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Designing videogames to improve students' motivation

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ABSTRACT

The use of new technical tools as a mean to increase the motivation and improve the education of students is an intriguing and pressing issue. Specifically, great interest has been shown in the use of videogames since they constitute a common leisure-time activity of many young students, a circumstance that shows their motivational, if not their educational, potential. In this paper we suggest that the design of videogames can be a very effective activity. To demonstrate this, we have used game design as a test-bed for an experience involving Computer Science and History students: interdisciplinary teams have cooperated in the design of a video-game on an historical theme. The experience has been repeated along three academic years. The students' motivation has been evaluated in the last 2 years, demonstrating that it is higher when they use the interdisciplinary design of videogames as a way of learning instead of traditional learning methods.

1. Introduction

Over the last years, not only have computer games become a popular leisure activity, they have also come to be considered as an important tool for learning and skill acquisition (Boyle, Connolly, & Hainey, 2011; Wong et al., 2007). Their use has been experimented with in educational settings, with the main purpose of increasing the students' engagement (Durkin & Barber, 2002). All this, based on the idea that, in the early years of life, games are one of the most important activities for learning (Smith & Pellegrini, 2008) and that recovering this ludic component can help learning in adult life as well. *Serious (or learning) games* are games intentionally designed for learning, skill acquisition and training. Contrary to pure entertainment games, the motivation behind learning games is educational, being their entertainment value merely a tool useful to improve learning. Several games for learning have been developed in different areas (Bos, Shami, & Naab, 2006; Hainey, Connolly, Stansfield, & Boyle, 2011; Kato & Beale, 2006; Skiba, 2008; Squire, 2004; Zwikael & Gonen, 2007), based on the underlying idea that the motivating power of entertainment games can be included in learning games, thereby helping players in their learning process. Game-based education recognizes that learning is a function of the activity, context and culture in which it occurs (Lave, 1988). Game-based learning is also consistent with problem-based learning, which asserts that learning is most effective when it poses significant, contextualized, real world situations and provides resources, guidance, and instruction to learners as they develop content knowledge and problem-solving skills (Mayo, Donnelly, Nash, & Schwartz, 1993).

The increasingly realistic experience obtained through video games has generated a great interest in using them to understand the mechanisms of students' engagement (Boyle, Connolly, Hainey, & Boyle, 2012). It has been found that computer games can have a positive impact on the development of cognitive capacities such as attention and concentration span (Jennett et al., 2008; Schneider & Shiffrin, 1977; Weibel, Wissmath, Habegger, Steiner, & Groner, 2008), which are extremely relevant in the learning process. Several theories (Savery & Duffy 1995) have been developed to explain why people of all ages and genders enjoy playing games; motivational theories have been used to explain the appeal of games, taking into account the very basic needs for competence, autonomy and relatedness that drive human behavior (Przybylski, Ryan, & Rigby, 2009; Ryan & Deci, 2000); other studies develop theoretical models about the role of satisfaction (Ryan, Rigby, & Przybylski, 2006). Physiological and psychological variables have been also widely studied as a function of the exposure of players to computers games (Baldaro et al., 2004). Several researchers also claimed that computer games can increase higher level cognition such as critical thinking, argumentation and hypothesis testing (Dondlinger, 2007).

Although there are several studies about the benefits of using games (Marchiori, Serrano, del Blanco, Martínez-Ortiz, &

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Fernández-Manjón, 2012; Moreno-Ger, Blesius, Currier, Sierra, & Fernández-Manjón, 2008), determining the advantages of the *game design* itself is a different matter on which results are scarce. This is the matter we are beginning to explore in this paper, studying if game design is an engaging activity that can whet interest in learning in our target environment (undergraduate university students).

In this work we have assembled a team composed of Computer Scientists, Psychologists, and Historians. With this interdisciplinary team, we have been able to develop a serious game model that can be designed and implemented by undergraduate students in the course of a semester. In this paper we show the details of the game design model and the characteristics that make it suitable for students. This information will be useful for the readers to get a better understanding of the potential applications of our game engines.

