

Towards the Use of Video Games for Learning: A Survey about Video Games Preferences of Engineering Students

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ABSTRACT

Video games are now a widespread cultural practice, especially among young people, making them an ideal medium for the design of learning processes. In order to design educational technologies that provide teaching support we must first understand the practices developed by the young with computers and especially with video games. The aim of the present study is therefore to learn about the experience and expectations about video games among students, particularly engineering students. The results are going to be considered in the design of educational technologies based on interactive virtual environments that mediate the learning processes, particularly in physics course of engineering studies.

Keywords: Design educational technologies, virtual reality, interactive learning environments, video games, simulations

1. INTRODUCTION

Worldwide deep socio-cultural transformations affecting both societies and their governments, communities and individuals are influenced by new technologies and advances in the digital world. In [1] is argued that “Children and young people are introduced to the virtual world via video games, and the ways that they interact with technology may affect the way they learn and develop knowledge. A game has been defined as “...an engaging interactive learning environment that captivates a player by offering challenges that require increasing levels of mastery...”([2]). The educational properties of Highly Interactive Virtual Environments (HIVE) [3] such as simulations and video games, include the following features: the dynamic representation of complex phenomena, difficult to implement in the classroom or the laboratory; the interaction between digital objects and the visualization of its consequences, allowing students’ mental models to become explicit; the representation of relationships and processes, fostering understanding of the underlying concepts; the immediate feedback, control of variables and the relationship between multilingual representations (oral, written, algebraic, graphic, technological), allowing hypothesizing and testing ideas. Technology understood as “a cultural tool”, either physical or symbolic, when used by individuals to mediate their actions in the world, develops ways of thinking and acting. More specifically, the internalization of the cognitive abilities involved in the use of ICT generates modes of symbolic representation that become tools of thought. There is therefore a cognitive residue that results from continuous exchanges with computer technology in different situations and contexts ([4]; [5]; [6]). If the

practices of entertainment with video games leave cognitive residues, these are going to influence new learning mediated by digital technologies, according to mentioned in [4].

We aim is to develop educational technologies based on interactive virtual environments that mediate the learning processes in courses of physics of first year of Engineering careers. Other similar works like that ([7]) comment that if they had interviewed teachers and students at the beginning of the process with no doubt they have had learnt a great deal about their needs in these areas and they had designed a very different sort of math learning software. This paper presents a study that shows the experience and expectations of video games of students of first year of engineering careers. A questionnaire survey was used to request information from the students. Section 2 presents a classification of video games. Section 3 describes the methodology used to conduct the study. Section 4 presents the results. Section 5 presents the conclusions and future work.

2. VIDEO GAMES’ CLASSIFICATION

Like most computer products, video games support multiple classification criteria. Classifications have been changing since they focus on different characteristics of video games. On the other hand, new games appear in the market that can incorporate new classification categories. The classification criteria can refer to subject, technique’s player, game mode, etc.

In ([8]) is presented a review of video games’ classification proposed by different authors.

Sedeño’s proposal in [9] groups video games in terms of the possibilities to develop certain skills such as reflection, strategic and tactic knowledge or mental agility.

The classification proposed by Carrasco in [10] takes into account the variable “game technique” rather than the theme. Game technique refers to the procedure or method to be followed by the player to achieve the goal.

Gross in [1] for classification considers what to do or to solve in the game, for example, the action games are those reaction-based games, the adventure games are those where you have to solve a number of tests to progress.

Some video games are easy to label, however, due to advances in games development, classification becomes increasingly ambiguous and difficult. In this study, a typology was developed (Table 1) based on these three mentioned classification. As can be seen each type or category is subdivided in different subcategories or subtypes. Our categories are non exclusive in the sense that one video game can belong to more than one group.

