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STUDENT MODELING ENGAGING OLPC GAMING

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ABSTRACT

The current paper describes the implementation of an educational game designed to assist students' comprehension on a given topic. The game was developed to operate on the One Laptop Per Child (OLPC) device, according the fundamentals of student modeling theory and of game based learning.
Students' interactions are enabled, either in their school environment or they can follow the outdoor approach, by creating ad hoc wireless networks form their homes. Students' performances are monitored by the Student Model component of the game.
The teacher is therefore assisted to outline a student model for each student in the class, considering also the outdoor activities of the learner.

KEYWORDS

Student Model, Blended Learning, OLPC, Educational Software.

1. INTRODUCTION

The use of Student Models 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).

As Student Models elicit information from the students regarding their misconceptions or 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; Holmerg 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 has made instruction and learning available beyond the walls of a physical classroom. Many modern classes are conducted in a virtual or online environment (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). Vastly different from brightly packaged drill-and- practice software of the past, these games offer something new to students-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).

OLPC has been extensively used for educational purposes as according to its mission statement OLPC was developed "To create educational opportunities for the world's poorest children by providing each child with a rugged, low-cost, low-power, connected laptop with content and software designed for collaborative, joyful, self-empowered learning. When children have access to this type of tool they get engaged in their own education. They learn, share, create, and collaborate. They become connected to each other, to the world and to a brighter future" (OLPC, 2010). Distribution of OLPC in Greek Schools (Elementary and Second Level Education) is dynamically increased as more than 500 OLPC have been delivered in Greek High schools and more than 2500 are expected in the upcoming month.

The current paper describes the implementation of an educational game, designed specifically for the One Laptop Per Child (OLPC). The game is addressed towards students of Elementary and of Secondary level Education assisting them to evaluate their knowledge on a particular scientific topic. Students are also able to interact with their peers, beyond their traditional classroom in order to formulate collaborative working groups. This feature is available by taking advantage of OLPCs' ability to build Mesh Network which communicate effectively in a range of 175 meters (Carrano et al, 2007). Mesh network is an umbrella name for a whole range of network architectures that use a wireless backbone and allow multiple routes because of the point-to-multipoint way radio works (Kravets et al, 2001). Therefore students located at close distance can create a neighborhood of Mesh networks which expands in a significant larger range than this of 175 meters

2. OVERVIEW OF STUDENT MODELS USED

As the game is addressed towards students of Elementary and of Secondary level Education two different approaches of Student Models have been used.

2.1 Overlay Student Model

According to this model the learner's knowledge at any point is considered as a subset of an expert's knowledge. Instruction aims to make students acquire an additional part of knowledge till eventually they reach the desired result, which is the expert's knowledge.

In this model it is assumed that "all differences between the learner's behaviour and that of the expert model can be explained as the learner's lack of skill" (Greer and McCalla, 1994, p. 7) (Figure 1).

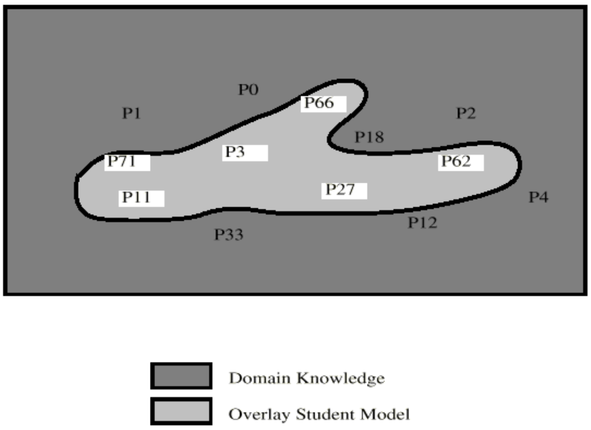

Figure 1. Overlay Student Model

As in youth ages between nine and twelve (9-12) years old, students' knowledge space verifies the assumption that a learner possesses lesser knowledge than the expert does, and consequently learner's knowledge is a subset of expert knowledge, for the above mentioned ages, the Overlay Student Model representation has been used in the game.

2.2 Perturbation Model and Bug Library

While the overlay model represented the learner only in terms of "correct" knowledge, a perturbation model normally combines the standard overlay model with a representation of faulty knowledge (Greer and McCalla, 1994, p. 8). In the perturbation model learner's knowledge is differentiated both quantitatively and qualitatively from expert's knowledge.

The perturbation model maintains a close link between the learner and the expert concepts but also represents the learner's knowledge and beliefs beyond the range of the expert knowledge (Figure 2).

This model utilises a bug library, which is a fixed collection of bugs and students' misconceptions. The bug library alerts for the existence of various potential misconceptions consequently leading to a more sophisticated understanding of the topics engaging the learner into higher cognitive processes.

