baqubah city, Diyala Governorate, for the 2023-2024 academic year.
2. The prescribed physics textbook for fifth-grade science students, tenth edition, 2023.
3. Questions from Chapters Two (Motion) and Three (Force).

Definition of Terms:

1– Strategy

An organized plan that can be modified and followed, with the goal of improving individual performance during learning (Al-Sharifi, 2000: 248).

Procedural Definition: "A set of steps followed by the researcher using an activity guide to represent and solve physics problems using artificial intelligence applications, aiming to develop the physics problem-solving skills of fifth-grade science students."

2– Artificial Intelligence:

Kamel defined it as "the simulation of human intelligence in machines programmed to think like humans and imitate their actions" (Al-Ghamdi, 2024: 12).

A modern scientific and technical trend concerned with studying methods and theories aimed at creating machines capable of mimicking human intelligence (Al-Mutairi, 2022: 149).

The researcher defines it procedurally as "an interactive environment designed to help the student represent the problem using graphs and solve physics problems."

3– Solving the Physical Problem)

It is the effective use of a variety of mathematical knowledge, methods, and techniques to solve non-standard problems, including real-life problems (Mohsen, 2007: 10).

The operational definition is: "The overall score obtained by a fifth-grade science student on a physics problem-solving test, according to the scale used in the current research and linked to the concepts of Chapters Two (Motion) and Three (Force)." "

4- Physics:

"It is the science that studies basic concepts such as energy, force, and time, and all that follows from them, such as mass, matter, and its motion. More broadly, it is the general analysis of nature, which aims to understand how the universe works." (https/ar.wikipedia.org)

The researcher defines it procedurally as "the physics curriculum implemented by the Iraqi Ministry of Education for the fifth-grade science class for the 2023-2024 academic year."

Theoretical Framework:

Educational systems tend to adapt to the requirements of the industrial age. Therefore, artificial intelligence has entered the arena of computer-based learning systems, producing tangible and measurable improvements and developments in the educational process, characterized by its ability to integrate text, audio, and still and moving images. (Salima, 2021: 77) The term "artificial intelligence" (AI) was coined in 1956 when Marvin Minsky and John McCarthy hosted a research project focused on artificial intelligence. It subsequently gained popularity. The term gained popularity due to the proliferation of big data and the rapid growth of computer

power. Over time, it evolved to refer to machines that mimic some of the features of human intelligence, such as perception, logical thinking, and problem-solving (UNESCO, 2023: 9).
The field of artificial intelligence is considered one of the most important modern sciences. It explores, on the one hand, the fields of systems science, computer science, automatic control, logic, mathematics, and languages, while, on the other hand, attempting to understand the nature of human intelligence through computer programs, enabling them to solve a problem, resolve a question, or make a decision in a given situation. Artificial intelligence is used because of its superior speed in generating inferences that exceed human capabilities (Tarrah, 2020: 15).
There are characteristics that characterize artificial intelligence programs used in education, including:
The ability to represent knowledge: They use a special structure to describe knowledge, including facts, the relationships between these facts, and the rules that connect them.
The use of an optimistic heuristic: Artificial intelligence programs can tackle unsolvable problems using sequential steps that lead to the correct solution.
The ability to handle incomplete information: Artificial intelligence applications can Artificial intelligence can find solutions even when information is unavailable. Learning Ability: Artificial intelligence applications can improve their performance based on past experiences and practices.
- Inference Capability: AI applications have the ability to derive possible solutions to a specific problem based on data and previous experiences.
- Natural Language Processing: AI applications can understand learner language input, whether written or spoken, fostering effective dialogue and identifying learner errors. (Salima, 2021: 86-87)
- There are positive effects of AI in the field of education, which can be summarized in the following points:
First, for the teacher, it is impossible to dispense with the teacher or replace them with a machine, but this technology can be used in the following aspects:
- It will provide tools that enable the teacher to perform their mission more effectively and with less effort.
- It helps the teacher develop their capabilities and fill existing gaps.
- It will devote more time to students and reduce the time required for correction and administrative work.
- The most important effects of AI for the student:
- It takes into account multiple intelligences by studying learner behavior and directing questions based on the student's weaknesses.
- Continuous assessment and student autonomy in self-assessment.
- Improving students' enjoyment of teaching and improving their grades by providing new ways to interact with information. (Ismail, 2023: 38-39)
Solving physics problems requires geometric thinking. A study (C Poluakan, 2019) concluded that physical laws are more easily interpreted in the student's mind when represented in the form of images or diagrams, which helps them organize their information to understand the problem. He also emphasized the need for textbooks to be rich in images and diagrams, which helps combine physics concepts with experimental observations in the laboratory.

