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Digital Games in Education: The Design of Games-Based Learning Environments

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Abstract

In recent years, electronic games have assumed an important place in the lives of children and adolescents. Children acquire digital literacy informally, through play, and neither schools nor other educational institutions take sufficient account of this important aspect. We consider that multimedia design for training and education should combine the most powerful features of interactive multimedia design with the most effective principles of technologically-mediated learning. An examination of the evolution of the design of videogames is a good way to analyze the main contributions and characteristics of games-based learning environments. At the same time, we will discuss the main obstacles and challenges to the use of games for learning. (Keywords: digital games, game-based learning, instructional design, videogames.)

Videogames Are Not the Solution to Educational Problems

The main idea of this article is that we need to change our teaching methods to enhance the skills that future citizens will need in a digital society. Children and young people are introduced to the virtual world via videogames, and the ways that they interact with technology may be changing ways of learning and the production of knowledge. Engagement and motivation are interesting benefits of the use of games but they are not enough for educational purposes. Like books and movies, videogames can be used in many ways. The content of a game can produce a simplification of reality, and a lot of games are based on violent and misogynistic themes. For this reason, many critics suggest that what people learn from playing videogames is not always desirable.

However, the design of a learning environment built on the educational properties of games can be an appropriate way to improve learning. Digital games are user-centred; they can promote challenges, co-operation, engagement, and the development of problem-solving strategies.

This paper is divided into five parts. First, we give a brief introduction of relevant research. The second part discusses the evolution of videogames. The third part focuses on research on the use of videogames in education. After this we discuss approaches to introducing games into formal education. Finally, some problems and challenges are discussed.

RESEARCH REVIEW

In recent years educational computer games have received increased attention from researchers and educators but less from the game industry. The British Educational Communications and Technology Agency (BECTA) has been one of the main forces in the UK saying that "titles such as Caesar II and Age of

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Empires operate within the context of ancient history and so include factual information about the period. With the increase in processing power and memory capabilities of new computers, there is an increasing demand for technically accurate simulations involving situations that would normally be impossible for the user to experience in real life. Genres such as real time strategy can lead to the development of game play, which demands that the user is able to test and develop strategies and reassess decisions." (2001, p. 3).

According to Squire (2005), American researchers are not very interested in examining whether existing computer games offer content that may be relevant to educational purposes; they oppose a narrow focus on content, skills and attitudes. Instead they look to the structural characteristics in computer games that could be used for education and social processes surrounding the educational experience.

The educational use of computer games is not unexplored research territory, but research is disjointed and the field lacks well-defined boundaries. Research has been distributed over a number of disciplines with little in common except perhaps the interest in computer games. Some of these are literature, psychology, media studies, anthropology, ethnography, sociology, history, business studies, military tactics, literary theory, educational, theory, instructional technology and computer games studies.

The research field of computer games is not yet well established, although there is much progress in the last five years. However, researchers still struggle for acceptance and academic credibility; there is a lack of common research language, and few basic and theoretical discussions; and funding for research is scarce.

An important research community is working on the use of simulation games. This community is older than the computer game research community. It is today centered on the journal *Simulation & Gaming*. This research tradition started in the mid-50's, and was especially promoted by business gaming and the perceived potential of learning through games (Butler, 1988). The focus is on games in general not necessarily computer games, but most of the research is relevant for computer games research.

The field broadened from the early 1970's and up through the 1980's especially in the business area. Until the last decade, this area became increasingly dominant, with a strong emphasis on simulations and less focus on games. However, the publication of the book *Digital game based learning* (Prensky, 2001), provided a new perspective on the use of simulation and training.

The other community focuses on computer games and took its first steps in the early 1980's with books like Geoffrey and Elizabeth Loftus' *Mind at Play* (Loftus & Loftus, 1983) and Patricia Greenfield's *Mind and Media* (Greenfield, 1996). From the late 1990's the research into games slowly accelerated, exemplified by the appearance of resource sites like Game-culture, Ludology, Game-research and Joystick. 2002 was the first year of the Woodrow Wilson sponsored *Serious Games* initiative, and from the 2004 *Serious Games Summit*, there has been a great explosion in the field of game-based learning.

