A Road Map for the Adoption of Intelligent Tutoring System for Education (3ITS)

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Abstract
Artificial Intelligence over the years has become very relevant in education at various levels. This paper presented a road map for the adoption of intelligent system of learning in institutions without compromising the physical interaction of teachers and students but rather complementing it. It defined and presented Intelligent Tutoring Software as a learning software tool containing an artificial intelligence component that can run on a TCP/IP enabled environment, locally accessed or globally accessed over the internet. This work also provides a road map for the adoption of intelligent system of learning in institutions without compromising the physical interaction of teachers and students but rather complementing it. The system was tested on a local and public server and was found to be very useful as a teaching. The application was designed strictly for the web integrating PHP, HTML and CSS.

Keywords: intelligent, tutoring, educational, software, Artificial Intelligence

Introduction
Artificial Intelligent systems exist in almost all aspect of our daily lives. It finds application in construction, manufacturing, exploration, computing, data management and lots more. One area that is of interest to us in this paper is its application in learning. An Intelligent Tutoring Systems (ITSs) is educational software containing an Artificial Intelligence (AI) component (Epstein & Hillegeist, 1990). The most general way to describe ITS, is to say that it is the application of AI to education (Ladislav, 2007). The system tracks the student’s work, tailoring feedback and hints along the way, by collecting information on a particular student’s performance. The ITS software can make inferences about strengths and weaknesses, and can suggest additional work (Duchastel, 1989). The basic underlying idea of ITSs is to realize that each student is unique. These systems can be used in the traditional educational setting or in distant learning courses, either operating on stand-alone computer or as applications that deliver knowledge through the internet.

‘In particular, ITSs are computer-based learning systems which attempt to adapt to the needs of learners and are therefore the only such systems which attempt to ‘care’ about learners in that sense. Also, ITS research is the only part of the general IT and education field which has as its scientific goal to make computationally precise and explicit forms of educational, psychological and social knowledge which are often left implicit’(Self, 1999).
ITSs must be able to achieve three main tasks:

- Accurately diagnose a student’s knowledge level using principles rather than programmed responses.
- Decide what to do next and adapt instruction accordingly.
- Provide feedback.

This kind of diagnosis and adaptation, which is usually accomplished using Artificial Intelligences, is what distinguishes ITS from Computer-Aided or Computer Assisted Instruction (CAI).

The 3ITS is an application presented in this work makes use of the basic principles of the ITS application with additional feature of being adaptable on the internet (basically running on the world wide web as a web application) or on an intranet (within an organization private network) network with synchronization ability. The 3ITS Application is an adaptable solution to various environments of learning which range from primary, secondary schools and tertiary institutions where learning can be aided using computer applications. This system can be customized to suit any field of learning with the basic functionalities still intact. The application is designed such that it is user friendly and can be used by beginners who are not familiar with the use of computer and by professionals as well.

Statement of the Problem/Motivation
South Korea has one of the most advanced ICT infrastructures in the world—computer penetration is extensive, and broadband Internet access is one of the best globally. The pervasiveness of ICT use in South Korean society has spilled over to the higher educational system. The accelerated adoption of virtual education in South Korea was a result of deliberate planning by government. It began in 1998 with the launch of the Virtual University Trial Project (VUTP). With 65 universities and five companies participating, the VUTP was designed to create a cost-effective virtual education system without diminishing quality among other reasons. Several years after the VUTP, however, policymakers and educators in South Korea continue to grapple with issues of quality management, capacity building, cost-savings, open access, and the appropriateness of the instructional model for adult learners (Mujumdar & Shantaram, 2009).

There have also been many studies that seem to support the claim that the use of computers enhances and amplifies existing curricula, as measured through standardized testing. Specifically, research shows that the use of computers as tutors, for drill and practice, and for instructional delivery, combined with traditional instruction, results in increases in learning in the traditional curriculum and basic skills areas, as well as higher test scores in some subjects compared to traditional instruction alone. Students also learn more quickly, demonstrate greater retention, and are better motivated to learn when they work with computers (Fouts, 2002).