Table.1. Video games' categories

Type of video game	Description
Arcade: <ul style="list-style-type: none"> • Action Arcade: <ul style="list-style-type: none"> ▪ Fighting ▪ Shooting: <ul style="list-style-type: none"> ○ FPS ○ TPS • Arcade platform • Arcade puzzle 	<p>These games require a great mental dexterity to respond quickly. There is interaction with the environment by providing precise and quick responses through simple actions (jump, kick, shoot, etc).</p> <p>Fighting games consist in characters engaged in hand-to-hand combat using martial arts techniques or weapons, an example is Mortal Kombat.</p> <p>Shooting games consist in shooting anything, either a character or an object such as an aircraft. In First Person Shooter (FPS) the player becomes the game's character. An example is Doom. Third Person Shooter (TPS) differ from FPS in the way that the player and the character are integrated. In TPS games, the player's character (Avatar) is visible on-screen.</p> <p>In platform or maze games, the player must advance along different screens overcoming obstacles, jumping and eliminating what prevents him from advancing. As the game unfolds, it becomes harder, due to either the time component or the environment impediments. An example is Mario Bros.</p> <p>Puzzle games demand mental agility from the player. These may involve problems of logic, strategy, pattern recognition, filling in words, or even chance. The genre may be difficult to describe as each one possesses its own style Examples are Tetris and Minesweeper.</p>
Strategy	<p>These games require planning and strategy in order to advance. The development of hypothetical thinking and logic in decision-taking may be facilitated. They are commonly characterized by their long duration. An example is Age of Empires.</p>
Simulation <ul style="list-style-type: none"> • Social • Construction • Sports 	<p>The player plunges into a virtual world that simulates real aspects of life.</p> <p>An example of social simulation is The Sims; An example of construction is The Sim City; An example of sport simulation is Pro Evolution Soccer (PES).</p>
Adventure	<p>An adventure is recreated through characters, tests, mystery and unfolding situations. There is high interactivity with the environment and other characters as well as a need for constant decision-taking, e.g. Indiana Jones.</p>
Role: <ul style="list-style-type: none"> • Single player role-playing • Multiplayer online role-playing 	<p>Progress depends on the characters evolution in an unreal scenario. Each player takes on a role. The player creates a character (choosing profession, race, weapons, and so on) and then, introduces the character in the game where fights against other characters (players or non-player) or performs various adventures or quests with the aim of to gradually increase the levels and the experience. Examples are Final Fantasy and World of Warcraft (WoW).</p>
Serious games	<p>These video games belong to any genre; however, here "...learning is the primary goal. A careful pedagogical and instructional design is required to create games that provide 'serious' experiences for different application areas, always taking into consideration the expectations of the intended players." ([11]). Examples are Rome Reborn and Virtual Priorato Undercroft.</p>
Casual games	<p>The term "casual" refers to games that are typically inexpensive to produce, straightforward in concept, fun, quick to access, easy to learn, simple to play and that require no previous special video game skills, expertise or regular time commitment to play. In addition, casual games are usually easy to pause, stop and restart with little consequence to the player's enjoyment. Casual games use less powerful computers when compared to shooting or RPG genres. They are available in many platform formats: PCs, video game consoles, handheld game consoles and mobile phones. ([12]). Examples are Minesweeper, Pacman, Tetris.</p>

3. SURVEY DESIGN

Questionnaire

The present research aimed to identify experiences, preferences and interests regarding video games among first year students of Engineering careers. We sought to understand the following key questions:

1. What knowledge and technological devices do respondents have access to?
2. What are the respondents' preferred leisure activities?
3. What are the video games most played by this generation?
4. Is there a significant difference in terms of gender regarding the choice of video games?

5. Which games' narratives are considered the best?
6. Which graphs are considered the best?
7. What games are easier to use according to the respondents?

The data collection was done using a questionnaire designed by grouping the questions in three main sections. In the first group of questions general information such as age, gender and type of engineering course was requested. In the second group of questions with the aim of gathering information about the students' experience as video games, the questions consisted of a table with 44 games arranged in the table's rows, with the alternative of adding more video games at the end of the table. The questions for each game were ordered in the table's columns and expressed so as to obtain information about which games students play or played, as well as about the narrative, graphics and difficulty of the game selected. The first closed-ended question inquired about what games the student was currently playing, which ones he had ever played or whether he had never played any. Two closed-ended questions asked respectively about the narrative/story and the graphics/animation of the game. The respondent answered by grading his answer as '0 Bad', '1 Relatively Bad', '2 Relatively Good', '3 Good' and '4 Very Good'. A closed-ended question regarding the difficulty of the game when the player started to play with enabled to choose among the following non-exclusive answers: : 'Difficult to understand rules', 'Difficult to use/ to know/ to find the game's commands or elements', 'Other difficulties' and 'No difficulties at all'.

