Designing social videogames for educational uses

Carina González-González*, Francisco Blanco-Izquierdo

Department of Engineering of Systems and Automatic and Computer Architecture, University of La Laguna, La Laguna, Tenerife 38204, Spain

ARTICLE INFO

Article history:
Received 31 May 2011
Received in revised form 8 August 2011
Accepted 9 August 2011

Keywords:
Educational videogames
Collaborative learning
MMORPG
CSCL
HCI
Playability

ABSTRACT

In this paper we analyze the main areas of research into educational videogames and in the evolution of the technologies and design methodologies that are making these interactive systems increasingly natural, immersive and social. We present the design and development of a prototype for a collaborative educational videogame based on a Massively Multiplayer Online Role-Playing Game (MMORPG) engine for use in various educational contexts in (a) university education and (b) secondary education.

© 2011 Elsevier Ltd. All rights reserved.

1. Research on educational videogames

Scientific research into videogames has been rather scarce, only coming into its own in the 80s, when videogames first started to proliferate. This research has focused mainly on the negative effects of videogames, namely aggressiveness, addiction and withdrawal, and was based on previous research into the effects of TV (Calvo, 1997; Goldstein, 1993; Healy, 1998; Huston, 1999; Irwin & Gross, 1995; Welch, 1995; Flood, Heath & Lapp, 1997; Cesarone, 1998; Wellish, 2000). The result has been a social discourse that has uniformly discredited videogames and, by extension, games, platforms and players, producing a negative effect on its perceived educational potential. In reality, research has demonstrated the practical non-existence of negative effects, along with the presence of some positive ones, including those of an instructional nature (McFarlane, Sparrowhawk & Heald, 2002). Already in 1978 the first findings on the subject were being published (Ball, 1978), laying the foundations for subsequent research – especially in terms of the motivational aspect for learning, as well as its cognitive potential. But its most solid foundations began to be laid in the 80s, while the 90s, especially the second half, saw the proliferation and fruition of that research. Estallo (1995) states that “videogame players tend to exhibit a higher level of intellect than their non-playing peers”. He highlights, among other virtues, their benefits in terms of motor skills and intellectual development, areas in which players excel above non-players. Also of importance are the perceptive and deductive elements, as well a parallel or simultaneous processing and, closely linked to this, spatiality and visual perspectives (Jackson, 1993; Okagaki & Frensch, 1994; Jordan, 1998). And let us not forget the importance of selective attention to stimuli from a perceptive standpoint (Dorval & Pepin, 1986).

Scientific research has already managed to establish a connection between videogames and various arenas of the human psyche – affective, cognitive, conative (Malone, 1981; White, 1984; Ricci, 1994; Kafai & Resnik, 1996; González & Blanco, 2008a). Science has also examined their relationship with the complex socializing process familiar to young people today (relationships with peers – playing together, talking about videogames and exchanging them, building identities, obtaining knowledge and experiences vicariously, developing a sense of self and of one’s surroundings) (Lewis, 1997; Garitaondia, Juaristi & Oleaga, 1999; Croson, 1999; Buckingham, 2000). Associations have also been made between types of videogames and cognitive, affective, motivational and intellectual development, as evidenced by how arcade, action, role and platform games foster the development of motor skills, manual dexterity and reflexes in cognitive terms, and provide a release for stress in affective and motivational terms. These are usually associated with machines like Gameboy, Playstation and

* Corresponding author.

E-mail addresses: cgonza@ull.es (C. González-González), fblanco@ull.es (F. Blanco-Izquierdo).
Nintendo, while the more complex games played on computers, like strategy and simulation games, are more relevant to intellectual development (Fisher, 1995; Moral, 1996; Acevedo & Álvarez, 2007). This research into videogames has made advances in different areas, such as: (a) access and use (differences by gender, age and socioeconomic status, contextual studies, relationships between their use and that of other media, as well as with other leisure activities); (b) content (themes, structure, background and precursors, technical effects); (c) social perceptions of the phenomenon (meanings attributed to the technical devices, models for spreading technology); (d) positive and negative effects (aggressiveness, addiction, sexism, social and cognitive skills, school performance, teaching potential, effect on social and family relations); (e) other applications and consequences (use in medical treatment – oncological, recovery from burns, alcohol and drug addiction, as a didactic tool – and for special educational needs, as an aid in technical research into artificial intelligence, in the development of technologies and their adaptation to users, effect on the development and implementation of technology in society) (Gros, 1998; Blanchard & Stock, 1999; Grupo F9, 2000; Botella, Quero, Baños, Perpiñá & GarcíaPalacios, 2004; Becta, 2006; European Schoolnet, 2009).

Papert (1998), Gee (2003), Gee & Hayes (2009), Prensky (2001), Whitton & Hollins (2008), Marty (2011) and Carron, Marty & Mangent-Nagata (2009) espoused the benefits of computer gaming and note the skills and attributes that they promote in learning. So, videogames have been used in school to promote and to assess reasoning abilities (Bottino & Ott, 2006; Bottino, Ferlino, Ott & Tavella, 2007; Facer, Ulicsak & Sandford, 2007; Bottino, Ott & Benigno, 2009). However, the impact of the serious games on knowledge and practices has been studied with encouraging results (de Freitas, 2006; Shute, 2009; Pivec & Pivec, 2009; Gee & Shaffer, 2010; Ulicsak & Wright, 2010).

Of note is Jane McGonigal’s assertion that “videogames can make us better persons and help to change the world” (Macgonigal, 2010). She states that there is a lack of research regarding the skill set that is acquired in immersive environments and why players, who often feel frustrated and are marginally integrated in real life, feel successful in these types of settings where they spend a great deal of time cooperating with others to achieve common goals. One example of this is provided by the online game World of Warcraft, which has a Wiki with over 80,000 pages and 11.5 million players who devote 22.7 hours a week to engage in epic quests and work as a team (Corneliussen & Walker, 2008). Taking into account the previous research, this paper considers the last line of research mentioned, that of the design, development and evaluation of technology, in this case for the development of educational and social videogames for collaborative learning.

