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# Survey of Intelligent Tutoring Systems Up To the End of 2016

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***Abstract:*** *The main goals of Intelligent Tutoring Systems (ITS) are: providing highly developed instructional guidance on a one-to-one foundation that is improved than what is attained with traditional computer aided instruction and is analogous to that of a decent human tutor; and developing and testing models of intelligent processes associated with instruction. ITS is a subfield of artificial intelligence. ITS consists of four interacting components: the student model which embodies the student's present knowledge state, the pedagogical module which comprises appropriate instructional measures which are depending on the content of the student model, the knowledge model which contains the domain knowledge, and the user interface model which permits an effective dialog among ITS and the user. Usually, the knowledge model is the central part in the instructional process but there is a diversity of approaches that also put the stress on the other components. In this paper we survey the existing intelligent tutoring system found in the literature prior to publishing it. There might be other intelligent tutoring systems that we have missed; but when found, they will be added to the next release of the intelligent tutoring systems survey.*

**Keywords**: Intelligent Tutoring System, Survey, Al-Azhar University, ITS

## 1. INTRODUCTION

Since the 1970s, Artificial Intelligence and it's techniques have been integrated into the field of education and learning in challenges to create pedagogically valuable computer artifacts that can one day take the place of a human instructor or turn out to be a great tool for them in conveying knowledge with easiness, these systems have occupied various forms from Computer Aided Instruction(CAI) media until lastly Intelligent Tutoring Systems came to life. Computer based Intelligent Tutoring Systems provide a auspicious preference for serving students get ready for high stakes valuations. Latest growths on intelligent tutoring systems have clearly proved that users of tutoring systems can make swift improvement and radically enhance their performance in precise areas and skills. There has been great enhancement from early e-learning systems to the current ITS, establishing systems that can provide a wide variety of multimedia for facilitating learning and a diversity of analysis techniques which provide students with optimal motivation and evaluation to maximize their limits.

Abu Naser defines it as: "An Intelligent Tutoring System (ITS) is software that aims to provide immediate and customized instruction or feedback to learners, typically without interference from a human teacher. ITS has the general aim to facilitates learning in an evocative and efficient way by using diversity of computing technologies"[1].

## 2. ARCHITECTURE OF INTELLIGENT TUTORING SYSTEM

A typical ITS has the following four basic components (as shown in figure 1):

- The *knowledge model*
- The Student model
- The *pedagogical* model, and
- The User interface model.

The section below lists them with their functionality, individually and then by way of their integration.

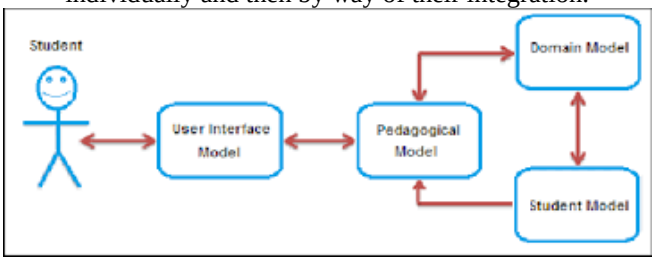


***Figure 1: Typical ITS architecture***

### 1.1 *Knowledge* model

*Knowledge model is sometimes called* Domain Model. It contains the knowledge about the actual teaching material (e.g. physics, computer science and mathematics).
Domain Model represents the domain knowledge and how the expert performs in the domain of knowledge.

### 1.2 *Student model*

It observes student's behavior and creates a qualitative representation of her/his cognitive and affective knowledge. Its purpose is to provide knowledge that is used to determine the conditions for adjusting feedback. It supplies data to other tutor modules.
A primary goal for the student model is to ensure that the system has principled knowledge about each student, so it can respond effectively, engage students' interest, and promote learning [4,6].
There are three techniques to represent the student's misconceptions [3]:

1. The overlay model: This model tries to compare the behavior of a student with the behavior of an expert. The difference between those two states

can be seen as the skills and knowledge the student has not gained yet.

2. The perturbation model: This model adds bug library to the overlay model. It tries to model the student not only with regard to the correct knowledge but additionally with regard to known errors and misconceptions in the domain.
3. Another type of student modeling is the learner-based modeling. The focus of learner-based modeling lies in the process of knowledge acquisition because the misconceptions are produced during that process. Problem solving rules which explain the steps taken until a misconception was created by the student, can be generated by utilizing machine learning techniques.

