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Can gamification improve the benefits of SRS in learning?. An experimental study

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Abstract—Student Response Systems (SRS) are becoming popular among instructors in nearly all levels of learning. The benefits of using SRSs have been demonstrated in many studies, in terms on attendance, attention, participation, engagement, or motivation. On the other hand, the use of some kind of gaming techniques in education has also been demonstrated in several studies that it is useful to stimulate students to learn in wider, longer, and deeper ways. The study analyze whether the integration of both, SRS and gaming techniques, leads to better results in motivation, attention, engagement and learning performance than only SRS. For this purpose, it has been developed a new tool for conducting an experimental study among students from different subjects and from different academic levels, considering three relevant factors: Learning Tool (non-gamificated SRS or gamificated SRS), Study Type and Gender. It has been considered a Multivariate Three-Way Factorial Design. The main finding is that students who took lecture sessions with a gamificated SRS had more positive perceptions with respect to motivation, attention, engagement and learning performance than students who took lecture sessions with a non gamificated SRS.

Index Terms— Computer aided instruction, Gamification, Student experiments, Student Response System (SRS)

1 Introduction And Literature Review

OVER 2500 years ago, Socrates founded an effective method to encourage students to became critical thinkers, and established a methodology based on asking questions as a way to promote learning and engage students [1]. Socrates approach was formerly utilized since the 1980s and exemplified in several universities in the UK, including Cambridge and Oxford as a mean to get feedback from students [2].

The traditional "clickers", small hand-held devices used to transmit data from the audience to the speaker, have been in use since 1970's, but the bloom of "clickers" in education was in the 1990's. As a result of technological development, clickers evolved into more complex systems becoming in powerful tools to provide real time students' feedback from learners to the instructor during a lecture. Those tools are known as student response systems (SRS) or audience response systems (ARS), and they are key pieces for the modern question driven instruction.

There are several key advantages from using these types of systems compared to traditional classroom techniques. Some examples are: increasing attendance (i.e., there is less student absenteeism) [3], improving attention (students pay more attention in class) [4], [5], participation (students participate with peers more in class to solve problems) [6], engagement (students are more engaged in class) [7], interactions with teachers and with student peers (students can have some feedback from other students by knowing the responses from each other, and teachers can obtain an immediate feedback from students, allowing them to change the course of the lecture depending on the received answers) [8], retention [9], and finally, motivation and fun [10], [11].

A review of the literature about the benefits and challenges of using ARSs can be found in [12]. They classify the benefits in terms of attendance, attention, anonymity, participation, engagement, interaction, discussion, contingent teaching, learning performance, quality of learning, feedback, formative and comparison, in the sense of comparing their SRS responses to class responses.

SRS are being used in all stages of education not only in mathematics and science subject areas, [13], but also in many other knowledge areas. The papers related to medical and nursery higher education should be particularly mentioned because of the very positive experiences they have obtained (see, for instance, [14], [15]).

While there is considerable evidence to suggest that higher education students are very willing to the use of SRSs [16], the implementation of an SRS in a classroom [17], [18] does not guarantee the improvement in student learning. Therefore, the definition of an adequate strategy for using SRSs is needed, [12].

All benefits of implementing these systems are very dependent on the questions asked. The cognitive benefits of SRSs are only as strong as the questions asked [19] and the critical challenge is to create questions that enable productive classroom interaction and discourse [20]. A wide range of suggestions from different authors have been offered regarding the most effective type of SRS questions [12], and how they have to be posed. Some of them have developed new formats of how to introduce the SRS, [21].

In [22] the relationship between the question format and the Bloom's taxonomy [23] have been studied. Thus the six cognitive domains from that classification –knowledge,

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comprehension, application, analysis, synthesis, and evaluation– are related to key words used to be in the test questions in order to evaluate the learning process.

On the other hand, benefits in learning performance might not be exclusively derived from the use of the SRS. Thus, for example, the development of peer group practices is also relevant in learning as argued in [3]. And some author highlights that pre-quizzes used in order to evaluate the SRS, are strongly associated with a higher rate of response to questions posed in class, [7].

Nevertheless, they have always had the lack of one of the most important techniques used in education: fun. Students are very excited at the beggining when they use SRSs for the first time, but when they use them in several sessions, and the novelty is lost, some of the benefits on attendance, engagement, or participation decline quite a few points, [24]. [20] describes some suggestions on how SRS should be used into a pedagogic framework and they have been taken into account for the set-up of the present study by introducing gamification.