In the following subsections we present some examples of uses of videogames in classrooms and some educational uses of 3D games related to our work. Then, the evolution of technology and videogames and the game based collaborative learning background is presented. Finally, the educational experiences carried out by us are described and conclusions are presented.

1.1. Some examples videogames activities in classrooms

Commercial videogames can help in the developing of different skills of students. These potential formative benefits have been studied under the project “Educational Games in the Classroom” (Felicia, 2009). Table 1 shows these games and the potential benefits to be gained during your play.

In order to describe in depth some experiences in classrooms with videogames, we cite below some examples of uses of commercial videogames (Padilla Zea, 2011):

1.1.1. Age of Empires III in the social environment subject

Age of Empires III was used in the primary school’s 6th year social environment subject (Gros, 2008). From this experience, the authors have found that, through the use of a videogame, has developed a set of new skills, like for example, understanding the complex multimedia environment, achieving read, write, speak and listen depending on the changes occurring in the game. Also, they have learned to manage the information the game provides them with the resources of each civilization, using it to improve and make more advanced civilization, for what they need to master four core competences: information management, digital asset management, management and development of design strategies and planning and management of information and variables of the game. Regarding communication skills, have improved both verbal and written, and electronic media related. It has encouraged debate, since all students have to manage their civilizations but also have to manage alliances with other civilizations so that everyone can achieve their goals. Finally, the dialog that occurs between students leads to a critical analysis of the proceedings which results in resistance to the manipulation of individuals. We see that seeks to promote such important skills as planning, resource management, communication, debate and criticism, all skills that are acquired and improve while students have fun with the game.

<table>
<thead>
<tr>
<th>Game</th>
<th>Formative benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age of Empires II</td>
<td>History, strategy and resource management</td>
</tr>
<tr>
<td>Age of mythology</td>
<td>Mythology, strategy and resource management</td>
</tr>
<tr>
<td>Bioscopia</td>
<td>Zoology, cellular biology, human biology, botany and genetics</td>
</tr>
<tr>
<td>Chemicus</td>
<td>Chemicals</td>
</tr>
<tr>
<td>Civilization III</td>
<td>Planning and troubleshooting</td>
</tr>
<tr>
<td>Making history: the calm and the storm</td>
<td>History, World War II, economic management and negotiation</td>
</tr>
<tr>
<td>Nancy drew: message in a haunted mansion</td>
<td>Investigation, puzzle solving and deduction</td>
</tr>
<tr>
<td>Oregon trail</td>
<td>History, geography, mathematics, logical reasoning, strategy, resource management, and reading</td>
</tr>
<tr>
<td>Return of the incredible machine contraptions</td>
<td>Problem-solving skills and physics</td>
</tr>
<tr>
<td>Roller Coaster Tycoon 3</td>
<td>Administration, kinetic and potential energy</td>
</tr>
<tr>
<td>Toontown</td>
<td>Social collaboration</td>
</tr>
<tr>
<td>Where in time is Carmen Santiago</td>
<td>Discovery and logic</td>
</tr>
<tr>
<td>World of Warcraft</td>
<td>Collaborative learning</td>
</tr>
<tr>
<td>Zoombinis logical journey</td>
<td>Logic and algebra</td>
</tr>
</tbody>
</table>

Table 1
Examples of commercial videogames and their formative benefits.
1.1.2. *Harry Potter and the Goblet of Fire* to train narrative skills

As part of the study by the University of Alcalá de Henares, in conjunction with Electronic Arts Spain (Lacasa, Martínez-Borda, Méndez, Cortés & Checa, 2007), we find the use of the video game *Harry Potter and the Goblet of Fire*. Just as was done with other games used in the experience (NBA Live 2007 and The Sims 2 Pets), the process of analysis was carried out using video and audio recordings, documents produced by the students and photographs.

*Harry Potter and the Goblet of Fire* is an adventure game based on the stories of J. K. Rowling’s book. There is a pop culture around the protagonist close to the child’s life through various objects that are associated with different values. In this study, the game was used to train the narrative skills of students.

In the workshop with this game the goal was to help children in fifth grade learn to tell stories from a person known to them, like Harry Potter. The phases of the workshop were developed as follows:

- **Motivation**: students became familiar with the character and explored the information available online. It was held in the computer room and students created their blogs, which seems particularly important to encourage the participation of both students and their family.
- **Identification of favorite characters**: in this phase students had to justify orally and in writing, through the blogs, which were their favorite characters. In addition, different fragments of the movie of the same name were visualized and the students became familiar with the presentation of different stories about the same character indifferent formats and with different codes.
- **Recap**: the children meditated on the figure of Harry Potter as a hero and the meaning of the concept. They also brought to the classroom objects related to the character and built a learning scenario defined by symbols related to children’s culture described in the book and game.

1.1.3. *NBA Live 2007* to achieve sporting habits

*NBA Live 2007* is a sports game that can help bring in daily life many of the values and skills associated with sports, but is merely an example of what can be done with other sports games such as Tiger Woods PGA Tour or Pro Evolution Soccer, for example. The use of sports video games can increase motivation, a key element in the educational process and to incorporate other important elements such as the competitive aspect.

As sport is very present in the life of the school children, the goal of this workshop was to use the game as a promoter of sports and team values. The workshop was held with children in second grade. In the first phase of work was the motivation workshop where the children meditated on how you can learn with the game. During the second phase, the children played video games in class and also could take them home to share what they learned with their families, gradually becoming aware of the learning that was occurring with respect to teamwork, athletic skills or relations between reality and fiction. Finally, the last phase the students became critics of video games: The students left everything learned reflected in a mural and displayed at the center aisle to share the experience with other classmates.

