

# AI empowered Learning: A review of past, present scenario and novel insights into future of Intelligent Tutoring Systems

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**Abstract:** Computers and related technology has been in use in the context of education and learning from last so many years. This paper studies the impact of latest generation of computers and recent trends in computing technology, particularly the AI wave that has taken over the computing world and is in the crossroads of transforming the 21st century education, unimaginable than ever before. The capability of Intelligent Tutoring systems(ITS) is surveyed and reviewed upon right from inception to the present role of the systems in providing just an assistance to the role of actual teacher, And paving way for the future vision and insights into these so called 'Artificially Intelligent' teaching counterparts questioning the possibility of these systems to ever achieving the eluding traits of free-thought, inspiration and creativity which comes naturally to real-world educator's and learner's interaction.

**Keywords:** AI and learning, Technology enhanced learning, Intelligent Tutoring systems(ITS), ITS, Applied Artificial Intelligence

## I. INTRODUCTION

Artificial Intelligence(AI) can be understood as the intelligence demonstrated by a machine or piece of software program that has the capability of taking decisions on its own or communicating with the peers in the ways a human could do, just by sensing its environment and responding to the needs of of the fellow beings. Now to bring a similar kind of Intelligent behavior in teaching/learning software systems to retrieve the benefits of one-to -one personalized and more effective learning experience, in comparison to, one-to-many in traditional classrooms or under the supervision of none-at-all, as in online learning, becomes the goal of implementing such AI accelerated models in formal and in-formal learning environments. But in such a scenario the role of a teacher can not be negated, neither advocated that

any AI system can take over the role of an educator. In fact the role of a teacher modifies to that of a facilitator. According to a report by Pearson, the incorporation of AI in Education, termed AIEd, "can offer learning, both now and in the future, with a vision towards improving learning and life outcomes for all."[1]

## II. UNDERSTANDING INTELLIGENT TUTORING SYSTEMS(ITS) in context of AI

In 1982, Sleeman and Brown reviewed the state of the art of computer aided instruction systems and first coined the term Intelligent Tutoring Systems (ITS) to describe a new generation of computer-based education tools. They defined ITS as being computer-based (1) problem-solving monitors, (2) coaches, (3) laboratory instructors, and (4) consultants.



[2]. An intelligent tutoring system (ITS) is a computer system based on artificial intelligence designed to deliver content and provide feedback to its user based on One-on-one interaction with students, which forms the main goal of ITS similar to a human tutor. The program personalizes the instruction based on the background and the progress of every individual student. The main reasons behind the popularity of ITSs are increase in student performance (ii) dependent Cognitive development and reduction in the time of the student to enhance their skills and knowledge. Students are given the freedom to ask questions and complete complex problems and assignments with effective and efficient feedback provided by the ITS[3].

### III. HISTORY AND RELATED WORK

In its Infancy, the concept of using computers to assist learning was originally known as "computer assisted instruction"(CAI) or "computer assisted learning"(CAL). It has been around since the 1950's. The main problem with the older systems is that they did not provide feedback nor could they be individualized for the students (Nwana, 1990). These systems have now evolved into the "Intelligent Tutoring Systems". Intelligent Tutoring Systems have their base in the Artificial Intelligence (AI) movement that occurred during the 1950s and 1960s. Many innovative thinkers like Alan Turing, Marvin Minsky, John McCarthy and Allen Newell believed that computers that could think just like humans would soon be developed. The first intelligent tutoring systems were recognized not until the 1980s. During this time those working in the realm of artificial intelligence realized the underlying problem with creating thinking computers - the assumption that people thought like computers. (Lurain, 2007) The focus shifted to creating expert systems that allowed for multiple solutions to a problem instead of one expert solution.(Nwana, 1990)

To get through a brief history, In 1950s, the linear programs created by B.F. Skinner guided the student in a linear way using very simple questions which made the students progress slowly. Incorrect answers were not expected if the designer had done the job properly and the student moved ahead and regardless of their answers, Students were assumed to move ahead. In 1960s Crowder incorporated the learner's responses by using them to choose the next question. There were still a limited number of questions. His branching program used pattern-matching techniques allowing for partially correct answers. 1970s led to breakthrough as computers could be used to generate and solve problems: "generative CAI". This was especially useful in mathematics as it led to systems to use less memory as questions did not need to be pre-stored. It is now possible to

adapt to the level of ability to some degree (Nwana, 1990). The period between 1980-2000 encountered major Improvements in ITS feedback methods. AI driven Programs were able to give helpful feedback to students and educators.[4]

