Expert System to Improve and Develop Mathematic Teachers Skills

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***Abstract*—This work intends to improve the educational process through the development of teachers skills and raise the level of learning by reducing the problems and obstacles facing the teacher and providing many different learning methods. This is done through expert systems, which is one of the important fields of knowledge-based artificial intelligence, where the expert system acquires all the information acquired by the expert in the field of mathematics by transferring all his scientific experience and how the mathematics expert deals with it, so that the knowledge acquired by experts in the field of mathematics is collected. In order to prepare a knowledge base and deal with it through the expert system, as well as the possibility of making the expert system that the teacher deals with, ready to answer any inquiries or the possibility of explaining any part of the curriculum on demand.**

Keywords— Expert System, Mathematics, Artificial Intelligence, Teachers Skills.

I. INTRODUCTION

Artificial intelligence is among the issues that occupy all social and economic sectors, including the field of education. Artificial intelligence can help accelerate the process of achieving global education goals by reducing barriers to learning, and by providing the best ways to improve learning outcomes. The field of AIED, who is 30 years old, soon achieved some of the goals. The first computer-based systems for teaching in appearance are computer based training systems and computer aided instruction systems.

This type of systems help to bridge the gaps in the explanation that can occur during learning, and also helps to provide a guide for each educational group, meaning improving the ability of teachers to provide appropriate guidance, and in other words, the teacher needs to determine what he says, when to say it and how to say it, often teachers do not realize that there are gaps in their lectures and teaching materials that can leave students confused about certain concepts. And there may be things that human teachers can provide, machines cannot, for example, some special education programs based on artificial intelligence that can help students in mathematical principles, writing, and other subjects. These programs can teach students the basics, but so far they are not ideal for helping students learn thinking and creativity skills, something real teachers still need to facilitate. Never the less, that is must not eliminate the possibility that AI teachers can do these things in the future. With the rapid pace of technical progress that has characterized the past few decades, and from now on we will have to live with artificial intelligence.

In this expert system, we will work to improve the educational process by developing teachers' skills in elementary mathematics and solving the problems they face. We will have to improve this system by adding many important rules that help in solving problems and difficulties faced by the teacher or student teacher in elementary mathematics, as well as to give them the ability to make the right decision. We will discuss the human expert on elementary mathematics topics with the proven knowledge he has acquired, decide what to include in the expert system, formulate the concepts and relationships between them and explain this with graphics and figures, then start programming using the Python language and set the logical business rules that are represented in use from the conditional sentence "if... , then" Incorporating the facts.The rules are entered into the computer through a database called knowledge bases according to specific controls. Then, we will set up a thinking machine that applies the rules to all facts fed to the machine based on the knowledge base and test the system from By consulting with it about real problems and providing answers (suggested consultation) to experts in the field of knowledge and discussing them in with adjusting the knowledge base if necessary, and so on until the system is ready to work.

II. REVIEW OF OTHER METHODS

Most of the previous studies were directed to students or those who have a desire to learn a specific field , such as calculation of quantum numbers, description of electron configurations of atoms, determination of oxidation numbers and electronegativity [1] , also to assist learners in their English grammar distinctly and without difficulty [2] or to teach mathematics on the basis of multilingualism (Russian-Tatar English) for eighth graders [3] and ITSB tool was used to design educational system, which facilitates the study of the CSS and HTML language as well as overcoming the difficulties they face students [4].

Most studies agree on the use of rules-based systems in their work, because most systems do not have a great complexity that leads to the use of other techniques, and because most studies are educational studies, this requires understanding the problem and linking it to many rules and this requires a technique back chaining, in this paper we use the same this technique.

Also, many different techniques have been used to implement the expert system such as the use of programming languages and various tools (Prolog,ITSB). Our work in implementing and designing this system is based on the Python language.

In general, there are a lot of research work has been done in this field, but concerning the expert system to improve and develop mathematic teachers skills as we know there are not so many work related to this problem.

III. OVERVIEW OF AI AND EXPERT SYSTEM

From ancient times, inventors tried to make a machine like the human body, for example, the memory was replaced by the hard disk, and the body or spine was replaced by the mother board, but the most important component, thinking and intelligence, was lost, scientists tried to come to how the human thinking is how it works and how to increase intelligence Hence the emergence of artificial intelligence. Artificial intelligence is not a modern thing, but it appeared in 1956. By McCarthy Scientist who invited a group of programmers and mathematicians to try to teach the machine. It was during this period with Newell and Simon that a model called Logic Theorist appeared to solve a set of mathematical equations. And here the minds were indeed directed and artificial intelligence was born, and from here many horizons were opened for scientists to go far in artificial intelligence. Artificial intelligence is defined as the capability of instrument to accomplish mission that require human intelligence. Artificial Intelligence an area of computer science where in the cognitive functions of the human brain are studied and tried to be replicated on an instrument system. Artificial intelligence is used very widely in many different applications like computer vision, speech recognition, decision-making, perception, reasoning, cognitive capabilities, expert system, and so on [16].