The scientific community agrees on the definition of gamification as *the use of game design elements in non-game contexts*, [25]. Thus, gamification is related to similar concepts such as serious games, serious gaming, playful interaction or game-based technologies as stated in [26].

The term "gamification" is relatively recent. The first paper referring to gamification dates from 2010, [27], but the concept of the use of games for influencing and motivating groups of people is much older. Teachers in elementary school have always been using the game as a part of the education pedagogy. But it was not until 2010, when several industry players and conferences popularized the term and it gained widespread usage since then [28].

Educate by means of games, as stated above, has been always used by teachers and instructors, but with the recent investigations about gamification, the use of these techniques have acquired a more formal structure, [27].

Gamification in education is relevant, because it can be useful to motivate students to engage in the classroom. Likewise, gamification can provide instructors with new redesigned tools to conduct the class, recompense students, and obtain students to bring their full identity to the chase of learning. It can show them alternative ways that can demonstrate that education can be funny, and be specially useful supporting students' motivation, engagement, and learning during apparently uninteresting learning activities, [29]. Gamification can blur the boundaries between informal and formal learning stimulating students to learn in wider, longer, and deeper ways, [30]. Indeed, in distance learning, with mobiles devices, gamification is gaining acceptance, [31].

There are some literature about how to design strategies and tactics to integrate gamification into any kind of business or consumer website, [32]. But specifically, there are relevant literature about how to carry out gamification in education, [33], [34]. As Sarah Smith pointed out [33], focusing on the ways that entertainment technology engages us can result in methods that we can transfer to any learning situation.

The lack of the full implementation and support of gamification techniques on existing SRS systems made necessary the development of a new tool. This tool was called *Interactive Gamification Classroom*, IGC, which combines both methodologies: real time feedback and game dynamics in order to make lectures even more enjoyable. In other words, a tool to improve traditional SRSs by incorporating the possibility of using games.

In order to evaluate the effect of this novation, it has been conducted an experimental study to answer the general question whether the use of games whithin SRSs improve the learning results compared with the only use of SRSs. At the same time, the paper explores the grade of influence of the gender and study type in the perception of the use of them in the classroom.

To do this, students from different genders of three groups of students, one of High School level and two of University level (a group of Sociology students and other group of Telecommunications Engineering students) were taken. Each of these three groups was divided into two subgroups, one of them, the control group, took classes using only IGC without any game dynamic and the other group, the experimental group, took classes using IGC with some kind of game dynamic. At the end of the four sessions, students voluntarily completed a survey with 16 questions to assess their perceptions of the effect of the use of SRSs in motivation, attention, engagement and learning performance. Thereby, it has been used a Multivariate Three-Way Factorial Design for answering experimentally the main question.

Some of the main findings in the experiment were that the most influential factor in almost all the answers of students was the Study Type (p-values < 0.05); the Gender was significant in the answers of students about motivation, attention and performance learning (p-values < 0.1); and the Learning Tool was significant in the answers of students about performance learning (p-values < 0.1). Likewise, the Learning Tool was significant (p-value < 0.05) to differentiate among groups of individuals, obtaining, in general, that students who took lecture sessions with a gamificated SRS had more positive perceptions with respect to motivation, attention, engagement and learning performance on average than students who took lecture sessions with a non gamificated SRS. Therefore, the answer to the question posed in the title of this paper can be fairly yes, but further research has to be done.

The rest of the paper is organized as follows: Section 2 briefly describes the tool IGC developed for the experimental study. Section 3 describes relevant aspects of the experimental study including participants, methodology, data collection and measures, statistical data analysis and results. Section 4 states some discussion and conclussions.

2 Brief Description of the IGC Tool

At that moment of the development of the tool, there were very few programs which could provide real-time information about the answers of the students by means of computers connected to Internet. One of the key feature was to ease the use of the tool for both teachers and students. The tool was developed to be used as a service from a web server. In this manner, the tool can be located in the classroom or in a sharing or virtual hosting outside the ed ucational organization. Students and instructors only require a web browser instead of having software installed on the student computers and a server for the instructor. Thereby, this approach eliminates the expensive hand-held devices required for the students and the complicated configurations on the instructor side. Students and teachers can use their own smartphones requiring only a simple data connection as Wi-Fi.