The third and last groups of questions inquired about the knowledge and experience in using information technologies and their preferred leisure activities. The issues refers to the type of equipment the respondents use and/or know (e.g. PC, Notebook, Netbook, Mobile Phone with no internet access, Mobile Phone with internet access, Video game Console and GPS). Also they respond the type of internet connection they have (dial up, broad band or none) and the time they spend connected to internet.

Finally, a question was included about the respondents' preferred leisure activities and usual kind of entertainment with the following options: "Watching TV programs", "Watching films", "Playing Play Station", "Using the computer", "Playing board games" and "Others".

Population sample

The sample consisted of 229 students from the first year of Engineering careers at two faculties at the National University of the Centre of Buenos Aires Province (UNCPBA), Argentina. The questionnaire was applied at the beginning of 2011, during the first month of the teaching period. The ages of most of the students fall within a range between 17 and 19 years old. The 60.8% of the students are 18 years old, 16.6% are 17 years old and 13.8% are 19 years old.

Various statistics of Iberoamerican countries and also international ones reinforce the fact that the sample chosen (fig. 1) for this study can be considered representative of the population of interest - technical and technological careers' young college students - particularly in terms of age and gender.

The first international report on the state of engineering published by UNESCO ([13]) noted, regarding to gender,

that the efforts made in many countries to promote the participation of women in engineering had resulted in increase. Along the 1980's and 1990, the proportion of young women enrolled in engineering careers increased from 10% -15% to 20%, and even more. However, from 2000 this proportion was declining. In some countries the women engineers students' percentage is below 10%.

The same results can be found in articles that refer to the situation of any particular College or University. In [14] is noted that new students to engineering careers in Argentina, only 20% are women. Similarly, in [15] taken as axis of analysis the National Technological University (NTU) in Argentina and is expressed the low index of entry of women to higher education (or undergraduate) dedicated to engineering and technical careers. In that article the author states that "... the engineering is the discipline that resists more the female advance, although most men also worried, here and around the world ...". Several of these published reports ([15], [16]) agree that women are inclined to the Engineering Chemistry where have even exceed to the number of male students. The same gender difference in technical and technological careers occurs in other Latin American countries such as Mexico ([17]), Brazil ([15]) and Chile ([18]).

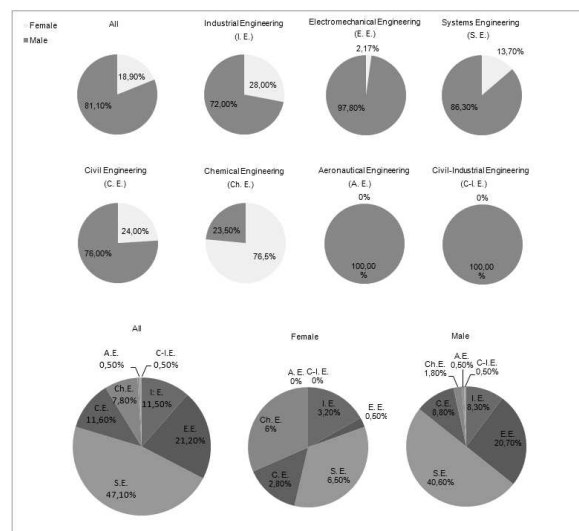


Fig.1. Distribution of respondents by gender and career

4. RESULTS

Data analysis was performed using GNU PSPPT Statistical Analysis Software. The frequency and percentage of each response were calculated.