In the field of education, there was very little attention until the late 1990's. In the Spanish community, we started to work in the field (Gros, 2004) with

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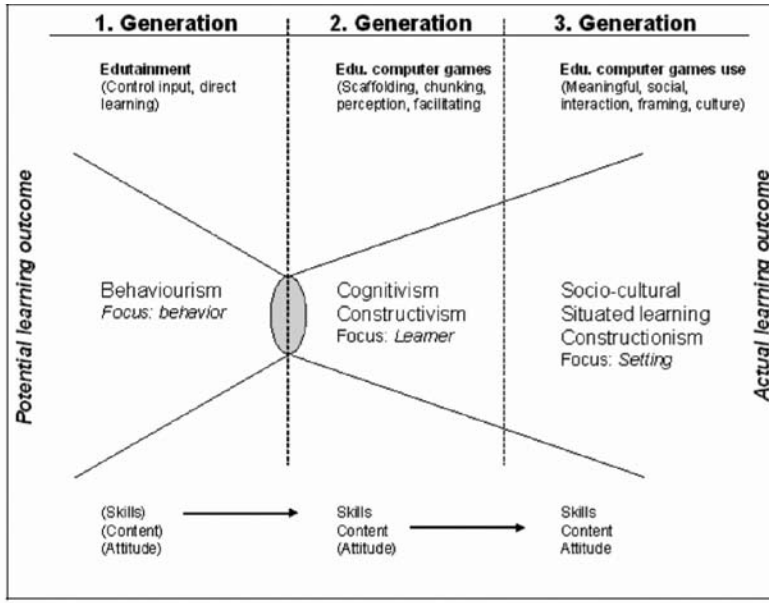

Figure 1: Evolution of games based on Egenfeldt-Nielsen (2005).

very few references of other colleagues in the area. The general perception of games was negative and very far-removed from the field of education.

In the last decade, there has been a large increase, mainly in two areas: structural aspects of the games such as influence of digital games in digital literacy, learning styles, skills, etc, and the integration of videogames in schools to improve learning.

EVOLUTION OF GAMES

Egenfeldt-Nielsen (2005) identified different generations of games based on the connection between educational computer games and the progression of learning theories (see Figure 1). The first generation's perspective corresponded to the description of early *edutainment*, which assumes that learning occurs when you have opportunities to practice certain skills enough times. Most edutainment has failed because the games were too simplistic in comparison with competing video games. The tasks were very repetitive, poorly designed and did not support progressive understanding.

The second generation was based on a cognitive approach. The learner became the centre of attention. People are not black boxes: they have previous knowledge, ideas, concepts, different schemata. This generation presents information in ways that are appropriate to specific learners.

The third generation approach did not exclusively focus on the specific computer games, but looked at the broader process of educational use of computer games. It stressed the key role of providing a social context that facilitated asking the right questions and going to the right places. The teacher became central as a facilitator, adapting computer games experiences to school.

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There is a variety of genres of games but there is not one standard classification. Industry, developers, and academics, all use different taxonomies. We will categorise seven major genres:

1. Action games (also called platform games)—These games are reaction-based; most of the games of the first generation are action games.
2. Adventure games—The player solves a number of tests in order to progress through a virtual world.
3. Fighting games—These games involve fighting against computer-controlled characters or those controlled by other players.
4. Role-playing games—Human players assume the characteristics of some person or creature.
5. Simulations—The player has to succeed within some simplified recreation of a place or situation to achieve a particular goal.
6. Sports games—These games are based on sports.
7. Strategy games—These games that recreate a historical or fictional situation to allow a player to devise an appropriate strategy to achieve a goal.

This taxonomy is not easy to apply because some games fall into more than one category. For instance, currently most of the sports games contain information to manage the team and combine simulation with characteristics of the strategy games.

What is important is that most of the famous games (with their constantly updated versions) contain features of simulations and adventure. Strategy is also present in most of historical simulations. In other words, there is a tendency in the market to produce games based on second and third generation learning models.

Games provide complex environments in which content, skills, and attitudes play an important role during the game.

4. LEARNING AND GAMES

We consider that most of the research has focused on three aspects: 1) Sociological approach in which the main goal is to describe the use of games effects on social development and relationships; 2) Effects of learning with digital games (digital literacy); 3) Learning with games in schools.

Sociological Approach

Most papers and research reports about the use of videogames aims to describe the current use of this technology and to try to analyse the differences in access and gender.

