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Autor: Mazza, Riccardo

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Riccardo Mazza[1]*

USING OPEN STUDENT MODELS IN DISTANCE LEARNING ENVIRONMENTS TO HELP TEACHERS PROVIDE ADAPTIVE TUTORING

Introduction and aims of the research

Web-based learning environments (WLE) are rapidly becoming a widely used education tool. There has been a growing interest of universities to use learning environments for on-line distance courses or for support conventional courses.

In commerce we can find several of this tools, known as *web course tools* or *course management systems*. However, this kind of tools are just sophisticated "web server applications", unable to offer the latest functionalities that we can find in research prototypes, such as the possibility to understand the users and adapt the content and the presentation to the specific learner (adaptivity). Even though such systems have been used in the last decade, current commercial applications lack of any kind of advanced features, specifically adaptivity. One of the reasons for this could be that these systems are quite difficult to use, especially for the authoring of the content, and often they are restricted to a specific domain (Math, Engineering, etc).

Nevertheless, commercial products have the great merit of having introduced interactive distance learning in places where teaching activities are carried out for centuries in forms of lectures from the Aristotle's age, and bring new advantages to learners, like asynchronous learning (Andriole and Lytle 1995), collaborative learning (Dillenbourg 1999), time and space independence.

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*University of Lugano, CH, riccardo.mazza@lu.unisi.ch

This research attempts to bring some advanced features to the commercial educational environments with respect to adaptivity. Particularly, we are interested in giving tutors additional functionalities to help them in his teaching activities and adapt teaching according to individual and class activities and progress. Past research has shown that one common problem in distance education from the tutor's perspective is monitoring and checking students activities in courses delivered with distance education tools (Mazza et al. 2001; Helic et al. 2000). This is in part due to the nature of computer mediated communication which lacks of some specific modalities of interaction like gesture, face expression, direct dialogue, etc. Interaction mediated by the digital media make difficult the tutor to verify elements essential in didactic, e.g. understand what part of the course an individual student or a group of students is working on, or the level of mastery achieved by each student for specific concepts of the course, etc. A good tutoring practise requires monitoring the learner progress with the content and testing the acquired knowledge and skills on a regular basis (Helic et al. 2000). While Web-based learning environments are supposed to help tutors to accomplish these tasks, they often provide complex, confused, and useless information.

Advanced methods for adaptive teaching have been employed in Intelligent Tutoring Systems (ITS). An ITS is a computer-based instructional system that provide individualized tutoring. Those systems include a model of the student's knowledge of the domain to be taught, a so called *student model*, in order to remedy misconceptions, generate feedback, make systems adaptable to individual learners and represent the learners' level of mastery of the current concept or topic (Holt et al. 1994; Tsinakos and Margaritis 2000; Nakamura et al. 1996). As before said, the difficulties of using this kind of systems as real application bring us in exploring the use of this methodologies in a widely-used commercial product.

The open learner model

An ITS is usually composed by the following components (Brown and King 1998):

Expert model: embeds the necessary knowledge about the domain to provide adaptive feedback, answer to questions, and support in problem solving.

Student model: is a component which represents the computer system's

belief about the learner's knowledge and could include learner's profile, domain knowledge, social characteristics, etc.
Pedagogical model: also called tutorial model, contains rules that enable the system teaching like a "*virtual tutor*" by the means provided by the expert system and the student model.

In a WLE we don't need all of the above components. In WLE is the tutor himself that bridges the gap between learners and coursware, customises the course material, provides explanation and support, answers to questions, etc. (Helic et al. 2000). What the tutor needs is a robust diagnostic algorithm that extracts the student model and provides the means for understanding students and adapting teaching to their needs. In particular, a good representation technique for the student model could be very helpful for the tutor and can improve the tutoring activity on distance teaching process.

Thus Student model in WLE may act as a monitoring and diagnosting tool for the tutor. The key concept in this case is not the use of the student model as an internal component for the simulation of a virtual tutor, like in ITS, but the mean to help the teacher to achieve more effective educational sessions (Tsinakos and Margaritis 2000).

