

QAOSM- Empowering Quest Atlantis with Open Student Model component

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Abstract: Personalized distance learning, Student Modeling, peer tutoring and students' collaboration are some of the most critical issues under debate in the Distance Learning literature. New technologies like game based learning, have significant impact on education as ICT boosted instruction and learning beyond the walls of a physical classroom. The use of Student Models (SM) in education (in person or via distance) has been pointed out in literature since early 1980. Student Models have been used in traditional education as one of the central components of Intelligent Tutoring Systems. The purpose of Student Models is to create a simulation of a virtual tutor or of a peer student, who contributes to more effective educational sessions. According to Barr, "Student Model represents student understanding of the material to be taught with the purpose to make hypotheses about student's misconceptions and suboptimal performance strategies" (Barr et al., 1982). The Quest Atlantis (QA) project, as described in its web site, has been designing a context for learning, which sits at the intersection of education, entertainment, and social action. It is designed to support social commitment and real-world action. The project is intended to engage children ages 9–16 in a form of transformational play comprising both online and off-line learning activities, with a storyline inspiring a disposition towards social action. This paper will demonstrate the benefits of empowering QA with an Open Student Model component (QAOSM) which is capable of monitoring students' behavior and learning characteristics in order to outline their learning preferences and their comprehension level.

Keywords: Student Models, distance learning, game based learning

1. Introduction

Student Models elicit information from the students regarding their misconceptions, their weaknesses during the learning session, they contribute to promote student and teacher interaction, student to student interaction, or peer tutoring and collaboration among students (Field, 1982; Moore 1989, p. 1-6; Holmberg 1984, p. 49-54).

Teachers should be aware of their teaching effectiveness, of the students' performance and cognitive space, how the students are acquiring new knowledge, and mainly, if there is any way to improve the students' learning ability.

On the other hand, new technologies have significant impact on education as ICT transforming the traditional instruction and learning process to an "everywhere activity" as many modern classes are conducted in a virtual or online environments (Schellens & Valcke, 2005; Hmelo-Silver, 2003, Woo & Reeves, 2007; Hong, Lee & Liau, 2005;). According Rovai and Richardson, combination of learning contents and instructional methodologies can be used to promote students' knowledge and performance (Rovai, 2004, Richardson & Swan, 2003)

Educational games (internet based or stand alone) have become quite popular among students and instructors. As Barab claims "...recognizing the power of this medium, designers are now creating games specifically for education (Barab et al 2009). These games offer something new to students, i.e. entire worlds in which learners are central, important participants, worlds where what they know is directly related to what they are able to do and, ultimately, who they become (Gee, 2003; Gee Q Levine, 2009).

Quest Atlantis (QA) is a 3D multi-user (metaverse) developed by the Center for Research on Learning and Technology at Indiana University, that is currently being used with students aged nine to sixteen. Barab, Gresalfi and Arici (2006) describe Quest Atlantis as offering "entire worlds in which learners are central, important participants". In this metaverse, students are assigned an avatar that can be personalized within predetermined limits set by the designers. QA is a 3D world where students and teachers can see and interact with one another using chat and simple body language.

This paper will demonstrate the benefits of empowering QA with an Open Student Model (OSM) component which is capable of monitoring students' behavior and their learning characteristics based on their learning preferences and their comprehension level. The OSM is also used by the teacher to

provide personalized training/assistance to each student or can provide evidences in order to produce clouds of collaborative avatars which share a common OSM. In each case the use of OSM component has a significant contribution in student monitoring and provision of personalized (distance) learning services.

2. Review of Quest Atlantis' features

Quest Atlantis is a 3D educational game implemented in the University of Indiana, employing more than 48.000 players (students). According project's web site "Quest Atlantis provides a powerful new learning environment that combines academic concepts and meaningful play with disciplinary practices with the goal to create socially committed citizens. The project is intended to engage children ages 9–16 in a form of transformational play comprising both online and off-line learning activities, with a storyline inspiring a disposition towards social action." (Quest Atlantis, 2010)
QA engages four core elements

- A multi-user virtual 3D environment,
- Learning Quests and unit plans
- A storyline, presented through a video, a comic book, that involves mythical characters and a set of social commitments
- A globally-distributed community of participants.

The activities of Quest Atlantis take place in registered centers, such as schools, under the direction of teachers. In most cases the teachers have participated in an pre-training seminar on using QA for teaching. QA includes a variety of curricular and optional projects that evolve either online and/or away from the PC, as students can work individually or as a team in order to accomplish a particular task. In most cases students are called to take some decisions as part of a problem solving scenario, such as environmental pollution. To accomplish that, the students have to consider what their use of particular tools tells them about the context that they are working with, in combination with their contextual knowledge. After making a suggestion (to solve a problem), students can become time travelers and step forward for some years in game time to check the results of their suggestion. Students in QA (so called Questers), have the ability for some of the activities, to play the roles of environmental scientist, reporter, historian etc (Figure 1).