- To what extent can artificial intelligence applications be relied upon in solving physics problems?

The researcher believes that these applications are not considered an alternative to traditional education, as students must master physics problem-solving skills and be self-reliant. However, they can be used as a support tool, as these applications can be used to:

1. Explain and represent the concepts of a physics problem.
2. Assign homework.
3. Self-assessment: Students can compare their solutions with the typical solution of the application.

Previous Studies:

1- Al-Rakabi's 2023 study, "The Level of Employment of Artificial Intelligence Applications in Teaching Physics at the Secondary Level, from the Perspectives of Teachers and Their Educational Supervisors."

This study was conducted in the Diwaniyah Governorate in Iraq. It aimed to identify the extent of the employment of artificial intelligence applications in teaching physics at the secondary level, from the perspectives of teachers and supervisors. The researcher adopted a descriptive research approach by developing a scale consisting of (31) items distributed over three axes: (determining the level of knowledge of physics teachers and their supervisors regarding artificial intelligence applications; the importance of physics teachers and their supervisors using artificial intelligence applications in teaching physics; and the difficulties of physics teachers and their supervisors using artificial intelligence applications in teaching). After verifying the validity and reliability of the scale, it was applied to a sample of (165). The study concluded that the level of assessment for the first axis was average, the second axis was very high, and the third axis was very high. In light of these findings, the researcher presented several recommendations and proposals, the most important of which is: emphasizing the use of artificial intelligence applications in secondary school.

2 - Al-Shabl's (2021) study, "Mathematics teachers' perceptions of learning and teaching mathematics using the artificial intelligence approach in public education in the Kingdom of Saudi Arabia.

This study aimed to identify mathematics teachers' perceptions of using the artificial intelligence approach in teaching and learning mathematics. A descriptive research approach was used to achieve the study's objectives by developing a questionnaire consisting of two axes. The first axis: mathematics teachers' perceptions of teaching mathematics using the artificial intelligence approach. The second axis: mathematics teachers' perceptions of the requirements for teaching mathematics using the artificial intelligence approach. The results of the first and second axes showed that mathematics teachers' perceptions of teaching mathematics using the artificial intelligence approach were moderate for both axes of the questionnaire.

3 - Fadel's Study 2023 "A Proposed Electronic Unit in the Physics Curriculum to Develop Artificial Intelligence Concepts and Foresee the Technological Future among Secondary School Students"

This study aimed to measure the effectiveness of a proposed electronic unit in the physics curriculum to develop artificial intelligence concepts and foresee the technological future among secondary school students. The experimental research method was used to verify the