1.1.4. *The Sims 2 Pets* to improve problem-solving skills

*Sims 2 Pets* is a simulation game that allows us to explore reality from different perspectives. Adults and children can play together and create a reality where characters and spaces are transformed. This workshop was held with students in fifth grade. The workshop consisted of caring for pets of a Sim family. As in previous workshops, the first phase was the motivation and the students took home the consoles to work with them and face the challenges of the game. In this phase, the children became expert critics and transmitted their experiences and tips to other peers. At first it made orally, then finally through print and Internet platforms. Finally, concrete questions were raised of design in the virtual world that promoted interaction among students. One of the conclusions of this report refers to the importance of adult intervention, in this case the teacher, in the process of play, so that children can make a reflection about what they have done in the game and how to move it to real life. So when the group works alone, students tend to make descriptions of what they have lived without any criticism. However, when this process involves an adult, problem-solving processes are carried out and relationships between the real and the virtual world are established, which allows a greater benefit of the game process.

1.2. Related educational uses of 3D games

As an example of commercial 3D games educational uses, “Second Life” is situated in a prominent position for its importance for the virtual learning communities. There are dozens of educational projects and a nascent academic literature related to it. However, the company that publishes and maintains the game, Linden Labs has even created a special area called “Campus: Second Life” which brings together universities, libraries, museums and other institutions related to education giving them a special economic offer. Among the most relevant educational sites are for example:

- Harvard Law School’s Austin Hall
- The U.S. Centers for Disease Control and Prevention (CDC)
- Ohio University Second Campus
- Northern Illinois University
- VINEC – Virtual Neurological Education Centre

Another project Sloode seeks to integrate Moodle with Second Life, combining the learning tools of a Learning Management System (LMS) on web with the richness and interactivity of a 3D graphical environment that uses the sophisticated technology of games. In our case, we integrated a 3D game engine Neverwinter Nights with the e-learning platform Moodle (González & Blanco, 2008b). *Neverwinter Nights* is a third person role-playing videogame based on the third edition of the “Dungeons and Dragons” board game that is played on setting, published and maintained by the Bioware Inc. Company. This game features a number of features that make it very
Another interesting project is the “Neverwinter Nights Learning Environment” of Nottinghams-hire West College and Peter Gorniak (MIT). Aimed at secondary students has been remarkably successful in improving student performance in so-called “key skills” (numerical and communication). It creates custom “adventures” for the curricular objectives in these areas in which the players/students must solve problems in context to further progress in the game.

On the other hand, the Neverwinter Nights ScriptEase is a project of the University of Alberta (Canada) that addresses the creation of a tool that facilitates the use of Neverwinter Nights Script for teachers without programming skills, so they can create educational adaptations easier. The idea here is that teachers can develop “adventures” in a simple way to fit the objectives of the curriculum. As an example of use of Neverwinter Nights for higher education can include the project of the School of Journalism and Mass Communication, New Media Institute (USA). The authors of the project experiment with the effectiveness of games for educational tasks in this framework by making the players-students in the role of journalists should develop a paper to report on the derailment of a train. They must do interviews, do research, and gather information from different sources.

2. Evolution of the technology to generate immersive, natural and social videogames

The history of videogames shows us that its evolution is marked by the constant search for more entertainment and ease of use, the most notable features being: (a) the search for immersion through increasingly realistic environments, new, interactive and more natural elements and 3D technology; (b) the creation of specific devices that facilitate the interaction, simulating real elements and offering new gaming experiences; and (c) entertaining all types of persons, bringing videogames to a broader spectrum of players, such as the elderly or disabled. We can then say that videogames are evolving in their design as interactive systems toward “natural interfaces” that are accessible and social (González Sánchez, 2010).

The “natural interfaces” comprise a means through which users provide inputs to their devices via gestures, words or bodily movements, as is the case, for example, of the Wii videogame console. We can find different categories of natural interfaces, such as:

(a) **Multimodal interfaces**: these interfaces feature multiple and natural inputs, with the computer processing the speech, gesture or tactile input and providing multiple feedback, also via voice, touch or visuals;

(b) **Humanlike interaction (natural)**: the importance of voice in man-machine communications, voice as an activator of remote actions;

(c) **New interfaces such as tangible interfaces** (a pen, book, eraser, etc.);

(d) **Biometrics and user recognition**: real-time identification of the people in an environment through the identification of biometric features (voice modulation, face, height, iris, typical gestures, digital fingerprint, etc.);

(e) **Disappearing computing**: the elements charged with offering the computing abilities used to develop Environmental Intelligence applications are embedded in normal, daily objects (tables, walls, lamps, pens, credit cards, etc.).

The latest trends in this area are facial, gesture, voice and haptic recognition (Sigut, Ould, Díaz & González, 2008; Torres-Jorge, 2010). The technology available for 3D games has allowed for realistic simulations and environments. This extraordinary level of detail has been used to cure post-traumatic stress and phobias. It has also been used to relax pre-operative patients and reduce their apprehension. Studies like those conducted by Saposnik et al. (2010) at the University of Toronto have proven the positive effects of using the Wii to regain motor functions (Saposnik et al., 2010).

In the case of augmented reality, this technology has been used to obtain environment-specific information through mobile devices (headsets or cellular telephone), as is the case with Savannah7 and the Museum of Augmented Reality (Schmailstieg & Wagner, 2007).

Of note in this area is the growth in the number of accessible videogames intended for disabled children and adolescents. In the case of a visual disability, audio signals are used to provide access to buttons and information, while readers or screen magnifiers can be used to read text on the screen. Some of these accessible games include Terraformers, Talking Typing, Teacher, Braille Twister and Quality Quiz. In the case of a hearing disability, the information is made accessible via subtitles, as in the well-known games Zork, Grand Inquisitor, HalfLife2 and StarCraft. Videogames can be adapted for people with physical disabilities through the use of a control adapted to the operating system itself or to the videogame’s mechanisms.

The true revolution in gaming, however, is social videogames, as noted the book *Digital Culture, Play and Identity* (2008), for whom such games already constitute a new way to have fun, make friends and cooperate (and compete) while promoting self-esteem and interpersonal
relations, and which are currently being “played” by over 400 million individuals. Some “social games”, like Farmville, Happy Aquarium, Farm Town, Restaurant City, Café World, Country Life, and many others are linked to social networks (Facebook, Myspace, Tuenti, etc.).