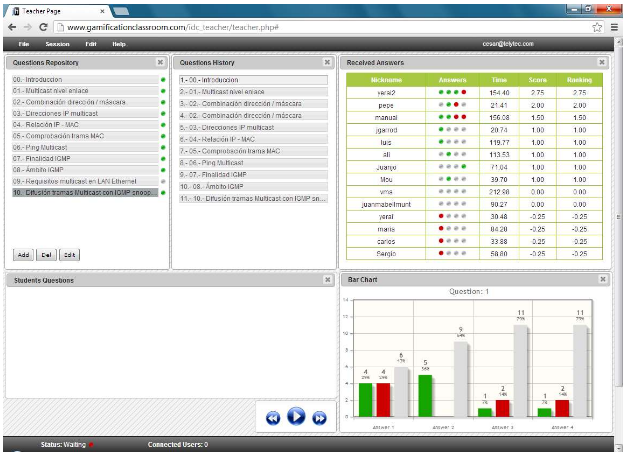

Fig. 1. Teacher Panel in the IGC. The controls are on the top of the page. The question repository is shown on the left. The record of the submitted question and some statistics are on the right. Other information is shown on the footer.

IGC, as other SRSs, consists of two different components: the teacher and the students section. Both can be accessed from the same web page, but from different login form boxes. In the teacher section, the instructors can create and prepare the questions; have the control to conduct the SRS assisted classroom, and are able, in real time view, the results of the students’ answers. The aspect of the instructor’s view is shown in **¡Error! No se encuentra el origen de la referencia.**. As observed, there are two panels to view the results, one is dedicated to view numerical data in a table with each user result for each question sent, and the other is dedicated to view graphical information with statistics of the whole class.

Questions are previously created and stored in the repository. When the teacher starts the session, he can select the questions to be sent to the students from this repository. When a question is submitted, a green mark is set right to it.

The record of the submitted questions is located next to the question repository. When the teacher clicks on one of them, automatically the result panels show the results for that particular question. If the last question is selected and students are already answering that question, the results change in real-time.

Teachers conduct the class playing (submitting the question to the students) and stopping (preventing the question to be answered) when they decide. Controls can be found on the top of the page.

In the footer of the page the status (online question in progress, waiting for playing a question, ...), and some connection statistics with the number of students connected, its IP addresses, operating system and browsers utilized by them can be shown.

The menus are intended to perform obvious actions as load, save, import questions or sessions, and to configure the parameters of a session. Question are tri-state/multiple choices type. Each question have 4 possible answers and each of these answers can be true or false. So students are compelled to evaluate each of the 4 answers individually and mark each of the 4 answers with true, false or don’t know. In this manner, the capability of the teacher to evaluate the understanding of a concept is improved and the student rewards can be even more flexible.

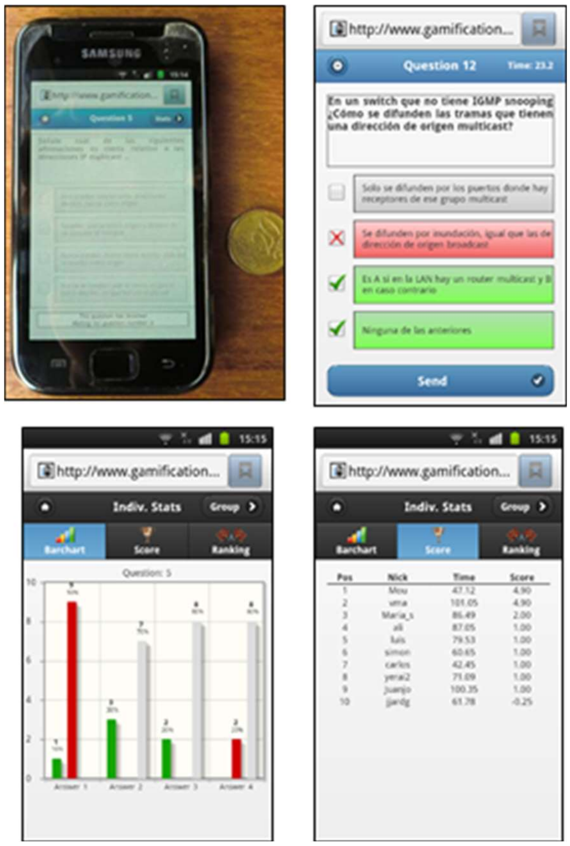

Fig. 2. The student’s view in a smart phone. The question and the alternative answers. Barchart for a question. Scores in a session.