research hypothesis. The study sample consisted of forty-one first-year secondary school students. The research tools included: 1. A list of artificial intelligence concepts; 2. A list of technological future foresight skills; and 3. A proposed electronic unit in the physics curriculum. The research tools were applied pre-test, followed by teaching the proposed unit to the research group. The research tools were then applied post-test. After using appropriate statistical methods, the results showed statistically significant differences between the students' mean scores in the pre- and post-tests, with a significant difference in favor of the post-test.
4. Aql 2021 Study: "The Effectiveness of an Educational Environment Based on Blended Learning in Developing Physics Problem-Solving Skills among Eleventh-Grade Female Students in Gaza"
This study aimed to measure the effectiveness of an educational environment based on blended learning in developing physics problem-solving skills among eleventh-grade female students. A quasi-experimental approach was used to design the experimental group with pre- and post-tests. The study sample consisted of 17 female students. The research results showed significant effectiveness of the blended learning-based learning environment in developing physics problem-solving skills among eleventh-grade female students in Gaza.
5 - Ahmed's study (2022): "An Artificial Intelligence-Based Training Program to Develop Self-Learning Skills and Attitudes Toward Collaborative Learning among Chemistry Teachers"
The research aimed to measure the effectiveness of an artificial intelligence-based training program in developing self-learning skills and attitudes toward collaborative learning among chemistry teachers in the Arab Republic of Egypt. To achieve the research objective, the training program was developed using artificial intelligence applications. Research tools were also developed, including a self-learning skills test and a scale for attitudes toward collaborative learning. A sample of 25 male and female science teachers was selected. The research tools were administered pre-test, followed by a three-week training program, after which the research tools were re-administered. The research reached several results, the most important of which was the presence of a statistically significant difference at the significance level (0.01) between the average scores of teachers in the pre- and post-test of the self-learning skills test as a whole, in favor of the post-test. - Discussion of Previous Studies:
By examining previous studies, the following becomes clear:
1 - All studies agree on the importance of expanding the use of artificial intelligence applications and employing them in several fields, including developing self-learning skills, as in the study by Ahmed (2022) and artificial intelligence concepts, as in the study by Fadel (2023). The current study is unique in employing these applications to develop physics problem-solving skills in Iraq. It differs from the study by Aql (2021) in the type of applications and the research community.
2 - Diversity of research methodologies. Some used descriptive research methods, as in the study by Al-Rakabi (2023) and the study by Al-Shabl (2021). Others used quasi-experimental research methods, as in the studies by Ahmed (2022), Aql (2021), and Fadel (2023). By familiarizing the researcher with these methodologies, she was able to form a comprehensive and clear vision of the subject of the current study. 3 - This may not be the first study in Iraq to address the topic of artificial intelligence applications, but it is the first study (to the researcher's knowledge) to uniquely employ these applications to solve physics problems, which can be a psychological obstacle and a challenge for many students in understanding physics.

Research Procedures:

First: Experimental Design: The researcher adopted an experimental design with pre-tests and post-tests, divided into two groups: the first was an experimental group (problem solving was taught according to the proposed strategy), and the second was a control group (problem solving was taught using the traditional method), as shown in the table below:

Table (1): Distribution of the Research Sample

Dependent Variable	Independent Variable	Pretest	The group
Post-test of Physics Problem Solving Skills	Proposed Strategy	Physics Problem Solving Skills Test	Experimental
	Conventional Method		Control

Second: Research Community and Sample: A purposive sample was chosen, consisting of fifth-grade science students at Sidrat Al-Muntaha Girls' Secondary School for the 2023-2024 academic year. The research sample was divided into two groups: the first was an experimental group consisting of (33) students, and the second was a control group consisting of (33) students.

Third: Research Tools:

1 - Identifying the most important artificial intelligence applications to achieve the research objective and preparing a student guide.

To achieve the research objective, the researcher reviewed the most important free applications for solving and representing physics problems available on the internet and mobile phones. She relied on two types of applications:

– Applications used to convert physics laws into graphs, including desmos, OneNote for Windows 10, and GeoGebra Graphing Calculator.

- Applications used to solve physics problems directly after entering data, including: phyWiz, Gemini.

2- The student guide (Appendix 2) was prepared according to the following steps and then distributed to all students in the experimental group:

1- Determine the lesson title, including the topics of Chapter Two (Motion) and Chapter Three (Force).

2- Determine the behavioral objectives.

3- Define the physics concept, its law, and its unit of measurement.

4- Determine a set of activities to be implemented using artificial intelligence applications.

5- Analyze and interpret the results obtained by the student.

After preparing the guide, it was presented to a group of referees (Appendix (1)) for the purpose of making amendments.

Fourth: Preparing a Physics Problem-Solving Skills Test: To verify the research hypothesis, an achievement test was developed that was appropriate for the current research objective, according to the following steps:

1- Defining the objective of the test: The test aims to identify the extent to which fifth-grade science students have mastered physics problem-solving skills in the topics of chapters two (motion) and three (force).

2- Preparing a list of physics problem-solving skills: After reviewing several studies, including Siraj (2017) and Abboud (2012), the researcher identified eight basic skills for solving a physics problem: (identifying data, drawing a diagram of the problem, determining what is required of the problem, standardizing units of measurement, determining the formula used, substitution within the formula, finding the value of the unknown, and determining the unit of measurement for the result). These skills were adopted in this research after being presented to a group of referees with expertise in the field of science and mathematics teaching methods (Appendix No. (1)). 3- Formulating the Test Items: The researcher constructed the test according to the list of physics problem-solving skills. The test included (8) problems related to the topics of Chapter Two (Motion) and Chapter Three (Force). The researcher ensured that all skills were included in each test problem. A set of easy and clear instructions was also developed, including the student's personal information and how to answer. An answer sheet was also prepared for the test.