**1.3 *Pedagogical model*:**

It is called sometimes teaching model or expert model, it provides the knowledge infrastructure to select and plan the teaching elements according to the student model. It selects the suitable action (e.g. feedback or providing a hint) in order to react to the student's interaction with the system. Pedagogical model works depending on the teaching strategy adopted by the system, taking care of student's time of respond and student's profile.

The main tasks of the expert model are summarized. It should [3]:

- select the content that is displayed by the communication model,
- select a tutoring strategy depending on the learning process,`
- control and adjust the speed of tutoring actions,
- select and generate questions to check the learning progress,
- select and generate constructive feedback,
- provide assistances and additional information to deal with gaps in student's knowledge,
- take actions to guarantee student's motivation during instruction.

**1.4 *User interface model:***

It is also called communication model. It is responsible of the interaction between learner and system. The communication between the learner and the system can be of various types. The authors mention some of them:[6]

1) GRAPHIC COMMUNICATION, which can be of the following types:
   a. Animated pedagogical agents. They are intelligent computer characters that guide learners through an environment.
   b. Synthetic humans. They are pedagogical AI agents rendered as realistic human characters.
   c. Virtual reality. It immerses students in a graphic environment that includes the pedagogical agent.
2) SOCIAL INTELLIGENCE: emotional and social connection. This is done by:
   a. verbal analysis (e.g. problem-solving time, mistakes, and help requests)
   b. Visual systems, this includes facial emotion recognition, understanding eye movement.
   c. Metabolic indicators. Student's affective states are sensed by noninvasive physiological devices (i.e. Devices that do not puncture the skin or entering a body cavity), that measure heart rate change, voice inflections, eye and body movements.
   d. Speech Cue recognition. Negative, neutral, and positive emotions can be extracted using speech cues. The best performing feature set contained both acoustic-prosodic and other types of linguistic features [6].

3) COMPONENT INTERFACES: These interfaces process student input (understand formulas, equations, vectors) or evaluate symbols specific to discipline (e.g., molecular biology, chemistry)[6].

4) NATURAL LANGUAGE COMMUNICATION.

There are four types of natural language-based tutors :

   a. Mixed Initiative Dialogue: either tutor or students initiate and direct the conversation.
   b. Single-Initiative Dialogue Tutor: considers students' previous and next utterance; but only the tutor has true initiative.
   c. Directed Dialogue: tutor remains in control and prompts students for explicit information. Tutor understands short student answers and generates NL explanations.
   d. Finessed Dialogue: dialogue is simulated through menu-based input, logical forms, or semantic grammars [6].

## 3. Overview of Existing Intelligent Tutoring Systems

In the following section, the authors will list the Intelligent Tutoring Systems from older to new ones.

### ► ELM-ART: An intelligent tutoring system on world wide web

This paper discusses the problems of developing WWW-available ITS and, in particular, the problem of porting existing ITS to a WWW platform. The authors present the system ELM-ART which is a WWW-based ITS to support learning programming in Lisp. ELM-ART demonstrates how several known ITS technologies can be implemented in WWW context [7].

► **An Intelligent Tutoring System for Deaf Learners of Written English**

This paper describes progress toward a prototype implementation of a tool which aims to improve literacy in deaf high school and college students who are native (or near native) signers of American Sign Language (ASL). The authors envision a system that will take a piece of text written by a deaf student, analyze that text for grammatical errors, and engage that student in a tutorial dialogue, enabling the student to generate appropriate corrections to the text. A strong focus of this work is to develop a system which adapts this process to the knowledge level and learning strengths of the user and which has the flexibility to engage in multi-modal, multi-lingual tutorial instruction utilizing both English and the native language of the user [8].

