

Examining Artificial Intelligence Techniques for the Design and Implementation of a Generally Acceptable Intelligent Educational Tutoring System (IETS)

Adesanya, Sunday Adelaja, *Member, IAENG*

Abstract--Recent trend in education system all over the world has indicated that education is indebtedness for service and a binding obligation for an invaluable means of survival in life. If this is true, then, the need to prepare for the future by transmitting culture, values, norms and lessons of the past to present generation is inevitable and so a crucial issue to be discussed in this paper. Meanwhile, learning which is a distinctive feature of education is now found so difficult than ever due to lot of interlocking technological changes associated with factors such as lack of skilled teachers/lecturers, materials and tools, infrastructures and funds, just few to mention, that have severely dragged our educational standard to the brim of extinction. Thus, this has also tremendously influenced the direction of modern education. In fact, many scientific and technological techniques that had been employed for developing e-learning aids to improve knowledge acquisition, retention and regurgitation via the use of computer have proved futile until the emergence of one of the most significant changes in technology; Artificial Intelligence (AI). This paper, therefore, attempts to identify and discuss some of the AI techniques that can be utilized to provide models for developing an intelligent learning aided system that will meet up with the internationally acceptable educational software if we must face the challenges for the future. It further aims at providing methodologies for integrating AI into our educational software such that the required framework for designing, developing, expansion, incorporation, implementation and maintenance of an AI based educational system can be easily sustained.

Index Terms: Artificial Intelligence, Education System, Learning, Knowledge Acquisition, Retentive, Regurgitation, Intelligent Tutoring System.

I. INTRODUCTION

The world is fast changing with nature tremendously craving tensions whose challenges are met by the various technological advances. In order to adapt to some of these changes and maintain existence in life; the machine called the computer came to being. However, in recent years, the process of using the computer and its facilities for teaching and learning purpose have generated enormous success and progress in our educational standard and a lot of application were developed to corroborate the achievement. Both public and private organizations are embarking on distant learning

Adesanya Sunday .Adelaja. Manuscript received August 8, 2011; revised January 3, 2012, Department of Computer Sciences, School of Technology, Lagos State Polytechnic, Ikorodu, Lagos. +2347083872359; email: sunadesanya@gmail.com

programmes and the Open University system which practically depends on the computer to address its continuity. What does this implies or why has this bore down our mind? If this question is answered correctly, then, we are not far from the optimal solution towards achieving a better educational standard that was initially drifted into the extinction.

More so, there are shortfalls that limit the optimal performance of those educational applications especially in the areas of alliance and administration of courses such as when a teacher no longer have the opportunity to meet the students face-to-face in a traditional classroom environment, the powers of computer tools available will determine the success of the teacher to student relationship. But, nowadays, new innovations are evolving in science that demands the use of human knowledge and capital. There is need for an intelligent learning system that offers personal services such as ability to learn, reason rationally, perceive, and be autonomous and dynamic whose technological changes can be kept abreast so that our knowledge workers can compete with an international market that has a good understanding of science. This bid, however, has led us to a major achievement in technological advances known as Artificial Intelligence, (AI). The understanding is of this concept, Artificial intelligence would, therefore, form our major focus for discussion in this paper. This is so because it serves as an ingredient whose knowledge is inevitable if we must develop educational software that must be of international standard.

II. RELATED WORKS

A lot of researches had been embarked upon over the decade with quite a great success but many computer applications that use AI technologies have so much become a part of our daily lives and they do not even recognize the science behind the scene. Thus, towards the goal of making computers that think like humans AI is now making new inroads into education with writing assessments engines and intelligent tutoring systems. Some notable achievements in Intelligent Educational Tutoring System, IETS can be evidenced from related works that were researched in the following cases. Some of these were employed as case studies to enable one proffer a suitable model for the proposed system.[1]

This includes as one; a smart tutoring system, which is an online learning system that acts as coaches, offering hints when students stumble in the problems solving process, not

just when they enter an answer which promises to radically transform our concept of online learning; some are IntelliMetric, which are web-based systems that let students draft and submit their work online. The program then automatically gives both an analytic and holistic score based on a four- or six-point scale. This leads to around-the-clock access to evaluation and feedback, increased scoring reliability; some are adaptive training Systems (ATS), which monitors individual students in learning specific principles as they perform exercise in such a manner that the student does not get easily bored with too easy work or frustrated with too much work; some are Auto Tutor, that were intelligent tutoring systems, which works by having a conversation with the learner. It was developed by an interdisciplinary research team.