4- Estimating Test Scores: A correction key was prepared for the test. The score was estimated by assigning each part of the required skill one point for a correct answer and zero for an incorrect or omitted answer. Thus, the total score became (64) points, as shown in the table below.

Table (2) Physics Problem Correction Criteria

He doesn't do it	He does it	Skill	No
1	0	Identifying the given data	1
1	0	Drawing a diagram of the problem	2
1	0	Identifying the required information	3
1	0	Unifying the units of measurement	4
1	0	Identifying the formula used	5
1	0	Substituting into the formula	6
1	0	Finding the value of the unknown	7
1	0	Identifying the unit of measurement for the result	8
8		Total score for all skills in one question	

Fifth: Test Validity: Validity is defined as "the actual and true measurement of what the test was designed to measure." (Majid, 2014: 93)

To verify the validity of the test, it was presented in its initial form to a group of judges specialized in science education and science and mathematics teaching methods (Appendix No. (1)). This was done to ensure the validity of the test in terms of its scientific formulation and its relevance to the measured dimensions. In light of the judges' opinions, some questions were reformulated, making the test ready in its initial form.

Sixth: Exploratory Test: The test was administered to a pilot sample of (22) female students (outside the research sample) to determine the following:

A - The time required by the student to answer the test items: The researcher found that the average response time of the students in the pilot experiment, between the first and last student, to the test items was (45 minutes). Thus, the time required to conduct the test was determined.

B - Finding the internal validity of the test:

To verify the internal consistency of the test, use the Pearson correlation coefficient to calculate the correlation coefficient between the score of each dimension and the total test score, as shown in the table below:

Table (3) shows the Pearson correlation coefficient between the scores of physics problem-solving skills and the total test score.

Statistical significance level	Correlation coefficient with the total score	Physics Problem-Solving Skills
0.00	0.857**	Identifying Given Information
0.00	0.796**	Drawing a Diagram of the Problem
0.00	0.880**	Identifying the Requirements of the Problem
0.00	0.910**	Unifying the Units of Measurement
0.00	0.931**	Identifying the Formula to be Used
0.00	0.924**	Substituting into the Formula
0.00	0.870**	Finding the Value of the Unknown
0.00	0.873**	Identifying the Unit of Measurement of the Result

The table above shows that all correlation coefficients are statistically significant at a significance level of (0.00), which reflects its validity.

D - Test Reliability: Test reliability means that "the measurement tools are highly accurate, precise, and consistent in the data they provide." (Majid, 2014: 124)

To verify the reliability of the Physics Problem Solving Skills Test, the split-half method was used by dividing the test items into two halves. The Guttman equation was used to calculate the correlation between the two halves. The results showed that the correlation coefficient between the two halves was (0.85), confirming that the Physics Problem Solving Skills Test enjoys a high degree of reliability.

E - Preparing the Final Form of the Test:

After verifying the test control procedures to ensure its validity, the final form of the test consisted of (8) problems, each of which tested (8) skills, as shown in the table below:

Table (4) shows the relative weight of each skill

Relative weight of each skill	Total	Physics Problem-Solving Skills
%12.5	8	Identifying Given Information
%12.5	8	Drawing a Diagram of the Problem
%12.5	8	Identifying the Requirements of the Problem
%12.5	8	Unifying the Units of Measurement
%12.5	8	Identifying the Formula to be Used

%12.5	8	Substituting into the Formula
%12.5	8	Finding the Value of the Unknown
%12.5	8	Identifying the Unit of Measurement of the Result
% 100	64	Total

Seventh: Implementation of the Experiment:

1 - Pretest:

A pretest was administered to the experimental and control groups on Monday, October 30, 2023. The results were then statistically analyzed.

2 - Implementation of the Research Experiment:

The experimental group studied according to the model proposed by the researcher. The control group studied according to the traditional method. The experimental group was taught according to the following steps:

A - The researcher introduced the applications, their benefits, and how to use them by the students.

B - Explained physics concepts (definition of the concept, its mathematical expression, and its unit of measurement, along with examples) using both presentation and classroom discussion methods.

C - Provided the students in the experimental group with an activity guide and instructions for implementing it as homework. Students were also contacted via Telegram to provide assistance to those experiencing difficulty using the applications.