Based on the games designed by the students, we have carried out a motivation study to obtain a deeper understanding of the advantages of interdisciplinary game design through the learning process. This study has been developed during two academic years (although the game design was developed along three academic years, the first year was used as a preliminary feasibility study, and no hard results were derived from it). In both years, the motivation study was based on the comparison of texts that the students made related to the videogames with text related to a critical analysis of a book (which is a task related to traditional methods of learning). As we will demonstrate, the students' emotion levels during the game design process are higher than those derived from traditional learning tasks. We will also demonstrate that the coordination between different disciplines is a key parameter to keep the students' motivation high.

2. Background and hypothesis

Computer Science freshmen at the Universidad Autónoma de Madrid follow a "programming project" course as part of their basic curriculum. In this course, they do not learn new material in the systematic way afforded by traditional lectures, but apply the knowledge they already have (acquired mainly in the Programming I and Programming II courses) to develop a semester-long programming project in groups of three or four people. The project consists generally of the design of an "adventure"-style videogame with very limited graphical capabilities (real-time graphics is beyond the skill level of freshmen and, in any case, it would take the emphasis away from the basic programming skills that the students are supposed to practice). A very important part of these projects is related to the storytelling, which is a topic that is not relevant, as a first approximation, in the Computer Science students' learning process. This fact led to the current cooperation between the Computer Science and History departments.

History appeared from the beginning as the ideal discipline for this kind of collaborative work for two reasons. Firstly, the shared scientific background would generate enough commonality to make the cooperation possible, while the difference in humanistic-technological orientation would create enough difference to make it interesting. Secondly, History has an important narrative component, which makes it uniquely suitable for games that implement an adventure, i.e. tell a story.

Our main hypothesis for this research is that, in an unstructured, semi-independent learning activity, such as the design of an adventure-style video-game will produce a higher level of students' motivation than the one from traditional learning methods.

3. Experimental set-up

In this project we are interested in the motivational possibilities of game developing, rather than those of playing, so we focused on the program design and storytelling activities, which were performed by groups of students with different majors, so as to allow for richer interaction and expose the student to peers with a different cultural background. During the design, the students had to face different points of view, thus improving their capacity to negotiate and reach agreements in heterogeneous groups of peers. Due to the final purpose of the project, the practical constraints of the activity, and the students' technical maturity, we decided that the game would be an adventure game with limited graphical support.

The main advantage of this kind of games is that the interaction between the player and the game takes place through text commands, thereby reducing the programming complexity to a level manageable by freshmen and sophomores in a semester. Despite the graphical limitations, this kind of games allows us to include a significant amount of information through text descriptions and images. Adventures can be based on a complex plot: the main character of the game is controlled by the player through text commands and, in a first-person point of view. In response to these actions, the game communicates information about the state of the world.

The design has been further simplified by basing the game on abstract *loci* and allowing movement only to occur from one locus to another. Loci can be used to model a plethora of environments: a room, a street, a whole city can be modeled as a locus. The only constraint that we impose is that a locus is an atom from the point of view of movement: the player can move from one locus to another but not inside a locus. We also assume that whenever the character is in a room, it has complete control over its contents; for example, the character can pick up any object in a room regardless of the precise location of the object. This structure allows us to model a great deal of gaming situation with a software structure that is relatively simple to manage. An example of the game interface is shown in Fig. 1.

The design groups were composed by up to four Computer Science students and up to six History students. The computing students designed the game engine (i.e. the general-purpose program that would then be customized with the content provided by the History students). The general design document was the same for every group, but the students were given a considerable leeway to experiment with different design and original solutions. Every group implemented different tools to support the narrative, often upon request from the history students and based on the specific needs of the plot that they were creating. The ability of the students to reach agreements in the face of conflicting priorities was crucial at this point: the computing students had to develop efficient tools to serve the needs of the history student, while the history students had to adapt their narrative to the limitations of the game engine. In both cases, knowledge about matters that are not usually included in their curriculum was required. As a result of this interaction, every game engine has some peculiarities. For example, some games implemented an energy counter (it decreases with every movement of the player and had to be filled by drinking or eating) while others implemented the possibility to introduce fights between the player and some enemies.

We conducted three separate experiences, during three academic years, resulting in the design and implementation of three separate sets of games. The games developed during the first academic year were quite specific, as each one resulted from a tight and constant cooperation between a group of programmers and one of plot designers. We considered it a pilot experience with the only objective of giving us enough experience to develop the correct experimental setup in the following years. During the second academic year, we tried to create a game engine that could be used by a wider variety of groups of students. To achieve this goal, we had to sacrifice many of the features that the history student

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