► **Network-based intelligent tutoring system**

A technique for providing a networked, distributed tutorial application having a direct manipulation graphical user interface displayable on an Internet client node is disclosed. The application has a first portion on an Internet server node and a second portion on the Internet client node, the first portion performing application specific subject matter processing and the second portion being substantially application independent in that this second portion is applicable in a wide variety of tutoring applications for generating and maintaining an appropriate user interface during user interactions. The second portion includes an Internet browser (e.g., a hypertext mark-up language browser) that is utilized for communicating with the server node to perform application subject matter specific processing. A user being tutored may create, delete or modify graphical objects whose data structure definitions are provided by the server node, each such object having, for example, a behavior or data structure representing the semantics of a tutorial subject matter entity. Such user interactions are accumulated and utilized on the client node to maintain, independently of any communication with the server node, an interactive user interface semantically consistent with both the tutorial application and the user's interactions [9].

► **CAPIT: an intelligent tutoring system for capitalizations and punctuation**

The authors describe a new Intelligent Tutoring System (ITS) that teaches the mechanical rules of English capitalization and punctuation. Students must interactively capitalize and punctuate short pieces of unpunctuated, lower case text (the completion exercise). The system represents the domain as a set of constraints specifying the correct patterns of punctuation and capitalization, and feedback is given on violated constraints. The ITS was evaluated during several sessions in a classroom of 10-11 year old school children. The results show that the children effectively mastered the 25 rules represented in the system [10].

► **A comparative study between Animated Intelligent Tutoring Systems "AITS" and Videobased Intelligent Tutoring Systems "VITS"**

This paper investigates the effect of using Animated Intelligent Tutoring Systems and Video-based Intelligent Tutoring Systems on the performance of first year biology students in Al-Azhar University, Gaza. The results indicated that there is an advantage of using Video-based Intelligent Tutoring Systems over Animated Intelligent Tutoring Systems and traditional method of teaching; Furthermore, the study indicated that ITS improved the performance of students in biology exams. Also. sex and instructors were not found effective factors in the use of ITS programs. The study showed a strong relationship between student performance in exams and student evaluation of ITS programs[11].

► **An Intelligent Tutoring System for Entity Relationship Modeling**

The paper presents KERMIT, a Knowledge-based Entity Relationship modeling Intelligent Tutor. KERMIT is a problem-solving environment for the university-level students, in which they can practise conceptual database design using the Entity-Relationship data model. KERMIT uses Constraint-Based Modelling (CBM) to model the domain knowledge and generate student models. The authors have used CBM previously in tutors that teach SQL and English punctuation rules. The research presented in this paper is significant because The authors show that CBM can be used to support students learning design tasks, which are very different from domains The authors dealt with in earlier tutors. The paper describes the system's architecture and functionality. The system observes students' actions and adapts to their knowledge and learning abilities. KERMIT has been evaluated in the context of genuine teaching activities. The authors present the results of two evaluation studies with students taking database courses, which show that KERMIT is an effective system. The students have enjoyed the system's adaptability and found it a valuable asset to their learning [12].

► **ITSPOKE: an intelligent tutoring spoken dialogue system**

ITSPOKE is a spoken dialogue system that uses the Why2-Atlas text-based tutoring system as its "back-end". A student first types a natural language answer to a qualitative physics problem. ITSPOKE then engages the student in a spoken dialogue to provide feedback and correct misconceptions, and to elicit more complete explanations. The authors are using ITSPOKE to

generate an empirically-based understanding of the ramifications of adding spoken language capabilities to text-based dialogue tutors[13].

- **ActiveMath: An Intelligent Tutoring System for Mathematics**

ActiveMath is a web-based intelligent tutoring system for mathematics. This article presents the technical and pedagogical goals of ActiveMath, its principles of design and architecture, its knowledge representation, and its adaptive behavior. In particular, The authors concentrate on those features that rely on AI-techniques [14].

- **KGTutor: A Knowledge Grid Based Intelligent Tutoring System**

This paper proposes an authoring model for the construction of intelligent tutoring systems in a more pleasant and effective manner. In return, a Knowledge Grid based intelligent tutoring system KGTutor is constructed to better support the distributed, student-centered and highly interactive learning approach. The kernel of the system is to organize course into a "concept space" rather than a "page space". Students' characteristics, such as background knowledge and learning styles, are used for selecting, organizing, and delivering the learning materials to individual students. During the learning progress, the system can also provide objective assessments and personalized suggestions for students according to their learning performance. An authoring tool and KGTutor prototype have been developed to support the proposed approach [15].