Technological resources

Considering that video games can be developed to be executed in different computing platforms, it is interesting to learn which are the most common technological resources that are used by the studied population. The results of the analysis indicate that the mobile phone with internet access (60.7%) and the video game console (53.1%) are the second and third technological device most widely used by students after PC (91.1%). The 50% of the students have a notebook , the 44.6% have a mobile phone without internet access and

29% have a netbook. The 25.9% of the students have a GPS but 2.2% don't know this technology.

About the type of internet connection is obtained that most of the students have a broadband connection (76%). And in relation to the time they spend connected to the internet just the 6% of the students don't connect at all and the 26% of the students spend connected less than an hour a day. Almost half of the population of the sample (45%) is connected between one to four hours a day and the 21% is connected more than four hours a day.

Preferent leisure activities

The results indicate that using the computer (84.8%) is of the students more preferred activity. Most of them specified that they use the computer to get access to social networks, to listen to or download music, to play video games and to chat. The second preferred activity is watching TV (61.2%). The most watched programs are about sports (football, basketball), entertainment and documentaries (particularly they pointed out Discovery Channel).

In the open option "others", the 43.8% of respondents mentioned other preferred activities. Among the leisure activities most mentioned are sport or physical activity

(8.5%), listening / playing music or dancing (3.1%) and reading (1.8%).

The most played video games

The main question about video games was, what are the video games most played by this generation. The results show that the number of games played at least once varies between 0 (no game selected) and 29 (maximum number of games selected per student). On average, students selected 10 games from the 44 proposed.

Figure 2 show the complete video games' ranking according to the student's selection.

The fourteen most played games are: Pro Evolution Soccer (PES), Need for Speed (NFS), The Sims, Mortal Kombat, Minesweeper, Pacman, Call of Duty (CoD), Age of Empires (AoE), Tetris, Pinball, FIFA Soccer (FIFA), World of Warcraft (WoW), Chess and Carte Blanche (Solitaire Card). Students suggested a total of 53 additional games to those proposed in the survey. Among the added games, the most mentioned ones were Counter Strike, in fifteen questionnaires (6.7%), GTA in eight (3.57%), and Crysis in seven (3.13%). The remaining ones were only mentioned by one or two students.