Another line of cutting-edge social online gaming is that of the MMORPG. An MMORPG is a type of game in which a large number of players, typically on the order of thousands, interact among themselves via characters in a three-dimensional setting. Second Life (SL) is a particular type of MMORPG in which there is no defined plot; rather, it creates an alternative virtual world called “metaverse” that the players can build as they play. In this “metaverse”, the players interact through avatars, socializing, trading, etc. Although SL is the best known of these metaverses, it is not the only one. These virtual worlds, of which the most popular on a global level is the role-playing game World of Warcraft, comprise a new area of research for social sciences, as noted in the introduction and demonstrated by lectures at the symposium on “Analyzing Virtual Worlds: Next Step in the Evolution of Social Science Research”, organized by the American Association for the Advancement of Science (AAAS) in Chicago in February of 2010, and by publications such as “The Warcraft Civilization: Social Science in a Virtual World”, by Williams Sims Bainbridge (2010) of MIT.

How and what students learn in social videogames is a good question to answer. So, in the following section analyzes the key points of learning collaboratively with videogames.

3. Learning collaboratively with videogames

In “What Videogames have to teach us about learning and literacy”, Gee (2003) maintains that good videogames are “machines for learning” since they incorporate some of the most important learning principles postulated by today’s cognitive science. Specifically, he states that:

(a) Good videogames provide the users information on demand and as needed, not out of context as is often the case in the classroom. It is much more difficult for people to remember or understand information that is given out of context or well before it is needed.

(b) Good games are capable of presenting users with tasks that are challenging, but at the same time doable. This is essential to maintaining motivation throughout the learning process.

(c) Good games convert their users into creators, and not mere receptors. Their actions influence or build the game’s universe.

(d) Good games feature initial levels that are specifically designed to provide users with the basic knowledge required to allow them to build generalizations that will enable them to face more complex problems.

(e) Good games create a “cycle of mastery”, in which players acquire routines through which they increase their level so as to accomplish a specific task. When said task is mastered, the cycle is started again with more difficult tasks.

As a result, many of these characteristics can be used for learning the material and skills relevant to school and professional work.

In addition, we must not forget the intrinsic social component in every human being that allows us to hold different points of view and attitudes, and which enhance different abilities and promote attitudes of respect and tolerance. This social component can then be incorporated into a videogame as a feature of a “virtual learning community” and collaborative learning (Jonnes & Issrof, 2005) so as to achieve common learning objectives. Working in a group, however, does not in and of itself guarantees collaborative learning. A context must be defined and the proper methodology employed that adheres to five guidelines (Johnson & Johnson, 1994): positive interdependence, face-to-face interaction, individual and group responsibility, learning of social skills and review of the group process.

In our experiences the activities in the videogame were designed following the principles of Computer Support Collaborative Learning (CSCL) (Koschmann, 1996). The CSCL meets the same characteristics and qualities of traditional collaborative learning, but includes a motivational element associated with the technology. Moreover, from the standpoint of the teacher, the use of computers as a learning tool allows you to track more detailed process, as different tools and applications can include a record of activities. Thus, the teacher can review the process that each student has followed in their learning and check the scores and errors.

Through collaborative learning the learning is favored and promotes individual social skills. Several studies have found that students who work collaboratively develop better attitudes toward learning process, devote more time to the task of learning, are more tolerant, hear more opinions of others and have better negotiating skills (Mendoza Barros & Galvis Panqueva, 1998). What they do is to learn during the construction of shared knowledge (Webb & Palincsar, 1996). Depending on the manner in which students choose to behave, it promotes the success of others, it hinders the learning process or has no effect on the failure or success (Johnson & Johnson, 1998).

Lastly, we must not forget that the goal of a player is to play. That is why in order to make the learning process as effective as possible when designing an educational videogame, factors such as motivation, attention, concentration and excitement must be maximized (Norman, 2004). The educational content, therefore, must be “hidden” within the videogame’s inner workings, with the videogame mediating the teaching/learning process and proposing collaborative activities that promote learning through group interaction, negotiation, the planning of joint strategies and a shared responsibility for success or failure (Moreno, González, Castillo, González & Sigut, 2007).

4. Improving the student’s experience with educational and collaborative videogames

In order to improve the student’s experience with videogames, we must first introduce the concept of playability, which can be defined as a “set of properties that describe the player’s experience with a specific gaming system and whose main goal is to amuse and entertain a single player or a group in a way that is pleasing and believable” (González Sánchez, 2010).

The methodology of Player-Oriented Videogame Design (González Sánchez, Padilla Zea, Gutíérrez & Cabrera, 2008) proposes incorporating playability throughout the design and development of a videogame as an interactive system. This requires specifying playability requirements for the different facets (Padilla Zea, González Sánchez, Gutíérrez, Cabrera & Pedereisky, 2009) that allow for an analysis of which playability attributes are affected and how to improve the playability associated with these attributes. The playability facets are as follows.
- **Intrinsic playability** – the playability resulting from the game’s very nature, that is, from its rules, goals and challenges and how these are projected to the player. It is associated with the design of the game play and to the implementation of the game mechanic, analyzing how the rules, goals, pace and mechanics of the videogame are represented.

- **Mechanical playability** – the playability associated with the quality of the videogame as a software system. It is related to the game engine and underscores features such as the smoothness of cinematic scenes, proper lighting, sound, graphic movements and behavior of characters and the environment in the game and, in multiplayer systems, the communications system.

- **Interactive playability** – facet associated with everything involving user interaction, the design of the user interface, dialog mechanisms and control systems. This is closely associated with the game interface.

- **Artistic playability** – involves the artistic and esthetic quality and suitability of the videogame’s elements to its nature. These include graphic and visual quality, sound effects, musical score and game songs, the game’s history and its narration, as well as how these elements are incorporated into the videogame’s environment.