D - The researcher received assignments from the students and provided feedback.

E - Discussed the model solutions in the classroom.

3- Post-test Application:

After completing the study experiment, the post-test was administered to the experimental and control groups on Wednesday (December 6, 2023). The students' scores were then calculated and the results recorded. Statistical analysis was performed using arithmetic means, standard deviations, and a t-test for two independent samples.

Eighth: Statistical Methods:

1- 1 - Pearson's correlation coefficient to calculate internal consistency.

2- 2 - Guttman Split-Half Coefficient to calculate test reliability using the split-half method.

3- 3 - t-test for two independent samples.

Research Results:

1- Results related to the first hypothesis: "There are no statistically significant differences at a significance level of (0.05) between the average scores of the students in the experimental and control groups on the pre-test of physics problem-solving skills." To verify this hypothesis, the researcher used the Independent Samples t-test after verifying its conditions. The results were as follows:

Table (5) Results of the t-test for the difference between the average scores of the students in the experimental and control groups in the pre-test of physics problem-solving skills.

statistical significance	probability value	t-tabular value	T-value	Standard deviation	Arithmetic mean	Number	The group	
Not statistically significant	0.534	2.00	0.625	9.47	46.66	33	Experimental	Physics Problem Solving Test
				9.42	45.21	33	Control	

The table above shows that the arithmetic mean for the first group was (46.66) with a standard deviation of (9.47), which is higher than the arithmetic mean for the control group (45.21) with a standard deviation of (9.42). The t-test result was (0.625), which is lower than the table value (2.00) with a probability value of (0.534), which is higher than (0.05). Therefore, we accept the null hypothesis, which is: "There are no statistically significant differences at a significance level of (0.05) between the average scores of the students in the experimental and control groups in the pre-test of physics problem-solving skills."

2- Results related to the second hypothesis: "There is no statistically significant difference at a significance level of (0.05) between the average scores of the students in the experimental and control groups in the post-test of physics problem-solving skills."

Table (6) Results of the t-test for the difference between the average scores of the students in the experimental and control groups in the post-test of physics problem-solving skills.

statistical significance	probability value	t-tabular value	T-value	Standard deviation	Arithmetic mean	Number	The group	
statistically significant	0.001	2.00	3.33	9.619	54.27	33	Experimental	Physics Problem Solving Test
				8.812	46.70	33	Control	

The table above shows that the mean score of the experimental group was (54.27) with a standard deviation of (9.619), which is higher than the arithmetic mean of the control group (46.70) with a standard deviation of (8.812). The calculated t-value was (3.33), which is higher than the tabular t-value (2.00) with a probability value of (0.001), which is less than (0.05). This indicates a statistically significant difference between the mean scores of the experimental and control groups in the post-application results of the physics problem-solving test, in favor of the group with the higher mean, the experimental group.

Interpretation of the research results:

The use of the strategy proposed in this research had a positive impact on the physics problem-solving skills of the students in the experimental group. The researcher attributes this result to the following:

1. The use of artificial intelligence applications to solve physics problems provides new ways to deal with physics problems by creating visualizations and representations in the

students' minds of difficult and complex concepts, motivating them to practice and search for solutions.

2. These applications complement traditional education, as they are powerful and effective tools for enhancing understanding and improving skills in physics.

3. Solving physics problems is not an end in itself. The curriculum is overloaded with problems that a physics teacher may be unable to explain in the classroom. The primary goal is to increase students' analytical ability in learning mathematical principles. The researcher believes that this ability increased among students in the experimental group when artificial intelligence applications were used.

The results of this research are consistent with the studies of Fadel (2023), Aql (2021), and Ahmed (2022), as well as the study of Al-Habashi (2017), which demonstrated a positive role for using electronic educational platforms in acquiring information. The study of Al-Mandlawi (2024) also demonstrated a positive role for using artificial intelligence applications in developing scientific thinking skills in science teaching.

Recommendations:

In light of the research findings of the study, the researcher recommends the following:

1. Work on developing artificial intelligence applications, as most applications currently available on the internet and mobile devices are efficient at solving mathematical equations only, but their efficiency is less effective at solving physics problems, possibly due to the complexity of the language used in the physics problem.

2. Work on developing artificial intelligence applications to explain the concepts of physics problems more accurately. For example, the researcher did not find an artificial intelligence application that draws a free-body diagram or converts the text of the problem into an image or video.