Students in Quest Atlantis can undertake some activities using one of the following three structures :

- a. Quests are curricular tasks which act as important scaffolds to virtual and real-world explorations to ensure effective content learning. Each Quest is connected to both academic standards and to our Social Commitments.
- b. Missions are collections of multiple learning opportunities and tasks interrelated through some general problem and narrative. While some Missions are entirely voluntary and are open to all Questers, others include Quests or classroom activities and must be activated by teachers.
- c. Units offer teachers an organized lesson plan of real-world and virtual activities that help to explore a particular content area. Each Unit is designed to provide a meaningful learning experience that is engaging, educational, and about real-world issues. (Barab et al., 2005)

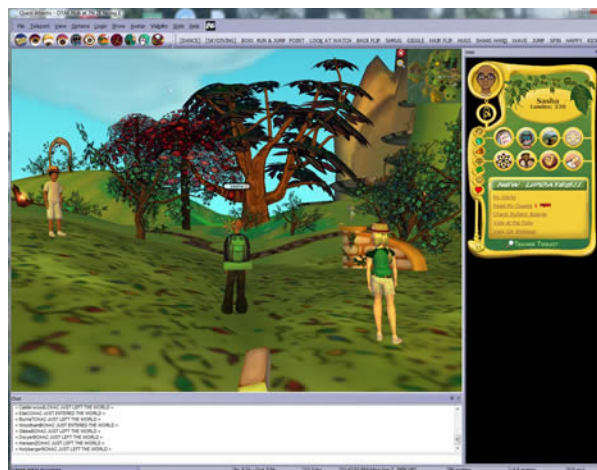


Figure 1: Typical Environment of QA (Quest Atlantis, 2010)

A number of case studies in various subjects such as Persuasive Writing, Science Classroom Comparison Study, Mathematics/Statistics, Language Arts/Reading-Writing Study, Social Studies Classroom Study, indicated an increasing progress on students' performance as result of using QA implying that it is a very promising educational environment (QA Research, 2010).

3. Student model applicable to QA

Student Model's (SM) related definitions come from Barr and Greer indicating that: "Student Model represents student understanding of the material to be taught with the purpose to make hypotheses about student's misconceptions and suboptimal performance strategies" (Barr et al, 1982)

Jim Greer illustrates the different interpretations that a Student Model might have indicating that such model may be: An abstract representation of the learner. teacher's conceptualization of a learner, system's beliefs about the learner or the learner's beliefs and skills. Additionally, it may also include history of learner actions or explanations of behavior (Greer, 1996).

He also indicates that "Student modelling is the process of acquiring knowledge about a learner, relative to the learning goals, and although some a priori knowledge might have been acquired about this learner or similar learners, normally the knowledge acquisition is carried out dynamically as the learner engages in interactions with the system" (Greer, 1996).

Student Models are not usually accessible to the students they model. On the other hand, related research indicates a number of educational benefits of allowing students to access their learner model contents. Raise of learners' awareness, of their developing knowledge, difficulties and the learning process, which lead to enhanced learning (Dimitrova et al, 2001; Mitrovic & Martin, 2002) are highlighted in the literature as advantages of students viewing representations of their model. It is reasonable to argue that opening the SM to the student can offer them an additional learning resource. Such models are usually described in the literature as Open Student Models (OSM) as they allow learners to explore analyze and consult their learning model by reviewing its externalization. Kay verify this argument by suggesting a variety of reasons for opening the student model to the students, claiming that such action help them to identify: what they know; how well, how to learn a particular concept and what they want to know. Furthermore, the students acquire more control and responsibility for their learning process enhance their knowledge comprehension, identify misconceptions, and potentially contribute to the improvement of students' performance and confidence (Kay, 1997; Mitrovic & Martin, 2002). The externalized representation may be simple or complex. Bull argues that "simple models indicating only a learner's level of knowledge of a range of topics can, of course, only present this simple information back to the learner. More complex models can make more detailed information available to the learner, though the existence of a complex model does not necessarily mean that the learner will have admission to all the model contents - they may have access to only a higher-level overview" (Bull 2004).