With Auto tutor, students are encouraged to articulate lengthy answers that exhibit deep reasoning rather than to recite small bits of shallow knowledge. Conclusively, a great deal of case studies had been demonstrated in such manner to show the realization of the proposed tools and techniques of AI and Soft Computing in this course; Amit Konar, (1999).

III. ARTIFICIAL INTELLIGENCE DEFINITION

The phrase AI was coined by John McCarthy many decades back, but evades a concise and formal definition to date. One representative definition is pivoted around the comparison of intelligence of computing machines with human beings. Another definition is concerned with the performance of machines which “historically have been judged to lie within the domain of intelligence”. None of these definitions or the like has been universally accepted, perhaps because of their references to the word “intelligence”, which at present is an abstract and immeasurable quantity. A better definition of AI, therefore, calls for formalization of the term “intelligence”.

According to Amit konar, (1999), Psychologist and Cognitive theorists are of the opinion that intelligence helps in identifying the right piece of knowledge at the appropriate instances of decision making. *AI thus can be defined as the simulation of human intelligence on a machine, so as to make the machine efficient to identify and use the right piece of “Knowledge” at a given step of solving a problem.* He further stressed that a system capable of planning and executing the right task at the right time is generally called rational. Thus, AI alternatively may be stated as *a subject dealing with computational models that can think and act rationally.* The rational action of an agent (actor), thus, calls for possession of all the elementary characteristics of intelligence. Relating AI with the computational models capable of thinking and acting rationally, therefore, has a pragmatic significance in the course for discussion of this paper. [4,6]

However, the Britannica concise encyclopedia define this as the ability of a machine to perform tasks though to require human intelligent while US history encyclopedic considers it as a branch of computer science that seeks to create a computer system capable of sensing the world around it, understanding conversations, learning reasoning, and reaching decisions, just as a would-be human. According to Wikipedia, the modern definition of artificial

intelligence (or AI) is “the study and design of intelligent agent of a system that perceives its environment and takes actions which maximizes its chances of success. Though exact definition may still be under contest, we may see AI as the branch of computer science that is concerned with the automation of intelligent behavior.

One key idea in the various definition of AI is that it intends to develop systems that have the ability to perceive and to learn, to accomplish physical tasks, and to emulate human decision making in order to design and develop intelligent agents as well as to understand them. A virtue training system that imitates the subject matter and teaching expertise of educators shall be an intriguing idea in educational growth. In conventional computer training an intelligent stimulation that causes users to answer questions while providing one-to-one assistance is acceptable.

A. Artificial intelligence and education

According to John A. Bullinaria (2003), Artificial intelligence (AI) is a field of computer science which focuses on developing hardware and software systems that solve problems and accomplish tasks that would be considered a display of intelligence, if accomplished by humans [2,5]. The theory and practice of AI is leading to the development of a wide range of artificial intelligence tools called intelligent agent, which are able to solve or help solve a steadily increasing range of problems, thereby producing a number of result that are important to students, teachers, our overall educational system, and to our society. No other machine can be compared to computer in storage, retention and regurgitation as a result of its characterized ability of versatility. Hence, in rote memory and retention, computers are far superior to humans, and looking at the types of skills that can be automated by computerized tools, computers are able to acquire many different skills and gain new skills through the development of new hardware and software.

One of the major things that would be achieved by AI is its capability for the transfer of learning from specific classroom-learning environment to other environment such that students would be able to use their school-acquired knowledge and skill at anytime, whether at home, workplace, school and so on, presently and in future. Thus, this concept, known as intelligent tutoring, is vital for any educational package that may meet up with international standards. Moreso, this attempt has very positive since the beginning of recorded history when people have been fascinated with the idea of non-human agencies such that popular notions about androids, humanoids, robots, cyborgs, and science fiction creatures permeate our culture, values, norms and lessons in forming the unconscious backdrop against which software agents are perceived [8].