The time that a particular child spends on a computer and their activities on the computer may depend on age, gender, ethnicity, and social class. In a national survey of children and teenagers from 2 to 18, the percentage of children who reported (or were reported by their parents) to have used a computer out of school the day before increased with age: from 26% in the 2 to 7 age range, to 44% among the 14- to 18-year-olds (Roberts, Foehr, Rideout, & Brodie, 1999). Interestingly, while more boys than girls reported using (or were report-

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ed to use) computers *in school* the day before, there were no gender differences in percentages using a computer *out of school*.

The core audience for computer game systems, such as Nintendo or Sega, has always been boys between the ages of eight and 14. Boys are five times more likely than girls to own a Genesis or Super Nintendo computer game system. Boys have always and continue to spend more time playing computer games (Roberts et al, 1999). The gender disparity in the amount of time spent playing computer games is greater for 14–18-year-olds than for 8–13-year-olds.

Both boys and girls reported equal levels of computer usage and expressed equal levels of confidence in their computer skills. In Spain, recent studies (Fundación Ayuda, 2002) describe that from 3000 adolescents interviewed, 97% declare that know what videogames are. Fifty-eight percent declare that they play almost daily, 36.7% one or two days per week, and 4.8% never use videogames.

Indeed, the Internet provides certain activities that strongly contribute to a more equal gender balance in computer usage. Again, Roberts et al.'s (1999) data suggest that younger girls and boys (between eight and 13) use computers similarly *except* in levels of gaming. When in-school and out-of-school usage data are aggregated, there are no gender differences in this age group in the use of the computer for chatting, visiting Web sites, using e-mail, doing school-work, or using the computer to perform a task. The picture is similar for the 14- to 18-year-olds, except that older boys significantly visit more web sites than do older girls.

Despite the trends in other aspects of computer usage, computer games continue to be more popular among boys. Because computer game playing might be a precursor to computer literacy, and the belief that computer literacy will be increasingly important for success in society, the gender imbalance in computer game playing has been a topic of much recent discussion. Efforts of the software industry to create "girl games" with non-violent themes and female protagonists have largely been unsuccessful with the exception of *Barbie Fashion Designer* and more recently with the social simulator *The Sims.*

Based on an examination of research on games that girls and boys design and on research on their play styles, and television and reading preferences, Subrahmanyam and Greenfield (1994) proposed that the *Fashion Designer* was successful because it contained features that fit in with girls' play and their tastes in reading and literature. In contrast to boys' pretend play, which tends to be based on fantasy, girls' pretend play tends to be based more on reality, involving themes with realistic, familiar characters. Probably similar conclusions can be applied in the case of *The Sims*.

In our work (Gros, 2005) we have observed that gender differences do not influence interest in the games, but do influence different lines of play or preferences. For example, when playing *The Sims*, girls devoted more time to the decoration of the house and to the determination of the physical aspects of people. Boys initiated the game more quickly. We obtained similar results from observing the playing of *Restaurant Empire* in that girls devoted more time than boys to the design of the restaurant. We recognized in group-discussions that

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boys were all impatient to begin the simulation while girls were unsatisfied with the design they had realized.

Research into role-playing games, however, suggests that the question of gender and character identification may not be quite as straightforward as earlier commentators suggested. For example, in role-playing games where avatars are created by players, there seems to be a pattern that the first creations do indeed mimic the player's gender and age identity, but that later characters play with gender, age, ethnicity and sexual orientation differences. This play with identity is widely believed to be so common that experienced players do not assume that an avatar reflects the player. In recent research with 16 to 28 year-old males, they expressed no interest in young female avatars in the MMORPG (Massively Multiplayer Online Role-Playing Game) they were playing, assuming they would be middle-aged men in reality (Burn, Carr, Schott, & Buckingham, 2003).

In summary, according to Kennedy (2002),

> If we are going to encourage more girls to enter the gaming culture then we need to encourage the production of a broader range of representations of femininity than those currently being offered. We also need to offer a critique of the entire discourse around gaming which serves to create the illusion that it is a masculine preserve. Feminist film criticism has had an impact (albeit only to a limited extent) on the representation of women in cinema. This critique has inspired many writers and directors, both within and outside the Hollywood system, to increase the range of possible subject positions offered to women. It is similarly vital that in the construction of a critical discourse about games we encourage and stimulate innovative and alternative images of men and women that do not simply reinstate doggedly rigid gender stereotypes (p. 3).

Effects of Learning with Digital Games

Videogames are useful instruments for learning specific strategies and for acquiring knowledge; they also develop the learning that is characteristic of the culture of the information society, and this learning is likely to have long-term consequences. Games can be used to learn a particular content, but they may leave an impression (Salomon's cognitive residue (Salomon, 2000) on the learners as well. Researchers are now investigating the types of learning that derives from the use of the videogames and their possible applications in other areas of study.

