



# Designing an Expert system based on Artificial intelligence for developing programming languages for producing creative Projects through Internet of things of students in STEM schools

## Article History

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## Abstract

The research aimed to measure the effect of designing an expert system based on artificial intelligence to develop programming languages to produce innovative projects via the Internet of Things among students of STEM schools. The research sample consisted of (40) students from STEM schools in Sharkia Governorate, and the research tools consisted of an achievement test to measure the cognitive aspect related to programming languages, a performance note card to measure the skill aspect of programming languages, and a product evaluation card to evaluate innovative projects. And after ensuring the validity of the tools for application, they were applied before and after on the research sample, and the statistical processing of the data was done and the validity of the hypotheses was tested. The results concluded that there were statistically significant differences at the level (0.05) between the mean scores of the research group in the achievement test to measure the cognitive aspect of learning the three programming languages (Python - JavaScript - PHP) in the pre and post test in favor of the post achievement test. It also found statistically significant differences at the level (0.05) between the mean scores of the research group in the skill performances related to learning the three programming languages (Python - JavaScript - PHP) in the pre and post application in favor of the post application. The use of the expert system and the development of programming languages (Javascript - PHP - Python) for students of STEM schools led to the production of innovative projects as an application of the uses of artificial intelligence, expert systems, machine learning and deep learning using many algorithms. This indicates the development of cognitive achievement and skill performance among the group members.

**Keywords:** *artificial intelligence - expert system - Internet of Things - innovative projects*

## Introduction

In recent years, the world has witnessed a revolution in the field of artificial intelligence and expert systems and their use in various fields, including education. This revolution has appeared in most areas of life, with almost no field devoid of the use of artificial intelligence applications, whether in medicine,

engineering, education, manufacturing, investment, space sciences, or communications. This development has placed significant responsibilities on the Ministry of Education, Technical Education, and Higher Education to develop their policies, curricula, and strategies to keep up with the tremendous advances in artificial intelligence. The progress in the fields of artificial intelligence and expert systems is seen as the

spark that has illuminated new areas for educators to explore in enriching the culture of artificial intelligence and including it theoretically and practically in different stages of education (Andriy Burkov, 2022).

Jamal Al-Dahshan (2019) also indicated that the Internet of Things can be integrated into the educational process and learning activities by designing educational plans by the teacher that help in teaching different subjects, to help students access various knowledge and skills, and to enable the teacher to manage classrooms electronically from a distance. The teacher can thus monitor the students during or after the lesson, and the teacher can also develop learning environments based on virtual classrooms and laboratories, employ interactive learning applications through participatory learning environments, and provide an opportunity for the teacher and students to create three-dimensional teaching materials and share them electronically through tasks web browser platforms, and the use of motion-sensing and temperature-sensing smartphone applications to monitor classrooms remotely.

As mentioned by (Kenneth C. Loudon (2020), Robert Harper (2020), David A. Watt (2023)) the importance of programming languages in the production of smart software, and programming is defined as the process of employing code to carry out certain operations and functions to produce software for computers. These logical operations are carried out by smart devices, and programming languages help different electronic devices communicate with each other, such as robots and computer peripherals such as printers, scanners, and other types of smart devices. It also allows humans to communicate with smart devices, despite having many languages. Programming has many similar characteristics, but each language has its own unique and distinctive structure, and each language includes a distinct set of keywords for building innovative projects that help enrich the educational process, and build software based on sound educational rules.

Many studies, including (J. L. Meriam 2023, Dennis G. Zill, 2022) mentioned that STEM schools are an acronym for Science, Technology, Engineering, and Mathematics. These schools are among the most important scientific schools, as many industries and vital fields such as medicine, energy, security, technology and many other fields depend on them. These schools aim to teach students the skills needed to solve problems, innovation, and critical and scientific thinking. Estem schools are distinguished by focusing on developing the skills necessary for students to solve practical problems and current global challenges. It also encourages innovation and creative thinking, teaching students how to apply theoretical concepts to reality and solve practical problems. It also relies on teamwork and encourages students to interact, cooperate, communicate and exchange ideas and

knowledge. It also contributes to the development of students' skills in analysis, design, programming, statistical analysis and other basic skills important in practical life. Students who study in these schools can advance in many promising professional fields such as engineering, computer science, data science, medicine, industry, design, and other vital fields.

Artificial intelligence is also considered a relatively recent field that has arisen as one of the computer sciences that is concerned with studying and understanding the nature of human intelligence and simulating it with smart computers, which can be programmed to accomplish many tasks that require a high ability of inference, deduction and perception, which are characteristics that humans enjoy and fall under. A list of his intelligent behaviors that a machine could not have acquired before (Peter Norvig, 2021).

And if the applications of artificial intelligence are important in many fields and fields, for educational institutions they represent an urgent and indispensable necessity, as many studies and previous research (Pardos et al. 2020, Siemens. 2020, Mubin and Hussain .2021) emphasized the importance of These applications in educational institutions, which enable them to achieve several advantages, most notably: improving the education process, solving all educational problems, and learning programming is one of the most important methods used to train a new generation of young people capable of scientific and economic competition, as is the case in the developed world countries where it is applied. This is for secondary school students in STEM schools and training secondary school teachers in STEM schools in programming languages to help students produce innovative projects to improve the quality of education, ..., and other advantages that directly contribute to enhancing the process. Education at the secondary level and ensuring its survival and growth.

An appropriate study by (Ocana-Fernández, 2019) addressed the role of artificial intelligence in the educational process, especially at the secondary level, where artificial intelligence is one of the most important areas of computer-based interactive learning that aims to understand. The nature of human intelligence, to produce computer programs capable of simulating human behavior characterized by intelligence, that is, the ability of a computer to solve an issue, make a decision, or provide advice or guidance in a situation after describing this situation, and the main goal of artificial intelligence is to simulate human intelligence using advanced software. It is used to solve atypical problems, train them to solve them, or make a decision.

Both (Manisha Biswas, 2020) mentioned the most important characteristic of the methods of building artificial intelligence programs, the complete separation between the knowledge base, the processing

systems, the interface engine, and the user interface that uses this knowledge. For the non-specialist, it is a group of processing systems that interpret the knowledge materials, and arrive at the required answer from the use of the expert system.

As stated by (Srikanta Patnaik, 2022, Bernard Marr, 2022 ) that artificial intelligence has contributed to many basic programming areas, including expert systems, natural language processing, machine programming, living language processing, computer vision, robotics, proving theories automatically, education Computer learning, computer games and other areas that enrich the educational process.

