International Journal of Engineering Education Vol. 27, No. 4, pp. 795–804, 2011
Printed in Great Britain

0949-149X/91 $3.00+0.00

Perceptions of Gaming as Experiential Learning by Engineering Students*

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After defining the term game and its characteristics, this paper refers to the origins of games, and supports the idea of gaming as one of the techniques included in the simulation and gaming methodology endorsed by associations such as ISAGA, NASAGA, JASAG, ABSEL or SAGSET.

Considering gaming as experiential learning this study offers the perceptions of forty seven engineering students in their third year of studies at the Universitat Politècnica de València (Spain) regarding the use of games in different supports as part of their activities to gain knowledge in subjects of their degree program throughout a semester, to reinforce previously covered material, and to help learners develop problem-solving skills, communication and teamwork skills.

A review of the advantages and drawbacks of using games leads us to carry out the statistical analysis of the answers to a survey concerning the use of gaming as a teaching-learning technique with these engineering students, the students' experience with games in different subjects attended before and during their university studies, and the students' perceptions on using games to learn or just for fun.

The study of the relation among the variables analysed allows us to perceive the students' feelings regarding gaming as opposed to more conventional strategies. As a whole, engineering students participating in the experiment back experiential learning and confirm that they learn and have fun when there is gaming in class activities.

Keywords: gaming; experiential learning; students' perceptions; higher education

1. What a Game is

According to the Concise Etymological Dictionary of the English Language [1] the word game comes from the Indo-European *ghem* and from the Old English *gamen* which means joy, fun and amusement. Some authors [2] distinguish between play and game pointing out that the former is something one person chooses to do that promotes learning since fun creates relaxation and amusement. This relaxation enables learners to assimilate easily at the time amusement allows them to make an effort as their involvement increases and thus it helps learning. For these authors a game is a subset of the terms play and fun in the sense that it contains most of the six factors that a game has: Rules (which distinguish it from other types of play that are not rule-based), Goals and Objectives, Outcomes and Feedback (it can be a numerical score, a graphic or an oral or written comment, for example), Competition/Challenge/Problem to solve, Interaction (with other people or with a computer) and a Story (either abstract or concrete with or without certain elements of fantasy). Well-constructed games share these characteristics plus what it is called [3] Closure and Contrivance, that is, the players know how and under what conditions the game ends because after all a game is just a game.

For other authors [4, p. 2], on the contrary, a game is "an intellectual activity engaged in for its own sake, with neither clearly recognizable functionalities nor immediate biological effects (. . .) and related to exploratory processes that follow the exposure of the player to novel stimuli". A game is also defined [5, p. 159] as "a set of activities involving one or more players. It has goals, constraints, payoffs and consequences. A game is rule-guided and artificial in some respects [. . .] it involves some aspect of competition, even if that competition is with oneself".

Hence, a game is considered an activity when it includes several fundamental characteristics: It is usually a contest that requires participants to follow a set of rules in order to reach a goal. This contest usually involves an element of chance, challenge, fantasy and mystery besides an educational purpose or competition with others or with oneself. Exposing players/students to activities with goals, rules, etc. that are safe experiences from which they can learn, put into practice or discover new knowledge (that will make them become more competent) has guided the authors of this paper to use educational games in Higher Education as well as design and develop games with the objective of favouring a meaningful and experiential learning.[1]

[1] *Culturball; Culturbasket; La Idea de Glup; Los Tu Padre por si Acaso; El Ingenioso Ingeniero; La Representación, Bravo; Te vi o no te vi; Tras la Pipa; Volveremos; Del Amor, del Tiempo y de la Historia; El Tesoro; Buscando a Cervantes*, etc.

* Accepted 15 October 2010.

2. Games and simulations

Games and simulations were formerly considered mere techniques [6] although they have now been encompassed in the methodology of Simulation and Gaming. Associations such as ISAGA (International Simulation and Gaming Association), NASAGA (North American Simulation and Gaming Association) and SAGSET (Society for the Advancement of Games and Simulations in Education and Training) among others endorse it as a consolidated methodology. Nonetheless, there are still certain controversies regarding the terms game, simulation and role-play that can lead to confusion.