On the other hand, the IGC has the student’s view. The student’s view is shown in **¡Error! No se encuentra el origen de la referencia.**. This view is cleaner and simpler than instructor’s view. Students just are able to read and answer the questions when instructor play them. After completion a question, students can view statistical information and score leader-board of the current question, per person and per group.

These views were implemented with hand-held devices in mind, so the IGC can be perfectly used with smart phones and tablets, and it is developed to adapt the view depending on the device. The tool was implemented to be flexible enough to meet the requirements of any kind of instructor. There are several configurations that can be done, those include:

- Allowing students login anonymity or not.
- Classifying students in groups or not.
- Allowing themselves to be assigned to a group or not.
- Changing the point reward criterion: positive points per right answer, negative points per wrong answer, additional points per quick answer or per relative position to other's answers.

The reward criterion used by the experimental research was the simulation of the formula 1 scoring: the results of each race (class) were evaluated using a point system in order to determine two annual World Championships, one for the drivers (individual students) and one for the constructors (students groups). The top ten students were awarded with points, receiving 25 points for the winner and 1 point for the 10th and last.

The student groups were divided into men vs. women, because it has been checked an augment of competitive behaviour between students when competing with the other gender. This scheme gained acceptance for students during all course and minimized the problem of the novelty in the use of clickers pointed out by several authors, [24].

Therefore, in order to gamificate SRSs it has been taken into account the three main principles of a game: (1) *A goal*: the win condition is to answer better and faster than others; (2) *obstacles*: obviously, students must study and be attentive during lecture (without those obstacles, winning would not mean much); and (3) *competition*: students themselves or with other members of the class.

3 Experimental Research

After evaluating the most important methodologies for experimental designs in online learning environments, [35], it has been proceed with "The Randomized Post-test-Only Control Group Design" described by [36]. On each class two groups were formed by random assignment. One group (control group) was committed to use the IGC without gamification elements, [37] while the other group (experimental group) used the complete gamificated IGC. Both groups were post-tested with a survey about the perceived advantages of using a SRS.

The four variables of interest which guided this study were: (1) motivation, (2) attention, (3) engagement, and (4) learning performance. The four hypotheses according to the above variables of interest are that the use of a SRS with gamification improves the studied variables in comparison with the use of a SRS without gaming concepts. Our studying hypotheses are the following:

- H1. *With a gamificated SRS motivation is higher than with a non-gamificated SRS.*
- H2. *With a gamificated SRS attention is higher than with a non-gamificated SRS.*
- H3. *With a gamificated SRS engagement is higher than with a non-gamificated SRS.*
- H4. *With a gamificated SRS learning performance is higher than with a non-gamificated SRS.*

3.1 Participants

In order to test the hypotheses proposed above, a sample of students from three different organization and educational levels has been used. In particular 131 students took part (answered the survey) in our experiment. The distribution was the following: 38 of them were students of Telecommunication Engineering enrolled in a course of Computer Networks at the Miguel Hernandez University of Elche; 38 participants were students of Sociology enrolled in a course of Socio-statistics at the University of Alicante and 55 were enrolled in introductory computer courses at the Jorge Juan High School. Their ages ranged from 15 to 26. The sample consisted of 77 males and 54 females. All data were collected during the 2012-2013 academic year. Likewise, all participants were from an urban environment and there were no cultural differences among them.

The participants were divided into two groups: the control group used SRS without gamification and the experimental group used the same SRS but gamificated, i.e., incorporating some game mechanic and dynamic. The control group consisted of 19 students of Telecommunication Engineering, 21 students of Sociology and 29 high school students; their ages ranged from 15 to 26 and there were 40 males and 29 females. The experimental group consisted of 19 students of Telecommunication Engineering, 17 students of Sociology and 26 high school students; their ages ranged from 15 to 26 and there were 37 males and 25 females.

3.2 Methodology

For each subject, students were divided randomly into the two groups: the control and the experimental. The IGC tool was used in a computer laboratory environment where each student has access to a computer. The experiment was conducted during 4 sessions. Each lecture session takes 1 hour and 30 minutes, and 10 questions according with the syllabus were asked during each of the sessions, [7]. Only students who attended to the four sessions were invited to participate in the survey.

Because of the importance of the questions design, they has be carefully selected, analyzed and adapted in order to reflect comprehension, application, analysis and synthesis of the concepts explained in class, [22].

For the experimental group, in order to encourage competition they were divided into men and women.