A study (Goksu, Idris, 2016) presented the design of expert systems to mimic human expert logic in the content domain. Expert systems are designed to replace advisors, and they combine the expert system's knowledge base and expert system's processing capacity for decision-making with the user's understanding and knowledge of specific circumstances. He found many of the advantages of these systems that they are easy to use for any user, whether a regular user or a developer, that they are clearly useful in the field of application, are able to learn from experts directly and indirectly, are able to teach non-specialists, are able to interpret any solutions they reach with Clarifying the way to access it, able to respond to simple as well as complex questions within the limits of the application, a useful means in providing high levels of expertise in the absence of an expert, capable of developing the performance of specialists with minimal experience.

The study (Vangie Beal, 2018)) also mentioned that programming languages, these languages carry vocabulary in addition to specific rules to instruct the computer to carry out specific tasks. Each programming language contains a set of special words (Keywords) in addition to a specific method of writing (Syntax), that determines how to organize the program commands that are used in the programming process.

WEB 3.0 is also considered the beginning of the emergence of the Semantic Internet and the Internet of Things "Internet of Things". (Pruet...et al, 2015) defined the Internet of Things as an emerging technology and will play an important role in many fields such as: commerce, health, transportation and education. The connection of devices via the Internet is growing very quickly. At present, five billion "smart" objects are deployed and this will increase to fifty billion connected devices in the coming period.

The study (Gul... et al, 2017) dealt with smart classes based on the Internet of educational things, where the study clarified the impact of the Internet of Things in the field of education, and the Internet of Things not only changed traditional educational practices, but also led to Changes in the infrastructure of educational institutions, and the term "Internet of educational

things" is considered two sides of the same coin due to its use as a technological tool to enhance the infrastructure or as a course to teach basic concepts of computer science.

Therefore, the use of technology, especially the Internet of educational things in the field of education, may open the doors to new and innovative ideas to achieve the quality of education and improve educational services for students and teachers, and provide privacy and security for devices and students, teacher training and other services.

The study (Fragou, 2020) mentioned the use of computing, mobile education, and the Internet of Things on a large scale in many applications of the Internet of things in the education sector, including interactive learning, as the study (Kuan-Ching Li,2022) emphasized the importance of the Internet of Things in many areas where it is not limited Today's learning is on multimedia only, but on more than that. Many interactive books are downloaded from websites that include videos, animations, and other materials to aid the learning process. This helps students acquire knowledge in new forms while understanding educational content and interacting with teachers and students.

The study (Willner-Giwerc, 2020) also mentioned the importance of security in the educational process, and the presence of many students in educational institutions is difficult to monitor. Moreover, students in educational institutions are more at risk, so smart security must be used. The Internet of Things can enhance the security of schools. Significantly. Three-dimensional positioning technology can be used, students can be monitored using a smart camera, and any violations can be reported, in addition to the presence of distress methods, so these technologies help to inform about danger when needed, and it helps to stop unexpected accidents before they occur.

The study (Kostas Kolomvatsos,2022) showed that the educational applications provided by the Internet of Things are considered creative tools and help to change the normal way of teaching and learning, and provide a large number of educational games, which led to many features that offer interesting possibilities for teaching and learning, and the availability of these applications Enables teachers and students to create 3D graphic books that feature videos and the ability to take notes. The study (Chris Bailey,2022) added that students spend a lot of time on activities that do not add any value to the desired goal of the teaching and learning process and do not increase students' efficiency, and given this shift towards the Internet of Things, tedious tasks for teachers and students can be reduced, allowing them to Focusing more on teaching and learning.

The Australian Government's Education Council, 2019 study supported the 'National STEM School Education

Strategy 2016-2026' (National Strategy) the long-term change agenda aimed at ensuring students have a stronger foundation in science, technology, engineering and mathematics (STEM). ) and be inspired to take up more challenging STEM subjects. The National Strategy sets two high-level goals: (1) To ensure that all students finish their studies with a strong foundational knowledge of STEM and related skills. (2) Ensure that students are inspired to take up more challenging STEM subjects. (ACER, 2022)

### **Sense of the problem**

The sense of the current study problem stemmed from the following sources:

#### **Related previous studies and literature**

By showing the researcher some studies and literature related to artificial intelligence, expert systems, the Internet of Things, and programming languages in STEM schools, and among these studies:

A study by (Stuart Russell et al, 2022, Thomas H. Davenport, 2022) which clarified the importance of using artificial intelligence in all aspects of knowledge, and also indicated the effectiveness of using artificial intelligence in the educational process, as it can design maps similar to reality with incomplete coordinates.

The study of both (Jeff Heaton, 2022 , Philippe Aghion et al , 2022 ) confirmed that artificial intelligence software helps students with less experience in solving problems by providing them with the necessary expertise, and helps facilitate the transfer of learning to learners in an interactive and gradual manner through experience and self-learning. The role of the teacher here is to guide and assist the learner in interacting with the expert system.

A study by (Simsek, Irfan, 2019, Jonathan Fink, 2023 ) referred to the expert system as one of the most powerful branches of artificial intelligence in computer science. Expert systems are programs that simulate the performance of a human expert in the field of expertise. This is done by collecting and using the information and experience of one or more experts in a specific field in an electronic form, so that these systems allow solving the expertise of specialists in a specific field or in rare specializations from which other people benefit - in addition to their abilities - in solving problems faster than a human expert. .

The study of (M. Zelkowitz, 2023, Caroline Talcott, 2022) classified programming languages in terms of their level into low-level programming languages, and high-level programming languages, and what is meant by level Here is the extent of the language's abstraction and its ease of understanding by humans. The most abstract languages, such as machine code, are considered low-level programming languages, and the closer the programming language is to the machine language, the lower its level. A decrease in the level, in machine language, commands are written directly in

the language that the computer understands, namely numbers, and in assembly language, commands are written in a slightly simpler way than machine language, so that a specific phrase is written that indicates the command instead of writing it in numbers, As a phrase (MOV AL, 61 h).

The Internet of Things (IoT) creates a world in which physical objects are seamlessly integrated into information networks in order to provide advanced and intelligent services to humans (Yan... et al, 2017).

(Rob van Kranenburg, 2023) believes that the social and economic impact of the "Internet of Things" is widespread and accelerating, in line with the significant increase in the speed and volume of information, and experts expect that 90% of the total population will be connected to the Internet within the next 10 years with the Internet Things, the digital and physical worlds will soon merge.

