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Design of a Computer Game for an Information Technology Class

Design de um Jogo de Computador para Aula de Informação e Tecnologia

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Resumo

Para conseguir captar e motivar estudantes de ciências de desporto na disciplina de "ciências de computadores", um jogo digital foi conceptualizado especificamente para a matéria da disciplina, seguindo o método de "digital game based learning" e as teorias de aprendizagem construtivistas. Procura-se incluir na narrativa assuntos relacionados com a vida destes estudantes e para além disso apresentar um ambiente de aprendizagem com contexto significativo. Os resultados deste projecto até ao momento incluem uma planificação (*design document*) para o primeiro nível do jogo com a inclusão de puzzles propostos pela professora da disciplina e um protótipo preliminar, que irá ser testado com os estudantes do primeiro ano lectivo do Departamento de Educação Física e Ciências de Desporto da Universidade de Thessaly (Grécia) para se comprovar a eficácia inicial e apelo geral.

Palavras-chave: digital game based learning; ciências dos computadores; teorias de aprendizagem

Abstract

In order to engage and motivate sport science students in the subject of computer science an educational game was designed specifically for the subject matter, following the digital game based learning approach and the constructivist learning theories. A narrative was included to which the students could relate themselves with and provides a meaningful context to the learning environment. The results of this project so far are a design document for the first level of the game with the inclusion of puzzles proposed by the instructor and a preliminary prototype to be tested with the first year students of the Department of Physical Education and Sport Sciences of the University of Thessaly (Greece) in order to evaluate the initial effectiveness and overall appeal of the game.

Keywords: digital game based learning; computer science; learning theories

1. Introduction

In the Department of Physical Education and Sport Science (DPESS), University of Thessaly, Trikala, Greece, 'Information Technology' is a compulsory course taught to all undergraduate students. Its basic theoretical components consist of: computer typology, basic computer functions, hardware and software types, computer networks, and the Internet. The instructor of the course is one of the authors (M.P.). According to her previous experiences of teaching computer science concepts in lecture format, students soon get bored and look forward to actually using computers and the Internet. In order to make students acquire lasting learning outcomes and become motivated with this course, it was decided to introduce into it digital multimedia environments designed according to basic principles of the constructivist learning theory, such as a game embedding the theoretical component of the course. Such a game could be used as learning and motivation tool, thus making use of the potential of Digital Game-Based Learning (DGBL) in the classroom. Previous studies have demonstrated that computer games have been effective in raising motivation and achievement levels of both children and adults in various areas of knowledge such as Science and Math (Klawe 1999), Language (Rosas et al., 2002), Geography (Virvou, Katsionis, & Manos, 2005) and Computer Science, where specific learning objectives can easily be stated (Kordaki, 2010; Papastergiou, 2009).

This is how the educational game project began, as an attempt to enhance the motivation among the students of the course together with their interest in computer science and information technology. DGBL is an approach implying that educational content and learning principles are introduced into video games. Its purpose is to engage learners, and it can be used for the learning of almost all subjects and skill levels (Coffey, 2009). This type of learning environment was chosen due to its acclaimed benefits: as computer applications, games can make learning more efficient, interesting and enjoyable (Malone, 1980) and they also embody well-established principles and models of learning (Eck, 2006). This approach is being widely studied because traditional teaching and learning methods may no longer be effective for the current generation of learners (Srinivasan, Butler-Purry, & Pedersen, 2008), whose way of thinking, learning and processing information has been changed thanks to technology (Prensky, 2001), and the research done so far has been able to expose the potential of videogames inside classrooms and

support some of the game-based learning claims with encouraging and positive results concerning student engagement and learning (Srinivasan et al., 2008; Tüzün, 2007).

2. Conceptual Framework

2.1 Videogames

With a legacy which started with board and card games about two centuries ago, and moved on to the TVs and computers' mainframes during the 50s-60s decade, digital gaming entertainment is one of the most profitable industry so far in this very century, in constant development on pair with technology improvements. The statistics released annually by the Entertainment Software Association (ESA) prove this much: 68% of the American households play computer or video games, and game sales during 2008 accumulated 11.7 billion dollars (ESA, 2009).