In the in developing countries like Nigerian, such problems as identified in in the educational system include but not limited to the following: Lack of equipment, Overcrowding of learning environments, skilled Man Power, epileptic Power supply, constantly evolving educational policies.
3ITS was designed to contribute to driving the educational system especially in developing environments. With its easy to use interface, cost effectiveness and its open source nature, it proves to be a good choice for secondary and tertiary institutions.

**Objectives of Study**
The purpose or aim of this study is to introduce an easy to use Web-based Intelligent Tutoring System where students can learn, make research and gather facts about certain relevant courses as well as find solutions to problems as regards to areas of difficulties in a particular course. The system will help to improve students’ attitude and enhance learning at all educational levels. This system will mostly be based on drill practice, tutorials and dialogue sessions, it will therefore be incorporated with Artificial Intelligent (AI) functionalities that would control the dialogue session and an interface that will enable lecturers to upload lesson related to the courses they teach so that students can in turn be able to interact with the system freely and learn conveniently. This system is designed to serve as a teaching tool for teachers and students and will reduce frequent appearance in the classroom and as well facilitate communication among students, between students and instructors, and beyond the classroom to distant students and instructors.

Achieving the above objectives leads to the following:

a. Convenience: It provides a convenient way of learning.

b. Economy: The project is also aimed at saving energy thereby minimizing costs.

c. Efficiency and Effectiveness: It will greatly increase the learning efficiency and promotes effectiveness of students’ at all educational levels.

This will be achieved using the following means:

i. Creating a web application interface for easy access and flexibility using HyperText Markup Language (HTML), Cascading Style Sheet (CSS) and Hypertext Preprocessor (PHP).

ii. Creating a database using MY-SQL, that will keep records of lecture materials that can be updated, modified and queried.

iii. Creating an Artificial Intelligent (AI) system that will control the dialogue session and as well provide feedbacks using Artificial Intelligent Markup Language (AIML) and Extensible Markup Language (XML).

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Basic Features of the 3ITS System

The importance therefore includes the followings:
1. Drill and practice: This system provides the students with exercises that reinforce the learning and supplies immediate feedback on the correctness of responses used in this manner. It as well functions as a supplements to regular classroom instruction and may be useful when a lecturer does not have the time to work individually with each students drill and practice on the system. It may also motivate students more than traditional work book exercises.

2. Tutorial: This project provides some information or clarifies certain concepts in addition to providing the students with practice exercise in this sense, taking over actual instructional functions tailored to the students’ individual level of achievement.

3. Immediate feedback: The Artificial Intelligent (AI) functionalities incorporated within the system will control the dialogue session thereby providing immediate and accurate response to questions asked. The system as well reacts to feelings and emotions and it possesses some characteristics that give it the ability to respond as though it were a human.

Short Historical Perspective

Intelligent Tutoring Systems have an interesting history, originating in the Artificial Intelligence (AI) movement of the late 1950’s and early 1960’s. Computer Aided Instruction/Learning (CAI/CAL) has evolved considerably since its inception in the 1950’s with Skinnerian type ‘linear programs’. This happened despite being set off in the wrong direction by Skinner’s insistence that students’ responses could be ignored in linear programs (O’Shea, 1981). There were major stages in the metamorphosis of the linear programs of the 1950s into the ITSs of the 1980s as shown in the figure below.
We observe in Figure 1 that computers have been used in education for over 30 years. Computer Based Instruction (CBI) and Computer Based Training (CBT) are the predecessors of ITSs. The field of automating tutoring (e.g. Computer Aided Instruction – CAI or Intelligent Computer Aided Instruction – ICAI) was one of the first most fruitful fields, which served aims of AI researchers. Application of machine learning algorithms in tutoring has a long history. The field of automating tutoring was one of the first most fruitful fields, which served aims of artificial intelligence (AI) researchers. These were more or less monolithic systems with low level of flexibility (Ladislav, 2007)

**General architecture of ITS**

Existing ITSs vary tremendously in architecture. In fact, it is almost a rarity to find two ITSs based on the same architecture. These results from the experimental nature of the work in the area: there is yet no clear-cut general architecture for such systems (Yazdani, 1986, 1987). Previously, there was considerable consensus in the literature that ITSs consist of at least three basic components (Barr & Feigenbaum, 1982):

a. The Expert Knowledge Module.
b. The Student Model Module.
c. The Tutoring Module.