A study (David E. Drew ... et al, 2023) stated that comprehensive high schools in the fields of science, technology, engineering, and mathematics have a variety of educational strategies, including problem-based or project-based learning (PBL) experiences, with the aim of building students' skills in the twenty-first century, and facilitating academic success at all levels. Long term, encourage the pursuit of science, technology, engineering and mathematics.

#### **Recommendations, seminars and conferences for artificial intelligence, expert systems, the Internet of things, and STEM schools:**

The Computer Science and Informatics Sector Committee of the Supreme Council of Universities organized the first international conference entitled "Artificial Intelligence and Information Technology and its Role in Building the Egyptian Knowledge and Innovation Society" during the period from 08-09 September 2019. This conference comes within the framework of Egypt's current interest in developing knowledge and innovation among Egyptian society, and the need to develop appropriate methodologies to build a knowledge society and develop the energies and capabilities of society in general and youth in particular to move towards the skills and concepts of knowledge, innovation and artificial intelligence. It is noteworthy that the main themes of the conference are: The fourth industrial revolution. - Smart universities. - Developing the uses of modern technology (including: artificial intelligence - data science - the Internet of things - cyber security - quantum computers). (Banha University President Sector, 2019)

-(United Nations News website, 2017) mentioned the establishment of the Internet Forum in Geneva on December 21, 2017 at the United Nations Headquarters in Geneva, and it focused on harnessing technology to achieve maximum benefits for societies. The Twelfth Internet Governance Forum held its work on several

topics, on top of which Artificial intelligence, big data, virtual reality, and fake news.

On Tuesday 6/7/2020, the “Mohamed Bin Zayed University for Artificial Intelligence,” the first university in the world for postgraduate studies specialized in artificial intelligence research, announced the launch of a series of online sessions that include a group of educational seminars aimed at delving into a number of exciting areas of artificial intelligence. Interesting from its current applications to its open future prospects.

The Innovation and Entrepreneurship Center (IHub) (2020) organized a symposium entitled “Artificial Intelligence Technologies” at the Faculty of Engineering, Ain Shams University. The course revolved around artificial intelligence, its importance and modern technologies in this field. The symposium aimed to study machine learning, deep learning, neural networks and expert systems.

#### **Exploratory study:**

An exploratory study was conducted aimed at determining the level of learning programming languages and their application in artificial intelligence programs, expert systems and the Internet of things among high school students and STEM schools, using the following tools:

#### **Personal interview (free dialogue)**

Through the work of the researcher and his field visits to many schools in most of the governorates of the Republic, and conducting personal interviews with some computer teachers and students in secondary schools and schools of excellence in science and technology “STEM”, the results of which were: lack of interest in learning programming languages that are taught within the curricula due to the difficulty of learning these languages The researcher presented a new way to learn programming languages through an expert system. The opinion of many computer teachers agreed on the importance of building an expert system that relies on artificial intelligence to learn different programming languages. The researcher also noticed the scarcity of using expert systems in learning programming languages and the scarcity of using artificial intelligence applications in studying projects among STEM students.

**A questionnaire was applied to a sample of (30) thirty computer teachers and students in STEM schools, where the questionnaire included three axes, and the results of the exploratory study resulted in the following:**

**the first axis:** programming languages, through which it became clear that 90% of the total respondents use programming languages. There is a low level of respondents in learning programming languages.

**The second axis:** artificial intelligence, which showed that 82% of the total respondents prefer to use artificial intelligence and expert systems to present the scientific

and practical content of learning programming languages, and that 85% have a desire to learn methods of building expert systems to present the scientific material of programming languages using artificial intelligence methods.

**The third axis:** expert systems, as it became clear that 90% of the respondents do not have expert educational systems for teaching programming languages.

**The fourth axis:** the Internet of Things, through which it became clear that 10% of the total respondents have knowledge of the Internet of things, and that 90% of computer teachers and students of the sample do not deal with the Internet of things, but the same percentage knows what the Internet of things is, but they do not have knowledge of its uses in Educational process.

From the results of the personal interview and the results of the questionnaire, it became clear to the researcher that the level of high school students and schools of excellence in science and technology “STEM” is low in learning programming skills. Feeling the importance of learning programming languages through expert systems and artificial intelligence via the Internet of Things for computer teachers and STEM students.

Through the literature, the results of studies, conference recommendations, the results of unstructured interviews, and the exploratory study, a guide and guide in emphasizing the importance of this study to provide a suitable student environment for teaching programming languages and building an expert system for learning those languages using artificial intelligence and publishing them through the Internet of Things to produce innovative projects produced by school students. STEM. In ways that keep pace with technological development and its innovations, and also take into account the economic dimension and the directives of the Ministry of Education and Technical Education.

**The scarcity of studies dealing with learning programming languages using artificial intelligence and expert systems through the Internet of Things has been noted due to the novelty of the subject and its limited spread within the education sector, which supported the need to conduct the current study.**

#### **problem**

By applying the questionnaire to a group of STEM students in the field of programming, it was found that the knowledge and skills related to programming languages are weak and low, which negatively affects the production of innovative projects for students of STEM schools in the field of programming.

**The above can be formulated in the following main question:**

**How to design the expert system - as one of the applications of artificial intelligence - in teaching programming languages through the Internet of**

### **Things in raising the programming level, in both its cognitive and skill levels, among STEM students?**

From this main question, the following questions branch out:

What are the basic knowledge and skills that STEM students should have in dealing with artificial intelligence?

What are the knowledge and skills related to programming languages via the Internet of Things that are required to be developed among STEM students?

What are the knowledge and skills related to dealing with expert systems required to be developed among STEM students?

What is the proposed educational design for designing an expert system via the Internet of Things based on artificial intelligence to develop programming skills and produce innovative projects for STEM students?

What is the effectiveness of expert systems represented in artificial intelligence and programming languages via the Internet of Things in raising the cognitive level of STEM students in producing innovative projects?

What is the effectiveness of the expert system based on artificial intelligence in developing the performance aspect necessary to deal with the three programming languages (Python - JavaScript - PHP) and the production of innovative projects among STEM teacher students?

#### **aims**

The research aims to achieve the following objectives:

Measuring the effect of using artificial intelligence and expert systems in developing the cognitive side related to the skills of developing programming languages among STEM students.

Measuring the effect of using artificial intelligence and expert systems in developing the performance aspect related to the skills of developing programming languages among STEM students.