Games have been part of the human existence (Crawford, 1997), and they can be defined as "a system in which players engage in an artificial conflict, defined by rules, that results in a quantifiable outcome" (Salen & Zimmerman, 2004). In addition, the games set in virtual environments are no different, bringing a wide variety of genres and game styles.

2.2 Learning Theories

The inclusion of principles of learning theories in games is of great importance, especially in serious games, and those suitable for educational purposes. There are three main paradigms: *behaviorism*, where the individual reacts to stimulus and positive or negative reinforcement, and the learning process occurs when there's a change of reaction; *cognitivism*, where the human mind is compared to a computer, that can think, memorize and solve problems, and requires active participation in order to learn; and *constructivism*, where the learning process is about constructing knowledge, not just acquiring it, and learners have different interpretations over reality depending on their past experience and interaction (Knowledgebase, 2009).

Given that constructivists strive to provide learners with an environment where they can not only construct knowledge, but also put in practice what they have learned in different situations, interact in order to advance, analyze data and test hypotheses (Jonassen, Davidson, Collins, Campbell, & Haag, 1995), and the influence of the learning theory in

computer science education (Greening, 2000), a game is a challenging medium for the creation of constructivist learning environments. In fact, games not only provide a source of strong motivation for student engagement in learning, but they can also essentially encourage students' social, emotional and cognitive development (Piaget, 1945/1962)

Even, commercial games which were not created for educational purposes provide environments with principles defended by the constructivists (Rosario & Widmeyer, 2009).

2.3 Games in education

Although *Spacewars!* is considered to be the first computer game in history, the military had already been creating simulations in computers since the 60s (Wolf, 2008), and nowadays, they consider the game *America's Army* to be one of their most successful communication tools, and they use it for training purposes. And not just in the military: the applications defined as serious games have been used for health promotion, training, advertising, production, science and research, and finally, education (Sawyer & Smith, 2008).

A game being used for educational contexts doesn't necessarily need to be created specifically for such purpose; for example, it may be a commercial entertainment game which was *modded* (term used for custom modifications made by others) so it can be used for learning, depending on the availability of such tools. There are three possible ways of introducing games in the classroom: (a) make the students create them, as a way of learning; (b) introduce COTS (Commercial Off-The-Shelf) games, with a genre and gameplay elements suitable for the class in question (e.g. a game situated in Ancient Egypt for a History class); and (c) utilize games created specifically for the class, by teachers and researchers, using their resources and applying the desired pedagogy in them (Eck, 2006). In the course of playing appropriately-designed computer games, learners can be introduced to new concepts, topics and skills which they can continue to explore through offline reading, discussions or activities (Fisch, 2005).

3. Game design proposal

The target public of the specific game presented in this paper is first year students of the Department of Physical Education and Sports Science (aged about 18 years old). Besides attending classes, those students also practice sports and their performances are evaluated. The theme of sports was suggested to be embedded in the game design with a view to providing a meaningful context the target public can relate with. In fact, the main character is a sports science student.

The storytelling is associated with the Olympic Games of Athens in a future where some technology progress has been done, but older hardware and software is still being used due to certain liabilities. The player assumes a character codenamed "Hero", who's a sports science student doing volunteer work for the Games, and he's being accompanied by a hovering robot coming from a prototype series of tourism robots. The network from the Games installations is suddenly affected by a series of crashes, affecting both newer and older computers, and inevitably, the Hero and the robot are involved in this chaos and have to solve the enigma behind the computer and network instability.

Games often do not need a complex narrative to complete them. Alien ships are invading and need to be destroyed in *Space Invaders*, *Pac-man* needs to evade the ghosts, and that is enough as a narrative. In other games genres, a strong narrative component is necessary to captivate the player alongside the game play, graphics and music.

To keep the player interested in this educational game the narrative can play an important part in creating a "motivationally engaging learning environment" (Waraich, 2004). The subject matter that needs to be mastered by the student-player remains important, but if it can be merged into the story, it is hoped that it becomes more challenging, relevant and interesting for him/her. The game not only incorporates course subject matter, but it also includes a series of puzzles, which require the player to discover or apply the concepts and processes constituting the subject matter. For example, the first puzzle is composed by a diagram of a computer which needs to be restructured, followed by an example of an application and theory, but the main character of the game is a sports science student working as a volunteer for the Olympic Games. This poses several questions: "What is a sports student going to do with a puzzle about computer science theory? How did he get involved with it?" and "How can both elements –sports and computer science- be merged together to make sense?"