3. Most applications currently available on the internet and mobile devices do not support the Arabic language, so we need to program applications that are compatible with the physics curricula in Iraq.

4. Set standards for artificial intelligence applications and programs that can be used in teaching science subjects.

5. Support the educational environment in schools with artificial intelligence components and employ them in lesson planning and implementation.

6. Develop artificial intelligence applications to enhance self-learning by providing individualized guidance to each student based on their performance in solving physics problems.

1- 7 - Encouraging physics teachers to use artificial intelligence techniques in modeling, drawing, and representing physics problems by holding training courses to introduce them to the most important developments in this field.

Proposals:

In light of the research findings, the researcher proposes conducting the following studies:

1. Employing the model proposed in this study to develop problem-solving skills in other scientific subjects, such as mathematics and chemistry.

2. Keeping abreast of new artificial intelligence programs and employing them to develop physics problem-solving skills, given this rapidly evolving field.
3. Employing artificial intelligence programs to achieve other goals of teaching physics, such as conducting experiments and developing scientific thinking.
4. Surveying the opinions of physics teachers and supervisors regarding the use of artificial intelligence techniques in teaching physics.
5. Studying the obstacles to the use of artificial intelligence techniques in schools.

References

1. Ahmed, Essam Mohamed Sayed (2022), "An Artificial Intelligence-Based Training Program to Develop Self-Learning Skills and the Attitude Towards Collaborative Learning among Chemistry Teachers," Scientific Journal of the Faculty of Education, Assiut University, Volume 38, Issue 3, Part 2.
2. Abu Jamal, Khaled Abdel Halim (2015), "Scientific and Practical Foundations of Educational Technology: An Integrated Approach," 1st ed., Dar Al-Hamed for Publishing and Distribution, Amman.
3. Ismail, Heba Sobhi Jalal (2023), "Employing Artificial Intelligence Applications in Education in Egypt in Light of the Experiences of the United Arab Emirates and Hong Kong: An Analytical Study," Matrouh University Journal of Educational and Psychological Sciences, Volume (4), Issue (6).
4. Bin Ibrahim, Manal Hassan Muhammad, (1443), "The Extent of Inclusion of Artificial Intelligence Applications and Ethics in Secondary School Physics Curricula," Journal of Educational Sciences, Issue 29, Part Two, University of Jeddah.
5. Tarah, Maryam Shawqi Abdul Rahman, 2020, "Artificial Intelligence Applications and Acceleration of the Digitization Process of Education," Supplement to the Iraqi University Journal, Issue (15/2).
6. Al-Jumaili, Khaled Faraj Abdul (2023), "The Role of Mathematical Skills in Empowering Secondary School Learners to Solve Physics Problems," Journal of the Iraqi University, Issue 60, Part 2.
7. Al-Habashi, Ayat bint Alawi Hussein, (2017), "The Effect of Using Educational Platforms to Track Homework on Perceived Self-Efficacy and Mathematics Achievement of Third-Year Intermediate Female Students in the City of Makkah Al-Mukarramah," Journal of Mathematics Education, Volume (20), Issue (9), Part Three.
8. Al-Hila, Muhammad Mahmoud (2014) "Classroom Teaching Skills", Dar Al-Masirah for Publishing, Distribution, and Printing, 4th ed., Amman.
9. Al-Rikabi, Abbas Jawad Abdul-Kazem (2023) "The Level of Employment of Artificial Intelligence Applications in Teaching Physics at the Secondary Level from the Perspectives of Teachers and Their Educational Supervisors", Al-Saeed University Journal for Humanities and Applied Sciences, Volume 6, Issue 3.
10. Al-Sarraj, Susan Hussein (2017) "The Effectiveness of the IDEAL Model for Solving Physics Problems on Developing Reflective Thinking, Physics Problem-Solving Skills, and Attitudes Toward Them among First-Year Secondary School Students", Arab Studies in Education and Psychology (ASEP), Issue Ninety, Part Two.