Producing innovative projects designed by STEM students.

#### **importance**

It is hoped that the current research will benefit both: Mentors by raising the professional competencies of mentors in expert systems and programming languages through the design of an expert system that contains many programming languages to train STEM students. Teachers, by raising professional competencies and providing real training opportunities for them to design an expert system for training in programming languages.

Teachers of other subjects interested in learning programming, expert systems and programming languages by employing artificial intelligence and expert systems through Internet of Things websites.

Students, by raising their scientific level in programming languages and training them in many languages used in artificial intelligence.

Contributing to presenting an awareness campaign among students, teachers and mentors to clarify the importance of artificial intelligence and expert systems in the educational process.

In overcoming many obstacles related to the difficulty of learning programming languages.

Activating dealing with programming languages by employing the Internet of Things to present the knowledge and skills that must be learned, which leads to the survival of the impact of learning.

Education technology specialist, through learning languages and producing an innovative technology (expert system).

#### **parameters**

The search will adhere to the following determinants:

#### **Limits**

**Artificial intelligence can be addressed through:**

(Cyber security - Intelligent engineering systems - Machine Intelligent - Data science)

**Also, artificial intelligence can be addressed through:**

(Machine Learning - Expert Systems - deep learning)

**The researcher will deal with expert systems in terms of:**

Basic skills needed to build an expert system.

Knowledge and skill content to build an expert system for training in programming languages.

Employing the expert system through the Internet of Things in producing innovative projects.

#### **Spatial boundaries**

Through students' devices, since all school students are handed a Laptop computer once they enroll in STEM Schools. This is for training in programming languages through the expert system.

#### **Temporal limits**

It was implemented during the second semester of the academic year 2022-2023.

#### **Technical limits**

An innovative technology "Expert System" was designed to be used in learning programming languages, easy to use and characterized by stability, honesty and objectivity.

Using artificial intelligence to design an expert system and deploy it on the Internet of Things.

#### **Research Methodology**

In this study, the researcher relied on each of the following two approaches:

The descriptive approach: in extrapolating the educational literature related to the subject of the research, to derive two lists of the basic skills necessary to deal with expert systems and the knowledge associated with them, using artificial intelligence.

The semi-experimental approach: due to its suitability to the nature of the problem, as the current study seeks to measure the impact of the expert system in developing the performance and cognitive aspect associated with the development of programming

languages to produce innovative projects for STEM students.

**Variables**

**Independent variable: expert systems.**

**Dependent variable:**

Developing programming languages, in both its knowledge and skills, among STEM students, which is represented in:

Basic knowledge aspects needed to learn programming languages.

Basic skill aspects needed to learn programming languages.

Designing innovative projects by students.

**The research sample**

A group of about (40) forty students from the Schools of Excellence for Science and Technology “STEM” in Sharia Governorate was selected to represent the experimental group.

**Research experimental design**

Due to the nature of the research, the researcher relied on the experimental design of one experimental group for one independent variable, "expert systems for training in programming languages" with pre and post measurement, because the sample had not previously dealt with expert systems, which is evident from the following table:

**Table(1) The experimental design of the research**

Telemetry	Experimental treatment	Tribal measurement	the group
Cognitive achievement test Skill performance appraisal card Final product evaluation card	The expert system is based on artificial intelligence	Cognitive achievement test Skills performance appraisal card	experimental group

**Tools**

To conduct this research, the following research tools were built, adjusted, and arbitrated:

Designing an expert system based on artificial intelligence for the development of programming languages. (prepared by the researcher)

A test (pre/post) to measure the cognitive aspect in the field of programming languages for STEM students. (prepared by the researcher)

An observation card to measure the skill aspect in the field of programming languages for STEM students. (prepared by the researcher)

Innovative Projects" product evaluation card. (prepared by the researcher)

**Hypotheses**

Through this study, the researcher verified the validity of the following hypotheses:

There is a difference in cognitive achievement related to knowledge in the field of programming languages at the level of (0.05) among STEM students in the pre and post application in favor of the post application.

There is a difference in the skill performance related to the skills in the field of programming languages at the level (0.05) of STEM students in the pre and post application in favor of the post application.

In order to answer the research questions, achieve its objectives, and verify the validity of its hypotheses, the researcher carried out the following procedures:

**Procedures**

- By reviewing previous studies, research, and literature explaining the steps of scientific research, with the aim of preparing the scientific framework for research, and building its tools.
- Deriving a list of the cognitive objectives and knowledge content of the expert system that must be available to STEM students, presenting the list of objectives and knowledge to a group of experts and specialists and making the required modifications.
- Deriving a list of the skill objectives and skill content of the expert system for teaching programming languages, which must be available to STEM students, presenting the skills card to a group of experts and specialists and making the required modifications.
- Deriving a list of design criteria for the expert system for training in programming languages, presenting the list of design criteria for the expert system and programming languages to a group of experts and specialists and making the required modifications.
- Designing the expert system for training in programming languages through the website in the light of the constructivist theory and the global needs and standards that must be met by the students of the “STEM” schools according to the educational design model of Dr. Abdul Latif Al-Jazzar. 2013

**Building research tools, which are:**

- An achievement test to measure the cognitive aspect related to the skills of programming languages (PHP - Javascript - Python) for STEM students, presenting it to arbitrators and experts and making adjustments to reach its final form.
- A note card to measure the performance aspect related to programming language skills (PHP - JavaScript - Python) for students of STEM schools, presenting it to arbitrators and experts, and making adjustments to reach its final form.
- An evaluation card for the "Innovative Projects" product, presenting it to arbitrators and experts, and making amendments to reach its final form.
- An expert system was designed for training in programming languages through the Internet of Things, and it was judged in the light of the design criteria and making the required modifications.
- An exploratory sample of (10) students from STEM schools was selected, and an exploratory experiment was conducted to determine the validity of the research tools, to identify the problems that the researcher may encounter during application.

- The research sample was selected from students of STEM Schools of Excellence in Science and Technology in Sharkia Governorate.
- The research tools were previously applied to the research sample.
- The basic experiment represented in the expert system for learning programming languages based on artificial intelligence was conducted on (30) students of the outstanding teacher of science and technology STEM in Sharkia Governorate.
- The research tools were applied dimensionally to the research sample.
- The data drawn from the two applications (pre and post) were processed with appropriate statistical methods to reach and interpret the results in the light of the theoretical framework, the results of related research, and the validation of the study hypotheses.
- Recommendations, proposals and complementary studies were presented in the light of the researcher's findings.