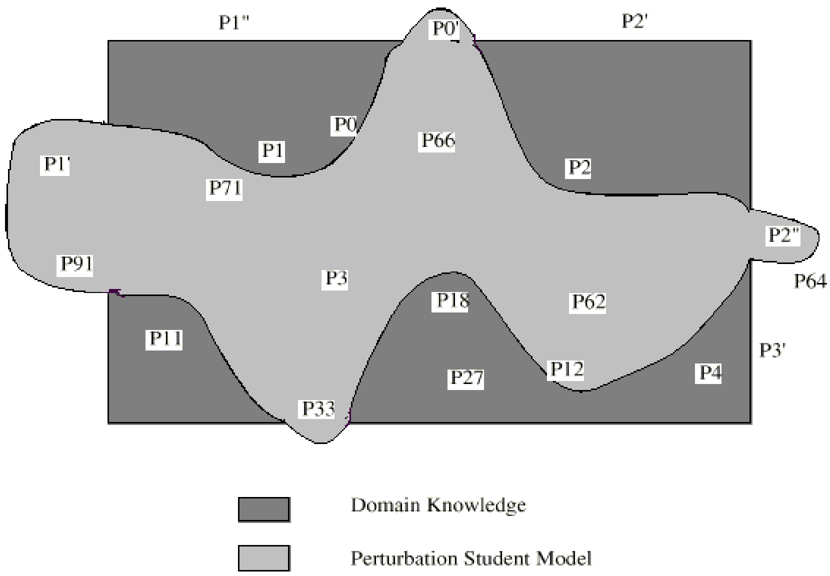

Figure 2. Perturbation model

The perturbation model is used as a representation model for the High School students who come with a variety of skills in a wide area of topics therefore their knowledge space could not always considered as a "clear" subset of teacher's knowledge space.

Both models are included in the game in order to represent accurately students according to their age. Student Models include both qualitative and quantitative data for each student in regard to their performance on a topic. The results of these models are exported in simple html format in order to be available even forom mobile devices used by the teachers.

3. GAME DESCRIPTION

The implemented game is a visual representation of the popular game "Hangman" in Python-PyGTK of the Sugar environment for the OLPC which was extended to accept a multiplayer mode.

In "Hangman" game, the player chooses a thematic category (i.e Geography) from which a "winging word" is derived and therefore tries to guess the word (i.e. Himalaya), knowing the number of letters represented by dashes (Figure 3). A summary description of the word's concept appears as an additional aid to the user. If the player finds an appropriate letter, it is therefore written in the correct positions by replacing hyphens. If the player (or the peers) fails in his/hers prediction, then a part of the sketch of a hanged man is drawn and the improper letter appears to the users screen in order to prevent further use of that letter.

In more detail, implementation's requirements were:

- Availability of thematic categories according the school topics from which the word is retrieved.
- Words must be randomly selected form a predefined pool.
- Dashes will represent the letters of the desired word.
- Along with the desired word, a generic description will appear.
- If a letter is not the desired word, displayed on the screen.
- If a letter is included in the word, to appear in the equivalent position.
- Partial sketch of a hanged man, when given the wrong letters.
- According player's performance (win or loose), to display an appropriate message to the user.
- A player has up to 6 attempts to find the word.
- Player's performance is monitored by the system and results are recorded in a (pro)file for each player.

Figure 3. Start screen of 'Hangman'

The player is prompt to enter a name and a corresponded age in order to start the game. Therefore a file is created associated to the payer's name where beyond the name of the player, information about his/hers performance in each game is recorded (i.e number of wins /attempts etc). In more detail, the name of the player, the date and start time of game, the categories chosen by the player, successful/unsuccessful attempts, and completed levels, are some of the stored elements in the system file comprising player's Student Model.

The system monitors player's performance and according to the player's age the appropriate Student Model is triggered. So in case of young players the Overlay Student model is applied, and consequently all the wrong answers are recoded as mistakes decreasing the player's mastery rate on the specific thematic area.

In case of elder players (above twelve years old) the Perturbation model is triggered and therefore wrong answers are used by the system in order to develop a bug library (of misconceptions or to trace erroneous data). In both cases, the teacher is alerted via sms for players' participation in the game, when the outdoor mode is selected. The teacher has the ability of on-line monitoring of player's behavior during the game or to access the Student Model component when the game is terminated.

As earlier stated, the player will have six attempts to find the word. The game ends (successfully) when the player finds the word in less attempts (Figure 4), or (unsuccessfully) when the word remains unknown even though the six attempts have been used. In that case the full sketch of a hanged man is drawn.

Figure 4. End screen of 'Hangman'

In case of successful game rounds the player is upgraded to participate in more advanced levels where concepts' complexity is increased requiring additional expertise on the user's side.

Since the game was developed for children using the OLPC device, a simple and pleasant interface, with bright colors and images were selected.

4. TESTING OF THE GAME

Formal surveys were carried out among teachers and students using OLPC in their every day school's activities. The main idea behind those surveys was, to measure the effectiveness of the "Hangman" comparing to students progress on mastering a specific thematic area.

The strengths of the project relate to the flexibility of the new environment allowing new pedagogical models to be trialed and implemented, particularly in relation to facilitating collaborative working among groups of students, the widespread adoption and usage of the OLPC for a diverse range of tasks by students and teachers, and the extensive use made of the wireless network by all.