The proposed OSM for QA (QAOSM) is an improvement of the Overlay Student Model initially introduced by Kass (Kass, 1989) where student's knowledge is always considered as a subset of expert's knowledge. The objective of instruction is to establish the closest possible correspondence between the two sets. In such approach it is assumed that all differences between the learner's behavior and that of the expert model can be explained as the learner's lack of skill. Overlay Student Model works well for systems where the goal is to strictly impart the knowledge of the expert to the learner. On the other hand the main problem with this model is that the model assumes that a learner's knowledge can be merely a subset of an expert which may not always be the case (Greer and McCalla, 1994, p. 7) especially when the students are adults. But as the project of QA is intended to engage children ages 9–16, the assumption introduced by the Overlay Student Model is consistent.

QAOSM provides two modes of representation according the type of the user (student or teacher) including information for problematic areas, of knowledge gaps and misconceptions. This additional information available via the QAOSM, stands as the improvement version of the initial Overlay Student Model.

4. Description of QAOSM

4.1 Student Mode of QAOSM

The first representation mode of QAOSM provides information to the students in the form of skill meter, indicating the extent to which the student has mastered a particular Quest, Mission or Unit. Simplicity in model presentations is required, keeping in mind that the target population is students between 9-16 years old, as they may not readily comprehend advanced representations of their misconceptions or understanding.

In the student mode, QAOSM provides a number of facial icons in order to represent non-satisfactory, good, very good and excellent progress. In addition the proportion of Quest Missions and Units accomplished is also available to the students either in metrics array (Figure 2) or in a graphical concept map (Figure 3).






QUEST	MISSION	UNIT
NO 15: For the specific Quest your performance was:	NO 3: For the specific Mission your performance was:	NO:8 For the specific unit your performance was:
 VERY GOOD	 GOOD	 EXCELLENT
Problems 		Actions Required 

Figure 2: QAOSM metrics array

In case the student wants to further explore the above representation, the “Problems” icon is available which stores information regarding student’s questions and misconceptions. Additionally the “Actions Required” icon provides a list of targets to be achieved (which can be educational actions i.e. essays, research, quiz) on behalf of the student, in order to complete a particular Quest, Unit or Mission. This option is clearly represented in the graphical concept map (Figure 3)



Figure 3: Graphical concept map

The students are able to click on each node of the concept map and retrieve information regarding the “Actions Required” or to check which of the nodes has been already completed successfully. Obviously the students are able to review the list of problems and misconception in self paced mode, as the model can be reviewed any time. Access to the graphical map, allow the students to raise their awareness on a topic, assist them to better direct their efforts to where the need is greatest and encourage reflection by showing the level of knowledge acquired, as they have a graphical representation of the completed/mission nodes in order to fulfill their target (Quest, Mission, Unit) .

Similar literature research indicates that students with a range of abilities could understand the meaning of their open model (Zapata-Rivera and Greer, 2002) so therefore it is believed that the above described implementation will assist students towards the improvement of their performance.

4.2 Teachers Mode of QAOSM

In the second representation, which is more complicated than the first one, the QAOSM provides access to teachers. Teachers can see areas in which students could have exhibited misconceptions, students' performance across the activities type (Quest, Mission, Unit) and the strength of evidence for the various types of misconceptions or bugs. Teachers can also edit the open model of an individual student to reflect knowledge changes, and therefore update the particular OSM. For example if a student manage to overcome a specific (theoretical) weakness using teacher's guidance and supervision, the teacher can therefore edit the OSM of the student and remove or update the particular record.

In addition, QAOSM provides to the teachers a graphical representation of the misconceptions per activity, of a particular student or of a particular group. The teacher can also be informed regarding the performance of an individual student against the average achievement of a group or the whole classroom (Figure 4,a,b,c).