## Terms

### Artificial intelligence:

(Srikanta Patnaik,2022) knew that artificial intelligence is a part of computer science that aims to design intelligent systems that give the same characteristics that we know as intelligence in human behavior, and it deliberately works on the principle of matching the formations by which things, events and processes can be described using their qualitative properties and their logical relationship. and arithmetic.

As defined (Kazem, 2012), it is that branch of computer science through which it is possible to build and design computer programs that simulate the method of human intelligence; In order for the computer to be able to perform some tasks instead of the human being, which require thinking, understanding, hearing, speaking and movement in a logical and orderly manner.

The study of both (Osama Al-Husseini, 2002) and (Ocana-Fernández, 2019) mentioned that it is a way of thinking, i.e., algorithms, about how to make the computer solve problems, so artificial intelligence programs and systems are programmed in any programming language, except that there are some programming languages dedicated to writing Artificial intelligence programs and systems because they have facilities for the programmer, where the programmer often writes the data or rather the process of representing the data and the language performs the search process, and the most famous of these languages: Prolog and Lisp.

Procedural definition "Artificial intelligence is the ability to carry out tasks that are normally performed by humans using human intelligence. Artificial intelligence is implemented by creating computer models based on human intelligence and using

programming techniques, machine learning, neural networks, deep learning and expert systems.

### Expert systems:

The expert system is a computer program that shows, within a specific field, a degree of experience in solving problems, and the method of solving problems in this system is similar to the method envisaged by the human expert in a specific field (Joseph Giarratano,2022) and the expert system consists of a base of knowledge and experience in a field , and an event database that includes the collection of data related to the research problem, while the inference engine is a set of programs that allow searching the knowledge base to find appropriate suggestions, asking complementary questions necessary to diagnose the problem, and proposing solutions (John Durkin,2022); Thus, we can consider the expert system as an intermediary between the expert and the user of the system.

Procedural definition of the expert system Expert systems are defined as computer systems that rely on specialized knowledge in a specific field, and aim to solve specific problems in this field. These systems depend on human expertise in the specific field, where knowledge and experience from experts in the field are collected and integrated into the system "Computational. Expert systems are characterized by the ability to make decisions independently, analyze complex problems and provide appropriate and effective solutions. These systems use artificial intelligence, machine learning, programmatic logic and other advanced computer technologies to analyze data and extract important information."

### The Internet of things:

It was defined by the study of (Daniel Elizalde,2023 , Omar Elloumi,2023 , Negin Moghaddam,2023) that the Internet of Things is a developed concept of the Internet where all things in our lives have the ability to connect to the Internet or to each other to send and receive data To perform specific functions through the network

Operational definition of the Internet of Things: "The Internet of Things (IoT) can be defined as a network of electronic devices connected to the Internet that uses a variety of advanced technologies to collect, analyze and exchange data between these devices. These devices include a wide range of things, such as smart home devices, cars, and medical devices industrial devices, measuring and monitoring devices, etc. The Internet of Things aims to improve communication and interaction between different things, improve user experience, improve efficiency and performance, and reduce costs and time used in daily operations."

### Programming language

It was defined by (Kiraly, 2020) that programming languages are a set of commands, written according to a set of rules specific to each language. Those



commands go through a set of stages until they are executed on a computer. Programming languages are divided into high level language such as Java, C and low level language (Assembly).

Procedural definition of programming languages: "It is a set of commands and rules that are used to define the activities that the computer must carry out. These languages are used to develop programs and applications that the computer can implement. Programming languages are characterized by the ability to convert human concepts and ideas into schemes and commands that the computer can understand and implement properly." Programming languages differ in their level of complexity, methodology, and focus, and include some popular programming languages such as Java, PHP, Python, JavaScript, and others.

#### **STEM Schools:**

It is mentioned (the website of the Ministry of Education, 2020) that the establishment of schools for outstanding students in Egypt aims to: take care of outstanding students in science, mathematics, engineering and technology and take care of their abilities, and apply new curricula and teaching methods based on investigative projects and the integrative approach in teaching, and achieve integration between the curriculum of science, mathematics, engineering and technology, including reveals the extent of the connection between these areas; To prepare a student with the ability to design, creativity and critical thinking, and to provide students with collaborative learning skills.

Procedural definition of STEM schools: STEM schools are defined as schools that focus on science, technology, engineering, and mathematics (STEM) education, and aim to develop students' skills in these areas. These schools use innovative educational curricula that focus on analysis, design and innovation, and are active in developing students' scientific and applied understanding. STEM schools are characterized by modern educational technologies, such as the use of robotics, programming, virtual reality technologies, and augmented reality, and encourage students to learn actively, creative thinking, and teamwork. These schools aim to prepare students for university studies and careers in technical fields, and foster students' interest in STEM subjects".

#### **Results:**

The following search results were reached:

##### **To answer the first question of the research questions, which states:**

What are the basic knowledge and skills that STEM students should have in dealing with artificial intelligence?

This question is answered in the theoretical framework chapter. The basic knowledge was determined through

the computer curricula, where Python - javascript - PHP are taught.

##### **In order to answer the second question of the research questions, which states:**

What are the knowledge and skills related to programming languages via the Internet of Things that are required to be developed among STEM students?

This question is answered in the theoretical framework chapter. The basic skills were identified through a questionnaire and an unstructured interview to determine the basic skills.

##### **In order to answer the third question of the research questions, which states:**

What are the knowledge and skills related to dealing with expert systems required to be developed among STEM students?

This question has been answered in the theoretical framework chapter and by dealing with the scientific material presented by the expert system.

##### **In order to answer the fourth question of the research questions, which states:**

What is the proposed educational design for designing an expert system via the Internet of Things based on artificial intelligence to develop programming skills and produce innovative projects for STEM students?

This question has been answered through the theoretical framework.

##### **In order to answer the fifth question of the research questions, which states:**

What is the effectiveness of expert systems represented in artificial intelligence and programming languages via the Internet of Things in raising the cognitive level of STEM students in producing innovative projects?

This question has been answered through many innovative programs based on artificial intelligence, and these programs have been documented within the innovative projects link in the expert system.

##### **In order to answer the sixth question of the research questions, which states:**

What is the effectiveness of the expert system based on artificial intelligence in developing the performance aspect of learning the three programming languages (Python - JavaScript - PHP) and producing innovative projects among STEM teacher students?