The expert systems are programs that simulate the performance of a human expert in a particular field of expertise, by collecting and using the information and expertise of one or more experts in a particular field. In short, these systems were created in order to extract the expertise of experts, especially in rare disciplines, and include them in an expert system that replaces the human being and helps transfer these experiences to other people in addition to his ability to solve problems in a faster way than the human expert. In order for the expert system to achieve this target level of intelligence, the system must have both the knowledge base and the inference engine, where the knowledge base contains specialized knowledge in the field of accumulated experience processed by the expert or group of experts. This specialized knowledge includes facts, rules, concepts, and relationships. The inference engine is a knowledge processing that compares the available information about a given problem with the knowledge stored in the knowledge base and derives useful conclusions and recommendations. In addition to the knowledge base and the inference machine, the expert system needs to have an interface, a modular module that provides interpretation facilities. Fig.1. shown the main components of expert systems [17].

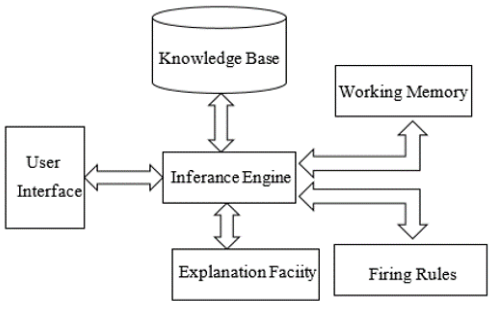

Figure 1: The main components of expert systems.

IV. THE IMPORTANCE OF ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS IN DEVELOPING THE EDUCATIONAL PROCESS

Intelligent applications and expert systems have helped learners break free from teaching in the traditional way or learning in one way. For example, intelligent tutoring applications and different education platforms that have become available to each learner according to their needs. Expert systems are a means to help overcome many of the barriers that make it difficult to ensure effective teacher access to every student and to overcome many of the challenges facing school systems, including teacher shortages and the lack of clear ways to develop them. By simplifying and automating essential teaching tasks for school leaders, AI embodying teacher's expertise has provided new options for tackling challenging conditions.

- When schools lack expert teachers, AI that embodies teacher’s expertise can go a long way toward increasing the effectiveness of existing teachers. Research shows that placing higher quality curricula and online learning materials at the disposal of lower-quality teachers can improve students’ academic performance.
- When expert teachers need to teach more than academic content, a growing body of research shows that deep learning and non-cognitive skills play an important role alongside content mastery in determining academic outcomes and student lives. Artificial intelligence that embodies teacher expertise gives teachers a greater ability to help students develop these important skills.
- Instead of seeing technological progress as a threat, teachers and education leaders must take advantage of the many ways technology and artificial intelligence can improve their work. Computers, non-expert teachers, and expert teachers have comparative advantages that complement each other. Computers are ideal for targeting core student content and skill gaps and providing teachers with timely assessment data.
- Teachers often suffer from a lot of office work, such as correcting exams and evaluating assignments. But AI can do many of these tasks, cutting down the time needed for correction and administrative work in order to devote more time to students.
- For the same grade, the options of "specialized services according to needs" provided by artificial intelligence techniques would help improve student’s enjoyment during lessons and improve their grades at the same time.
- Even outside the classroom, artificial intelligence technologies can provide the required support for the student. Students who learn the basic principles of reading, science, mathematics and other sciences rely mainly on the explanations from their teachers and parents to understand these foundations and rules. Since the time of teachers and parents is tight, this puts a lot of pressure on the different parties and the result may not be satisfactory. But when an intelligent and full-time assistant is available, who can understand the student’s psychology and know

his abilities, strengths and weaknesses, and the topics in which he suffers from lack of understanding or lack of information, then he can adapt the scientific material and even the entire educational process to suit the individual's capabilities. It provides the required assistance And the necessary support in a timely and appropriate manner for each individual student. On this basis, it is assumed that the results will be more positive, when each student, regardless of his family's financial capabilities, geographic location, or mental abilities, has a special teacher with the capabilities of scientists available at all times and places [19].

V. THE MODEL OF THE SYSTEM

The block diagram of ES used to improve and develop mathematic teacher's skills is shown in Fig.2. The details of the main stages of the system explained in the following sections.