Participants in a role play [7] have to act a part, mime or imitate a behaviour that is guided for a certain period of time. In a simulation participants are not actors since they are themselves when taking decisions to find the best solution to a problem, for example, to find a job, etc. as they would do in their real lives. The main difference between a role play, a game and a simulation lies in the fact that a role play and a game are close-ended activities, especially the former with set up guidelines to follow. Simulations, on the contrary, are open-ended tasks where participants always decide or negotiate at the end.

A game can be distinguished by the fact that there has to be a competition or an educational purpose. The players' fundamental task is to win [8] over acquiring, reviewing or increasing their knowledge of the contents of a subject or field of study, for example.

A simulation is viewed as a representation of some real world system whereas a game [9] does not intend to represent any real world system since it is a real system in its own right. Both contain rules and strategies; the key distinction is that games do not propose to represent reality whereas simulations do. At the risk of introducing a bit more ambiguity, it is proposed [10] that simulation can contain game features: fantasy, rules/goals, sensory stimuli, challenge, mystery, and control.

3. The origins and spread of games

Game playing is believed to be as old as civilization itself. Nevertheless, games are not a human invention. A trip to the zoo will suffice to see two lion cubs wrestling close to their mother and apparently playing when, as a matter of fact, what they are doing is learning the skills of hunting and survival [11]. They are learning by doing in a safe environment although the educational motivation may not be conscious. Games can be considered the most ancient vehicle for education: No mother lion has been seen lecturing her cubs at the chalkboard!

Despite the evidence, determining the origins of games is not an easy task mainly because, as experts of the Elliott Avendon Museum and Archive of Games of the University of Waterloo (Ontario, Canada)[2] mention, people did not make the effort to keep records about something that seemed as trivial as games. Even nowadays when something is identified as a game it is considered a pastime with the sole goal of player enjoyment. However, games are and have also been used for other purposes such as education. The following lines offer a brief approach to the origins and diffusion of games from a complementary perspective to the one offered by different authors [12] considering gaming as one of the techniques of the methodology Simulation and Gaming and bearing in mind the lack of accurate documentation on its origins, in some cases.

The Elliott Avendon Museum and Archive of Games mentions three possible parts of the world in which the first games may have come to light some 5000 years ago or even more: a) the lower river valleys of the Nile from where they spread east to the present-day Iraq; b) the valleys of the rivers Euphrates and Tigris spreading west to Egypt or c) the possibility of having originated in Northern India and spread southwest to Babylon (Iraq) and Egypt. Be that as it may, these games spread to Greece and certain parts of Africa. From there, they arrived in present-day Italy, North of Turkey, South of Russia, Rome, and those parts where citizens had contact with the Roman Legions (current France, Britain, Germany, and Denmark). Supposedly some games were introduced from Scandinavia to the North American Continent.

Games that may have originated in India spread east to Nepal, Tibet and China. Later, from India they reached present-day Iran and Egypt. Meanwhile, those games that may have originated in China went east to Korea, Japan, Indonesia, the Malay Archipelago and also reached the North America. Games were spread by Crusaders, Asian and Arabian traders, colonists from Europe who taught their games to North American natives, more soldiers, other travellers, etc [13].

Regarding particular games, worthy of mention is that the oldest known dice are found with a 5000-year-old board game set at the archaeological site of Shahr-e Sukhteh in south-eastern Iran. Another game, SENET/SENAT, which means passing, was found in ancient Egypt painted on the tomb of Rashepses dating about 3500 BC. The game is first translated as chess and afterwards as draughts although certainly it can not be chess or draughts. It has boards of different sizes intended for more or fewer pieces, and consequently for longer or shorter

[2] http://www.gamesmuseum.uwaterloo.ca/About%20Games/index.htm Accessed 11 January 2010

games, according to the time players have to play [14].

One of the most popular board games of the ancient world is THE ROYAL GAME OF UR, from Ur (southern present-Iraq) and dates back about 2600-2400 BC becoming the oldest set of board gaming equipment ever found. This game and the SENET are considered race games in which the goal is to move the players' pieces to the end of the board. A classic game of this type is the well known SNAKES AND LADDERS, a game based on morality that originates in India; in it the ladders represent virtues (generosity, faith, humility, etc.) whereas the snakes vices (anger, theft, murder, etc.).

Among the treasures found at Ur about 2500 BC there is a board game called BACKGAMMON. It resembles SENET but with moves controlled by the roll of dice. Like in other games of antiquity, luck plays an important role; however there is a large scope for strategy [15] and the goal of the game is to remove from the board all of one's own checkers or stones before the opponent can do the same.