This question was answered through the production of many innovative programs based on artificial intelligence, and these programs were documented within the innovative projects link in the expert system.

##### **The first hypothesis of the research was tested, which states:**

There is a statistically significant difference at the level ( $\leq 0.05$ ) between the mean scores of the research group in the achievement test related to basic knowledge learning programming languages (Python - Javascript - PHP) in the pre and post application in favor of the post achievement test.

In order to test the validity of this hypothesis, a (t-test for two related averages; Paired Samples t-test) was calculated to compare the average scores of the trainees before and after attending the training through the expert system designed using artificial intelligence (using the SPSS program) on the students' scores. The results are as follows:

It should also be noted about the types of assignments, which are the zero hypothesis  $H_0$ : in which the average score of the pre-achievement scores of the students = the average post-achievement score, that is, there is no effect of the training program.

Alternative hypothesis  $H_1$ : in which the average score of students' pre-achievement scores is  $\neq$  the average score of post-achievement scores, i.e. there is an effect of the training program.

**Application of statistical processes for the research sample:**

The following figure shows the scores of the experimental group in applying the pre-achievement test and the post-achievement test.



Figure (1): The scores of the experimental group in applying the pre/post achievement test

**This can be calculated using SPSS as follows:**

It must be verified that the results follow the normal distribution, which is a condition for applying the tests

**Table(2) : The normal distribution of scores in the pre and post achievement test**

Statistic	df	Sig. Significance level	Statistic	df	Sig. Significance level	application
.153	40	.020	.949	40	.070	Pre-achievement (cognitive) test
.100	40	.200*	.970	40	.347	Post-achievement (cognitive) test

We note from the previous table that  $sig > .005$  (significance level), and therefore the scores follow the normal distribution and the t-test is performed correctly to fulfill the condition.

**T-test using SPSS program**

When the test is conducted on the trainees for the pre/post achievement test, the following results appear:

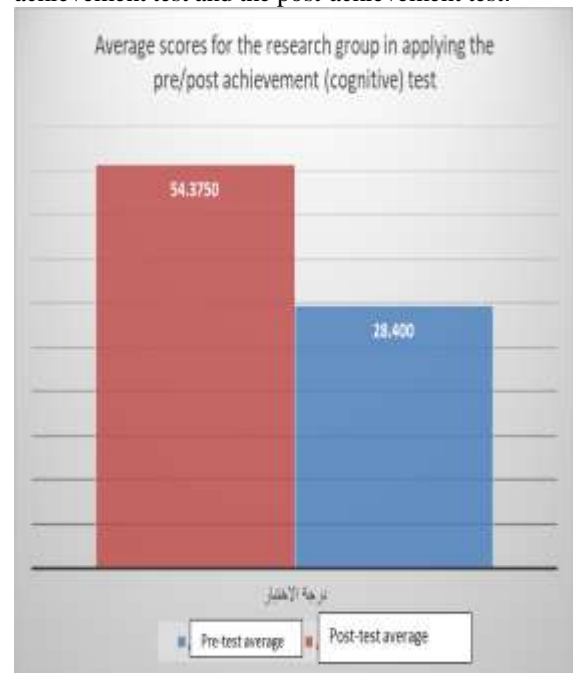
The first table, which is a statistic on the sample, and it is clear from it:

**Table(3) : Mean scores and standard error of the achievement test**

standard error	standard deviation	The number of sample members	average	application
.67823	4.28952	40	28.4000	Pre-achievement (cognitive) test
.49703	3.14347	40	54.3750	Post-achievement (cognitive) test

The mean of the pre-test is (28.4000) and the mean of the post-test is (54.3750). The number of respondents is (40). The standard deviation of the pre-test is (4.28952), the standard deviation of the post-test (3.14347), the standard error of the pre-choice (.67823), and the standard error of the post-test (.49703). We note that The upper average of the post-test.

The following figure shows the mean scores of the experimental group in the application of the pre-achievement test and the post-achievement test.



Figure(2) : Average scores for the experimental group in the application of the pre-achievement test and the post-achievement test

The following table shows the value of the t-test for the achievement test.

**Table (4): T-test for the pre/post achievement test**

Significance level	degrees of freedom	T-test	Paired Differences			group name
			standard error	standard deviation	average	
.000	39	29.955	.86713	5.48418	25.97500	Pre-achievement test (cognitive) - Post-achievement test (cognitive)

It is clear from the previous table that the higher average scores of the achievement (cognitive) post-test. And that the arithmetic mean of the variable (pre/post) was 25.97500, the standard deviation was 5.48418, the standard error was .86713, the value of "t" was 29.955, the degrees of freedom were equal to 39, and the significance level was .000, i.e. less than .005, which indicates that there is a statistically significant difference between the mean scores of students in the pre-application. And the post-test for the achievement test - in favor of the post-achievement application - where the value of "T" for the test was (29.955), which is a statistically significant value, and the value of the significance level is .000, which is less than 0.005. The researcher interprets this as a good indicator that shows the effectiveness of the expert system for learning programming languages (Python). - Javascript - PHP) published on the expert system based on artificial intelligence (independent variable) in the development of the achievement aspect of learning programming languages (Python - Javascript - PHP) for students of STEM schools in the development of educational computer material.

This agrees with what was presented by (Nurutdinova & Perchatkina & Zinatullina, 2016) regarding the impact of online training on raising the efficiency of teachers.

The researcher believes that these results related to the first hypothesis are due to:

The diversity of the scientific material presented within the expert system for learning programming languages (Python - Javascript - PHP) is diverse, as the scientific material was presented in many forms to include text, pictures and video, which is commensurate with the nature of the scientific material and facilitates its absorption by students and users of the expert system and raises their technological and software competence.

The expert system for learning programming languages (Python - Javascript - PHP) based on artificial intelligence helped to provide educational lessons and make them available effectively through the presence of exercises for each training topic, which allows refining the educational process and obtaining the best results in addition to the presence of a group of innovative projects Which are evaluated by the researcher, which contributed to the exchange of experiences between the researcher and the trainees through the exchange and sharing of different

knowledge, which was reflected in the assimilation of the content provided in the expert system for learning programming languages (Python - Javascript - PHP), which showed its impact on the students' knowledge achievement. This is consistent with the study (Ahlam Abdullah, 2016), which aimed to identify the impact of different methods of organizing the content on acquiring the achievement and performance side of the skills of designing the default rate for students of educational technology. The study found that the method of organizing the content was more effective in developing the achievement and skill side.

