Student Modeling: An Overview

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ABSTRACT - The intelligent tutoring sytems (ITS) are generations of computer based educational sysems that supports the teaching and learning processes with the aim of helpping students to achieve maximum learning goals. A major advanage of these systems is that they can be implemented in all kinds of educational environments either in the normal school environments in the form of stand-alone applications or as programs that remotely deliever knowledge through computers over the internet. The underline idea behind building intelligent tutoring systems is to integrate modern technological advancements with artificial intelligence techniques in the field of education with a view to making the teaching and learning activities highly advanced and more effective. An important feature that enhance the effectiveness of the teaching and learning processes with the ITS is the ability of the system to adapt to each individual student based on his/her characteristics, through making observations on the student's activities while they interct with the system. This phenomenum for observing student's actions while interacting with the ITS in order to build their profiles is known as student modeling. The aim of this paper therefore, is to review the state of art in student modeling in an intelligent tutoring system.

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1. Introduction

The ITSs are instructional systems developed using techniques of artificial intelligence (AI) that contain models for delievering the instructional contents through understanding the backgrounds of of what to teach (domain model), how to teach (tutor model) and who to teach (student module) [8]. An important characteristic that distinguished ITS from the older versions of e-learning systems is adaptiveness, a feature that gives ITS the abilities to personalized the tutoring services and inspire students to learn both simple and complex cognitive tasks [13]. The mode of tutoring provided by an ITS is the typte that support a step-by-step problem solving approach. This approach is effective in assisting students as they try to solve complex problems because the emphasis is mostly towards guiding them to understand every step of the solution instead of attaching so much emphasis on getting the final answer. That's why to many researcher's view, it is this ste-by-step approach for guiding students to achieve their learning objectives that make the ITS more and more effective [14]. One quality of an adaptive instructional system like an ITS is that the system is capable of managing the teaching and learning processes by observing each student's behavior, interprete those behavior changes with the aim of making an inference to conclude on the needs, preferences or learning style appropriate for each student. A vital component of an ITS that helps it to achieve it's adaptiveness is called the student model. The ITSs rely heavily on this model to build a complete representation of the student, that is why if a student model is designed so poorly to the extent that it fails to provide a complete

representation of the student, then all the decisions of the other components of an ITS that depends on this model are going to be of poor quality [6].

II. Related Literature

A. Overview of Student Model Design

The fundamental ideology of an intelligent tutoring system is that each student is unique and therefore deserve to be treated based on his/her individuality. One important characteristic of an intelligent tutoring system that enables it to recognized and respect the individuality of a student is that an ITS is adaptive. The student model is considered as the base for providing the personalized and adapive tutoring offerred by an ITS. The main goal of a student model is to build a complete profile of astudent based on his/her knowlege level (cognitive state) and characteristics with a view to making conclusions about the type of learning style or the most preferred teaching methods or strategy that may be suitable for each individual student [7].

B. Architecture Of n ITS

An ITS is an integreated system and therefore is made up of four basic components namely, the student model, the tutor model, the domain model and user interface model. These four components must always come togather to complement their roles and make the ITS more functional.

C. Student model

The main goal of a student model in an ITS is to create a repository for providing all information regarding the student throuh tracking his/her activities with the system to maintain a model inform of a profile that represent the student. It is necessary to build such student's profiles in order to enebles the other components of the ITS whose decision making roles largely depend on the student model to function effectively by liasing constantly with the profile.

D. Tutor/Pedagogical Module

The main idea behind developing intelligent tutoring system is to mimic the functions of a human tutor in the teaching and learning processes with a view to providing the expert abilitis needed to achieve the goals of teaching [9].

Such expert abilitie performed by the tutor model includes the choices of effective teaching strategies and relevant learning contents that will ensure effective delievery of tutoring tasks .

E. Domain Module

The domain module is a representation of the subject matter interms of concepts and their relation in a particular domain. The ITS make use of the knowldge of the subject matter from this model to provide effective feedback to students. The domain model also help in providing the ITS with the understanding of the domain specific concepts and the relationship that exist between those concepts in the domain in order to solve pedagogical issues as well as the other issues that relates to the domain concepts.

F. Interface Module

An ITS being a Computer based system need to be designed with the idea of providing an interactive user-system environment in order to provide a medium for communication between the system and the student.
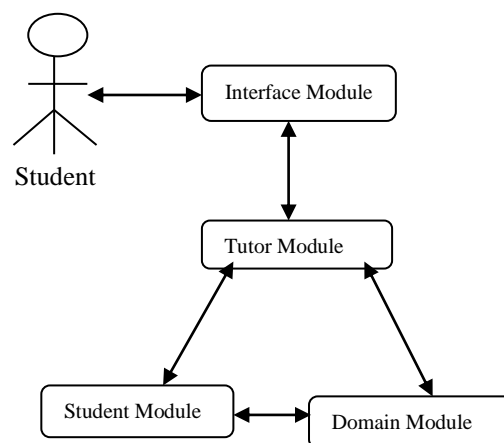

Figure 1 Architectue of an ITS

III. Student Modeling Approaches

A. Types of Student Models

Since the emergence of intelligent tutoring system, a number of researchers were able to proposed and implement various approches for designing a student model. Each approach has it's own peculiar characteristics (Table 1).

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Table 1. Summary of types of Student Models

Type of Model	Designer	Characteristic
Overlay	Carbonell, (1970)	Consider student's knowledge as a subset of the whole domain knowledge.
Perturbarion	Brown & Burton (1978)	Views student's knowledge as a dichotomy between "Correct" and "Incorrect".
Differential	Burton & Brown (1982)	Divide the domain knoledge to be learnt by students into categoies of "Compulsary" and "Optional".
Constarin-Bases	Mayo & Mitrovic (2001), Ohlsson (1992)	Represent the domain knowledge to be learnt by a set of contraints over a problem state.
Knowledge Tracing	Anderson, Corbett &Koedinger (1995)	Aimed at finding what knoledge the student has at any stage of the learning process.
Model Tracing	Conati, Gartner &VanLehn (1997)	Guide students when they are stucked and participate in pedagogical decisions also.
Stereotype	Rich (1979)	Clustre students in groups according to their common characteristics
Machine Learning	Webb (1998)	Observe students behaviors and generate training examples

B. **Benefits Student Modeling**

- Tracking students activities with the system in order to provide effective feedback that will motivate the students to improve their performances
- Creating and regularly updating students profiles through the observation an ITS made on student during interaction and this enable the system to identify the strength and weakness of each student.

- ITS help in the realization of one of it's fundamental theories that each student is unique and therefore deserve to be treated with the individuality approach.
- Providing one of the best medium of instruction, that is one-on-one tutoring.
- An ITS is a Computer instructor that is always cheerful and never treet students with any negative emotions and the students are always free to express their feelings with no reason to hide their ignorance.
- As a Computer based system, an ITS can be implemented in both traditional and modern educational environments, since the systems can be operated either using stand-alone Computers in the case of normal school environments or by using Computers with internet connections that can provides their tutoring services remotely.

Conclusion

Student modeling as an area of research in the developments of ITS has over the years keep growing to the extent that it has started to reach a sufficient stage. As a promising technology in the field of intelligent tutoring systems towards the realization of the main goal of the ITS, student modeling has contributed and is still contributing in making the ITS more adaptive. The research has shown how vital a student model design is in the development of intelligent tutoring systems. The student model is undoubtedly the most significant component of ITS whose roles continue to provide the base for other components of an ITS to function effectively.

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