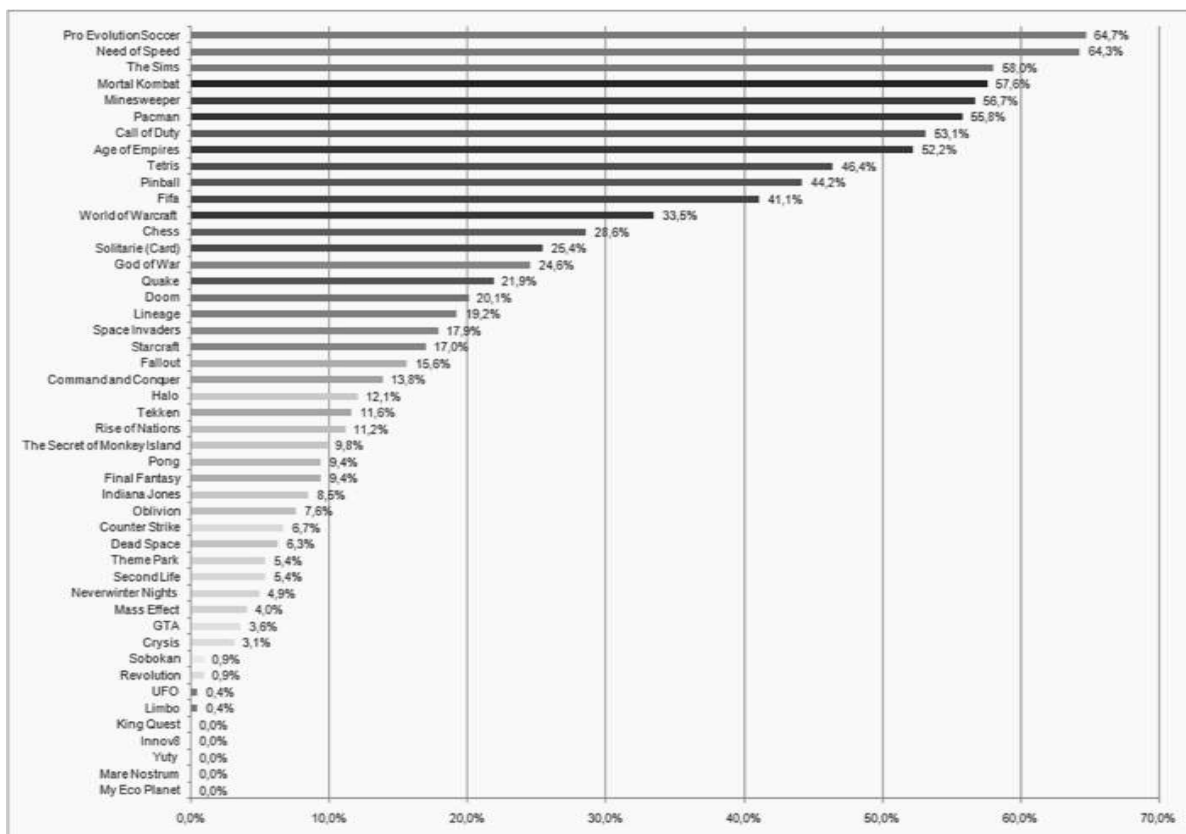


Fig.2. Ranking of video games with the percentage of students selecting each one of the video games

Table 2 shows the 14 most played video games characterized based in the typology defined in section 2. On the basis of this table, it can be stated that simulation and casual games (arcade puzzle and platform games) are the most played types of games. Of the simulations, protrude of the sports

simulations. This coincides with the leisure activities most mentioned in "others" options and programs TV most watched. PES is considered a hybrid with strategy since it enables the player to develop organizational skills in a sport team ([8]).

Table 2. Types of the fourteen most chosen videogames

Video game	Type
PES	Sports simulation + strategy
NFS	Sports simulation
The Sims	Social simulation
Mortal Kombat	Arcade action (fight)
Minesweeper	Casual game: Arcade puzzle
Pacman	Casual game: Arcade platform
CoD	Arcade action (shot) + simulation
AoE	Strategy
Tetris	Casual game: Arcade puzzle
Pinball	Casual game: Sports simulation
Fifa	Sports simulation
WoW	Role
Chess	Strategy
Solitaire (Card)	Casual game: Arcade puzzle

An analysis of the two games' rankings corresponding to past and present respectively was realized. In general it is observed that the respondents play less in the present than in the past. Some of the comments indicate their current lack of time available to play due to university obligations. Related to this, the analysis shows that most of the most played casual games appear within the first fourteen videogames in the two rankings (past and present), which could suggest that they are games that have not lost its validation.

While in Table 2 the video games The Sims, Mortal Kombat and Pacman appear among the fourteen most played, this is because they were the most played in the past. However, they are a long way from the top in the ranking of the most played nowadays (PES, NFS, CoD) are characterized by being quite realistic simulation. The first two are sport games (racing, driving and football), whereas the third one is an action game (CoD) which simulates the infantry and the army fighting during the Second World War. The three games are multiplayer.

Gender and video games' selection

Several researchers on video games ([19]; [8]) define the market of video games as a male market, where most of the agents involved are men, despite the slow but progressive increase of the number of amateur women in this entertainment.

In this study, we wonder if there is significant difference in term of gender regarding the choice of video games to play. Women's and men's responses were analyzed in order to characterize their preferences.

The results show that men had played between 0 and 29 games, with an average of 10 games. In contrast, women had played between 0 and 12 games with an average of 6 games. Table 3 shows the percentage of women's and men's respondent who have reported playing each of the fourteen games respectively.

Table 3. The 14 most played games according to gender.