The expert system was designed to learn programming languages (Python - Javascript - PHP) on the web in the light of specific educational goals and outputs that students must achieve and have been followed up through interaction and communication tools, exercises and activities on the web, and this is consistent with the study (Febronia Saad, 2014). To verify the effectiveness of a web-based participatory course in developing the achievement and skill side.

The trainees dealt with the expert system for learning programming languages (Python - Javascript - PHP) via the web easily and easily by navigating inside it, which helped to make the educational process attractive and have effects on the trainees, as it included the expert system for learning programming languages (Python - Javascript - PHP ) Multiple set of links Included links to all training topics. This helped to develop programming competencies for the achievement and skill side related to the knowledge and learning skills of programming languages (Python - Javascript - PHP) for students of STEM schools.

The students dealt with the expert system for learning the programming languages (Python - Javascript - PHP) in an interactive manner, as it leads to learning reaching the maximum results in light of the reinforcement that may reach it through solving activities and exercises or through communication via e-mail by responding to the solution of the activities This is consistent with (Abdul Latif Al-Jazzar, 2013; Atef Al-Saifi, 2009) that learning via the web is based on a set of foundations for enhancing cooperation between learners, stimulating learning, providing feedback, providing sufficient time for learning, and focusing on the learner.

The expert system for learning programming languages (Python - Javascript - PHP) via the web presented the scientific material in a variety of attractive ways, and the trainee could download that scientific material so that it would be available to him on an ongoing basis. Also, learning via the web made it possible to train at any time and place.

These statistical results prove the effectiveness of the expert system for learning programming languages (Python - Javascript - PHP) via the web in developing students' competencies in learning programming languages, and this is consistent with the study (Mohamed Fawzi, 2010), which aimed to reveal the effectiveness of

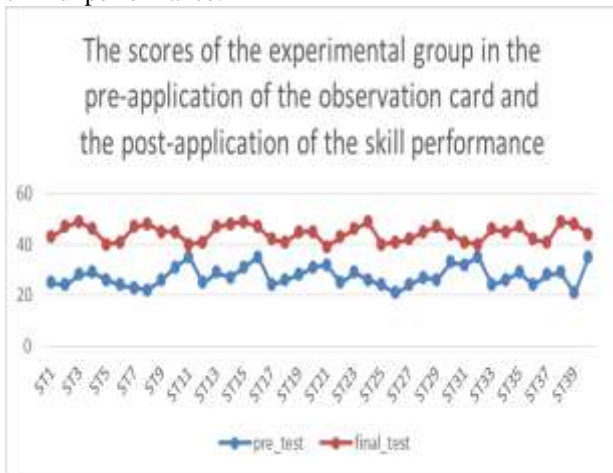
the training program in employing technology In education, the results indicated the effectiveness of the training program in developing the achievement, performance and emotional aspects of the competencies of students and teachers.

The expert system helps to follow the proper rules for writing programming language codes and determines the correct path for learning programming languages in most of the interactive links through which the student learns to write codes and gets to know the different paths to learn programming. There is also a link to answer questions about writing the code and studies all language topics from Through the expert system codes link, the expert system also includes an online translator for programming languages, through which the code that the student learned can be tested without the need to prepare a code editor to compile and implement the code. Modification and implementation of the written code is also available during the explanation.

**The second hypothesis of the research was tested, which states:**

There is a statistically significant difference at the level ( $\leq 0.05$ ) between the mean scores of the research group in the skill performances related to dealing with the three programming languages (Python - JavaScript - PHP) in the pre and post application in favor of the post application.

The following figure shows the scores of the experimental group in the pre-application of the observation card and then the post-application of the observation card for the skillful performance.



**Figure(4) : The scores of the experimental group in the pre-application of the observation card and then the post-application of the observation card for skill performance**

To test the validity of this hypothesis, a (T-test for two related averages) was calculated to compare the mean scores of the students before and after attending the training through the application of the observation card, and the following table summarizes that:

**T-test calculation through SPSS program:**

It must be verified that the results follow a normal distribution, which is a condition for applying the t-test

**Table (5):Average scores for applying the observation card for the research sample**

Statistic	df	Sig. Significance level	Statistic	df	Sig. Significance level	application
.147	40	.030	.943	40	.044	Note card app before me
.138	40	.053	.927	40	.013	Note card application after me

We note that sig  $>.005$  (significance level) and therefore the scores follow the normal distribution and the t-test is performed correctly to fulfill the condition.

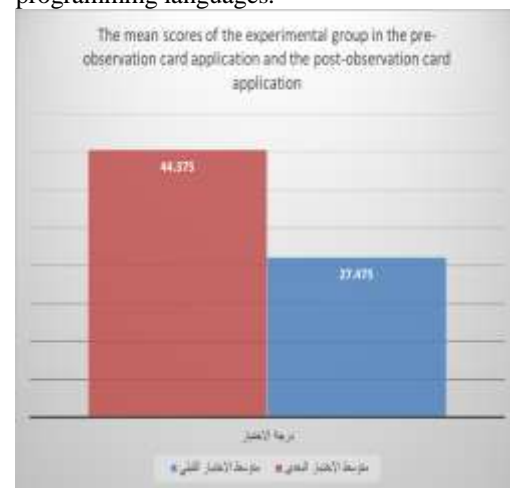
T-test: When the observation card is applied to the pre/post score group, the following tables appear:

The first table, which is a statistic on the sample, shows:

**Table (6) : Median, Standard Deviation, and Standard Error Observation Card Application Before/After**

standard error	standard deviation	The number of sample members	average	application
.61913	3.91570	40	27.4750	Note card app before me
.48791	3.08584	40	44.3750	Note card application after me

We note from the previous table that the average score of the pre-test observation card application is (27.4750) and the post-test average score is (44.3750), meaning that the post-test average is the highest. The following figure shows the mean scores of the experimental group in the pre-application of the observation card and the post-application of the skill performance of learning programming languages.



**Figure (5): Average scores of the experimental group in applying the observation card**

As shown in the previous graph, the average score of the experimental group for the post observation is greater than the average score for the pre observation of the experimental group.