However, research (Wenger, 1987) has identified and added a fourth component to the list.

d. The User Interface Module.
Figure 2: General Structure of an ITS (Hyacinth, 1990)

Expert Knowledge Module
The Expert Knowledge Module comprises the facts and rules of the particular domain to be conveyed to the student, i.e. the knowledge of the experts. In the transition from CAI to ITSs, such knowledge has been the first aspect of the teacher's expertise to be explicitly represented in systems.

Student Model Module
The Student Model Module refers to the dynamic representation of the emerging knowledge and skill of the student. No intelligent tutoring can take place without an understanding of the student. Thus, along with the idea of explicitly representing the knowledge to be communicated comes the idea of doing likewise with the student, in the form of a student model. Human tutors would normally combine data from a variety of other sources, like voice effects or facial gestures. They may also be able to detect other phenomenological factors such as boredom or motivation which are also crucial in learning.

Tutoring Module
The Tutoring Module is the part of the ITS that designs and regulates instructional interactions with the student. In other architectures, this module is referred to as the teaching strategy or the pedagogic module. It is closely linked to the student model, using knowledge about the student and its own tutorial goal structure to decide which pedagogic activities will be presented: hints to overcome impasses in performance, advice, support, explanations, different practice tasks, tests to confirm hypotheses in the student's model, etc. (Self, 1999). The tutorial component is thus the source and the orchestrator of all pedagogic interventions. The decisions involved are subtle.

The User Interface Module
The User Interface Module is the communicating component of the ITS which controls interaction between the student and the system, as depicted in Fig. 3. In both directions, it
translates between the system's internal representation and an interface language that is understandable to the student. Because the user interface can make or break the ITS, no matter how 'intelligent' the internal system is, it has become customary to identify it as a distinct component of its own.

Review of Existing Tutoring Systems

Cognitive Tutors

“Cognitive Tutors,” reflect a basis in cognitive science research and the use of intelligent tutoring systems to guide student problem solving. Each of these products consists of software (called a “Cognitive Tutor”), print materials (equivalent to a textbook, homework assignments, teacher’s guide, etc.) and teacher training. The intent is that each of these products provide teachers with all the materials and support they need to teach an entire mathematics course (Ritter, Koedinger, Hadley, Corbett, & Lilly, 2004)

Andes

Andes: is an ITS which was developed to teach physics for the students in Naval Academy. Bayesian networks were primarily used in Andes for decision making (Abigail, Gertner & Kurt, 1998).

- The major foci of the system are:
  1. Select the most suitable strategy for the student
  2. Predict Student’s actions
  3. Perform a long term assessment of the student’s domain knowledge.

Andes is a domain dependent ITS. Each problem in the system was broken into some steps and Bayesian network was formed using those steps as nodes. So, the problems were represented in the system as Bayesian networks. The Bayesian network would predict the most probable path for the student during a course. Each student could have different approaches to a problem, the network would be adjusted accordingly (the probabilities would change) and finally for a new problem it would predict the best strategy for the student.

VisMond

ViSMod: is another ITS which used Bayesian network (Zapata-Rivera & Greer, 2004). In the system the Bayesian network was divided into three levels. At the top most level the concepts (to be taught) were represented in a hierarchical manner. After that in the second level student’s performance and behavior were described. Finally the third level nodes represented some analysis on the student’s performance. Only the first level is domain dependent, whereas other two levels would remain same over different domains. Again student can observe only the top two levels of the Bayesian net. The third level is only visible to the teachers. During a course the probabilities in the second and third level of the Bayesian network changed according to the student’s performance.

Mathematics Tutor

The Mathematics Tutor helps students solve word problems using fractions, decimals and percentages. The tutor records the success rates while a student is working on problems while providing subsequent, lever-appropriate problems for the student to work on. The subsequent problems that are selected are based on student ability and a desirable time in is estimated in which the student is to solve the problem (Melis & Siekmann, 2004).
ZOSMAT
ZOSMAT was designed to address all the needs of a real classroom. It follows and guides a student in different stages of their learning process. This is a student-centered ITS does this by recording the progress in a student's learning and the student program changes based on the student's effort. ZOSMAT can be used for either individual learning or in a real classroom environment alongside the guidance of a human tutor (Ayтурк and Ali, 2009).