- **Mathtutor: A Multi-Agent Intelligent Tutoring System**

In this paper the authors propose a multi-agent intelligent tutoring system building tool that integrates different formalisms in order to facilitate the teacher task of developing the contents of a tutorial system and at the same time to provide adaptiveness and flexibility in the presentation. The adopted formalisms are ground logic terms for the student model, data-bases for the domain model and object Petri nets for the pedagogical model. The interaction between the student and each agent of the system is controlled by an object Petri net, automatically translated into a rule-based expert system. The object Petri net tokens are composed by data objects that contain pointers to the student model and to the domain knowledge, stored into a data-base of texts, examples and exercises. The object Petri net transitions are controlled by logical conditions that refer to the student model and the firing of these transitions produce actions that update this student model [16].

- **The Andes Physics Tutoring System: Lessons Learned**

The Andes system demonstrates that student learning can be significantly increased by upgrading only their homework problem-solving support. Although Andes is called an intelligent tutoring system, it actually replaces only the students' pencil and paper as they do problem-solving homework. Students do the same problems as before, study the same textbook, and attend the same lectures, labs and recitations. Five years of experimentation at the United States Naval Academy indicates that Andes significantly improves student learning. Andes' key feature appears to be the grain-size of interaction. Whereas most tutoring systems have students enter only the answer to a problem, Andes has students enter a whole derivation, which may consist of many steps, such as drawing vectors, drawing coordinate systems, defining variables and writing equations. Andes gives feedback after each step. When the student asks for help in the middle of problem-solving, Andes gives hints on what's wrong with an incorrect step or on what kind of step to do next. Thus, the grain size of Andes' interaction is a single step in solving the problem, whereas the grain size of a typical tutoring system's interaction is the answer to the problem. This report is a comprehensive description of Andes. It describes Andes' pedagogical principles and features, the system design and implementation, the evaluations of pedagogical effectiveness, and our plans for dissemination [17].

- **Integrating Affect Sensors in an Intelligent Tutoring System**

This project augments an existing intelligent tutoring system (AutoTutor) that helps learners construct explanations by interacting with them in natural language and helping them use simulation environments. The research aims to develop an agile learning environment that is sensitive to a learner's affective state, presuming that this will promote learning. The authors integrate state-of-the-art, nonintrusive, affect-sensing technology with AutoTutor in an endeavor to classify emotions on the bases of facial expressions, gross body movements, and conversational cues. This paper sketches our broad theoretical approach, our methods for data collection and evaluation, and our emotion classification techniques [18].

- **AutoTutor: an intelligent tutoring system with mixed-initiative dialogue**

AutoTutor simulates a human tutor by holding a conversation with the learner in natural language. The dialogue is augmented by an animated conversational agent and three-dimensional (3-D) interactive simulations in order to enhance the learner's engagement and the depth of the learning. Grounded in constructivist learning theories and tutoring research, AutoTutor

achieves learning gains of approximately 0.8 sigma (nearly one letter grade), depending on the learning measure and comparison condition. The computational architecture of the system uses the .NET framework and has simplified deployment for classroom trials [19].

- **COLLECT-UML: Supporting Individual and Collaborative Learning of UML Class Diagrams in a Constraint-Based Intelligent Tutoring System**

Automatic analysis of interaction and support for group learning through a distance collaborative learning system is at the forefront of educational technology. Research shows that collaborative learning provides an environment to enrich the learning process by introducing interactive partners into an educational system. Many collaborative learning environments have been proposed and used with more or less success. Researchers have been exploring different approaches to analyses and support the collaborative learning interaction. However, the concept of supporting peer-to-peer interaction in Computer-Supported Collaborative Learning (CSCL) systems is still in its infancy, and more studies are needed that test the utility of these techniques. This paper proposes an Intelligent CSCL system that uses Constraint-Based Modeling (CBM) approach, to support collaborative learning addressing both collaborative issues and task-oriented issues. The system supports the tertiary students learning Object-Oriented Analysis and Design using UML. The CBM approach is extremely efficient, and it overcomes many problems that other student modeling approaches suffer. CBM has been used successfully in several tutors supporting individual learning. The comprehensive evaluation studies of this research will provide a measure of the effectiveness of using CBM technique in Intelligent CSCL environments [20].