Video game	Gender	
	Female	Male
PES	16.7%	75.8%
NFS	31%	72%
The Sims	71.4%	55%
Mortal Kombat	40.5%	61.5%
Minesweeper	71.4%	53.3%
Pacman	81%	50%
CoD	11.9%	62.6%
AoE	28.6%	57.7%
Tetris	61.9%	42.9%
Pinball	54.8%	41.8%
Fifa	11.9%	47.8%
World of Warcraft (WoW)	9.5%	39%
Chess	35.7%	26.9%
Solitaire (Card)	42.9%	20.3%

Table 4. Ranking of preferred games according to gender

Rank	Favorite Videogame	
	Female	Male
1	Pacman	PES
2	Minesweeper	NFS
3	The Sims	CoD
4	Tetris	Mortal Kombat
5	Pinball	AoE
6	Mortal Kombat	The Sims
7	Chess	Minesweeper
8	NFS	Pacman
9	AoE	FIFA
10	PES	Tetris
11	CoD	Pinball
12	FIFA	WoW
13	WoW	Chess

It can be stated that males prefer sport simulation games (soccer (PES), car racing (NFS)), action games (shooting (CoD), fighting (Mortal Kombat)) and strategy games (conquest (AoE)). In contrast women prefer equally either casual games (Pacman, Minesweeper, Tetris, and Pinball) or social simulation games (The Sims). Pearson's Chi-square statistic was used to test significant dependence between the respondent's gender and the selected video game. The results demonstrated a significant relationship between the variable that shows whether the student plays PES (.000), Pacman (.003), CoD (.000), FiFa (.000) or Solitaire Card (.000), and the gender variable, since in the five aforementioned cases, the value obtained are lower than 0.05.

The size of the sample, the accuracy of the data and the sample bias are three factors that may alter the results of the Chi-squared test, for this motive an accuracy test was performed that validated the results obtained with chi-squared test. The results too agree with the report of Nielsen ([12]), who takes a look at Americans' adoption of the casual games. Chou & Tsai in [20] suggest that "... girls like to play non-aggressive games that allow them to create fantasies and to play with familiar characters in familiar settings".

According with this, The Sims is among the most preferred by women. Most of the games what were chosen by a very small percentage of women not provide any lead role to women; for example CoD.

Narratives, graphics and difficulty of the video games

The underlying narrative in a video game is one of the most important aspects associated with the interest that they can generate. The results of analyses suggest that most of games with the best narrative (CoD, WoW, AoE, PES and NFS) are simulations that require that the player to identify himself with an avatar that belongs to a particular social group and challenges them to carry out missions in which feelings and emotions are at play.

The graphical elements of the games have change in the last two decade at an very accelerated rate, from classic 2D games, passing through for pre-rendered graphics, awesome 3D visuals, photorealistic visuals up to graphics similar to movies. The games considered to have the best graphics (CoD, NFS and PES) are those developed in a virtual 3D world with a very good design and providing a attractive level of realism. These games they correspond to those mentioned them above as the most played nowadays. Each new version of these games launched to the market incorporates improvements mainly in both the game engine and artificial intelligence (AI). These video games are followed by FIFA and WoW.

Conversely, the narrative and the graphics of most casual games are considered "Bad" or "Relatively Bad" because they tend to be quite simples.

Incorporating a video game into a pedagogical design should not mean taking up lesson time to learn to master it or deflect the student's attention to other different cognitive activity. Therefore it is interesting to know which games are more easier and intuitive to the students. Casual games were the least difficult to play according to of the surveyed . These results agree with the main traits of casual games, i.e. being easy to learn.

Approximately half of the students expressed the view about the difficulty of NFS, FIFA, PES, The Sims, CoD and Mortal Kombat considered that are not difficult to play. Of these games, the first three are sports simulations.

Mortal Kombat and PES were found difficult in terms of using /knowing/ finding the games' commands and elements. The main difficulty may be that the player must employ a combination of keys or controls to make the character play tricks and thus gain credits. However, these two games are considered less difficult because less than 4.3% of students declared them difficult in terms of the rules.

Age of Empire received the lowest percentage, among the fourteen video games, of students who considered it does not present difficulties. This percentage is small compared with the sum of those who argued that these games' rules were difficult to understand and those who consider difficult to use / to know / find the game's commands or elements. AoE is a strategy game simulating a conquest, much slower than others, and there are numerous options on the screen which may prevent quick familiarization with the game's objectives. It becomes then necessary before playing it, to explore the game by using the demo and the training or retry plays.