To answer those questions, the puzzles had to be merged within the storyline carefully. Specifically, some events had to be triggered to get the student-player involved: the game starts with a system crash occurring during a basketball game, and after listening to a transmission from the robot, the main hero moves to the cabins where the hardware is stored, and he is told to make the calculations for the basketball game's score. His portable PDA is bugged, and when he introduces the chip with a program in it, the PDA crashes and he sees scattered pieces across the screen; when grouped correctly, those pieces complete a computer diagram, and the character gains access to the application. During this event, the robot unveils more information about computers and how they work.

The interaction between the robot and the main character is also prominent, since the robot can provide hints and detailed explanations about the subject matter during the puzzle solving process, upon the player's request (by pressing the robot icon in the slide menu). The robot's speeches may be lengthy (in order to provide the player with the necessary information), but this is compensated by light conversations between the robot and the main character, some humor included.

3.1 Game mechanics and Gameplay

Several elements from known game genres are incorporated within the game: the dialogues function in a similar way as seen in most basic RPGs, certain scenes are explored by clicking on items and activating switches, like in some mystery solving adventures, and there are puzzles and quizzes, most with multiple choices. Specifically, after a brief introduction to a new act with the inclusion of dialogs and explanations, the player can: start exploring the environment, interact with elements in the background, check the current items in the inventory and their uses, consult the knowledge database in the minicomputer, and unlock applications. At a point where the player will have advanced enough in his/her investigation, he/she will unlock a puzzle. Solving the puzzle will initiate the act's conclusion and the player will proceed to the next act.

The game's progression follows a linear path, and the puzzles are solved in a static order, but in later parts of the game it becomes possible for the player to explore various scenarios instead of a single one and to perform experiments. For now, there's no "game

over" implemented in the game. The player can try, fail and try again without being penalized. And after successful events and challenges, the player is rewarded with items and information chips, which when introduced in his PDA device, unlock information bits about computer science basics, a feature which should prove to be useful for players, as advanced puzzles will require knowledge acquired previously.

The game is planned to include three levels. At this point, the planning documents are being developed in detail for the first level, which includes 24 puzzles and its respective plot story and dialogues. As an educational tool, the game is meant to be divided in acts and solved gradually within a semester of classes. The instructor can give students access to the acts after they have finished a specific subject. The students will be able to save the game progress online where the instructor can consult and identify who has solved the puzzles and advanced.

4. Preliminary Prototype

The preliminary prototype itself only includes the first puzzles, but it is possible for the student, even within such a small part of the game, to interact with the minicomputer, and the inventory, to unlock at least one application and to become familiar with the main characters and dialogs of the game.

The first level of the game is being implemented through using Flash tools such as Adobe Flash CS4 and ActionScript 3.0, for easiness of development and implementation of graphic elements, and the possibility of installing the application as a web browser game. If at latter stages it is decided to switch development tools, the graphic elements (such as character art for the dialogue scenes) can still be reused.

Figure 1 shows a segment of the first scene that demonstrates how a dialogue is executed inside the game; similarly to other games with a strong character interaction, such as role-play games.

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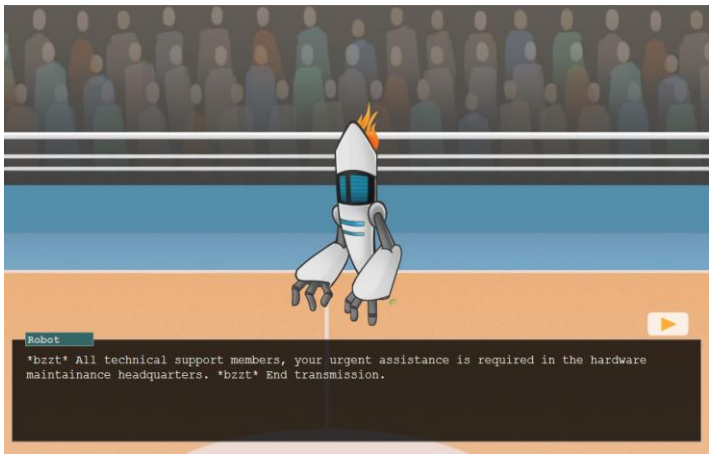

Fig 1 – The distress call from the initial dialog.