Before the experiment, all students were provided with an introductory guideline about the SRS in general, how they work, the purposes for the teacher to use them, the immediate feedback, and particularly, they were instructed how to use IGC tool.

For the experimental group, they were additionally instructed about the working scoring and punctuation set in the tool. Rewards in terms of extra points for the final mark of the course were not used for winners in the experimental group, which can downplay to a real effectiveness of a complete gamificated SRS. We have not evaluated the impact or relevance of this lack in our study.

Therefore, both groups of students knew that they were going to use IGC as a SRS but the experimental group would use it involving some kind of competition as part of a game.

The limitations of this experimental study include the fact that students' answers to the survey were voluntary. The survey used a seven-point ordinal scale. Likewise, the survey only reflects the perception of the student. Therefore our results are based on subjective answers. On the other hand, the number of lecture sessions was reduced, only four sessions. Consequently the novelty could have affected the answers of the students.

3.3 Data collection and measures

Data collection was made by the same survey to all the participants after finishing the experiment. Each participant was provided with a questionnaire and a brief background to the study. It was made clear that participation in the survey was voluntary and anonymous. The survey used seven-point Likert scale items that ranged from 1 (strongly disagree) to 7 (strongly agree). The survey also included questions about demographic information (age and gender).

In order to design a neutral questionnaire the statements were the same for both groups, henceforth both groups thought they were doing the same but there was one difference: gamification. Thus, we wanted to observe whether gamification improved the perception of students about motivation, attention, engagement and learning performance when using SRSs.

In order to analyze each of the four hypotheses previously stated, four item questions/statements were designed for each hypothesis which provided information about what it was dealing with. Therefore, the survey to be answered by the students consisted of sixteen questions/statements. The item questions, grouped by hypotheses, were the following:

H1. With a gamificated SRS motivation is higher than with a non-gamificated SRS.

With the use of the SRS…

Q11.- I felt lectures would be funnier.
Q12.- I felt I would be more motivated to attend to class.
Q13.- I felt I would be more inspired to learn the material.
Q14.- I felt pleased with the use of them.

H2. With a gamificated SRS attention is higher than with a non-gamificated SRS.

With the use of the SRS…

Q21.- I felt that I disconnect from the lecture less often.
Q22.- I felt that my disconnections are of short duration.
Q23.- I felt that cause me increase the mental effort in the class.
Q24.- I felt that my grade of concentration is more intensive.

H3. With a gamificated SRS engagement is higher than with a non-gamificated SRS.

With the use of the SRS…

Q31.- I felt that my opinions have been taken into account.
Q32.- My peer and faculty interactions made me feel valuable.
Q33.- Has favoured my personal relationships with my teachers.
Q34.- I were actively involved in the learning process.

H4. With a gamificated SRS learning performance is higher than with a non-gamificated SRS.

The use of the SRS…

Q41.- Helped me to discover and resolve misconceptions.
Q42.- Has allowed me to better understand the concepts studied.
Q43.- Can influence me to get better results in the exams.
Q44.- Has led to a better learning experience.

Therefore, the study database includes the following variables: learning tool, study type, age, gender and the sixteen questions/statements posed above, four corresponding to each hypothesis.

The variables we have considered as relevant in our experiment take the following values:

- Learning Tool (LT) is a binary variable taking the value 0 for the control group (only SRS) and 1 for the experimental group (SRS + gamification).
- Study Type (ST) takes three values, 0 for High studies, 1 for Sociology studies and 2 for Telecommunication studies.
- Gender (G) is a binary variable taking the value 0 for females and 1 for males.
- Qxy takes seven values from 1 (strongly disagree) to 7 (strongly agree).
- Hx is the average of the corresponding four variables Qxy. Therefore, Hx takes values from 1 to 7 in steps of 0.25.

The role of each of all above variables in the study is as follows. The variables Learning Tool, Study Type and Gender are considered the three factors to group individuals, therefore they are the explicative, independent or predictor variables in our experimental study, and variables Qxy and Hx are response or dependent variables. Therefore, we are considering a Multivariate Three-Way Factorial Design.

3.4 Statistical data analysis

Statistical data analysis has been carried out by using software StatGraphics Centurion XV (StatPoint Technologies Inc., USA) and the GNU software R (The R Project for Statistical Computing, [38]).