B. AI Agents

As “agents” of many varieties have proliferated, there has been an explosion in the use of the term without a corresponding consensus on what it means. Some programs are called agents simply because of the task they perform, for instance, because they accomplish low-level computing tasks while being instructed in a higher-level of programming language or script (Apple Computer 1993); some because they abstract out or encapsulate the details of

differences between information sources or computing services (Knoblock and Ambite 1997); some because they implement a primitive or aggregate “cognitive function” (Minsky 1986, Minsky and Riecken 1994); some because they manifest characteristics of distributed intelligence (Moulin and Chaib-draa 1996); some because they serve a mediating role among people and programs. But, an agent has been reliably defined as an encapsulated computer system that is situated in some environment and that is capable of flexible, autonomous action in that environment in order to meet its design objectives according to *Jeffrey M. Bradsha, (1999) [2,8]*.

However, for clear understanding of the definitions, several points must be further elaborated which includes thus;

Agents are:

- Clearly identifiable problem-solving entities with well defined boundaries and interfaces.
- Situated (embedded) in a particular environment; they receive inputs related to the state of their environment and they act on the environment through effectors.
- Designed to fulfill a specific purpose; they have particular objectives (goals) to achieve.
- Autonomous; they have control both over their internal state and over their behaviour.
- Capable of exhibiting flexible problem solving behaviour in pursuit of their design objectives; they need to be both reactive (able to respond in timely fashion to changes that occur in their environment) and active (able to act in anticipation of future goals).

This understanding would however enable us to have deep insight into the study as a way of ascertaining the working principles of an intelligent agent or system as it would affect the or architectural design and implementation of a reliable learning aided system.

C. Needs for AI agents in educational software

While automation of an educational system provides more convenient virtual interactions between educators and learners around the world, there are some shortfalls that limit the benefits especially in the area of communication, collaboration pedagogy and course administration. Although many of this software incorporate easy-to-use features, most offer passive services in the area of collaboration and interaction. As a result, instructors spend more time and effort teaching course in a virtual environment than they would have done for the same course in a traditional classroom setting. This is mainly as a result of operational nature of the system. It may either be that the system does not incorporate adequate AI or that the AI does exist in the system at all. Technically, such a system may be described as a dumb system.

An example is where an instructor checks a student's progress and participation by visiting many web pages and using different tools for monitoring. In addition, handling of email messages has become a major time-consuming operation for teachers of online training systems. A system that does not include adequate AI features will not be able to handle all these successfully. Good AI procedures working

within an educational application could perform some of these burdensome and time-consuming tasks thereby alleviating the instructor of all stress.

IV. BASIC ELEMENTS OF AI AGENTS

Below are other means with conventional learning system by which major problems, that is, knowledge acquisition, retention and regurgitation associated with developing IETS can be solved by artificial intelligent. Realizing that great deal of these elements has to be integrated into education learning systems in order to develop IETS that meets the international market.

A. AI agents in retention

Presently our educational system portrays memorization, repetition and forgetfulness. This is because the human mind has a high tendency to forget memorized information especially the ones that it does not understand or that it does not frequently use. Thus most of what is memorized for a test is quickly forgotten. These problems can easily be overcome with AI-based tutors because computers are very good in storage, retention, and regurgitation and if one considers the types of skill that can be automated by AI tools and then the system has the capability to acquire a lot of different skill and knowledge.

B. AI agents in understanding

A computer is machine designed for the input storage, manipulation and output of data and information. However, the knowledge and wisdom require understanding, not just rote memory. The ability of computers to store and use knowledge becomes more inevitable because many virtual educators are now actively engaged in using computers for “knowledge management” knowledge management is about the use of computers to process data and information in order to produce knowledge. The recent development and rapid growth of the field of knowledge management suggest that many people feel computer system can effectively deal with knowledge and make wise decision.

C. AI agents in environment

Another important point is that the learning environment needs to be designed to be relatively similar to the environment in which students can apply their learning. For instance, the best way a student can be assisted is to properly design help features, which represents the effective storage of knowledge in a form that is easy to retrieve and use by a human. According to some research, in situated learning majority of what we learn is intricately intertwined with the environment or situation in which we learn it. A system that may exhibit this feature must make use of AI [3].