The first use of games for education and research can be found in the field of war gaming. WEI-HAI is perhaps the oldest war-game attributed to Sun Tzu, a Chinese philosopher, military leader and author of the book *The Art of War* on military strategies and tactics [16]. It is a board game for two players that originated in ancient China in about 2500-3000 BC. In spite of its easy rules, it is rich in strategic complexity and its objective is to control with stones (black or white) a larger portion of the board than the opponent; it is designed to teach discipline. Later, about AD 735, it is called GO in Japan.

Chess is believed to have originated in India and its early form is known as CHATURANGA. This progenitor of chess is believed to date back to a period of about 4000-5000 years before the sixth century of our era [14] but the current form of the game emerges in Europe during the 15th century or early 16th [13] when versions of chess begin to reflect military development by including among its pieces knights, bishops, halberdiers, bowmen, etc. Whatever its origin, Chaturanga is from the beginning a game of war.

The game LUDUS LATRUNCULORUM or LATRUNCULI is a board game played by the ancient Romans whose references are found in Homer's time. It is generally considered a game of military tactics, resembling modern chess in some ways. Its name comes from the word *latrones* which originally meant mercenaries or soldiers in early Roman times.

All things considered, no matter what ancient game we refer to, its beginning could have been simply a form of recreation. However, from pastimes these games evolved into profound religious rituals or challenging situations by adding more complications and making the game more interesting by allowing the players, for example, to choose and move more than one piece. Thus, such pastime activities became learning environments which enabled players to acquire strategic thinking, discipline and tactics, among other learning skills. The games were systems in which players engaged in an artificial conflict defined by rules that resulted in a quantitative outcome [17].

4. Experiential learning

The term active learning is growing in popularity within universities and it refers to any learning activity that involves the active and reflective participation of the student. Among the many active techniques are Problem-based Learning, Project Work, Case Studies, and Simulation and Gaming. The use of active learning in education is not a new idea since it was most certainly the first method used. The first human societies survived by hunting and the quickest and most efficient method of training the young was to let them watch and imitate the behaviour of the elders. However, the first written account of active learning comes from ancient Greece and the Socratic Method.

Related to active learning is experiential learning, that is, the learning acquired through reflection on doing. In order to gain knowledge from an experience [18], certain abilities are required. They are skills that teachers have to pursue and foster in their students:

(a) The learner must be willing to be actively involved in the experience.
(b) The learner must be able to reflect on the experience.
(c) The learner must possess and use analytical skills to conceptualize the experience.
(d) The learner must possess decision making and problem solving skills in order to use the new ideas gained from the experience.

Experiential learning is based on what is presently called social constructivism, a bringing together of aspects of the work of Piaget and that of Bruner and Vygotsky, which argues that we all generate knowledge and meaning from our experiences. The principle of constructivism was credited by Piaget and can be summed up by saying that knowledge is actively constructed by learners, but not passively received from the environment that surrounds them or from their teachers. Social constructivism takes into account the social world of learners that affects them; therefore, the teaching strategies using social constructivism as a referent (and gaming is one of them), include teaching in meaningful contexts for

the students, where negotiating, class discussion and small group collaboration stand out over correct answers.

As an active learning technique, gaming bears in mind what Comenius (1592–1670), often considered the father of modern education, sustains when he invites readers in the frontispiece to the Didactica Magna[3] to seek and find a method of instruction by which teachers may teach less, but learners may learn more. Students will surely learn more if teachers spend less time teaching, and the students spend less time passively listening.

5. Gaming in higher education. Benefits and drawbacks

The use of games requires careful planning, design and execution since games should not be used just as ice breakers or time fillers but as a part of the instructional design of the subject and as a motivational tool that helps students/players learn and sense the consequence of their decisions at no risk. The same way military personal from ancient times did when playing games or the ones that are being played in Inuit culture, for example, by putting emphasis on cooperation as a way of winning. Without such cooperation Inuit life would have probably disappeared in the cold climate of the Canadian Artic [19].