We have analyzed the data by using nonparametric statistical tests because all variables involved in our experimental study are categorical or ordinal. The structure of the statistical analysis is the following. First we performed a multivariate multifactorial analysis of variance (MANOVA) by applying the Permutational MANOVA (formerly nonparametric MANOVA) (see, [39], [40]) included in the R package "vegan", [41]). This statistical test is applied to analyze the differences among groups concerning multivariate effects of the interest variables H1, H2, H3 and H4. Next we have applied the nonparametric Kruskal-Wallis test for *k*-sample comparisons to every combination of factor and response variable. Finally, when necessary, we have performed nonparametric Tukey multiple comparison of all pairwise treatments (Tukey's HSD for ranks) to uncover where the differences are.

In all statistical analysis we have distinguished four levels of *p*-values to conclude statistically significant differences:

- "***" *p*-value < 0.01,
- "**" *p*-value < 0.05,
- "*" *p*-value ≤ 0.1,
- " ", *p*-value > 0.1.

3.5 Statistical data analysis

First, it is presented some descriptive statistics of the Hx response variables with respect to the factors to show the basic features of the data in the study. In particular, it shows the mean (A), the standard deviation (S), the median (M), the quartile 1 (Q1) and the quartile 3 (Q3). The results are shown in Table 1,

Table 2 and Table 3.

Table 1: Descriptive statistics for treatments in factor Learning Tool for each response variable H1, H2, H3 and H4.

	LT	N	A	S	Q1	M	Q3
H1	NonGam	69	5.36	1.06	5.00	5.75	6.00
	Gam	62	5.44	0.95	5.25	5.63	6.25
	LT	N	A	S	Q1	M	Q3
H2	NonGam	69	5.00	1.04	4.50	5.00	5.75
	Gam	62	5.28	0.96	4.75	5.25	5.94
	LT	N	A	S	Q1	M	Q3
H3	NonGam	69	5.27	0.92	4.75	5.50	6.00
	Gam	62	5.39	0.89	4.75	5.50	6.00
	LT	N	A	S	Q1	M	Q3
H4	NonGam	69	5.29	1.05	5.00	5.50	6.00
	Gam	62	5.69	0.83	5.25	5.75	6.25

Table 2: Descriptive statistics for treatments in factor Study Type for each response variable H1, H2, H3 and H4.

	ST	N	A	S	Q1	M	Q3
H1	HS	55	5.53	1.00	5.25	5.75	6.25
	Soc	38	4.88	1.07	4.31	5.25	5.69
	Tel	38	5.89	0.67	5.50	6.00	6.25
	ST	N	A	S	Q1	M	Q3
H2	HS	55	5.00	0.84	4.50	5.00	5.50
	Soc	38	4.70	1.06	4.06	4.75	5.44
	Tel	38	5.75	0.89	5.31	5.88	6.25
	ST	N	A	S	Q1	M	Q3
H3	HS	55	5.21	1.01	4.50	5.25	6.00
	Soc	38	5.36	0.86	4.75	5.38	6.00
	Tel	38	5.45	0.77	5.25	5.75	6.00
	ST	N	A	S	Q1	M	Q3
H4	HS	55	5.48	0.97	5.25	5.50	6.00
	Soc	38	5.22	1.01	4.81	5.38	6.00
	Tel	38	5.74	0.86	5.31	6.00	6.25

Table 3: Descriptive statistics for treatments in factor Gender for each response variable H1, H2, H3 and H4.

	G	N	A	S	Q1	M	Q3
H1	Female	44	5.18	1.13	4.75	5.25	6.00
	Male	77	5.63	0.88	5.25	5.75	6.25
	G	N	A	S	Q1	M	Q3
H2	Female	44	4.93	1.03	4.50	5.00	5.50
	Male	77	5.27	0.97	4.50	5.25	6.00
	G	N	A	S	Q1	M	Q3
H3	Female	44	5.32	0.87	4.75	5.50	6.00
	Male	77	5.32	0.93	5.00	5.50	6.00
	G	N	A	S	Q1	M	Q3
H4	Female	44	5.29	0.90	5.00	5.50	6.00
	Male	77	5.61	0.99	5.25	5.75	6.25

Table 4: Permutational MANOVA on Euclidean distances and 999,999 permutations for perceptions of students using Student Response Systems (SRS).