We should also remember that videogames have certain features of their own that distinguish them from other computer products. The content of the medium—as McLuhan (1994) says—is another medium, since many types of content in videogames introduce important modifications. To quote Provenzo (2000), "Videogames are a complex, rapidly evolving form to which most parents and adults pay relatively little attention" (p. 109).

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Many computer applications, especially computer games, have design features that shift the balance of required information-processing, from verbal to visual. The very popular action games, which are spatial, iconic, and dynamic, have things going on at different locations. The suite of skills children develop by playing such games can provide them with the training wheels for computer literacy, and can help to prepare them for science and technology, where more and more activity depends on manipulating images on a screen.

According to Subrahmanyam and Greenfield (2001), "Despite advances in interactive technology and the capabilities of current computer games, the fundamental nature of computer games has remained unchanged" (p. 13). The current generation of games continues to include features that emphasize spatial and dynamic imagery, iconic representation, and the need for dividing attention across different locations on the screen. Therefore, the nature of the effects of computer game playing that stem from structural features of the medium would likely remain the same—although the strength of the effects on visual intelligence could change with increasing sophistication of the graphics.

Computer game playing will only enhance a particular spatial skill if the game utilizes that skill. In principle, skills can only be enhanced by game playing if these skills have reached a certain level of maturation. However, to our knowledge, only one study comparing the cognitive impact of games on children of different ages has been carried out and they found no changes in effects between fifth, seventh, and ninth grade students (McClurg & Chaille, 1987). All three age groups showed improved mental rotation, a spatial skill, as a result of playing two computer games.

Another skill embodied in computer games is the ability to read images, such as pictures and diagrams. Indeed images are frequently more important than words in many computer games. In a cross-cultural study carried out in Rome and Los Angeles, Greenfield and colleagues (1996) found that playing a computer game shifted representational styles from verbal to iconic. In the study, undergraduate students played the game Concentration either on a computer or on a board. Those who had played the game on the computer used more diagrams in their descriptions of an animated computer simulation, whereas those who played the game on a board offered more verbal descriptions. Both iconic and spatial representations are crucial to scientific and technical thinking; these representation ways take part in the utilization of all kinds of computer applications.

Another skill incorporated in playing computer and video games is divided visual attention, the skill of keeping track of a lot of different things at the same time. Greenfield (1996) explored the effect of video game expertise on strategies for divided visual attention among college students. Divided attention was assessed by measuring participants' response time from two events of varying probabilities at two locations on a computer screen. Participants who were expert computer game players had faster response times than novices. Playing an action game also improved strategies for keeping track of events at multiple locations. Overall the study showed that more skilled video game players had better developed attentional skills than less skilled players.

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Although this research focused on college students, computer and video game playing could have similar effects on children and help to develop the skills for occupations that require expertise in divided visual attention (e.g., instrument flying, military activities, and air traffic control). However, there is no research that actually documents a link between video game playing, attentional skills, and success in academic performance or specific occupations. Furthermore, much of the research on the impact of computer games on cognitive skills has only measured the effects of game playing immediately after practice, and does not address questions about the cumulative impact of interactive games on cognition.

Two studies of children's use of computers at home argue that children's early interactions with computer games help to develop a playful approach to computers. This author considers that the use of games facilitates the use and understanding of technology. This has implications in the way that children approach computer based learning tasks.

The central argument of Gee (2003) about what video games offer to learning is the idea that semiotic domains are shared by groups of people, described as affinity groups, sharing knowledge, skills, tools and resources to form complex systems of interrelated parts. Learners gain resources from fellow members that equip them to solve problems. This is the evidence of active learning "the learner needs to learn not only how to understand and produce meanings in a particular semiotic domain that are recognisable to those affiliated with the domain, but, in addition, how to think about the domain at a 'meta' level" (Gee, 2003, p. 23).

Players have to understand the meanings of the internal design grammar and the ongoing social practice that determine the activity. This systemic view makes players think about and critically appraise games as systems and designed spaces (Gee, 2003). According to Squire (2005) videogames create experiences in which learners are immersed in situations in which they think with tools and resources with the aim of complex problem solving. In fact, when games become more complex, they begin to use intelligent tutors, scaffolding, etc.