### IV. ARCHITECTURE OF INTELLIGENT TUTORING SYSTEMS(ITS)

Intelligent Tutoring System(ITS) are classified into three categories, namely

1. Traditional three-model
2. Classical four-model
3. New-generation architectures[4]

But for generality of discussion the following important components are being discussed to ascertain common characteristics of ITSs:

#### A. Domain model:

It is the area where the expert knowledge and behavior is located. The domain model possess system domain knowledge to make inferences or solve problems. It provide explanations of problem solutions giving alternative explanations of the same concept and answers arbitrary questions from the student incorporate knowledge about common misconceptions and missing concepts.

#### B. Student model

It assesses the student's level of knowledge and is where the AI functioning of the system is essential so students are directed properly in their learning needs. Student Model maintains information about the student's knowledge, and skills (current and advancing) in the student model; Store information on the student's cognitive processes; Store information on student's learning preferences and/or past learning experiences in the student model, if the need arises; Monitor and assess student performance and update student model.

#### C. Teaching model

It possess system teaching goals & plans. Also provides alternative teaching strategies. Learners are guided by an underlying instructional theory. System's teaching strategies are tailored with student's needs allowing student to initiate instructional activities. It provides contextualised, and engaging learning activities. It also Diagnose misconceptions and learning needs and can intervene if the student appears to be having difficulty. They Relate a diagnosed error to a

misconception or a missing concept and incorporate remedial strategies in order to provide alternative remedial teaching styles

#### D. System Control

Provide helpful feedback on student input; Treat all detected errors and respond if it cannot diagnose an error. It intervenes to remediate a misconception or a missing concept and adapt to student's level of advancement and to the needs and preferences of the student.

#### E User Interface

It is the interface with which the student interacts. They promote ease of use incorporating natural interaction dialogues and ensuring that the dialogue is task-oriented and adaptive. It contains effective screen design. The UI can embrace a variety of interaction styles.

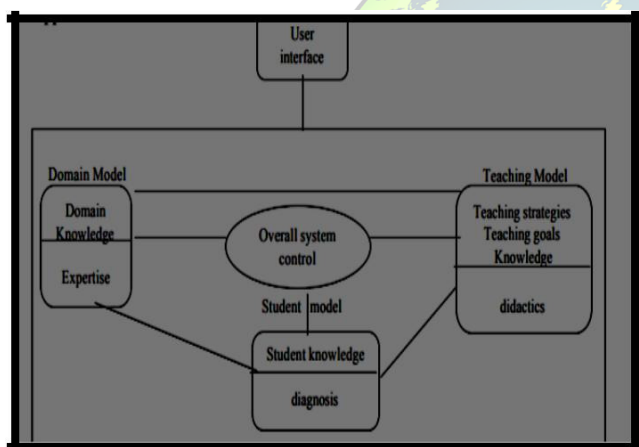


Fig.1 General Intelligent Tutoring System

Architecture Source: Siemer & Angeledis[1998-87]

### V .APPLICATIONS OF OF INTELLIGENT TUTORING SYSTEMS(ITS) IMPLEMENTED IN VARIOUS FIELDS

1. **Active Math** [5] was developed by the University of Saarland in Germany in conjunction with the German Center for Research in Artificial Intelligence: it is a complete ITS for mathematics education. This system is adaptive to students, diagnoses errors made by students and diagnoses misconceptions. The site is aimed at university courses such as calculus. Active Math is free and it is also possible to integrate it into a link title Moodle.

2. Built in response to the 'No Child Left behind policy' in the US, **Assistments** [6], a web-based tutoring system that would "assist" and "assess" at the same time with these two

integrated into the same system is such an another ITS , created by a group at Worcester Polytechnic Institute (WPI), funded by the Department of Education. Students are given scaffolding and hints when they ask and teachers can evaluate and monitor their progress.