Source	d.f.	SumsOfSqs	MeanSqs	F	P-value
LT	1	9.15	9.1520	2.6779	(*)0.0620
ST	2	48.17	24.0853	7.0473	(***)0.0000
G	1	8.36	8.3565	2.4451	(*)0.0772
LT:ST	2	10.35	5.1773	1.5149	0.1792
LT:G	2	1.58	1.5791	0.4620	0.6807
ST:G	1	5.67	2.8362	0.8299	0.4931
LT:ST:G	2	1.43	0.7173	0.2099	0.9768
Residuals	119	406.70	3.4177		
Total	130	491.42			

In Table 1,

Table 2 and Table 3 it can be observed that most of the students involved in the experiment marked 4 or more points to all posed questions. In fact, the average points are close to or above 5 points and in all cases the first quartile is above 4. These results are consistent with other experiments about SRSs in the literature. Likewise, the values for the descriptive statistics for gamificated SRS and male students are, respectively, higher than the corresponding ones for non gamificated SRS and female students. Finally, it can be observe that Telecommunications Engineering students marked, in general, higher than Sociology students and High School students.

After this brief exploratory analysis, a Permutational MANOVA was performed in order to test whether there are significant differences among the different groups concerning multivariate effects of the interest variables H1, H2, H3 and H4. The result of this statistical test is shown in Table 4.

From Table 4, it can be observed that there are no significant interactions among the three main factors (Learning Tool, Study Type and Gender), but these three factors are significant in different levels. Therefore, analyzing where the differences are is relevant. An alternative is to look at the relative position of the centroids in order to exploratory detect where the differences can be. In **¡Error! No se encuentra el origen de la referencia.**, it can be observed that response variable 3 does not contribute much to differentiate among the groups because all the coordinates of the centroids corresponding to H3 are very close each other. Likewise, it can be observed that for the other three variables, it is posible to differentiate the groups. On the other hand, it can be noted that the most relevant factor to differentiate groups is Study Type because for response variables H1, H2 and H4 it can easily separate the individuals from the three treatments. Finally, the Learning Tool and

Gender factors are equally relevant to differentiate the groups. Thus, for H1 Gender factor is better than Learning Tool factor, for H2 both factors are similar, and for H4 Learning Tool factor is better than Gender factor.

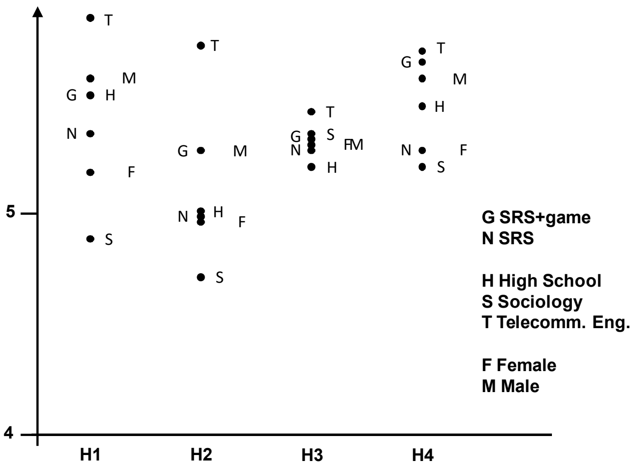

Fig. 3. Relative location of the coordinates of the centroids of the factors.

In order to statistically verify our previous conclusions, we first performed a Kruskal-Wallis test for each factor and each response variable. And then, when necessary, we perform nonparametric Tukey multiple comparison of all pairwise treatments to uncover where the differences are. From the Kruskal-Wallis tests we will obtain information to discover which response variables were more influential in the results obtained in the Permutational MANOVA, and then knowing where the differences among the groups are. Likewise, we obtain information about which questions were more influential in the response variables Hx in order to differentiate the groups. Therefore, the Kruskal-Wallis tests provide us relevant information about the relevance of each response variable Qxy in our results.

Table 5: P-values for the Kruskal-Wallis tests performed for each factor and each response variable.

Factor	Q11	Q12	Q13	Q14	H1
LT	0.2759	*0.0822	0.8623	0.4537	0.4661
ST	**0.0288	**0.0117	***0.0000	***0.0001	***0.0000
G	*0.0748	***0.0018	0.3937	0.1162	**0.0208
Factor	**Q21**	**Q22**	**Q23**	**Q24**	**H2**
LT	0.2189	*0.0819	0.3735	0.2730	0.1327
ST	***0.0000	**0.0315	***0.0022	***0.0003	***0.0000
G	0.3264	0.3108	0.1808	**0.0152	*0.0967
Factor	**Q31**	**Q32**	**Q33**	**Q34**	**H3**
LT	0.9810	0.4175	0.3985	0.7395	0.4758
ST	0.3495	0.3130	0.3145	0.2300	0.5618
G	0.2935	0.9131	0.5708	0.0389	0.8713
Factor	**Q41**	**Q42**	**Q43**	**Q44**	**H4**
LT	0.1046	**0.0350	0.1379	0.1744	*0.0639
ST	**0.0187	***0.0096	0.1069	0.5974	**0.0385
G	0.1013	**0.0249	*0.0889	*0.0837	**0.0218