Gaming is a technique that is becoming popular in more and more universities although long ago it seemed to belong to kindergartens and lower grades. Gredler [20] points out how different authors consider that, although educational games are accepted in primary and secondary levels, their use declines in the later grades. Nevertheless, several reviews of the literature on gaming offer results of the use of games to teach different disciplines such as Engineering [21], Agricultural Engineering [22], Civil Engineering [23], Nursing [24], Medicine [25], Chemistry [26], Mathematics [27], Cheminformatics [28], Economics [29], Business [30], Social and Emotional Learning [31], Languages [32–33] and Biology [34], among other fields of study.

There is an extensive body of literature regarding the value of educational games, which shows that they are now gaining more credibility as educational tools. The benefits of the effective use of games are considerable since games tend to involve learners and increase their interest and motivation [10]. The fun aspect appears to promote learning by generating joy but this motivation has to be sustained through reflection, active involvement and feedback responses. Students' behaviours can be intrinsically or extrinsically motivated: Challenge (goals and scoring), fantasy and curiosity are the primary factors that make a game intrinsically motivating, that is, learners engage in the game because it is interesting or enjoyable.

Gaming allows learners to participate in the communicative process; progress, motivation and learning come with practice and as people learn from active engagement with the environment [10] this experience coupled with instructional support (i.e. debriefing) can provide an effective learning environment. For some authors [35–36] instruction incorporating game features leads to improved learning whereas others [37] state that games improve reasoning and reduce the time devoted to lecturing.

Games can also be implemented for assessment purposes by way of scoring mechanisms which games tend to have to rate group dynamics, attitudes, behaviours, contents, leadership potentials, values, etc. They can also be utilized to connect content and skills in an environment where the student can make mistakes and learn [38].

Literature on game-based learning for adult education explores the design and development of learning games [39, 2, 40–41], their educational value [42, 20, 43], the impact on students' learning [44], the learners' profiles and expectations [45], games' effectiveness [46–47], and academics' real views on the use of educational games in Higher Education [48], among others.

Regarding the effectiveness of games, some of these studies report results favouring their effectiveness over conventional teaching, whereas others offer results to the contrary; as well, there are results that find no significant differences. The learning from the experience of a game depends on a host of circumstances such as what the student is looking for, his/her nature, his/her intrinsic pleasantness or unpleasantness of the experience, how a game is run [49], etc.; variables that also affect what anybody learns from any experience. Different authors [10] provide a wide review of learning outcomes obtained by researchers concerning the uses of different games, in particular skill-based learning outcomes, cognitive learning outcomes (procedural and strategic knowledge), and affective learning outcomes. Studies comparing standard lecture with gaming find that learners have similar information retention although they have more fun in the gaming sessions [50].

Despite the numerous advantages, there is one great pitfall in the use of games as a teaching strategy: Games can be time consuming. It is necessary to allot time to explain the rules, to play and debrief, and even more for the process of design, not to mention the issue of competition, a necessary

[3] http://core.roehampton.ac.uk/digital/froarc/comgre/#intros and http://core.roehampton.ac.uk/digital/froarc/comgre/part2/fly2.pdf Accessed 2 January 2010

component of games. In our viewpoint the competition aspect involving losing and winning can be softened by allowing players to see their efficiency throughout the game[4]. Some studies show that their use is often most effective with particular learners who enjoy learning with games [51]; therefore, researchers have to take into account the fact that some students learn from games while others do not. The most effective use may need to be differentiated according to the learners' specific requirements, that is to say their learning level, competencies, skills, etc. It is agreed that learning with games is not efficient when there is no teacher support or instruction since the teacher's role is essential in guiding, facilitating and encouraging learners to learn from experience. Likewise, there are some variables which affect the effectiveness of games and the teacher who administers the game can significantly influence the learning [49]. A study conducted by García-Carbonell and Rising [52] supports this statement showing that the role of facilitator is more effective than that of interventionist.

6. Aims of the study and methodology

The review of the advantages and drawbacks of using games as a teaching-learning technique leads us to consider the perceptions of a sample of forty seven engineering students regarding the use of games in different supports. Questions involve games as part of the syllabus and tasks carried out throughout a term to reinforce previously covered material, to teach new concepts or introduce new ideas, to help learners develop problem-solving skills, communication and teamwork skills, and engage participants as well as to determine their use of this strategy in primary and secondary school. These students are between the ages of 20 and 25 and are completing a three-year degree in Surveying at the Universidad Politécnica of Valencia (Spain). A statistical analysis of the answers to a survey gives us the opportunity to study:

1. The use of gaming as a teaching-learning technique in a specific context at the university.
2. The students' experience with this technique in different subjects attended before and during their university studies.
3. The existence of relationships among the variables studied that allow us to know how learners feel before gaming.
4. The students' perceptions on using games to learn or just having fun with them.