11. Sarheed, Haider Mohsen, (2019) "Difficulties Facing Middle School Students in Solving Physics Problems", Journal of the College of Basic Education for Educational and Human Sciences, Issue 45.
12. Salma, Ja'arir; Sabrina, Ben Qoum, (2021) "Artificial Intelligence in the Educational Field and Its Role in Advancing Education in the Future", The First Virtual Conference on Artificial Intelligence and Digital Humanities: The Limits of the Relationship and Problems of Practice in the Humanities and Social Sciences in the Arab World, Dar Qadi for Publishing and Translation, Algeria.
13. Al-Shabl, Manal bint Abdul Rahman Youssef (2021) "Mathematics Teachers' Perceptions of Learning and Teaching Mathematics Using the Artificial Intelligence Approach in Public Education in the Kingdom of Saudi Arabia", Journal of Mathematics Education, Volume 24, Issue 4, Part One.
14. Al-Sharifi, Shawqi Al-Sayyid, 2000, "Dictionary of Educational Science Terms," Al-Obeikan Library, 1st ed., Riyadh.
15. Aboud, Anwar Nafie, et al., 2012, "The Effect of the Proposed Wave Model on Developing Fifth-Grade Science Students' Physics Problem-Solving Skills and Developing Their Attitude Towards Physics," Journal of the College of Basic Education, University of Babylon, Issue 8.
16. Al-Otaibi, Faten bint Eid, et al. (2022), "The Role of Artificial Intelligence in Developing Critical Thinking Skills and Scientific Attitudes among Second-Grade Secondary School Female Students in the Physics Course," Journal of Educational Sciences and Humanities, Taiz University, Issue 21.
17. Aql, Magdy Saeed. Arwa Saqr Jundia (2021) "The Effectiveness of an Educational Environment Based on Blended Learning in Developing Physics Problem-Solving Skills among Eleventh-Grade Female Students in Gaza," Moroccan Journal of Educational Evaluation and Research, Issue 6.
18. Al-Alwani, Muhammad Daham Yassin, 2018, "Difficulties in Teaching Physics at the Intermediate Level from the Perspective of Teachers in Anbar Governorate, Iraq," Master's Thesis in Curricula and Teaching Methods, Middle East University.
19. Al-Ghamdi, Muhammad bin Fawzi, 2024, "Artificial Intelligence in Education," First Edition, King Fahd National Library, Dammam.
20. Fadel, Iman Muhammad Ahmad, 2023, "A Proposed Electronic Unit in the Physics Curriculum to Develop Concepts of Artificial Intelligence and Foresee the Technological Future among Secondary School Students," Egyptian Journal of Science Education, Volume 26, Issue 2.
21. Al-Qassim, Jamal Mithqal Mustafa, 2015, "Fundamentals of Learning Difficulties", Third Edition, Safaa Publishing and Distribution House, Amman.
22. Majeed, Sawsan Shaker (2014) "Foundations of Constructing Psychological and Educational Tests and Measures", De Bono Center for Teaching Thinking, Third Edition, Amman.
23. Mohsen, Ahmed Muhammad Jawad (2007) "Educational Views on Teaching Mathematics", 1st ed., Kiwan House for Printing, Publishing, and Distribution, Damascus.
24. Al-Mutairi, Alia Zaid (2022) "The Effect of an Artificial Intelligence-Based E-Learning Environment on Developing E-Learning Skills among Female Students of the College of

Education at Umm Al-Qura University", Arab Journal of Science and Research Publishing, Journal of Curricula and Teaching Methods, Volume (1), Issue (7).
25. Al-Mandlawi, Alaa Abdel Khaleq and Ali, Zainab Hussein (2024) “The effect of using artificial intelligence applications in teaching science on developing scientific thinking skills among sixth-grade primary school students.” Journal of Women’s Studies, a peer-reviewed scientific journal, Issue 2.
26. UNESCO, (2021), "Artificial Intelligence and Education: Guidelines for Policymakers", United Nations Educational, Scientific and Cultural Organization (UNESCO) in partnership with the Regional Centre for Educational Planning, Paris.
27. UNESCO, (2023), "Artificial Intelligence Curricula from Kindergarten to Grade 12 (AI)", A blueprint for government-approved AI curricula, United Nations Educational, Scientific and Cultural Organization (UNESCO) in partnership with the Regional Centre for Educational Planning, Paris.
28. C Poluakan, (2019), "The importance of diagrams representation in physics learning", Journal of Physics.
29. Ukoh, Edidiong Enyeneokpon, Nicholas, Jude (2022) “AI Adoption for Teaching and Learning of Physics” University of Ibadan, International Journal for Infonomics (IJI), Volume 15, Issue 1.