**Table (7): The value of the observation card application test for the research sample**

Significance level	degrees of freedom	T-test	Paired Differences			group name	
			standard error	standard deviation	average		
.....	39	20.74	.81477	5.15304	16.90	Pre-achievement test - post-achievement test	Experimental

**Interpret and discuss the results related to the second hypothesis:**

It is clear from the foregoing that the higher average of the post observation card application is Table (0). And that the arithmetic mean of the new variable, pre/post, was 16.90, standard deviation 5.15, standard error .81477, "t" value 20.74, degrees of freedom equal to 39, and the significance level .000, less than .005, which indicates that there is a statistically significant difference between the mean scores of the trainees in the pre-application. In the post-test, the observation card was applied in favor of the post-application, where the value of "T" for the test was (20.74), which is a statistically significant value, and the value of the significance level is .000, which is less than 0.005. The researcher explains this as a good indicator that reflects the effectiveness of learning programming languages published on the expert system based on Artificial intelligence (the independent variable) in developing the skill aspect of learning programming languages among students of STEM schools, and this is consistent with what was presented by (Jyoti Grover,2022) about what is the impact of using the expert system via the Internet of Things on raising the scientific, programming and technological competence of students and teachers.

**The researcher believes that these results associated with the second hypothesis are due to:**

The diversity of the practical scientific material presented within the expert system via the Internet of Things is diverse, as the scientific material was presented in many forms to include text, pictures and video, which is commensurate with the nature of the scientific and practical material for the development of the skill side, which facilitates the absorption of the skills of students of STEM schools on the programming language learning program that helped to Raising the skill and technological level of students.

The expert system helped to raise the skills of students in dealing and writing code using programming languages and dealing with artificial intelligence programs, meaning that the scientific material helped raise the skill side and raise the skill of writing the code correctly, and this is consistent with the study (Sangeeta Kakoty et al ,2022), which aimed to identify the effect of using visual explanation through pictures or video, which led to interaction with the explanation at any time and any number of times. .

Designing the expert system and applying the observation card to the students, then following them up during the training through the performances that the students perform, which led to raising the skill side of the students on programming skills, writing the code correctly, and making innovative programs, and this is consistent with the study (David S. Stein,2022). To verify the effectiveness of a web-based site in developing the achievement and skill side.

Training in the three programming languages (Python - JavaScript - PHP) in a practical way leads to the skill reaching its maximum mastery in light of the reinforcement that may reach a mechanism through solving activities, practical exercises and practical tests, and this is consistent with the study (Mohamed Jaber, 2010) that She referred to the production of training programs in a practical way.

The expert system based on artificial intelligence helped increase the practical skills of learning the three programming languages (Python - JavaScript - PHP), where students found it easy to navigate within it, which helped develop practical skills, as the expert system included multiple practical exercises that were trained during meetings At school. This helped to develop the practical side related to the skills of programming languages for students of STEM schools



**Figure (6): part of the student training The use of artificial intelligence helped me:**

Help to raise the student's ability to think.  
 It helps to raise the person's skills in using scientific sources and references.  
 It helps to highlight the personality of the learner in the educational process because it depends on self-learning.  
 The individual's attitude is positive, as he participates in the production of innovative projects, starting from defining the idea of the project until reaching writing the code and testing it.  
 Interested in the practical aspect of learning programming languages for students and seeks to raise the knowledge and skills of programming languages for students in order to produce innovative projects.

It seeks to create an individual who can face the difficulties of life and think scientifically.

Provide training in the method of thinking to reach the skills required to produce applications of artificial intelligence.

The individual learns through it the self-learning method because it teaches him how to learn and rely on himself in collecting facts and information.

This agrees with what was presented by the research of (Garst & Gagnon & Brawley, 2019).

- There are statistically significant differences at the level ( $\geq 0.05$ ) between the mean scores of the research group in achievement related to the basic skills of learning the three programming languages (Python - JavaScript - PHP) in the pre and post test in favor of the post achievement test.
- There are statistically significant differences at the level ( $\geq 0.05$ ) between the mean scores of the research group in the skill performance related to learning the three programming languages (Python - JavaScript - PHP) in the pre and post application in favor of the post application.
- The expert system for learning the three programming languages (Python - JavaScript - PHP) achieved a gain percentage in the achievement test score, and the performance practical application score, after following up on the use of the scientific material on the expert system.
- There is a positive correlation between the scores of students in the research group on the achievement test, and the application of the observation card for the skillful performance.
- The effectiveness of the expert system based on artificial intelligence while dealing with it through many links such as (programming languages expert - ask the expert system - expert system and code correction - expert system codes ..... ) which helped in the following:

The expert system helped in developing the achievement aspect related to the skills of dealing with learning the three programming languages (Python - JavaScript - PHP) among students of STEM schools.

The expert system website helped in developing the performance aspect of learning the three programming languages (Python - JavaScript - PHP) among students of STEM schools.

#### **Recommendations:**

Benefiting from the achievement test and the observation card that was used in evaluating the achievement and skill performance of students in the computer curriculum and as a guide to designing tools similar to other curricula.

Using the expert system to learn the three programming languages (Python - JavaScript - PHP) based on artificial intelligence to raise the level of performance and skills in programming languages and to produce innovative projects that serve the educational process and the environment surrounding students.

Using the expert system to test students on achievement exams and practical exams to measure achieving goals in learning programming languages and producing innovative projects.

Encouraging students to use the expert system while learning programming languages.

Paying attention to artificial intelligence research in order to enrich education technology research.

#### **Suggested Studies :**

- The current research was limited to dealing with the expert system in learning some programming languages in a comprehensive manner through three languages (Python - JavaScript - PHP), and therefore it is possible to deal with each axis in an independent research in more depth.
- Studying the impact of using the expert system through the Internet of Things in some courses such as: science, mathematics, studies and languages.
- The current research was limited to dealing with the independent variable on students of STEM schools, so it is possible that future research will deal with the different stages of education as well as students and mentors.
- Studying the effect of using the expert system using artificial intelligence on self-learning skills, and tendencies and attitudes towards learning programming languages.
- Studying the impact of learning programming languages and producing innovative projects and their impact on the security of the educational and economic communities.
- Studying other aspects of artificial intelligence such as machine learning and deep learning and its impact on the production of smart projects that serve the educational process.
- Studying programming languages with artificial intelligence through modern applications such as CHAT GPT and its role in spreading healthy behaviors in writing code among students.
- Research by employing expert systems for Egyptian school students in learning mathematics, science, computer and all scientific curricula because of its ability to transform these materials into an enjoyable method of learning.
- The expert system course through the Internet of Things in raising students' awareness in dealing with the Internet and programming smart projects in a better way.
- The impact of students practicing correct rules in writing code while dealing with programming languages and their role in providing job opportunities in the future.

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