- **Intrapersonal playability** – or simply personal or perceptive playability. The goal of this facet is to study the perception of the videogame’s user and the feelings that the game produces. Its value is highly subjective.

- **Interpersonal playability** – or group playability. This involves the feelings or perception of the users and the group awareness that are produced when playing with others, either competitively or collaboratively.

We may then conclude that a game’s playability results from the value of each of the attributes in the aforementioned facets. Said value must be adapted so as to maximize the player’s experience or response when playing. Likewise, when analyzing the requirements for creating a collaborative game, we must bear in mind those components that are essential to collaborative learning. Taking as our starting point the previous research indicated in Section 3, we note the elements and characteristics that must be included during the game’s design phase in order to achieve effective collaborative learning.

1. Positive interdependence: achieving this interdependence requires that every member in the group share common recreational and/or learning goals or objectives, group responsibility or “a team life”, and evaluation and scoring as a group.
2. Face-to-face interaction: achieving this type of interaction requires designing situations in the game that promote trust among the group’s members and raise the level of commitment with other players such that they all interact similarly and make common decisions.
3. Individual and group responsibility: this aspect is enhanced by establishing roles and by rotating the leader’s role among group members, as well as by establishing individual rewards and competitions with other groups.
4. Learning social skills: promoting social skills requires designing situations involving group planning, strategizing, negotiations, debates and decision making, as well as the exchange of roles.
5. Review of the group process: the group’s members must be aware of their performance as a group, meaning that activities must be provided where members assess their own mistakes and the group itself can decide to change role assignments and/or objectives in order to improve results.

### 5. Design and implementation of a prototype for an online multiplayer collaborative educational videogame

In order to design, implement and validate educational activities that follow the game based collaborative learning principles we design an educative game prototype using the Neverwinter Night’s Aurora engine. The design of this prototype follows the considerations presented in the previous sections, the bases for videogame design (Salen & Zimmerman, 2003), the design centered on player methodology (González Sánchez, 2010) and the guide of design collaborative activities in videogames (Padilla Zea et al., 2009).

This prototype has been used to teach the fundamental concepts of some subjects, like Human–Computer Interaction (HCI) in 3rd year of Computer Engineering career, and to validate the aspects related with motivation and learning. In the prototype, the activities have been designed following the fundamentals of CSCL applied to multiplayer games. In the case of the experiences carried out in High School, the Neverwinter Nights prototype was used to teach Physics and Chemical of 4th course, but also we used other commercial videogames, like WOW, in which the very students had to implement the game server and the activities.

The reasons to decide to select these subjects (HCI, Physics, Chemistry and Technology) among others was that the authors developing the educational experiences in their area of expertise and teaching at university and secondary education.

The objectives intended through the use of these multiplayer game types are also the improvement of instrumental, interpersonal, informational and digital competences. The instrumental competences encompass cognitive skills, methodological skills, and technical and language skills (oral and written communication, basic skill for the computer and information management). The interpersonal skills can improve teamwork, self-capacity and ethical commitment. In the case of information skills and digital acquisition and develop understanding of the information (searching information, selecting it, analyzing it and extracting it), the expression and diffusion of information (develop digital content) and social communication and interaction (collaborative work, chats, forums). In this sense, through the activities around the videogame it is possible to contribute to develop skills related to the information technology and communication, essentials in the 21st century.

#### 5.1. Design

In the design of our educational videogame prototype we followed the scenario approach of Leite, Hadad, Doorn & Kaplan (2000) which relies on the use of natural language (Liu & Yu, 2001) and an iterative design process. In the requirement analysis phase, we analyzed the scenarios in our game and defined their objectives, the tasks, the use context, the user profiles and the use cases (González & Blanco, 2008b). In terms of the user profiles and their roles in the context of the videogame, said profiles can be divided into two levels: one involving the game itself, and the other their role in the learning activity. In this way, each participant assumes a role in relation to the game itself. For
example, one participant may be a “warrior” or a “rogue”, which affects the skills his character has within the game and how they develop within it. For example, “warriors” are tasked with protecting and defending the group, while “rogues” explore the terrain, picking locks that obstruct the group’s progress and removing traps from the field of play. The instructors also take part in the entertainment aspect through their role as “Dungeon Master”, placing obstacles in or removing them from the players’ paths and interacting with them through avatars. In addition to their role with the game, each player develops a role related to their part within the learning activity. As a result, our activity features:

(a) students (take part in the group activity, debating and providing specific knowledge to achieve the desired results);
(b) spokesperson (coordinates decisions and speaks for the team when a common answer has to be given to a question); and
(c) instructor (guides the learning activity and evaluates the students).

These role types are related. For example, an instructor can inhabit the avatar of a character that provides a clue that is necessary in order to solve a puzzle.

We must also consider the playability facets and their attributes in the prototype, such as: (a) the satisfaction associated with the videogame; (b) learning the game, its levels and sequence; (c) effectiveness in achieving objectives; (d) game immersion through the avatar, the maze and overcoming obstacles and challenges; (e) the motivation provided by overcoming challenges, gathering objects, competitiveness among groups and interest; (f) the emotion, as manifested through greater motivation, happiness, euphoria, hostility or frustration at not achieving objectives, among others; and (g) social aspects resulting from the communications and support among partners that are necessary to complete the tasks.

During the design phase we also conceived different collaborative learning activities in various phases: start, development and finish. These phases and the activities designed within each are described below.

Stage 1. Start

Activity type: introduction to the environment
Description: in order to undertake the learning activities proposed in the game, the students must first learn to “play” in the game environment. To this end, a game tutorial was designed with different characters to guide the action and tell the player how to move within the environment and manipulate its objects.

Activity type: role and characterization
Description: each student must create their own character, assigning it a personality, physical appearance, clothing and powers. They must also give it a name that is related to the student’s own name, such that the instructor and fellow players can identify it within the environment. Then, within this environment, they must travel through a maze and become acquainted with each other. This activity also features entertaining action elements such as monsters, demons and other characters with which to interact. In this phase they also have to acquire the tools they will need to face the challenges presented in the concept maze.