An important point mentioned by Squire (2005) is that the main differences between e-learning and games is related to the content. In e-learning content is the most important thing, while the experience is the most important aspect of a game. Games structure the entire experience around problem solving.

In summary, researchers of the potential of games to support learning consider that games are not as good as other media for generating textual understanding. What they are able to do effectively is to promote conceptual learning, problem solving skills, co-operation, and practical participation. "Games are powerful contexts for learning because they make it possible to create virtual worlds, and because acting in such worlds makes it possible to develop the situated understandings, effective social practices, powerful identity, shared values, and ways of thinking of important communities of practice" (Shaffer, Squire, Halverson, & Gee, 2005, p. 7).

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Learning with Games in School

In recent years there have been a number of studies of the use of computers in schools intended to explore whether these games can have any role in supporting educational goals. In fact, the benefits described in the previous section, seem to introduce some tensions when schools uses videogames to support learning. Studies on the application of videogames in school curricula concentrate on the impact of the material in the games on learning. In these studies, knowledge of material in the curriculum correlated clearly with knowledge used in the games.

On the transfer of material in areas of the curriculum the study by Nussbaum and colleagues (1999), conducted with 300 children in the fourth year of primary school, is particularly interesting. The team designed a series of games using *Gameboy* in language and mathematics. Each game was a story that included specific characters and interactions, but all shared certain common basic elements: the way the task was presented and how it was resolved; positive or negative feedback at the end of the task; interaction with rival characters; rewards; assigning a score. An important feature of the software is that it includes a self-regulation system, that is, a set of rules that adapt the game and its contents to the user's level, which is recorded by the machine itself. The aim is to avoid frustration and boredom.

Forty-six educational videogames were designed, covering almost the entire educational program in language and mathematics. In the area of language a single objective was set, namely to support the process of decoding via the development of visual vocabulary, the visual discrimination between letters, and phonological and morphemic analysis: all different strategies for recognizing and analysing words.

In the area of mathematics two broad objectives were set: a) to familiarize the child with the basic structure of skills and mathematical thought, and b) to learn and apply basic mathematical contents, focusing on the areas of arithmetic and geometry. During the experiment, teachers learnt to use the instrument autonomously in their classes within a relatively short period of time (two-three months). A key factor in the success of the project was the fact that the teachers themselves had the opportunity to use the instrument. Their opinion at the end of the experiment was positive; they considered the videogame to be an easy-to-use educational instrument with potential as backup to other teaching material.

McFarlane, Sparrowhawk, and Heald (2002) also assessed the knowledge acquired via the use of videogames in primary and secondary teaching. The study was based on teachers' opinions on the limits and potential of videogames. Their results reflect that most of the teachers had a very positive view of adventure games and above all of simulations. However, in spite of this very positive assessment, they stressed the difficulty of using these simulation games in secondary teaching due to pressure of time and the need to cover the educational curriculum outline in its entirety.

The requirements of the curriculum were also mentioned by teachers in the studies by Sanger (1997) and Gros (2004). For this reason, it is important to design guides that can explain the merits of games to teaching staff and enable

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Table 1: Areas of Learning in Which Videogames Can Contribute

Areas	Aspects videogames can contribute
Personal and social development	Provide interest and motivation to learn; Maintain attention and concentration.
Language and literacy	Encourage children to explain what is happening; Use talk to organize, sequence and clarify thinking, ideas, feelings and events.
Mathematical development	Use everyday words to describe position.
Creative development	Respond in a variety of ways; Use their imagination in art and design music, and stories.
Knowledge and understanding of the world	Use early control software to investigate direction and control.
Physical development	Fine motor control can be developed with the increased refinement in using a mouse for navigation and selecting objects.

McFarlane, 2002, p. 13-14

them to use them in a way that is oriented far more towards the acquisition of the knowledge required by the school curriculum[1].

Another group of research stresses the influence of the use of videogames in improving students' strategies and procedures. The interest is not focused on learning a particular subject, but on the ability of the instrument to develop learning in general. One of these studies was by Greenfield (1996) who analysed children between the age of 12 and 16 years, using adventure games most of the time. The main conclusions she reached are the following:

1. Videogames aid the development of strategies for reading three-dimensional images
2. They help to develop learning through observation and hypothesis-testing.
3. They broaden the understanding of scientific simulations.
4. They increase strategies for parallel attention.