- **Adapting to When Students Game an Intelligent Tutoring System**

In this paper, the authors introduce a system which gives a gaming student supplementary exercises focused on exactly the material the student bypassed by gaming, and which also expresses negative emotion to gaming students through an animated agent. Students using this system engage in less gaming, and students who receive many supplemental exercises have considerably better learning than is associated with gaming in the control condition or prior studies [21].

- **A web-based bayesian intelligent tutoring system for computer programming**

In this paper, the authors present a Web-based intelligent tutoring system, called BITS. The decision making process conducted in our intelligent system is guided by a Bayesian network approach to support students in learning computer programming. Our system takes full advantage of Bayesian networks, which are a formal framework for uncertainty management in Artificial Intelligence based on probability theory. The authors discuss how to employ Bayesian networks as an inference engine to guide the students' learning processes. In addition, the authors describe the architecture of BITS and the role of each module in the system. Whereas many tutoring systems are static HTML Web pages of a class textbook or lecture notes, our intelligent system can help a student navigate through the online course materials, recommend learning goals, and generate appropriate reading sequences [22].

- **An intelligent tutoring system for visual classification problem solving**

The manuscript describes the development of a general intelligent tutoring system for teaching visual classification problem solving. Materials and methods: The approach is informed by cognitive theory, previous empirical work on expertise in diagnostic problem-solving, and our own prior work describing the development of expertise in pathology. The architecture incorporates aspects of cognitive tutoring system and knowledge-based system design within the framework of the unified problem-solving method description language component model. Based on the domain ontology, domain task ontology and case data, the abstract problem-solving methods of the expert model create a dynamic solution graph. Student interaction with the solution graph is filtered through an instructional layer, which is created by a second set of abstract problem-solving methods and pedagogic ontologies, in response to the current state of the student model. Results: In this paper, The authors outline the empirically derived requirements and design principles, describe the knowledge representation and dynamic solution graph, detail the functioning of the instructional layer, and demonstrate two implemented interfaces to the system. Conclusion: Using the general visual classification tutor, The authors have created SlideTutor, a tutoring system for microscopic diagnosis of inflammatory diseases of skin [23].

- **An intelligent tutoring system for circuit analysis**

The Interactive Multimedia Intelligent Tutoring System (IMITS) is designed to assist electrical engineering undergraduate students taking their first circuits courses. The IMITS system places the student in a real-life engineering scenario in which the student is a newly hired engineer within the fictional IMITS Corporation and given "real-life" problems to solve, corresponding to course material. The office has file cabinets, bookshelves, a printer, and a personal computer. The personal computer allows the student to receive televideo messages, receive "e-mail", and send "e-mail"

reports to senior engineers. A feature of IMITS is that the student decides which actions to take and may validate analyses and designs using a virtual laboratory incorporated with the software. A brief historical perspective of intelligent tutoring systems is presented, followed by an explanation of their architecture. Next, a detailed description of the intelligent tutoring system IMITS is given. Then the results of usability and effectiveness evaluations of the software are given[24].

- **Intelligent tutoring system for teaching database to sophomore students in Gaza and its effect on their performance**

This study presents an Intelligent Tutoring System called DB-ITS for teaching database to sophomore students in computer science in Al-Azhar University. DB-ITS is designed as a guided learning environment and supports problem solving. An evaluation was carried out using DB-ITS to see if students performance in the database exams using DB-ITS is enhanced. The results indicated that the advantage of using DB-ITS over the conventional methods, the use of ITS was effective in improving students' performance in exams and gender had no effect on the use of the ITS program designs in our study; furthermore, the removal of multimedia effects reduced the advantages of using ITS[25].

- **JEE-Tutor: An Intelligent Tutoring System For Java Expressions Evaluation,**

This study presents an Intelligent Tutoring System called JEE-Tutor for teaching Java operator precedence, associativity and expressions evaluation to freshman students in the Faculty of Engineering and Information Technology in Al-Azhar University. An overview of the JEE-Tutor architectural design and user interface will be discussed. According to the success of other similar Intelligent Tutoring Systems, it is also hypothesized that students will be able to learn operator precedence, associativity, expressions evaluation and gain knowledge more quickly and effectively than students using traditional methods of teaching [26].