Figure 2 represents the game interface for the first puzzle to be solved. Loose pieces of a diagram are scattered across the PDA's screen and it is necessary to rearrange them to represent the model of the computer as a programmable data processor. Also represented in Figure 2 is the slide menu -on the right side of the screen-, where the student-player can request a hint from the robot, consult the PDA or check the inventory. As shown in Figure 3, when the puzzle is complete, the robot will provide a wider explanation about the model, and the student-player will be able to proceed to the next task.

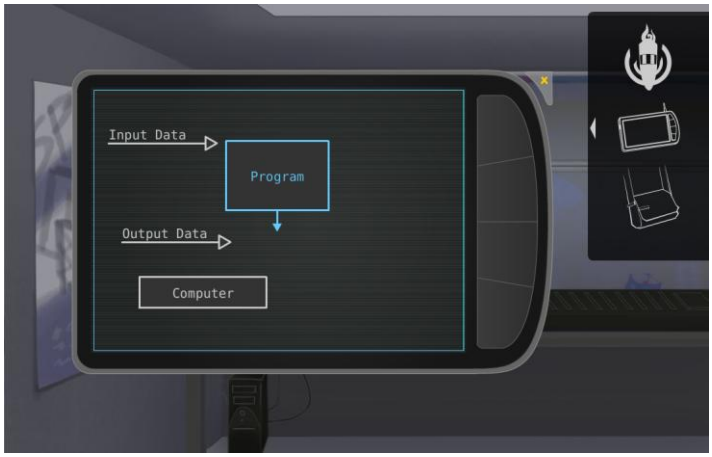

Fig 2 – Solving the first puzzle.

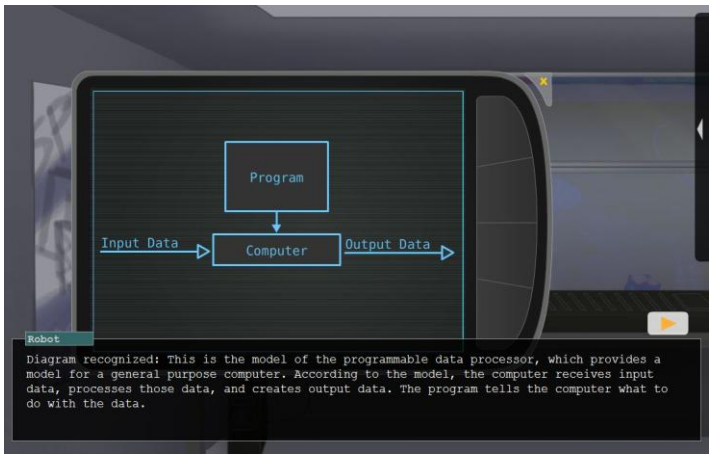

Fig 3 – After completing the model of the computer as a data processor.

5. Final comments

The prototype will be tested in the Department of Physical Education and Sports Science of the University of Thessaly with the new first year students during their introduction into the 'Information Technology' course. After having interacted with the prototype, those students will be asked to fill in a questionnaire addressing their perceptions and motivation regarding the game as an educational tool. Another evaluation session will take place in the Department of Communication and Art of the University of Aveiro with a target audience different than the first one. The purpose for conducting this second evaluation is not to compare the data between the two evaluations, but to gain further insight from students more familiar with computer applications and interactive environments.

With the data analysis of the preliminary evaluation, it will be possible to tell if the students consider this method of educational gaming interesting and profitable. It would be beneficial to hear about what the students expect from an educational computer game and register any alterations regarding the student's levels of motivation.

There are also other game play extensions which may be considered in later stages of development, such as the implementation of a multi-player system, either friendly co-op, or versus mode, which will act as an incentive for students to solve problems together.

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