McFarlane and co-workers (2002) show that most teachers acknowledge that games contribute to the development of a wide variety of strategies that are extremely important for learning: problem-solving, sequence learning, deductive reasoning, memorizing. In addition, group strategies such as cooperative work and task-based learning can be introduced easily in the setting of a game. That report also presents an interesting summary of the many areas that the teachers stressed.

[1] See the section on "Teaching resources" coordinated by the group F9 in the *Revista Comunicación y Pedagogía* in which, since the year 2000, each issue contained a description of how to use a particular videogame in teaching.

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The opinions proffered by the teachers in McFarlane's study in Great Britain coincide with those given by the Chilean teachers interviewed by Nussbaum (see Table 1).

The main disadvantage of the use of games in the classroom is the amount of time it takes for both the student and teacher to guide themselves within the game. Squire (2005) describes several sessions using simulation games showing the considerable effort needed by the teaching staff to use the game in the curriculum. In the interesting dissertation by Egenfeldt-Nielsen (2005), he concludes that we need more experiences in the classroom to see what happens when computer games area brought into an educational setting accompanied by sound didactic considerations.

PEDAGOGICAL USE OF VIDEOGAMES IN SCHOOL

In the various experiences of our group (Gros, 2004), we used a methodological approach that focused on the creation of a learning environment in which the videogame is essentially selected in order to provide the students with a rich learning experience.

In all the cases, the methodology used is similar. We have tried to build an integrated learning environment within the curriculum in which all the activities are designed with the videogame at the beginning, as the starting-point for the students' experience. The use of the game usually occupied approximately 10 to 15 hours of work. In many cases, the content of the game did not refer to a particular subject and the activities were designed in an interdisciplinary manner. For example, we used the game *Age of Empires II* in order to work on aspects that are related to the social sciences while, in parallel, the mathematics teacher used the same game to work on a reading of statistical graphics.

Also, in the selection of the games it was realized that the games would be accessible and, in many cases, already known by the students themselves and, as a consequence, the experience of playing with them was usually quite simple.

The work methodology used is based on the creation of a learning environment that itself is based on four types of actions:

1. **Experimentation**. During the first session they establish the learning objectives and the activities that they are going to carry out. Generally, it is important that there are one or two sessions of group-play about which the students are asked both to note down the decisions that they have taken and to analyse the results they have obtained.
2. **Reflection**. At the end of the sessions, the results obtained in each group are compared, analysing the varied strategies that each group has adopted.
3. **Activity**. Specific curricular activities are designed for the game. Students must not only use the game but must also specify the use of other materials: books on the subject, Internet searches, etc.
4. **Discussion**. Throughout the process, two aspects are especially relevant: the reflection on the actual process of learning and the joint discussion related to the proposed activities. In the first instance, they design files

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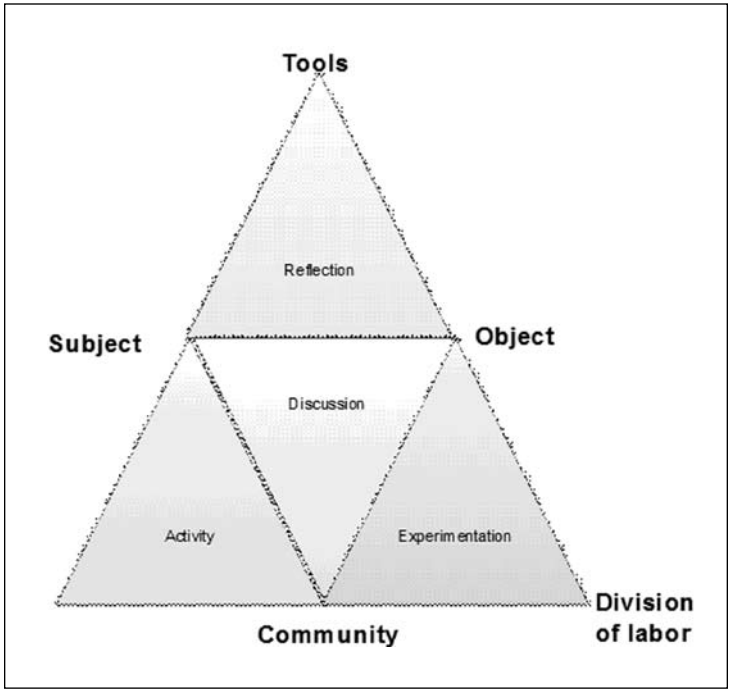

Figure 2: Learning process for educational use of videogames.

in which each group indicates the activities carried out during the game and analyses the strategies used. The files must be handed in at the end of each session. For the discussion group, the teacher also has a group of subjects that is previously prepared before each session. Lastly, there is the evaluation of the contents learnt during the activities proposed by the teacher.