[4] Besides feedback responses, the computer games that the authors of this paper have designed and developed show participants a final screen with the number of questions that have appeared, the ones that have been correctly answered and the efficiency measured in percentage of right answers.

After having used educational games in different supports (computer-based, computer-supported, board, card and digital games) for a three-month period, participants have to assess anonymously 33 statements by rating them from 0 to 10. Table 1 shows these statements.

The first six questions are excluded from the study because they have to do with the contents of the subjects. Out of the answers a mean value is obtained for every statement or variable. Table 2 shows the meanings of these values.

To examine the relationship among variables a correlation analysis between pairs of them is carried out in order to find possible significant relations as well as their intensity based on the correlation coefficient value. To clarify results the interrelated variables are subjected to a multivariable analysis by means of the Principal Component Analysis (PCA).

7. Analysis of results

As can be seen in table 3 the mean value of every statement or variable shows that these engineering students prefer playing to studying and their grades at University are not as good as those they obtained in secondary school. In primary and secondary school they got better marks in subjects such as Mathematics, Physics, etc. than in Literature, Language, etc., which is logical, if we keep in mind the profile and the degree program of the students.

They consider themselves sociable since they have friends, do not like solitude and maintain contact with their classmates. Students emphasize their lack of gaming in primary and secondary school except in PE although in the university they mainly play games in subjects dealing with languages. In spite of the fact that they like computers and routinely use them, videogames do not arouse their interest very much.

If they are asked to choose between traditional multiple choice questions on paper[5] and including this type of questions in games, they prefer the latter. They think that they learn playing games and consider them useful, enjoyable and educational. Students refuse to consider games as non-serious activities that make them waste their time in class and admit that, in general, they are good at gaming.

The relationship between the 19 variables (Table 3) offering information regarding the students' perceptions on gaming is analysed. A correlation analysis between pairs of them is done to find possible significant relationships and their intensity. Table 4

[5] To check comprehension, test knowledge on a topic and learn from mistakes.

Table 1. Statements engineering students assess anonymously regarding their opinions on using games as a teaching-learning approach

Question number	Statement
7	I like playing
8	I like studying
9	I get good marks at University
10	When I studied primary or secondary school I got good marks in Mathematics, Physics, Biology, etc.
11	When I studied primary or secondary school I got good marks in History, Literature, Languages, etc.
12	I have a lot of friends
13	Teachers have made me play to learn in primary and secondary school
14	Teachers have made me play to learn subjects on sciences in primary and secondary school
15	Teachers have made me play to learn subjects on humanities in primary and secondary school
16	Teachers have made me play in Physical Education (PE)
17	Professors at University have made me play in subjects dealing with sciences
18	Professors at University have made me play in subjects dealing with languages
19	I like computers
20	I like videogames
21	I have a computer at home
22	I frequently use the computer at home
23	I maintain contact with my classmates
24	I like to be alone
25	I prefer traditional multiple choice questions on paper
26	I prefer questions that are included in games
27	Educational games help me review contents and learn new ones
28	Games are interesting
29	Games are necessary
30	Games are educational
31	Games are ingenious
32	Games are enjoyable
33	Games are amazing
34	Games are appealing
35	Games are useful
36	Games are motivating
37	I learn playing games
38	Games are not serious
39	Games waste my time in class
40	I am good at gaming

Table 2. Meaning of the mean values

Mean value	Meaning
0.00 to 2.00	Strongly disagree
2.01 to 4.00	Disagree
4.01 to 6.00	Neutral
6.01 to 8.00	Agree
8.01 to 10.0	Strongly agree

lists the R values of the statistically significant correlations. The closer R value is 1, the greater the reliability of the relationship is.

To facilitate the understanding and edition of the table, only the R values with statistically significant relationships equal to or higher than 95% are shown. The size of the sample (47) is included in the calculations of every correlation even though it is not mentioned in the table. Nevertheless, results that are not significant are omitted since their levels of significance could reach 95% if the sample were increased.