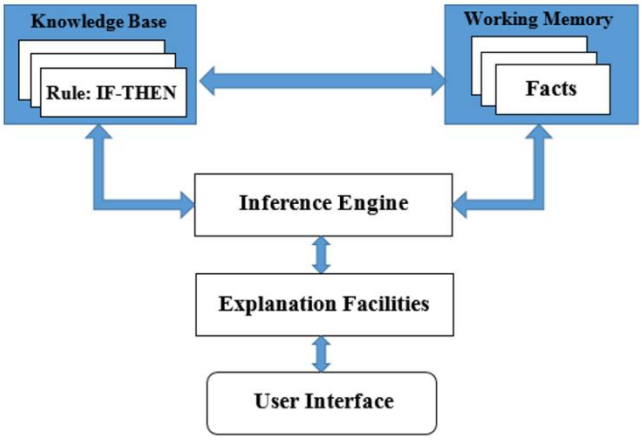

Figure 2: Block diagram of the Proposed System.

In the beginning, the goal of the system was to help teachers and develop their skills to raise the level of the educational process, so this project went through two main stages separate from the stages of the expert system. The stage of assembling problems or difficulties, a simple questionnaire was made to understand or reach the most complex mathematical concepts that the teacher struggles to convey to the student. After knowing these problems and difficulties, the role of the educational inspector comes to solve these problems facing the teacher, as well as developing an easy educational plan for the teacher to be able to communicate information to the student in a flexible manner, then start designing the system and choosing the most important algorithms and techniques that we will use. The most important stages of the proposed system are:

A. *Knowledge Base*

The knowledge can be represented in several ways in artificial intelligence, in this system the rules-based method was adopted, because the proposed system is clear and flexible in its dealings and there is no complexity that deserves the use of other methods.

1) Rule-Based Expert System: The rule-based is most commonly used type of knowledge representation, can be defined as an IF-THEN structure that relates given information or facts in the IF part to some action in the THEN part. A rule provides some description of how to solve a problem. Rules are relatively easy to create and understand. The Rules can represent relations, recommendations, directives, strategies and heuristics ,In this system, Heuristic rules is used as a method of representing knowledge , therefore to deal with the rules related to each other to reach a correct result.

B. *Working Memory*

The working memory represents the set of facts known about the domain. In an expert system, the WM typically contains information about the particular instance of the problem being addressed. For example, in our expert system, the WM contain the details of the teacher mathematics problems and the solution of them. The actual data represented in the WM depends on the type of application. The initial WM, for instance, can contain a priori information known to the system. The inference engine uses this information in conjunction with the rules in the knowledge base to derive additional information about the problem being solved.

C. *Inference Engine*

The inference engine carries out the reasoning whereby the expert system reaches a solution. It links the rules given in the knowledge base with the facts provided in the database. In a rule-based expert system, the domain knowledge is represented by a set of IF-THEN production rules and data is represented by a set of facts about the current situation. The inference engine compares each rule stored in the knowledge base with facts contained in the database. When the IF (condition) part of the rule matches a fact, the rule is fired and its THEN (action) part is executed. The matching of the rule IF parts to the facts produces inference chains. The inference chain indicates how an expert system applies the rules to reach a conclusion. They are two types of inference chain.

- Forward chaining is the data-driven reasoning. The reasoning starts from the known data and proceeds forward with that data. Each time only the topmost rule is executed. When fired, the rule adds a new fact in the database. Any rule can be executed only once. The match-fire cycle stops when no further rules can be fired. Forward chaining is a technique for gathering information and then inferring from it whatever can be inferred. Therefore, if our goal is to infer only one particular fact, the forward chaining inference technique would not be efficient. Fig.3. shown the forward chaining technique.

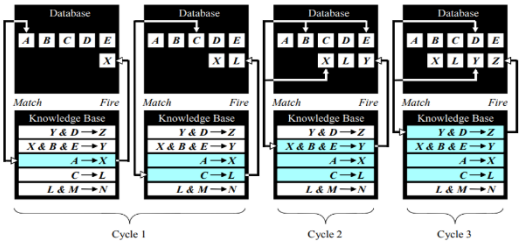

Figure 3: Forward Chaining Technique

- Backward chaining is the goal-driven reasoning. In backward chaining, an expert system has the goal (a hypothetical solution) and the inference engine

attempts to find the evidence to prove it. First, the knowledge base is searched to find rules that might have the desired solution. Such rules must have the goal in their THEN (action) parts. If such a rule is found and its IF (condition) part matches data in the database, then the rule is fired and the goal is proved. However, this is rarely the case. Thus the inference engine puts aside the rule it is working with (the rule is said to stack) and sets up a new goal, a sub goal, to prove the IF part of this rule. Then the knowledge base is searched again for rules that can prove the sub goal. The inference engine repeats the process of stacking the rules until no rules are found in the knowledge base to prove the current sub goal. Fig.4. shown the backward chaining technique.