Table 5. Responders' opinion about narrative, graphic and difficulty of the fourteen most chosen videogames

Video game	Narrative	Graphics	Difficulty
PES	Very good	Very good	Relatively hard (1)
NFS	Good	Very good	Relatively soft
The Sims	Relatively good	Relatively good	Relatively hard (1)
Mortal Kombat	Relatively good	Relatively good	Hard (1)
Minesweeper	Bad	Bad	Relatively hard (2)
Pacman	Bad/Relatively bad	Relatively bad	Soft
CoD	Very good	Very good	Relatively Hard (2)
AoE	Good	Relatively good	Hard (1 and 2)
Tetris	Bad	Bad	Soft
Pinball	Bad	Relatively bad	Soft
FIFA	Good	Good	Relatively soft (1)
WoW	Very good	Good	Hard (1)
Chess	Bad	Relatively bad	Hard (2)
Solitaire (Card)	Bad	Relatively bad	Hard (2)

1:use commands or elements 2:understanding the rules

The four most played games are considered with the narrative and graphical acceptable (Very Good /Good / Relatively good). However, with the exception of NFS, the use the commands or elements of these games presents some difficulty in the respondents' opinion.

Casual games are considered with narratives and poor graphics, and most of them are not difficult or the difficulty lies in understanding the game but not in the use of the commands or elements game. The best narratives (very good) also correspond to games that have the best graphics.

5. CONCLUSIONS AND FUTURE WORK

Our final goal is to develop educational technologies based on interactive virtual environments that mediate the learning processes, particularly in courses of physics of first year of Engineering careers. We consider that we should first understand the practices developed by the young with computers and video games. In this paper we presented the results of a survey to get knowledge of the population of interest about practices with technology and video games.

Technological devices that the students possess in a country can be influenced by exogenous factors such as policies of govern, acquisitive power of the society, cost of the technological devices. However there is a worldwide tendency to incorporate new technologies in the learning process. The Ibero-American States Organization (OEI) and the Ibero-American Conference of Ministers of educations agreed a set of educational goals for the region, and they assumed that "it is necessary to move towards a knowledge society and information, incorporate new technologies in teaching and learning, to design curriculum commensurate with the skills that students will need to actively integrate in society and in the workplace, and to incorporate in schools, the scientific progress, educational innovation and the new meanings of culture"([21]). Particularly, due to the policy implemented by the government of Argentina and others

countries of the region, in a few time most of first year students will have a notebook.

Our results show that 91% of students have a PC, the 50% of them also has a notebook and the 60% has mobile phone. Thus the most appropriate platform formats to design educative technologies would be not only the PC but in a short time it also would be the mobile phones and the notebooks.

One of the preferred leisure activities of young are communicating with peers and sharing experiences in social networks. That is why incorporating online forums, chat rooms and also multiplayer video games in the design of technologies for learning is considered opportune. Besides this fact these tools add the social nature of learning attributed by educational theories.

The results show that students spend a long time playing with video games. Knowing which and how are the most played video games by the students could be used to infer their previous knowledge and skills. There are differences in the number and type of video games chosen for men and for women. Women have less experience with video games than men. Women choose casual games such as arcade platforms and puzzles, and also social simulation games. While men choose simulation sport games, arcade action games and strategy games. In spite of the difference in some choices, there are some common points that can be taken into account. For instance, both men and women, have experience with casual games, that have simple graphics and narrative and that are easy to learn. Besides these simple video games, also simulations video games (social and sportive) are chosen by both genres. This type of games used to be multiplayer and have the most realistic 3D graphics.

It should be desirable to design a video game based educational tool with a reduced time for learning itself, with no difficulties in commands and rules. There some elements to be extracted from the highlights games such as the possibility of seeing a demonstration and also the possibility of exploring with training or retry plays to familiarize with.

As a future work it is the study of some games that are adapted to teach specific physics concepts. The specific competences that the students of engineering have to acquire could be corresponded to video games' levels of crescent complexity. The particular difficulties pointed by professors should be defined as a challenge that the students must overcome to reach the success of the level.

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