3. **Cognitive Tutor** [7] is an ITS from Carnegie learning Inc and is a well-researched and highly regarded system. It uses form of blended learning which combines textbooks and MATHia software. They concepts are well-researched and they are aware of effect that motivation is a big factor in learning. They want to get students to think, not become rote learners.

4. **Realise-IT** [8] was created by an Irish company called CCKE. They have constructed a program that will assess a learner's prior knowledge and optimize their learning path and objectives mapping in an area that they are about to study.

5. **Wayang Outpost** [9] ,(renamed as [mathspring.org](http://mathspring.org)) is a system designed to prepare middle and high-school students in their preparation for standardized math tests. Wayang Outpost is free to teachers, schools, after-school programs, and for use from home.

6. **AutoTutor** [10] was developed by C. Graesser et al. in the year 1999, at the Institute for Intelligent Systems, University of Memphis. The system helps students to learn Newtonian Physics, Computer Literacy, and critical thinking topics through tutorial dialogue in human language. It asks questions and present problems, evaluate the meaning of the student's answer, and give feedback on that answer by responding to the student according to their facial expression. It uses Latent Semantic Analysis (LSA) pattern-matching algorithm for evaluating whether student input matches the expectations and misconception .

7. **SQL-Tutor** [11] was developed by Antonija Mitrovic in the year 2003, at University of Canterbury, New Zealand. It was developed for teaching Structured Query Language (SQL). It is based on a student modeling approach Constraint-Based Modeling (CBM) and developed in Allegro Common Lisp. This system is available for MS Windows and Solaris. Besides local users, More than two thousand people worldwide are currently using it.

Many other systems like **german Tutor**, **duolingo**, **Elm-Art**, **Acharya**, **Sherlock**, **Lisp tutor**, **SmithTown**, **fsmile**, **baghera** can also form good examples of such creative and intelligent learning systems.





## VI. THE FUTURE OF AI AND INTELLIGENT TUTORING SYSTEMS(ITS) IN EDUCATION

Today Multi-agent systems have made a great impact in the field of education, as it incorporates flexibility, robustness, intelligent, interactive, adaptive, collaborative features in E-learning systems. The advances in architecture of ITSs are capable of now reading user moods. In order to determine an individual's emotions they use sensors and cameras to record heart rate and read facial expression. At the moment they can determine the mood with up to 80% accuracy (Gulli, 2011). The capabilities of ITSs have also expanded with the advancement of AI more generally. For instance, ITSs capable of natural language have now been developed. Intelligent Multi-agent Infrastructure for Distributed Systems in Education (IMINDS) was designed by Soh et al. in the year 2005, at University of Nebraska. It is based on Computer Supported Collaborative Learning (CSCCL) infrastructure, which provides a synchronous learning environment for students and classroom management applications for teachers.

Agent Based Intelligent Tutoring System (ABITS) was proposed by José et al. in the year 2005. It is a multi-agent based E-learning system, which works in learning as well as a teaching environment.[12] It is not to any specific domain. The system consists of four modules that are Student Module, Pedagogical Module, Domain Module and Educational Module. There are four agents in the systems.

1. Preference Agent- observed preferred style of presentation
2. Accounting Agent- this agent interacts with the student's interface and keep record of the student when student move on to the next page that how long student stay on the page, the name of the page, etc.,
3. Exercise Agent- select the appropriate exercise to the student,
4. Test Agent- choose the question that is related to the topic, which student read.

Such and many other similar advanced systems can be predicted as the future of transforming education.

## VII. CONCLUSION

By reviewing the existing ITSs, it can be concluded that all these AI empowered Intelligent systems are a good resource to provide students with proven better learning outcomes through engaging learning based on the temperaments and abilities and interacting with them in more than ever natural ways to provide a personalized and enhanced learning environments but one thing which can still be a bottleneck to these intelligently advanced systems is their nature of being domain specific and the creation and adoption of the systems in the conventional classroom settings which is a major

challenge for the flourishing of these systems. If AI empowered education is intended to be taken by the student-teacher community globally, major efforts need to be made to make them economically and socially viable in the world where surprising huge digital divide is still prevailing.

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