Activity type: grouping
Description: the students are supposedly teletransported to a library where they must come together as a group and, above all, learn to communicate. This library has different rooms with chairs and sofas where they can sit and speak, as well as scattered treasure chests with different colored cloaks: blue, green, red and yellow. Each color identifies a group, and the students have to don the corresponding colored cloak. In this phase of the game, team members have to assign a leader who will interact with the other groups and with the instructor.

Stage 2. Development

Activity type: search for concepts
Description: in this activity they must look for and gather concepts from various subjects. The subjects to which the concepts belong are initially unknown. At the end of the maze, they must select a subject and have a minimum number of concepts before proceeding to the next phase. If they do not, they must return to the maze and find more concepts and/or negotiate for any missing concepts with the other groups. The roles played in this phase of the game by the team members are: (a) gatherers (find and collect various objects, they can also speak to other gatherers to obtain objects); (b) guardians (protect other members in their missions and safeguard any treasures that are found); and (c) leader (responsible for interacting with other groups and with the instructor).

Activity type: negotiation
Description: in this phase the teams must acquire additional concepts, some of which must be obtained through negotiating with other teams or the instructor. Each team must set up a store and visit the other teams’ stores in search of the concepts missing from their subject (chosen in the previous phase). The instructor also has a store with “exclusive” concepts, at a higher price, which must be obtained by answering a series of related questions posed by the instructor. Even though the leader interacts with the instructor, the former can consult with teammates at any time before answering the questions posed by the instructor.

Stage 3. Finish

Activity type: joint building of the final product
Description: once the different activities proposed in the game (search, discovery, negotiation, competition and cooperation) are completed, teams obtain all of the concepts needed to build a collaborative conceptual map of a specific subject assigned to the group. The maps are then integrated into an overall conceptual map of the subject within the virtual classroom.

5.2. Implementation

The prototype was implemented using the Neverwinter Nights engine. Neverwinter Nights is ideal for role-playing activities because it was designed to be modified, allowing you to create in a simple and flexible manner a variety of game scenarios (and in our case, learning). Moreover, it is a multiplayer game that includes the possibility that users have different access privileges, allowing among other things, teachers to have some ability to change the scenario as it occurs or embody different avatars that interact with players. It also allows researchers to observe the action taking place in the game by avatars undetectable and therefore not interfere with the development of the
students’ actions. And, it allows creating experiences with controlled environments, unlike what happens in massively multiplayer games where it is not possible to prevent interference from people or elements of the game that have nothing to do with the activity itself.

We also used the Moodle Learning Management System (LMS) connected with our prototype. We implemented several online tests in the Moodle platform to check the overcoming of objectives associated with each topic, but covered from the videogame prototype. Thus, for the student the game was a motivating interface to explore and study these concepts, and the teacher could check the results of this activity from the e-learning platform and relate them to other activities of the subject not included in the game. Moreover, the students have to complete their “mission diary” (blog) that is connected with Moodle. Thus, the teacher can observe the student progress easily and follow the activity in the videogame jointly with the other course activities.

6. Experiments with collaborative educational games in different educational contexts

The prototype for the collaborative educational videogame described in Section 5 was used in different educational settings, such as at the University of La Laguna’s Computer Engineering Department (Figs. 1 and 2) and at the La Orotava and Mencey Acaimo (Guímar) secondary schools in Tenerife. The various experiments are described below. We should note that for the secondary school setting, in addition to using the Neverwinter Nights prototype, other educational videogames were used, including World of Warcraft, which highlight the acquisition of social skills both inside and outside the game.

6.1. University education

6.1.1. Setting

The prototype was evaluated during several sessions in a computer classroom with 25 third-year students of the HCI course offered by the University of La Laguna’s Computer Engineering Department. The students were not required to attend and the sessions had no bearing on their final grade.

During the various gaming sessions, each student kept a blog, recording their progress, problems and perceptions, as well as the answers to questions posed by the instructor during each session.

6.1.2. Conduct of the experiment

The following conclusions were drawn after observing the various sessions.

During the first session, we noted that the game interface was more difficult for the students than we had anticipated, since it took them some time to become acquainted with elements such as the characters’ inventory and the game’s verbal and gestural communication tools. The students were not able to act in a coordinated manner or to communicate effectively within the game. For example, they tried to face monsters in the maze individually, resulting in their defeat. The leisure nature of the activity meant that some of the students did not take it very seriously, as manifested by the use of “offbeat” nicknames and slightly disruptive attitudes. They were quick to adjust their behavior, however, with barely any prompting.

In the second session the players were given a complementary activity in addition to the main one. This activity stripped the game almost entirely of its “action” component and focused on communication. The players also had to form into teams, with their characters exhibiting a clearly distinguishable color (cloak), which aids in distinguishing the different players at all times. Most of the time, the teams must cooperate and communicate. During this session, the students learned to communicate within the game. The idea of clearly distinguishing the team members visually was extraordinarily useful to the students themselves. Despite the successful communications, the students were unable to complete the activity, which we attribute to its excessive difficulty and to the short duration of the session.

During the remaining sessions, the activity was carried out as planned. Most of the students were able to manipulate the game interface reasonably well and were able to coordinate their actions. They divided into teams, though it was noted that some teams further subdivided into groups of two or three students. There was a certain amount of competition among the teams, all of which completed the first part of the activity. Only one, however, had time to finish the second part successfully (the winning team).
6.1.3. Observations

At the end of the activity, the students were given a questionnaire that allowed them to respond, on a scale of 1–5, to a series of questions involving the activity and to the emotions and motivation present during the work sessions. With regard to the activity’s level of difficulty, the students regarded it as easy, though some stated that the time allotted for the activity was insufficient. By other hand, the 30% of the students did not feel that the activity’s objectives were not clear. We believe that the fact of including a videogame in the course represented a clear disruption to the lectures and practical sessions that accounted for most of the students’ class time. We asked the students if this activity improved their motivation toward the subject and if it was useful, which yielded very promising results, with 79% of the students replying that this activity increased the appeal of the subject and 71% saying that the activity proved useful. In addition to these types of questions, others were analyzed involving the playability, the interaction with the interface and the communications in the 3D setting. There were also open-ended questions intended to provide a qualitative analysis of why certain emotions were produced and why the activity did or did not increase the appeal of the subject, as well as regarding the usefulness of the activity. Some of the answers revealed the positive features of the activity (entertaining, different, useful, a new way to interact with classmates and instructors), as well as the negative (not gradable, adds to workload, unclear). Likewise, the answers regarding the activity’s usefulness yielded opinions that were both positive (perception of videogames as a means of communication, expands view of HCI, learning of concepts, stimulates curiosity) and negative (should include more class content, loss of lecture classes, not enough time).