The results lead us to deduce that students who like playing prefer questions that are included in games instead of traditional questions on paper. They consider that games help them review and learn new contents of the subjects. Moreover, they find games interesting, educational, useful and motivating and they admit that they are good at gaming. There is an inverse statistically significant relationship between what they like to play and the consideration that games are a waste of time in class; that is to say, the more they like playing, the less they think games make them waste their time in class. Interestingly, the students who like studying think that games are necessary, motivating and make them learn.

For learners who prefer traditional questions on paper there is an inverse statistically significant relationship between the fact of learning by playing and their opinions regarding games: the more they prefer traditional multiple choice questions on paper, the less they appreciate games and the more they consider them non-serious activities to do in class. On the contrary, students who prefer questions included in games think games help them review contents and learn; so, the more they like this type of questions, the less they feel games make them waste their time in class sessions.

Accordingly, the more interesting, educational, enjoyable, appealing and useful the games are, the less learners consider games make them waste their time in class. Furthermore, those who think games

Table 3. Mean value of every statement or variable

Question Number	Statement	Mean Value
7	I like playing	8.34
8	I like studying	5.72
9	I get good marks at University	5.04
10	When I studied primary or secondary school I got good marks in Mathematics, Physics, Biology, etc.	7.89
11	When I studied primary or secondary school I got good marks in History, Literature, Languages, etc.	6.45
12	I have a lot of friends	7.54
13	Teachers have made me play to learn in primary and secondary school	3.66
14	Teachers have made me play to learn subjects on sciences in primary and secondary school	3.25
15	Teachers have made me play to learn subjects on humanities in primary and secondary school	3.36
16	Teachers have made me play in Physical Education (PE)	7.93
17	Professors at University have made me play in subjects dealing with sciences	3.13
18	Professors at University have made me play in subjects dealing with languages	6.07
19	I like computers	7.02
20	I like videogames	5.12
21	I have a computer at home	9.28
22	I frequently use the computer at home	7.35
23	I maintain contact with my classmates	7.51
24	I like to be alone	3.91
25	I prefer traditional multiple choice questions on paper	4.95
26	I prefer questions that are included in games	6.19
27	Educational games help me review contents and learn new ones	6.77
28	Games are interesting	7.19
29	Games are necessary	6.44
30	Games are educational	7.35
31	Games are ingenious	7.07
32	Games are enjoyable	7.49
33	Games are amazing	5.77
34	Games are appealing	6.95
35	Games are useful	7.23
36	Games are motivating	6.70
37	I learn playing games	7.12
38	Games are not serious	3.39
39	Games waste my time in class	2.39
40	I am good at gaming	6.95

Table 4. R values with statistical significant relation

Statements	7	8	19	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
7					0.46	0.41	0.39		0.34					0.51	0.33			–0.31	0.36
8								0.50							0.38	0.44			
19							0.31												
25								–0.37		–0.34			–0.49		–0.56	–0.30	0.47		
26						0.49	0.45	0.30	0.52		0.45			0.52				–0.31	
27							0.73	0.35	0.66		0.58		0.49	0.73	0.51	0.49			0.45
28								0.39	0.74	0.32	0.80		0.62	0.82	0.47	0.39	–0.31	–0.44	0.45
29									0.37	0.47	0.36		0.31	0.36	0.59	0.69			
30										0.43	0.67		0.42	0.78	0.36	0.41		–0.37	0.48
31											0.37	0.66		0.34	0.72	0.77			
32													0.64	0.71	0.42			–0.38	0.49
33													0.37		0.59	0.49			
34														0.67	0.56		–0.38	–0.35	0.67
35															0.55	0.42		–0.35	0.58
36																0.76			0.42
37																			
38																		0.64	
39																			

are motivating show with an R value close to 1 that they learn when playing. Nonetheless, there is a significant statistically relationship between those learners who believe games are non-serious activities and their feeling that such activities make them waste class time.