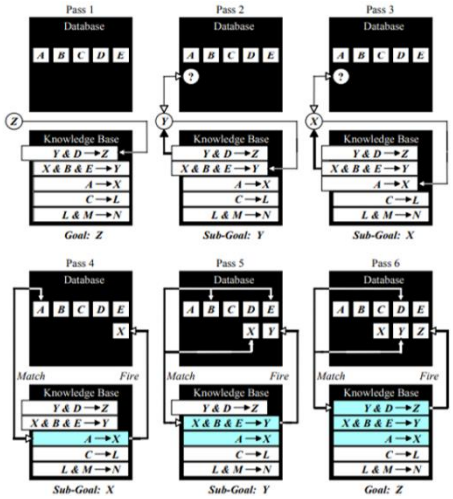

Figure 4: Backward Chaining Technique.

If an expert first needs to gather some information and then tries to infer from it whatever can be inferred, choose the forward chaining inference engine. However, if your expert begins with a hypothetical solution and then attempts to find facts to prove it, choose the backward chaining inference engine. In this project and because we need to ask the user several questions and connect them in the inference rule with each other, we used firstly the forward chaining then to back chaining to find facts. Fig.5. and Fig.6. Shown part of an inference chain of the system.

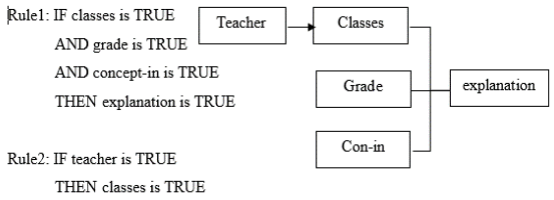

Figure 5: Inference chain of available concept.

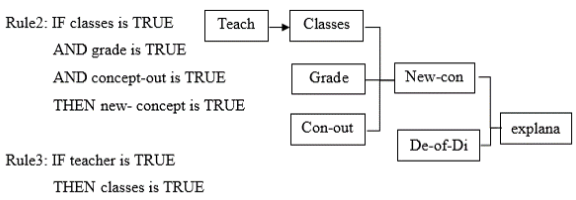

Figure 6: Inference chain of not available concept.

D. *Explanation Facilities*

Enable the user to ask the expert system how a particular conclusion is reached and why a specific fact is needed. An expert system must be able to explain its reasoning and justify its advice, analysis or conclusion.

E. *The User Interface*

A user interface is the means of communication between a user seeking a solution to the problem and an expert system. These can be through dialog boxes, command prompts, forms, or other input methods.

VI. THE DECISION TREE OF THE SYSTEM

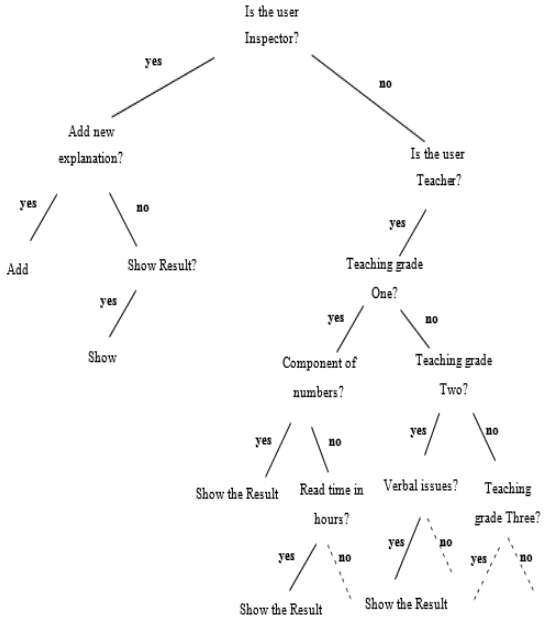

Figure 7: Decision tree about Knowledge of the system.

VII. THE IMPLEMENTATION OF THE SYSTEM

A. *The System Interface*

We have used Python programming language for implement the proposed system architecture. We have designed and implemented the main screen as GUI as shown in Fig.8. This GUI enabled us to use and apply the system processes or functions. It's contains two main control buttons.

Figure 8: The GUI of the system

B. *The Teacher Button*

The teacher button takes you to another page that allows you to choose the appropriate class and math concept you need as shown in Fig.9.