In Table 5 it can be observed that response variables Q3y and H3 are not relevant but they can somehow have distorted a bit the results obtained in Table 4. Thus, when perform the Permutational MANOVA removing response variable H3, it obtains the results shown in Table 6.

Table 6: Permutational MANOVA on Euclidean distances and 999,999 permutations for perceptions of students using Student Response Systems (SRS), excluding H3.

Source	d.f.	SumsOfSqs	MeanSqs	F	P-value
LT	1	8.69	8.6897	3.3709	(**)0.0405
ST	2	46.85	23.4229	9.0861	(***)0.0000
G	1	8.36	8.3553	3.2412	(**)0.0446
LT:ST	2	8.62	4.3090	1.6715	0.1537
LT:G	2	1.13	1.1317	0.4390	0.6530
ST:G	1	4.04	2.0209	0.7839	0.5152
LT:ST:G	2	1.26	0.6296	0.2442	0.9314
Residuals	119	306.77	2.5779		
Total	130	385.71			

Now, from Table 6, it can be observed that there are no significant interactions among the three main factors, but they continue being significant. From Table 5 and Table 6 it can conclude that the most influential factor in the answers of students is Study Type. Now, applying the nonparametric Tukey multiple comparison to all response variables with p-value < 0.1 for the factor Study Type, it founds that Telecommunications students marked significantly higher than High School students and these significantly higher than Sociology students in all cases. On the other hand, applying the nonparametric Tukey multiple comparison to all response variables with p-value < 0.1 for the factor Learning Tool, it observes that students who were taught using gamificated SRS marked significantly higher than those taught using only SRS in all cases. Finally, it was performed the nonparametric Tukey multiple comparison to all response variables with p-value < 0.1 for the factor Gender, and it shows that male students marked significantly higher than female students.

4 Discussion and Conclusion

First, it is noted that student perceptions of usefulness both in motivation, attention, engagement and learning performance are in general positive, what is consistent with previous experimental studies in the literature. However, the study emphasizes that the type of study very significantly influences the perception of students on the use of SRSs regarding motivation, attention, engagement and learning performance. In particular, it can be observed that telecommunication engineering students were who considered more positively the use of SRSs in classroom, and sociology students, although also perceived it as a useful tool, did so to a lesser extent. In between high school students responded (see **¡Error! No se encuentra el origen de la referencia.**, Table 5 and Table 6). Perhaps this is due to the fact that students of telecommunications engineering are more likely to use new technologies, as evidenced by the characteristics of the type of university degree in which they are enrolled.

Regarding the relationship between gender and perception of the usefulness of SRSs, it can be observed that male students considered more positively the use of SRSs in classroom than female students. In particular, the differences of perception among female and male students respect to the use of SRSs were very significant for motivation and learning performance (see Table 5). Nevertheless, both female and male students had a very positive perception about the use of SRSs in classroom (see Table 3). Therefore, although there have been significant differences in perception about the use of SRSs in classroom between female and male students, these differences would be within a positive perception of the use of SRSs.

Finally, as regards gamification, in general, that students who took lecture sessions with a gamificated SRS had more positive perceptions with respect to motivation, attention, engagement and learning performance on average than those students who took lecture sessions with a non gamificated SRS (see Table 1). Likewise, from MANOVA analysis it can be observed that the learning tool (SRS+gamification vs only SRS) is a significant factor to differentiate groups (see **¡Error! No se encuentra el origen de la referencia.**, Table 4 and Table 6) and then there are differences among the individuals with respect to it. Nevertheless, this relevance is only substantiated in three out of the 16 questions in the survey, which significant differences in the perception of the use of SRS were found for (see Table 5), and these would be due to the use of games in addition to the SRS. Despite this, the results are encouraging and positive (see Table 1, **¡Error! No se encuentra el origen de la referencia.** and Table 6) and, therefore, the answer to the question posed in the title of this paper can be fairly yes. Consequently we believe that the possibilities of gamificating the classroom are still to discover.

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