6.2. Secondary Education

6.2.1. La Orotava Secondary School

6.2.1.1. Setting. The experiment was carried out in two grades within the program leading to the completion of the required secondary education curriculum in Spain at the La Orotava secondary school in Tenerife. This type of learning is intended to promote diversity and is designed for those students who did not finish their mandatory education curriculum through traditional means, either because they dropped out or because of poor academic performance. These studies combine the same subjects that are taught in normal secondary education programs, though they are structured into generic areas, such as scientific-technical or social-linguistic. Practical work is emphasized in workshops, given the generally low disposition shown by these students for classroom work. While all of the students demonstrated poor performance in previous stages of education, the reasons are varied and are often related more to training deficiencies carried over from previous educational stages and with their social and/or family environment than to intellectual deficiencies.

6.2.1.2. Conduct of the experiment. The videogame activities were carried out as part of the scientific-technical curriculum, which includes subjects like mathematics, physics, chemistry, biology and geology. They were conducted over the course of 15 sessions lasting 55 min with 19 students from the first grade, and over 20 sessions lasting 55 min with 26 students from the second grade, at the rate of one session per week on average. The instructor played the role of a participating observer and doubled as the activity organizer, both during the preparation and execution phases. The instructor focused on the course’s own teaching-learning processes during the design and selection of the activities, as well as during their execution.

Due to the limitations of the corporate network and to the restrictions on installing software on the computers of the Board of Education, it was decided to use a “live CD” with various games that could be run on the computers in the Medusa classrooms of the Government of the Canaries. In addition to the prototype of the first-person online role-playing game (Neverwinter Nights), other games were used, such as first-person shooters with a low level of violence (Assault Cube) and board games (GNU Chess). In terms of the activities developed, they were designed to be relevant to large parts of the curriculum, which in this type of program is simpler than in traditional schooling given the
more open vision of the material to be taught. At the conclusion of the activities the students were asked to respond to a series of questions or to provide their impressions of the activity.

The students were allowed to communicate verbally in the classroom as long as the normal course of the activities was not disrupted. They were also allowed to sit wherever they wanted to in most of the sessions and for several people to use the same computer. When teams had to be formed, the instructor made the arrangements, though students were allowed to change teams if they so requested. They were motivated by being offered extra credit if they performed the activities correctly.

6.2.1.3. Observations. The objective tests show that the curricular content was not always assimilated. The key could be in the design of the activities, specifically in the way that the content is used. This could be the focus of future research. For example, the activity in which the students had to obtain some type of information (such as when they went inside the library in Neverwinter Nights with books whose contents involved the subjects being taught) and, after finding it, had to write it on an index card did not achieve the desired result. On the other hand, the activity in which the information had to be used repeatedly in order to advance in the game yielded better results (for example, objects with symbols from the periodic table were used in which the name had to be associated with the element). In any case, if the content is not relevant to the students’ experience, the format in which it is presented does not appear to have much of an influence.

Activities with games motivate students and generate other learning that contributes noticeably to the development of basic skills. Students show a preference for these activities over those normally used in the classroom. They talk amongst themselves about their results; they form small communities and share information; they solve technical problems and take an interest in relatively complex technical issues (computer networks, BIOS settings); they organize teams, develop rankings and propose educational projects (such as, for example, organizing an “Assault Cube” tournament or league); within the game setting they are much less disruptive and more predisposed to accept mediation, whether from instructors or peers; they are participative and express preferences for subsequent sessions.

The grade reward for this type of student, whose only academic interest is simply to pass, was only useful initially, since the activity proved motivational in and of itself. Moreover, the general effect on “normal” class days was also positive, as evidenced by the improved attitude of the students.

6.2.2. Mencey Acaimo Secondary School

6.2.2.1. Setting. The experiment was conducted with two groups of 4th-year ESO (obligatory secondary education) students (15–16 years of age, up to 18 for those left back) who had opted for the science curriculum. The performance of these groups at the school was considered satisfactory overall, though around 20% exhibited low academic performance (five or more subjects pending). The reasons for this notwithstanding, we note that at this school, those 4th-year ESO students choosing the science-technology curriculum (Technology, Biology and Geology, or Physics and Chemistry) have a higher average grade in previous courses than those opting for the humanities curriculum (with subjects such as classical culture or Latin) or who are assigned “diversification” courses. We may thus assume that some of these students could be considered “gifted”, though some with an acceptable or even outstanding academic record were in the low performance group. When interviewed, the students admitted to being “hooked on a computer game”, World of Warcraft.