A case study approach was employed to obtain both quantitative and qualitative data based on frequency of students' using the game and on the Students' Models reports available to the teachers.

A total number of one hundred and twelve (112) students were randomly selected as research sample. Geography, Environmental-Physics, History and Grammar were the four the thematic areas available to the students in order to participate in the game. The initial requisition of the survey assumed that all the students were already familiar with the content of the chosen thematic area. The student could participate in the game using either the indoor mode of the game (within the class environment) or the outdoor option (i.e form their home location).

Students could also ask for help form their peers (if available) especially in the outdoor approach. To eliminate the participation stress on the students' side, it was clearly stated to them that the main purpose of the experiment was the scientific evaluation of the game's effectiveness rather than their personal performance evaluation, and that their school marks would not be affected regardless of their performance during the game. This final clarification has been a great relief for the students, boosting up their participation to the game. Furthermore the students were informed that their actions during the "Hangman" game, were monitored by system's Student Model.

On the other hand, the teachers participated voluntarily in the survey, under the initial conditions to protect students' personal data, and of reporting results by replacing students' names by alpharithmetic titles (i.e. Student No23 rather than student's full name)

Participation to the game was unrestricted in regards of time, for two weeks period time, having only a minimum threshold of four participations per student.

4.1 Data Collection

A total number of one thousand five hundred and sixty eight participations (1568) have been recorded during the two weeks evaluation period, indicating an average number of fourteen (14) game participations per student. A total number of one hundred and four reports (104) where available by the Student Models to the teachers for review (derived form the participation of 112 students which was the original set), indicating a rate of 92,85% of successful participations to the game where performance reports have been created.

The remaining presentence of 7,15% of failure participations, was due to insufficient students' participation to the game (lees than the minimum threshold) where therefore the Student Model could not generate a summative evaluation report on student's performance, or due to unsuccessful attempts to participate in the game.

The popularity (among students preferences) of the four selected thematic areas was as follows:

- Geography (GE) 33%
- History (HI) 27%
- Environmental-Physics (PH) 24%
- Grammar (GR) 16%

Their performances (successful games/correct answers) related to their mastery level on a topic are displayed in Figure 5, where the vertical axis represent students (average) access to the game and the horizontal axis represent the queries asked in total to each student.

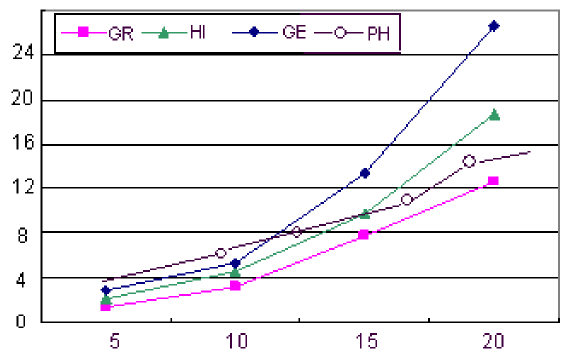

Figure 5. Students' performance per topic

5. CONCLUSIONS AND FURTHER WORK

Discussing the above reported results, it is clear that as students' participation is increased the mastery level on a topic is also increased. Therefore content comprehension is further assisted and enhanced as the student compels to test his/hers skills by playing.

According to the Students' Models reports, the students performed better in Geography as the course content includes a number of simple terms and descriptions such as "The highest mountain in the world" or the "Most crowded capital city" etc, comparing to the Grammar content where term's definition becomes more complex. Also, utilization of Perturbation Student model resulted to the creation of bug libraries on each thematic area indicating students' misconceptions (poor guesses) which can provide evidence to the teachers to either improve the specific course content or their teaching performance.

In addition teachers using Student Models could outline student comprehensive characteristics and detect erroneous data included in the original data (course) set.

Summing up, the results of the surveys related to a successful intervention and clearly indicate that a high percentage of teaching-related staff and students have embraced the use of the OLPC, wireless access to the game in the context of their teaching, work and study. The general consensus is that the use of this technology has had a positive impact on teaching and on the overall school experience. From a teaching perspective, it offers flexibility, mobility and opportunities for new modes of teaching and work-related activities. The student perspective is even more positive, where the technology was very quickly integrated into the overall student experience, becoming indispensable in a very short time period

Staffing resources would be required to support the ongoing operation of the enhanced learning environment, although this could probably be achieved by the utilization of the existing support resource, freed up from existing roles. In addition, a willingness by staff to embrace new pedagogical paradigms is essential for the enhancement of the student learning experience.

Some of the future developments of the "Hangman" game is the implementation of visual effects, where a student can adapt to an initial role (i.e that of the explorer in case of Geography) having some tasks assigned to the corresponded role. Each time the student accomplish successfully a game round, some tasks will be fulfilled enabling the student to proceed in the selected journey (in the content). Advanced visual effects might increase students' willingness to participate in to the game and further stimulate content comprehension.

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