Methodology
This software was designed using an Object-Oriented Analysis and Design Methodology approach; this implies breaking down the whole program into different classes of objects. The objects that make up this application are:
   i. User(Students)
   ii. Lecturers
   iii. Administrator
Each of these classes of object is categorized by assigning a particular action to make the program easier and its goals easily met. The methodology is made to specify exactly the flaws and tasks of development of the project and gives a detailed documentation of the project. The process methodology of OOADM includes the following:
   a. Problem identification
   b. Feasibility studies
   c. System analysis
   d. Design phase
   e. Implementation phase

High Level Modelling and Use-Case Diagram of the New System
The main components of the system include will include:
   a. The Users/Students.
   b. The Lecturers.
   c. The System Administrators
The modelling methodology involved studying the functional diagrams, and then abstracting the pertinent data and methods by asking questions like:
Figure 3: High Level model of the 3ITS

Figure 4: Use-Case Diagram of the 3ITS
A use case diagram graphically depicts the interactions between the system, the external system and the user. Use case diagrams play a major role in system design because it acts as a roadmap in constructing the structure of the system; it also defines who will use the system and in what way the user-expects to interact with the system.

**System Flow chat**
A flow chart is like an activity diagram. It illustrates the objects work flow (sequence of events) during program execution. The figures below represent the various operations as they are to be carried out in the new system.

**Figure 5: Overall System Flow Chat**

**Result and Documentation**
This will state clearly what is required for the program to run effectively and efficiently. This includes the hardware, software, and network requirements which are as follows.

**Hardware Requirements**
Any Computer system that possesses the following specifications can run the 3ITS:

i. 512 MB of minimum memory or a higher RAM size.
ii. 1.0 GHz minimum processor speed (INTEL/AMD)
iii. Hard disk of about 60GB minimum capacity
iv. A high speed internet connection required with an option to run the system on an intranet facility.

2. Video adapter and Monitors with a minimum of 1024 x 768 resolutions and at least 256 colors.

The above listing does not signify the totality of the hardware needed but they are the major requirements needed for the implementation and functionality of this Intelligent Tutoring System.

![Home page of the 3ITS](image1)

**Figure 5: Home page of the 3ITS**

![Registration Page](image2)

**Figure 6: Registration Page**
Conclusion
With the introduction of the 3ITS system, learning can be fun and friendly. Schools/teachers can track all performance of their pupils and treat them individually. As we always say different stokes for different folks. Every individual is different and have unique characteristics especially in learning. This system creates that diversity and gives teachers room to advice individuals on specific areas of improvement.
The 3ITS can be customized to suit any field of learning and at the same time adaptable to various levels of learning including; primary, secondary, tertiary and other specialized courses.
The 3ITS is user friendly and can be continuously updated to suit needs when needed. Since it’s a web based application, it is not restricted by distance and as such has the potential of being deployed on the cloud platform if the need arise (space, speed and cost).

Recommendations
For institutions to achieve great feats in learning we recommend the following:
 a. Proper training of teachers especially with relevant IT tools that aids learning
 b. Making IT equipment, tools and apps available to school especially at the early stage of learning
 c. Decentralizing learning such that learning can take place not only in the class room but remotely.
 d. Stable policies in the educational sector with proper engagement of the stakeholders before policy changes are made. Furthermore, policies should have a life span before they can be altered.

Future work
Two key areas of interest should be considered for future work:
 a. **ITS security**: One major challenge faced by web application is security. Applications on the internet can easily be compromised if not properly secured. The best approach to securing ITS systems is; designing a special security interface that will be plugged in to the system to act as a firewall.
 b. **Cloud based ITS system**: As the need for the system increases, hosting ITS systems on conventional hosting platforms might become problematic and thus the need for a scalable and robust platform for hosting likes the cloud.

References