The model described is linked with the proposal developed by Activity Theory (Engeström, Miettinen, & Punamäki, 1999). This is an important issue because formal learning transforms the experience of the player making specific experiences relevant in a broader context through the concepts used during the exploration of the game.

CONCLUDING REMARKS

We consider that there is a series of critical aspects that should be investigated not only from the point of view of specialists in education but also by the videogame designers.

Organizational Aspects

An important problem for the integration of videogames is the time that is necessarily required to produce an activity. Generally, the games require many hours and, on occasion, it is difficult to establish the sequences of play that should be significant for both the students and school curriculum. In this sense, the most efficient thing to do is to let students continue to advance their knowl-

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edge of play outside the classroom, via the provision of access to the game in the school.

The differences between students in mastering the game inevitably result in a situation where many students have experience and are used to playing the game. In our experience, this issue has not been problematic as the more advanced students have been able to act as tutors for the groups who have more difficulties.

The Role of the Teachers

Teachers with little experience in the use of videogames are reluctant to use them. They feel insecure and require significant support during the process. In this sense, our intervention in the schools always had more success when we were able to give staff support during experiments.

McFarlane and her group (2002) demonstrate how the opinion of the staff in such situations is unanimous. The majority recognise that games support the development of a wide range of strategies that can be very important for learning: the resolution of problems, the learning of sequences, deductive reasoning, and memorization. However, in spite of the favourable opinion, few teachers have decided to use videogames in their classes.

It is difficult for teachers to identify how a particular game is relevant to some component of the curriculum, as well as the appropriateness of the content within the game. There is also a lack of time available to teachers to familiarise themselves with the game and methods of producing the best results for its use. The staff with little knowledge showed themselves to be fundamentally re-active while the staff that had expertise in the game was able to assume a pro-active role. Students valued to assist their teachers in the use of the game. However, teachers very seldom supported the knowledge of their students. There is no doubt that the role of the teacher is very important with respect to how the game becomes a learning process. In other words, the basic function of the teacher is to provide elements of analysis and reflection that allow work to be done on the contents of the game.

Individual Differences

Most studies show that the less advanced students benefit from games. However, we consider that there should be more explanation given in relation to this conclusion. There are many individual differences between students and we believe that there are no studies yet that take this into account. Egenfeldt-Nielsen (2005) states, "The best students were capable of connecting the two modes—playing and learning—whereas the least successful don't make this connection" (p. 221). In our case, we do not have such conclusive results. There were students who were not very advanced who, thanks to the game, were able to implicate themselves a great deal in the learning activities.

The Transference of Learning

A critical aspect is the transference of the learning experienced. There is little evidence in the research done on this subject and perhaps this is one of the most important challenges we face. Another crucial aspect is also the conceptual

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learning that the games provide. In this sense, the role of the teacher is also fundamental in that not all games use simulations based on scientific concepts. Game designers are not concerned with the accuracy of contents of the games and, on occasions, they are capable of producing contradictions or erroneous concepts with respect to the function of particular games used in learning activities.

Complex Learning

Adventure and simulation games provide complex learning environments that are appropriate for the acquisition of learning with meaningful materials that encourage the construction of relevant knowledge using the suitable models. This does not involve the construction of games whose aim is to teach, but of games that teach students to experiment and work with those educational aspects of play that require the intervention of the educator. In this way it should be difficult for the player himself to become isolated.

Context of Learning

Beyond the characteristics of the tool, we have to be conscious of the context of its use. Our activities condition the development of the medium. Therefore, only a deep knowledge of the tool, of the programs, of how it is used, may enable us to select the most suitable methods and mediums according to our needs and education objectives. Therefore, it is very important to analyse the practices and the role of the game within its specific context. In this sense, whatever analysis one does, one has to take into account four fundamental aspects:

1. How the game is contextualized: it forms a part of a daily activity; it is based on something extraordinary, as a reward, as something without relation to a usual practice, etc.
2. The type of exercises carried out: the development of the sessions.
3. The type of interaction between participants: the role of the teacher, competitive activity, co-operative activity, both, etc.
4. The qualities of the critical and reflective elements of the game itself.

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