To sum up, from the statistically significant relationships found, it can be inferred that learners influenced by more traditional class activities underrate games and feel they are non-serious activities that make them waste class time. Nevertheless, learners who are in favour of less traditional activities and those who assert they like studying together with the students who consider games interesting,

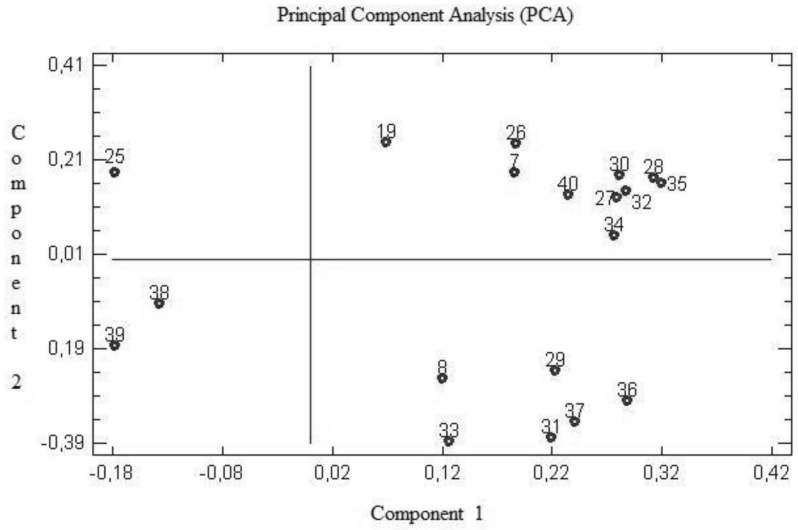

Fig. 1. Principal Component Analysis.

necessary, educational, ingenious and amazing confirm that they learn with games and thus with the experiential learning approach.

To show results regarding the significant statistically relationships in a more visual way a PCA is carried out (see Fig. 1). This mathematical procedure transforms a number of correlated variables into a smaller number of uncorrelated variables called principal components. The first principal component accounts for as much of the variability in the data as possible, and each succeeding component accounts for as much of the remaining variability as possible. The analysis discovers two components: a first component that accounts for the 38.38% of the variance and a second one that explains 14.07% of it.

Figure 1 offers an image in which variable number 25 ("I prefer traditional multiple choice questions on paper") and two variables clearly related to it, statements 38 and 39 ("Games are not serious" and "Games waste my time in class") are placed at the other extreme of the spectrum with the variables that are closely related to including questions in games instead of using the traditional questionnaires on paper. In the upper right quadrant variables more related to variable 7 ("I like playing") are located, whereas in the lower right quadrant there is a group of variables among which variable 8 ("I like studying") is found.

PCA visually confirms the results obtained in the correlation analysis: variable 7 ("I like playing") and number 8 ("I like studying") have statistically significant relationships with other variables that show positive perceptions on games. On the contrary, variables 25, 38 and 39 ("I prefer traditional multiple choice questions on paper", "Games are not serious" and "Games waste my time in class") are distant from variables that, as a whole, show a closer student preference for gaming as an effective and motivating learning and teaching strategy.

8. Conclusions

The forty-seven engineering students participating in this study emphasize their lack of gaming in primary and secondary school except in Physical Education and recognize that in their university studies they mainly play games in subjects dealing with languages. This finding gives us a rough idea of the frequency of the use of games employed in our university, despite the widespread use of gaming in different subject areas around the world.

Students, as a whole, support experiential learning and assert that they learn and have fun with gaming in class; they refuse to consider games as non-serious activities that make them waste their time in class; therefore, the more they like playing, the less they think games make them waste their class time. However, there is a significant statistically relationship between learners who believe games are not serious activities and the feeling that such activities make them waste their time. At the same time, students who prefer more traditional exercises underrate games. This minority of students may belong to the group of learners for whom games may not be an effective teaching technique since they do not like playing or have to struggle to process the information.

Learners who favor less traditional activities, together with those who affirm they like studying and those who consider games interesting and amazing, state that they learn with games. As can be seen, there is a certain mismatch among students' perceptions although a majority back the use of

games. Since there may be a considerable extent of disagreement between teacher's and learner's perceptions regarding the usefulness of different techniques and strategies, we consider that analyzing learners' feedback and clarifying their attitudes towards gaming are a priority.

Such disparity may also occur among academics. Their real views on the use of games in higher education, no matter what their level of seniority or expertise is, are a barrier because they do not value the technique, not to mention the idea that games are too time-consuming to implement in spite of positive perceptions by both academics and students [48]. Nonetheless, the engagement of both points of view on gaming as a serious way of learning should bring us all to take advantage of the learning potential that games can offer in higher education. The potential it can be only observed when educators include games in their practice as teachers are a fundamental key to game implementation.

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