Figure 9: The teacher window

1) Available or not Available: After clicking on the Enter button, the data will be sent to the system, and one of three windows will appear.

- In the event that you did not enter the class information or the mathematical concept, a message will appear informing you of this. As shown in the Fig.10.

Figure 10: Enter the information.

- In case the data was entered correctly and was sent to the Knowledge Engine to choose the appropriate base to display the required information, if any. You will see the appropriate figure of the information, such as the Fig.11

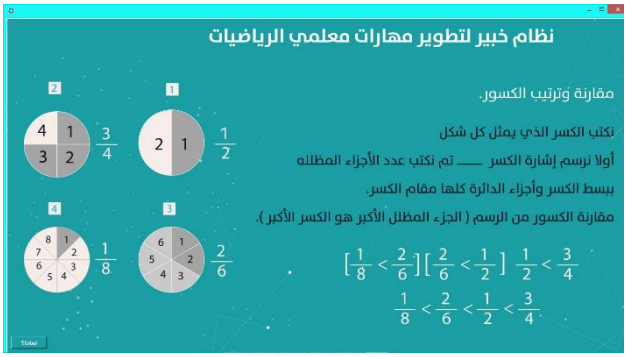

Figure 11: The required information

- As you read the information, you may be curious about how to access it, so when you click on the Why button, a window will appear telling you some of the details we are using to reach the answer you asked in the past.as shown in Fig.12.

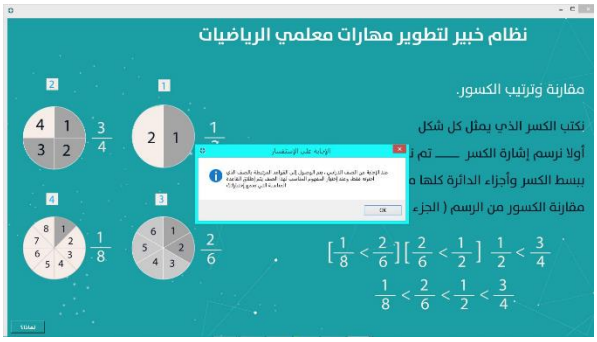

Figure 12: The window of Why button.

- In some cases or concepts, we do not have enough information about them, so the window shown in Fig.13. will tell you some details and allow you to enter the degree of difficulty of the desired mathematical concept.

Figure 13: There is not enough information.

C. *Educational Inspector Button*

After you enter a mathematical concept that we do not have enough information on, and after choosing its degree of difficulty, we send this data to the educational inspector so that he can answer the most frequent concept and has the highest degree of difficulty, to answer it at a later time by clicking on the Add button (this button can be worked on in the future work). Fig.14. shows the educational inspector screen, Fig.15. Shown the message box of Add button.

Figure 14: Educational inspector window.

Figure 15: The message box of Add button.

VIII. EXPERIMENTAL RESULTS

The system was developed by the programming language Python, and the system was designed to be a system able to help the teacher with some mathematical concepts that the teacher finds difficult to explain to the student or sees that the student does not understand them easily, but in the some cases the system does not include a solution to all concepts, but it is able to take the concept that has difficulty and send it to the educational inspector to answer it. In addition, the system can be used as a sub-system under any other system, this means that a subsystem of an electronic platform or mobile application ..... etc.

IX. CONCLUSION

According to the results, the use of expert systems in education can simplify the process of teaching subjects, in our case, mathematics. Proper use of the system can significantly reduce the problems and difficulties of working on the teacher, save more time for self-development and improve professional mathematical competence.

In our system, mathematical concepts were included, in which the teacher had difficulty explaining them to the student, and these concepts were explained in a smooth and enjoyable way to students by domain experts, so that the rules were applied to these facts and linked to each other to deduce the correct understanding that the teacher wanted. These steps were carried out through several different stages and techniques One of the main stages in the system is to know the problems and difficulties as well as the facts that they meet in the solution by sitting and discussing with mathematics teachers to find out their problems with the educational inspector to solve these problems and difficulties, then comes the stage of creating the rules based system (IF-THEN Rules) necessary for the system and which will be matched with the facts, then the stage of applying the hybrid inference engine (forward and backward) chaining to these facts to reach the result that the teacher (the user) wants, with the possibility of asking the teacher or the user how to reach this result to solve the teacher's problem, and finally the user interface to help the teacher enter Some data that helps us to reach the appropriate and desired result.

As a future work, it is necessary to plan the development of the system and cover all the mathematical concepts as well as to connect this subsystem to a main system such as a website, mobile or desktop application in order to test the system in a real-life environment, and because it is very important Establishing a modern educational system that raises the level of teacher efficiency.

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