6.2.2.2. Conduct of the experiment. On this occasion, the experiments were not structured and were organized outside a school setting. Of note in this case was an experiment involving the game World of Warcraft, due to the social skills that were exhibited as part of the game, but not within it. This experiment featured a group of 17 students from both classes who were participating on a private World of Warcraft server, with some of the students administrating the game while the others collaborated in its maintenance or development. This server had hundreds of player accounts and its use was in no way restricted to the school’s server, with some of the students administrating the game while the others collaborated in its maintenance or development. This server had a complete disconnect between the content taught in some subjects, and which they considered irrelevant, without this being caused by a lack of ability. The reasons for this “academic failure” are beyond the scope of this analysis. And yet, these students, through their own initiative and with the school’s socializing influence as a catalyst, embarked on a parallel educational project in which they had to acquire the skills necessary to:

- install and maintain the software for the game server, including also a web server that hosted the forums;
- conduct online searches and read documentation in English (and use machine translation methods);
- organize and distribute tasks and assign specialized roles, including organizing the rotation for being the “leader” inside the game server;
- create and enforce a set of rules, including a system for mediating and judging questionable cases; and
- sharing thoughts within the community, discussing improvements to the server (changes to the rules, installing content, etc.), arguing for their points of view and accepting advice. On this point it is interesting to note that though there was no “formal” leadership structure, more importance was given to the opinions of the leaders. And yet, since several of those servers competed for the audience, the decisions had to please the majority of the community’s components. In this regard we note how, despite the great efforts that instructors must make to have the students read and write, the players spent many hours not only reading the forums but also posting in them, as they did inside the game, where all communications are in written form. While the writing contained spelling mistakes and abbreviations, it nevertheless fulfills its communicative purpose in this context.
Lastly, it is particularly interesting to note how in the game, the students mirror the social patterns they perceive in the adult world: the financial and ownership structures, the methods of reciprocity and trade (by means of the game’s “gold coins”), the distribution of power and the assignment of prestige.

7. Conclusions

In educational games, learning principles tend to be more focused at practice and exercise than at understanding. This means that the student can memorize the answer to a question that shows many times, but without understanding the underlying rules. On the other hand, most games have a very basic gameplay, often derived from classic games or a simple adventure that takes place in a world where the player can travel.

Although not designed for educational purposes but ludic, the use of commercial games like World of Warcraft open up a world of possibilities in education today (Chang, 2008; Cornelissen & Retberg, 2008; Hui-Yin & Shiang-Kwei, 2010; Golub, 2010; Ducheneau, 2010; Pirius & Creel, 2010; Bainbridge, 2010), such as: students collaborating and discussing ideas, possible solutions, connecting with other students around the world, on topics of study, immersing students in a learning experience that allows them to grapple with a problem, gaining higher-order thinking skills from pursuing the solution, among others.

While not targeted at education, nor seeking to cover any type of educational content, Green and Hannon (2007) cite multiple skills associated with being a “guildmaster” (one of the roles in WOW), such as: attracting, evaluating, and recruiting new members; creating apprenticeship programs; teaching children to work together for a common goal; communication skills; understanding multiple perspectives, respecting and even embracing diversity of views, understanding a variety of social norms, and negotiating among conflicting opinions; orchestrating group strategy and organized thinking; managing disputes, etc.

We see that the objectives intended through the use of these game types in the education where mainly the improvement of instrumental, interpersonal, informational and digital competences, which includes cognitive skills, methodological skills, technical and language skills, teamwork skills, self-critical capacity, ethical commitment, skills about searching information, selecting it, analyzing it and extracting it and social communication and interaction (collaborative work, chats, forums). In this sense, through the activities around the videogame it is possible to contribute to the use of information technology and communication and to develop 21st-century skills.

Inspired by the objective to use this kind of videogames for exploring activities that intended to develop 21st-century skills, we analyzed in this paper the main areas of research in educational videogames, the technical trends and tendencies toward social videogames, as well as the design principles behind educational videogames that enhance the playing experience and guarantee collaborative learning.

We have likewise presented the design and development of a prototype for an educational collaborative videogame based on the 3D online multiplayer role-playing game Neverwinter Nights, which features the collaborative playability and learning principles noted above. Lastly, we described various experiments involving this prototype based in Neverwinter Nights and other online multiplayer educational games, such as World of Warcraft, conducted in various educational settings: (a) in a university learning environment and (b) in a secondary learning environment, the latter of which was specifically tailored to meet special educational needs.

Concerning the two educational experiences using the Neverwinter Nights prototype, two ways of evaluation were chosen: (a) quantitative, using the log sessions to analyze collaborative indicators elaborate through the traces of students when collaborates and the student scores in the videogame, and (b) qualitative, with questionnaires, recorders in video, direct observations of the teachers and the student diary (blog) of the activity.

In the case of the experiences with the WOW in the secondary level we used only the qualitative method. The recollection of data was done by questionnaires, observations of the teachers and the student diary (blog) of the activity.

The collaboration process has been analyzed through the interactions in the activities carried out in the prototype. Thus, it is possible to determine the degree of collaboration that has taken place during the group learning process, for example, if the set of partners is working or not. We recorded the interaction that occurs during the resolution of the problem and the students’ conversations, and evaluated five dimensions correspond to the collaborative process: communication (mutual understanding, dialog management), conjunct information processing (sharing of information and consensus building), coordination (division of tasks, time management and technical coordination), interpersonal relations (mutual interaction) and, finally, motivation (on learning).

The findings from these experiments lead us to conclude the following.

- There continues to be a mistaken cultural perception regarding the educational potential of videogames. There is also a persistent and deep-rooted dominance of lecture classes in our educational systems.
- Collaborative educational videogames promote the development of technical and social skills, not only as part the activities carried out within the virtual world, but also outside of it, in the real world.
- Collaborative educational videogames serve a highly motivational function that favors immersion and learning in a “natural” way.
- Our experiments reveal that, the content notwithstanding, the most significant type of learning provided by games is the social learning that takes place in gaming communities. Such a community can, in theory, develop around any game, as long as the experience’s duration is not too brief.
- Videogames that spawn communities can be very useful to the development of the basic skills specified in Spain’s educational legislation, such as those involved in linguistic communications, mathematics, knowledge of and interaction with the physical world, information processing and digital skills, social and civic skills, cultural and artistic skills, learning to learn, and self-reliance and initiative, among others.

References

Acevedo, E., & Álvarez, L. (2007). Incidencias de los juegos de estrategia tipo Age of Empires para el desarrollo de las estructuras de apertura, nudo y desenlace de en la elaboración de cuentos (Tesis de Licenciatura). Universidad Tecnológica de Pereira, Colombia.