- **Developing an intelligent tutoring system for students learning to program in C++**

The aim of this study is developing an intelligent tutoring system for helping students enrolled in computer sciences 1 (an introductory C++ programming course) at the Faculty of Engineering and Information technology in Al-Azhar University. The C++ Intelligent Tutoring System is called CPP-Tutor. In this paper The authors present an overview of the CPP-Tutor architectural design and user interface. This pilot project is for constructing a model domain of a subset of the C++ programming language. The completed project will be sufficient to prove the concept and that a fully developed C++ Intelligent Tutoring System will provide an interactive learning environment for students. According to the success of other similar Intelligent Tutoring Systems, it is also hypothesized that students will be able to learn to program in C++ and gain knowledge more quickly and effectively than students using traditional methods of teaching [27].

- **An Agent Based Intelligent Tutoring System For Parameter Passing In Java Programming**

The authors have developed an agent based intelligent tutoring system for the parameter passing mechanisms in computer science (2), an introductory Java programming language, in Al-Azhar University in Gaza. The agent based intelligent tutoring system helps students better understand parameter passing mechanisms in Java using problem based technique. In this paper, The authors will describe the architectural design and features of the agent based intelligent tutoring system. An initial evaluation of effectiveness of the system was carried out and the result was found to be positive. The evaluation confirmed the established hypothesis that using the intelligent tutoring system would result in an improvement in the learning of the students[28].

- **Evaluating an Intelligent Tutoring System for Making Legal Arguments with Hypotheticals**

In this paper the authors present a formative evaluation of LARGO (Legal ARgument Graph Observer), a system that enables law students graphically to represent examples of legal interpretation with hypotheticals they observe while reading texts of U.S. Supreme Court oral arguments. The authors hypothesized that, compared to a text-based alternative; LARGO's diagramming language geared toward depicting hypothetical reasoning processes, coupled with non-directive feedback, helps students better extract the important information from argument transcripts and better learn argumentation skills. A first pilot study, conducted with volunteer first-semester law students, provided support for the hypothesis. The system especially helped lower-aptitude students learn argumentation skills, and LARGO improved the reading skills of students as they studied expert arguments. A second study with LARGO was conducted as a mandatory part of a first-semester University law course. Although there were no differences in the learning outcomes of the two conditions, the second study showed some evidence that those students who engaged more with the argument diagrams through the advice did better than the text condition. One lesson learned from these two studies is that graphical representations in intelligent tutoring systems for the ill-defined domain of argumentation may still be better than text, but that engagement is essential [29].

- **Evaluating the Effectiveness of the CPP-Tutor, an Intelligent Tutoring System for Students Learning to Program in C++**

In an attempt to support the growing development of the C++ programming language and to press forward web-based tailored teaching, the C++ Intelligent Tutoring System (CPP-Tutor) was designed and developed. CPP-Tutor expertly checks the student's submitted solution and determines the appropriate feedback. In this research, the authors describe an experiment in which The authors try to measure the effectiveness of the CPP-Tutor. This was accomplished by comparing the traditional method of teaching (instructor and textbook) and CPP-Tutor of an introductory course in C++ programming to freshman students in the faculty of Engineering and Information Technology of Al-Azhar University in Gaza. A group of students were taught C++ programming concepts using CPP-Tutor and a second group was taught the same concepts in parallel by traditional methods of teaching. Both groups were coordinated for similar background knowledge of the topics being taught. Post testing revealed that the CPP-Tutor group achieved significantly higher scores than the group taught using the traditional method. Furthermore, The CPP-Tutor group showed that the retention of specific topic of knowledge was better than the traditional method group [30].

- **Thermo-Tutor: An Intelligent Tutoring System for thermodynamics**

The authors present the design and an evaluation of Thermo-Tutor, an Intelligent Tutoring System (ITS) that teaches thermodynamic cycles in closed systems. Thermo-Tutor provides opportunities for students to practice their skills by solving problems. When a student submits a solution, Thermo-Tutor analyzes it and provides appropriate feedback. The authors discuss the support for problem solving, and the student model the ITS maintains. An initial evaluation of Thermo-Tutor was performed at the University of Canterbury. The findings show that the ITS supports student learning effectively [31].