The student model can be an internal component (black-box) of a complex system, or can be available to students and tutors for inspection and tuning. This case is referred to as *open student models*, *inspectable student models* or also *scrutable student models* (Holden and Kay 1999) and is mainly aimed at improving the quality of the learner model and promoting students' meta-cognition. Others have gone beyond the simple exploration, and has combined the externalisation process with the possibility for the students to negotiate and tuning this model (Dimitrova et al. 2000; Kay 1995). Recent studies have demonstrated that opening the student model to individuals can encourage the learner reflection, as the awareness about what they know and what they doesn't know enhance the learning process (Bull 1997).

A lot of research has been dedicated during last years to open student models to the learners, but very few research has been dedicated in opening the learner model to tutors (Zapata-Rivera and Greer 2001). Most of them are solutions where the student model is opened both to students and tutor, but the primary target of this is the student. No research has been performed in order to identify specific tutor's didactic requirements and build a student model representation according to these requirements.

If the open student model has demonstrated to enhance the learning process for students, it's likely to be the same for the tutoring process. No systematic study has been done to assess the potential of externalising the student model to tutors in a graphical format.

Methods

We want to create an external representation of the student model in order to optimally support tutor in his work. Past research into open student models has explored representation techniques using conceptual graphs (Dimitrova 2002), tree structures (Kay 1995), tables (Bull 1997) prolog clauses (Dimitrova et al. 2000). Very few attempts have been made to explore visualisation techniques. Zapata-Rivera and Greer (2001) proposed this kind of representation, but this is restricted to Bayesian network student models. Kay (1995) also proposed a viewer for the student model, but the aim is to give students an understanding of their own student models.

We propose an original approach of using information provided from WLE in order to obtain student models, built upon the specific pedagogical requirements expressed by tutors. These models will be externalised using information visualisation methods and tools . The main aim of information visualisation is to organise and render complex multi-dimensional data to help user to obtain a better understanding of specific features of the data (Tufte 1983; Spence 2001). One of the biggest problem with the data provided by the WLE is the huge amount of data. This data is provided in a numerical tabular format, with a poor logical organisation. Good graphics, instead, shall communicate complex idea with clarity, precision and efficiency (Tufte 1983). Visualisation methods are facilitated by graphical external representation, from which people construct internal mental representation of the world (Ruddle et al. 2002). In this context we want to apply information visualisation methods and tools to facilitate tutors in processing and analysing data of individual and group of learners.

Help for the tutors

Graphical external representation of student models have a strong potential in WLE. Tutor can use information provided by the student model in several ways:

- *Class knowledge monitoring.* Tutors often need to obtain an overview of the performance of their classes. This system can create at a glance a "big picture" of what is happening in the class, and allow to individuate immediately if there are some problems in the class.
- *Forming group for collaborative problem solving.* Forming a group for collaborative problem solving has always been a critical issue. Finding the most appropriate team of individual isn't a trivial process. Groups are formed taking into consideration ability, leaning style, behaviour, intentions etc. Some of this qualities can been found using the student model.
- *Find the most competent peer to answer a question about a topic.* This could be finding a person with a model showing good knowledge of this topic (Brusilovsky 1999).
- *Identify irregular students.* Good tutors have to concentrate their attention in students who need particular attention, like those that are progressing too fast or too slow with the schedule, or those that doesn't access the course for long time, or don't participate to assessment activities (Brusilovsky 1999).

Summary and current status

In this paper we discussed our proposal to extend a web based learning environment integrating an external graphical representation of the student model which can help tutors in distance learning courses. The student models has been opened to students and tutors in different ways in past research, but we propose to better characterize tutor's needs and specifities, and tailor the external representation of the students model to this specifities applying appropriate techniques from information visualisation.

Actually we are investigating which are the requirements for externalising individual and group modelling. In particular, we are in the process of identifying which social and cognitive aspects tutors need to understand in distance learning, discover how such understanding can be supported by externalising data from WLE, implementing visualisation techniques that could be applied to these data. Then we want to apply these results in a commercial WLE (e.g. WebCT) using data collected in some past distance learning course in order to assess the effectiveness of the method. Furthermore, the idea of "openness" can be extended to group modelling, in order to identify tendencies in different group of learners, discover common misconceptions, etc.

The advantage in respect of the existing ITS, other then the innovative visualisation methodology, is that tutors and students continue to use the same learning environment that currently are using, without the hassle of learning a new tool, changing their acquired habits or converting the course content in different formats.

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