V. SOME AI TECHNIQUES

A number of AI techniques exist, which expands the potential of educational software, into becoming an intelligent teaching and learning system. Some of these techniques are discussed below:

A. Machine learning

Machine learning is a subfield of artificial intelligent which is concerned with the design and development of algorithms and techniques that allow computers to “learn”.

For instance, a computer that learns to play a ‘scissors, paper, stone’ by observing and mimicking human players could lead to machines that automatically learn how to spot an intruder or perform vital maintenance work. This machine teaches itself how to play the children’s game by searching for patterns in video and audio of human players and then building its own ‘hypotheses’ about the game’s rules. However, at a general level, there are two types of learning inductive and deductive. Inductive machine learning methods extract rules and patterns out of massive data sets. The major focus of machine learning research is to extract information from data automatically, by computational and statistical methods.

B. Expert systems

Expert systems explore how to computerize the expertise of a human expert. One may wonder if it is possible to computerize the expertise of a teacher. As an example we know that a large amount of the knowledge of its author. It may contain detailed step-by-step procedures which, if carefully followed, will solve certain problems or accomplish certain tasks that here-to-fore were done by a human expert. Computerized versions of the same general ideas are called expert systems. Expert system typically consists of four major components:

- i. Knowledge base: The knowledge in the expert system developed by some combination of humans and an automated learning system, and coded in a form that the expert system can use.
- ii. Problem solves: a combination of algorithms and heuristics designed to use the knowledge base in an attempt to solve problems in a particular field.
- iii. Communication: This is designed to facilitate appropriate interaction both with the developers of the expert systems and users of the expert system.
- iv. Explanation and help: This is designed to provide detailed help to the user.

C. Artificial neural networks

An artificial neural network, ANN is a computer model of certain aspects of the neural networks in a brain. One can think of the simple processors (unit) as being somewhat akin to a biological neuron, and the network of connections being akin to biological axons and dendrites. An ANN is trained (learns) by adjusting the numerical values of the weights of the connections between the simple processors (units). An ANN learns from example, much in a way that a child learns from examples, for example a child learns to distinguish toy animals from live animals through seeing many examples and being provided appropriate feedback.

D. Case based reasoning

Case based reasoning stores a set of problems and answers in an organized data structure called cases. A case based reasoning system upon being presented with problems finds a case in its knowledge base that is most closely to the new problem and presents its solution in an output with suitable modifications (Kristin et al 1989).

VI. AI MODEL/Framework FOR DEVELOPING INTELLIGENT EDUCATIONAL SOFTWARE

A. Methodology

Framework for developing generally or internationally acceptable intelligent educational tutoring software was achieved using the following methodologies. Intelligent Educational System, IETS consists of four different subsystems called model or module: *the interface module, the expert model or domain model, the student model, and the tutor model*. The interface module is the way the student interacts with the IETS, usually through a graphical user interface and sometimes through a rich simulation of the task domain the students is learning. The experts or domain model contains a description of the knowledge or behaviours that represent expertise in the subject-matter domain the IETS is teaching- often an expert system or cognitive model. The student model contains description of student knowledge of behaviors, including his or her misconceptions and knowledge is signaled to the IETS, which subsequently takes corrective action. To be able to do this, it needs information about what a human tutor in such situation would do: the tutor model.

An Intelligent Educational Tutoring System, IETS is only as effective as the various models earlier enunciated. It relies on to adequately model expert, student and tutor knowledge and behavior. Thus, the building of an IETS needs careful preparation in terms of describing the knowledge and possible behaviors of experts, students and tutors. This description needs to be done in a formal language in order that the IETS may process the information and draw inferences in order to generate feedback or instruction.

In order to provide hints guidance and instructional feedbacks to learners, IETS systems typically rely on three types of knowledge organized into separate software modules: an expert model, an instructor model and a tutoring system. The “expert model” represents subject matter of expertise and provides the IETS with knowledge of what its teaching. The “student model” represents the student’s knowledge, skills, and other attributes that affect how the students should be taught. This model lets the IETS know who it’s teaching. The “instructor model” enables the IETS to know how to teach, be encoding instructional strategies used by the tutoring system. [5,6,7]

The intelligent agent may have access to an array of dynamic and static data, which may be from the student information system course management system, student profile databases etc. The agent is then able to think and take decisions based on the knowledge base and configurations setting provided by the administration and designers.