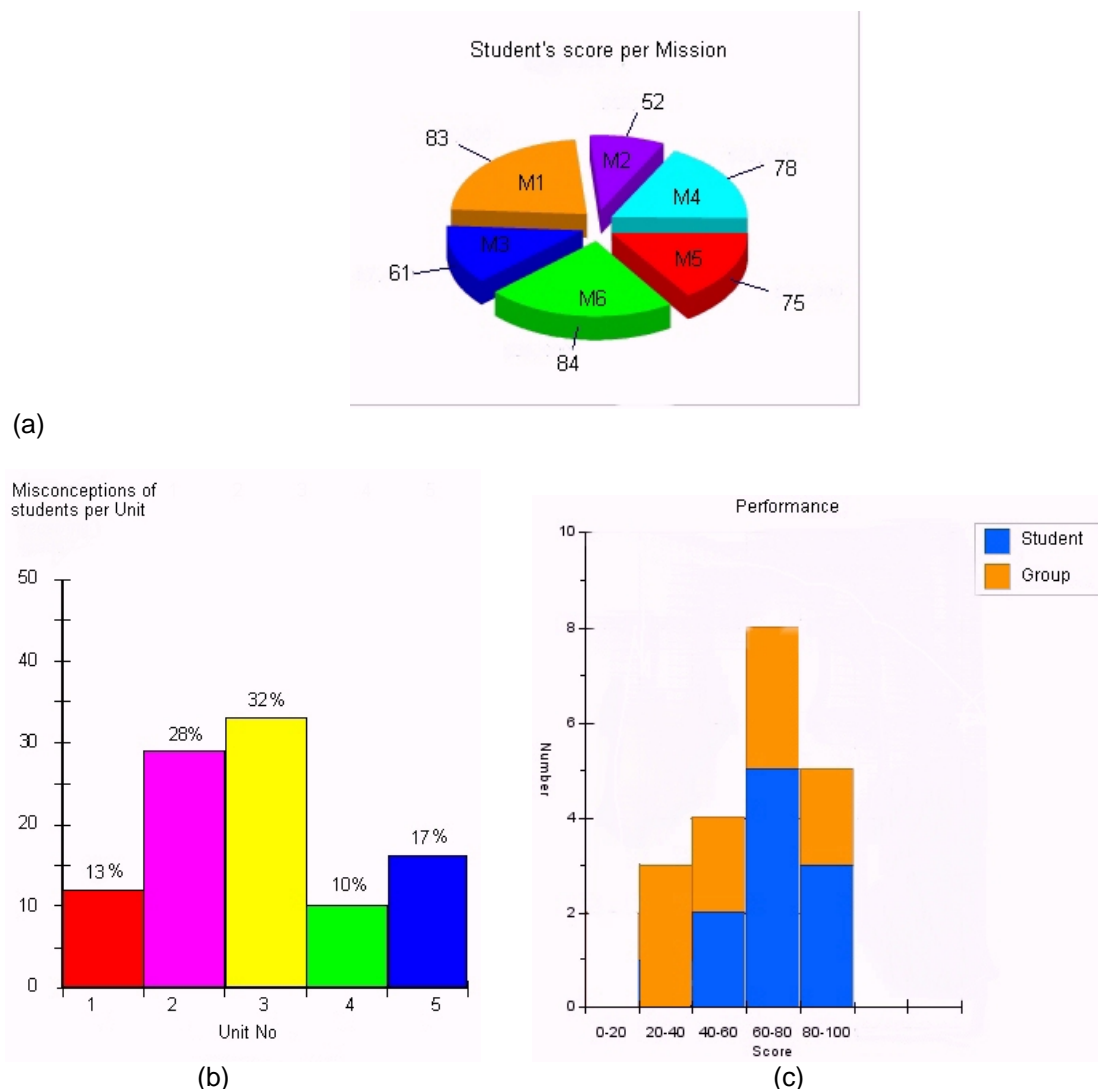


Figure 4 : Teacher's mode graphical representations

The tutors may also use the available OSM as an assistive source of information to adapt or modify their teaching to the individual student, or to a group or a classroom (e.g. Zapata-Rivera & Greer, 2001).

Additional benefits are related to actions such as:

Planning education: What topics are to be learned? Which are well known? Choosing exercises at the edges of the student's capacity

Planning delivery: What experiences are suitable to encourage learning of the intended topic and which previous experiences can be utilized?

Effective Assistance: such as providing hints during the problem solving is based on known subjects.
Generating feedback: Feedback on performance should build on previous knowledge as well as current conditions.

Remediating misconceptions: Remediating misconceptions by pointing them out to the student or by heaving a meta-level discussion.

5. Conclusion and expected benefits

Personalized services, Student Modeling, distance learning, game based learning peer tutoring and collaboration among students are some of the most critical issues under debate in the Distance Learning literature. Instruction and learning became available beyond the walls of a physical classroom. Quest Atlantis is a powerful new learning environment which is in line with the above mentioned trend, aiming to modify and improve the instruction/learning process based on a storyline scenario. The number of "Questers" (students playing QA) involved is a critical proof of its success and dynamic. The expected achievements by the use of Open Student Models in QA are the inspection and analysis of students' mental behavior, of their reasoning and of the knowledge that was believed to underlie such behavior. QAOSM is beneficial not only for the students but also for the tutors as they can monitor educational activities, coach students individually or as a group and adapt their instruction methodologies according the indications or the findings of the Model. The extent use of QAOSM among "Questers" of different ages will demonstrate its usefulness or its valueless. Teachers' feedback on the use of QAOSM will be also critical to evaluate its usefulness. So lets the game begin!!!

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