- **An intelligent tutoring system for learning java objects**

The paper describes the design of a web based intelligent tutoring system for teaching Java objects to students to overcome the difficulties they face. The basic idea of this system is a systematic introduction into the concept of Java objects. The system presents the topic of Java objects and administers automatically generated problems for the students to solve. The system is dynamically adapted at run time to the student's individual progress. The system provides explicit support for adaptive presentation constructs. An initial evaluation study was done to investigate the effect of using the intelligent tutoring system on the performance of students enrolled in computer science III in the Faculty of Engineering and Information technology at Al-Azhar University, Gaza. The results showed a positive impact on the evaluators [32].

- **Human Computer Interaction Design of the LP-ITS: Linear Programming Intelligent Tutoring Systems**

The Linear Programming Intelligent Tutoring System (LP-ITS) was designed and developed in an effort to help students who are facing problems in linear programming. This tutoring system is unique in several ways. Most programming tutoring systems require the instructor to creator problems with corresponding solutions. LP-ITS, on the other hand, generate the problem and solution automatically. LP-ITS analyzes the student's solution step by step to determine the weak points of the student and intelligently guides the student towards the correct solution of the linear programming problem. LP-ITS is intended to be used by students enrolled in Linear Programming course at the University level. This paper discusses the Human Computer Interaction (HCI) design elements in the LP-ITS for improving the Linear programming Intelligent Tutoring System. LP-ITS has been and is currently being field-tested by students enrolled in Operations Research in the Faculty of Engineering and Information Technology at Al-Azhar University in Gaza [33].

- **A conversational intelligent tutoring system to automatically predict learning styles**

This paper proposes a generic methodology and architecture for developing a novel conversational intelligent tutoring system (CITS) called Oscar that leads a tutoring conversation and dynamically predicts and adapts to a student's learning style. Oscar aims to mimic a human tutor by implicitly modeling the learning style during tutoring, and personalizing the tutorial to boost confidence and improve the effectiveness of the learning experience. Learners can intuitively explore and discuss topics in natural language, helping to establish a deeper understanding of the topic. The Oscar CITS methodology and architecture are independent of the learning styles model and tutoring subject domain. Oscar CITS was implemented using the Index of Learning Styles (ILS) model to deliver an SQL tutorial. Empirical studies involving real students have validated the prediction of learning styles in a real-world teaching/learning environment. The results showed that all learning styles in the ILS model were successfully predicted from a natural language tutoring conversation, with an accuracy of 61–100%. Participants also found Oscar's tutoring helpful and achieved an average learning gain of 13% [34].

- **Predicting Learners Performance Using Artificial Neural Networks In Linear Programming Intelligent Tutoring System**

In this paper, the authors present a technique that employ Artificial Neural Networks and expert systems to obtain knowledge for the learner model in the Linear Programming Intelligent Tutoring System(LP-ITS) to be able to determine the academic performance level of the learners in order to offer him/her the proper difficulty level of linear programming problems to solve. LP-ITS uses Feed forward Back-propagation algorithm to be trained with a group of learners data to predict their academic performance. Furthermore, LP-ITS uses an Expert System to decide the proper difficulty level that is suitable with the predicted academic performance of the learner. Several tests have been carried out to examine adherence to real time data. The accuracy of predicting the performance of the learners is very high and thus states that the Artificial Neural Network is skilled enough to make suitable predictions [35].

- **A Qualitative Study of LP-ITS: Linear Programming Intelligent Tutoring System**

This paper is an attempt to evaluate the Linear Programming Intelligent Tutoring System on the basis of perspective and experiences of instructors and students who used the system in the Faculty of Engineering & Information Technology at Al-Azhar University in Gaza. A phenomenological method, with a focal point group was used. The first objective of this study was to discuss the important aspects of the design and development of LP-ITS. The second was to evaluate LP-ITS on the basis of instructors and students experiences. The third was to explore the perspectives of students and instructors about the implication of LP-ITS skills in lecture hall situations. The results were discussed in terms of the evaluation of the LP-ITS and its implications for learning and teaching activities in the lecture hall [36].