VII. INTEGRATING AI INTO EDUCATIONAL SYSTEM

A. AI Integration Approaches

Integrating AI into our educational software may not require major design and implementation efforts because issues relating to the design, development expansion, incorporation, implementation and maintenance of an AI

based educational system are much easy to address. In most cases, all that is needed may be some few lines of codes to access and analyses existing data within an existing educational software system. There are various ways by which designer and administration may integrate AI into educational system. Some of these ways include:

i. Integrating AI into existing educational system as an add-on tool to improve functionality and practicability of the different tools in the obtainable system and offer intelligent services.

ii. Developers may release newer version of their existing educational software to offer services that had earlier been offered by humans within the obtainable system.

iii. Campuses that make use of existing course management system and portals that were developed in-house and are in charge of the management and control of their software may also integrate AI into their system. this however is practicable if the institution has a high level of programming, database and knowledge expertise as well as significant human and material resources within.

iv. In case of institution that make use of course management system and portals that were developed in-house, then they have to depend on their software provider to provide an educational system that incorporates AI.

B. Accessibility

Artificial intelligent program should be available at users (student or teachers) disposal whenever it is needed. Therefore, it is pertinent that the system should be online in order to cater for the generality. Also, they should be more graphical than command oriented so that it allows for easy access, as web based application on net to facilitate a smooth learning process.

C. Reliability

The ability of a system to stand the test of time is very important here. To this effect, the software system should be reviewed frequently to make sure that it serves the purposes for which it is designed. There should be sequence of survey from the present users to determine if the system is performing optimally. Questions about the operation of the system and possible solutions to problems highlighted should be emphasized in the survey.

VIII. CONCLUSION AND RECOMMENDATION

A. Conclusion

Indeed, AI technology has made a mark in the field of education. It has given the educational software a new face lift in the area of software development. However, realizing the fact that man has been struggling to transcend the goal of modeling human intelligence by the use of a machine, introducing intelligent systems into the computerized system of education will make the systems (machines) to outperform a good human tutor in some area where he or she has restrictions.

AI can therefore be seen as the future of computing. Thus, with records from researches (kulik, 1994), it has shown that on average students can learn faster and better by the use of IETS as compared with conventional classroom instruction [7]. This is so because it has led to the understanding of how to represent knowledge, to reason, learn, perceive and create software with more human abilities. In fact, the progress of AI is resulting in the proliferation of some intelligent systems that have helped to meet up with the competitive software international market.

B. Recommendation

With the successful completion of this paper, while other areas of AI can further be explored to improve on the performance of this system such as the genetic algorithm, it should be noted that AI has become the hallmark for the design and implementation of most intelligent computer-based educational systems as students would no more be confronted with the problems of unavailability of tutors in classes and problems of skilled tutors will be a thing of the past. Therefore, for effective and efficient learning processes in all higher institutions of learning, IETS is highly recommended.

REFERENCE

- [1] John McDermott (2003), AI agents; <http://www.aaai.org/AITopics/pmwiki/pmwiki.php/AITopics/Agents>
- [2] John McDermott (2003), Application of AI; <http://www.aaai.org/AITopics/pmwiki/pmwiki.php/AITopics/Applications>
- [3] John Bullinaria (2004), AI Techniques; <http://users.erols.com/jsaunders/papers/aitechniques.htm>
- [4] John A. Bullinaria (2003), AI Applications in Education <http://www.acm.org/crossroads/xrds3-1/aied.html>
- [5] John McDermott (2003), Reinforcement Learning; <http://www.aaai.org/AITopics/pmwiki.php/ReinforcementLearning>
- [6] John McDermott (2003), Educator Resources <http://www.aaai.org/AITopics/pmwiki.php/AITopics/EducatorResources> Cindy kranz(1997), The enquirer; <http://news.enquire.com/apps/pbcs.dll/article?AID=2008224/NEWS0102/802240361/1058/NEWS01>
- [7] Kulik, J.A. (1994), Technology Assessment in Education and Training; <http://otec.uoregon.edu.learningtheory.htm>
- [8] Jeffrey M. Bradshaw (1999), An Introduction to Software Agents.