- **The PHP Intelligent Tutoring System**

Teaching introductory programming has challenged educators through the years. Although Intelligent Tutoring Systems that teach programming have been developed to try to reduce the problem, none have been developed to teach web programming. This paper describes the design and evaluation of the PHP Intelligent Tutoring System (PHP ITS) which addresses this problem. The evaluation process showed that students who used the PHP ITS showed a significant improvement in test scores [37].

- **Predicting College Enrollment from Student Interaction with an Intelligent Tutoring System in Middle School**

Research shows that middle school is an important juncture for a student where he or she starts to be conscious about academic achievement and thinks about college attendance. It is already known that access to financial resources, family background, career aspirations and academic ability are indicative of a student's choice to attend college; though these variables are interesting, they do not necessarily give sufficient actionable information to instructors or guidance counselors to intervene for individual students. However, increasing numbers of students are using educational software at this phase of their education, and detectors of specific aspects of student learning and engagement have been developed for these types of learning environments. If these types of models can be used to predict college attendance, it may provide more actionable information than the previous generation of predictive models. In this paper, The authors predict college attendance from these types of detectors, in the context of 3,747 students using the ASSISTment system in New England, producing detection that is both successful and potentially more actionable than previous approaches; The authors can distinguish between a student who will attend college and a student who will not attend college 68.6% of the time [38] .

- **JavaTutor: An Intelligent Tutoring System that Adapts to Cognitive and Affective States during Computer Programming**

Introductory computer science courses cultivate the next generation of computer scientists. The impressions students take away from these courses are crucial, setting the tone for the rest of the students' computer science education. It is known that students struggle with many concepts central to computer science, struggles that could be alleviated in part through hands-on practice and individualized instruction. However, even the best existing instructional practices do not facilitate individualized hands-on support for students at large. The authors have built JavaTutor, an intelligent tutoring system for introductory computer science, which works alongside students to support them through both cognitive (skills and knowledge) and affective (emotion-based) feedback. JavaTutor aims to make advances in interactive, scalable student support. JavaTutor's behaviors were developed within a novel framework that leverages machine learning to acquire tutorial strategies from data collected within tutorial sessions between novice students and experienced human tutors. This demo presents an overview of the data-driven development of JavaTutor and shows how JavaTutor assesses and responds to students' contextualized needs. It is hoped that JavaTutor will help to usher in a new generation of tutorial systems for computer science education that adapt to individual students based not only on incoming student knowledge,

but on a broad range of other student characteristics [39].

- **ITSB: An Intelligent Tutoring System Authoring Tool**

Intelligent Tutoring System Builder (ITSB) is an authoring tool designed and developed to aid teachers in constructing intelligent tutoring systems in multidisciplinary fields. The teacher is needed to create a set of pedagogical fundamentals, which, in line, are inured to automatically build up a broad tutor framework and construct an intelligent tutoring system. In this paper an explanation of the theory and the architecture of the tool is outlined. A presentation of several system components, the requirements of the different components, integration of these components in ITSB tool are shown. Furthermore, implanting of requirements, cognitive principle, and common design fundamentals in the tool to ease the use of teachers. A variety of design matters, an example of building an intelligent tutoring system for teaching Java language using ITSB tool and an evaluation are presented [40].

- **An Intelligent Tutoring System for Teaching Grammar English Tenses**

In this paper, the authors describe the design of an Intelligent Tutoring System for teaching English language grammar to help students learn English grammar easily and smoothly. The system provides all topics of English grammar and generates a series of questions automatically for each topic for the students to solve. The system adapts with all the individual differences of students and begins gradually with students from easier to harder level. The intelligent tutoring system was given to a group of students of all age groups to try it and to see the impact of the system on students. The results showed a good satisfaction of the students toward the system [41].

- **An intelligent tutoring system for teaching advanced topics in information security**

In this paper, the authors present an intelligent tutoring system for teaching information security. This intelligent tutoring systems target the students enrolled in Advanced Topics in Information Security in the faculty of Engineering and Information Technology at Al-Azhar University in Gaza. Through which the student will be able to study the course and solve related problems. An evaluation of the intelligent tutoring systems was carried out and the results were promising [42].

## 4. Conclusion

In this paper we surveyed 36 existing intelligent tutoring system found in the literature up to and including the year 2016. There might be other intelligent tutoring systems that we have missed; but when found, they will be added to the next release of the intelligent tutoring systems survey.

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