This is a pre-print of an article published in **Innovations in Education and Teaching International**. The final authenticated version is available online at:

de la Torre, R.; **Berbegal-Mirabent, J.** (2020). Using game-based principles to empower students in non-STEM academic programs. *Innovations in Education and Teaching International*, 57(5): 511-520.

Using game-based principles to empower students in non-STEM academic programs

Abstract: This study describes an intervention carried out in the course on Statistics within the Bachelors' Degree in Business Administration, and Marketing and Digital Communication. Prior to it, problems related to attention in class and low motivation were identified. A game-based activity was designed aiming at boosting students' attention and encouraging autonomous study habits, which in turn, positively impact on their grades. To assess the effectiveness of the activity we tracked the grades and satisfaction of 153 students. Critical aspects highlighted by students in a focus group were also analysed. Evidences show the usefulness of the activity in improving students' grades and, to some extent, in changing their habits.

Keywords*:* motivation, gamification, focus group, higher education

1. Introduction

Human motivation is a complex topic which is still under debate (Bouwma-Gearhart, 2012). People's motivations are typically shaped by two dimensions: the level of motivation and the orientation/reason for this motivation (Deci and Ryan, 1985). Put differently, in the context of education, a student can be motivated to pass a subject, but the underlying reasons might be diverse, ranging from enjoying that particular subject, an interest for understanding how the subject might help him/ her in the future, or the mere interest in passing the subject because of a scholarship requirement.

According to the Self-Determination Theory (Deci and Ryan, 1985), motivations can be intrinsic or extrinsic. The former entail doing something because it is inherently interesting or enjoyable, while the latter are effective only when the desirable outcome is achieved. Back to the example, if a student is motivated to work hard in a particular

task by the expectation of improving his/her grades, as soon as that goal is reached there is no longer a motivation to work hard. On the other hand, an intrinsic motivator—i.e. interesting activity—will continue to motivate him/her to work hard indefinitely.

The study of intrinsic motivations and how they can be nurtured has attracted sound attention among educators. Intrinsically motivated students are not only able to develop a deeper approach to learning, but also show decreased anxiety, improved daily well-being and enhanced academic performance (Nowel, 2017).

This study focuses on intrinsic motivations. Particularly, it describes an intervention that, aimed at increasing this type of motivation, has the ultimate goal to promote students' attention in class and encourage their autonomous study habits. The original contribution of this work stems from the unique combination of 1) the use of the focus group as a tool to identify the weaknesses of the course and students' perceptions, 2) the design of a game-based learning activity, and 3) the use of an adapted version of the Student Evaluation of Educational Quality Questionnaire (SEEQ) to evaluate the impact of the intervention.

2. Literature review

Gamification is defined as the use of games or activities in a non-playful environment (Yildirim, 2017). The diversification of games has been enlarged by the widely use of the Internet in every life aspect. Consequently, it is reasonable to take advantage of the dynamics of games, and introduce them in the learning context.

Scholarly articles reflecting on the effectiveness of games in education is extensive. Most of them focus on digital educational games (Yildirim, 2017) and their application is wide, particularly in business, corporate management or marketing-related disciplines. Yet, its use in the university sphere is still limited (Dicheva et al., 2015).

Instructional games not only favor an active attitude in class but also foster knowledge acquisition in a more appealing environment, facilitating students' learning process and increasing their satisfaction. Su (2015) converge in that the gamification of teaching is an essential direction to follow, allowing students to become the center of their learning process, while increasing their motivation and active participation.

There are, however, critical voices claiming that games are only a complementary strategy to support learning objectives (Wilson et al., 2009). It is therefore crucial to design such activities while considering the desires and motivations of students, in order to satisfy their ultimate purpose—to become a learning instrument.

Csikszentmihalyi (1990) identifies the main factors that make an activity playful and useful: i) it must be a challenge that requires the use of personal skills and the acquired knowledge; ii) the objectives must be clear and must provide feedback; and iii) it is necessary to adapt it and improve it over time. Burguillo (2010) adds that activities conducted in class should include a competitive element to further engage students with the activity, support the management of the class, improve the environment and reduce learning times. Probably, the above reasons explain why its use has been so extensive in non-STEM (science, technology, engineering and mathematics) programs for teaching STEM subjects (Buckley et al., 2017).

When designing a game-based activity, besides using extrinsic motivators (e.g., prize and incentives) it is of utmost importance including elements that can also intrinsically motivate them. In this direction, Perryer et al. (2016) found that gamification promotes the development of soft skills (i.e. teamwork, oral communication, study habits).

Chen (2017) further confirms that extrinsic incentives combined with a proper activity design are likely to produce an intrinsic change in students. Similarly, Gil-

Doménech and Berbegal-Mirabent (2019) show how active learning methods can boost students' intrinsic motivation in a low-motivated environment.

3. Preliminary analysis

The experience presented here refers to the course on Statistics, split in two semesters (Statistics I and Statistics II) within the Bachelor's Degree in Business Administration and Management, and Marketing and Digital Communication.

To ensure the effectiveness of the intervention, three initial meetings lead by the same professor were conducted at the end of the first semester of the academic course 2015/16: one with professors and two involving students. Although there is room for subjective interpretations, having the same professor in the initial meetings and in the re-design of the course, reduces the risk of potential misalignments (Nestel et al., 2012).

The two professors participating in the first meeting were the responsible of the course over the past two years. The rationale behind this meeting was to discuss students' attitude in class and their academic performance. Consensus on the need to change the pace of the lectures was rapidly reached. In all groups (regardless of the professor) responses were similar: i) students' attention drop very quickly; ii) students struggle in identifying the main concepts and methods, with doubts raising exponentially over the semester; and iii) students do not study at home.

Students' opinions were obtained through a focus group[*]. Through this technique a range of questions can be explored, being two of the main advantages the contribution of the participants' issues and not just those pre-determined by the moderator, and the large amount of data that can be collected in a short time (Varga-Atkins et al., 2017).

[*] Full information about the focus group can be obtained upon request.

Two focus groups with students were conducted, one for each degree. The main goal was to understand how students perceived the courses, classroom dynamics and the evaluation method. Nine (Bachelor's Degree in Business Administration and Management) and ten students (Bachelor's Degree in Marketing and Digital Communication) enrolled in the subjects during the first semester in 2015/16 participated. Students were notified by email, being both sessions supervised by the same professor. A specific date and time was settled with those showing interest.

Each focus group took no more than 60 minutes. To start with, the purpose and the rules (i.e. all contributions would remain confidential) were explained. To stimulate the debate several questions were posed (Table 1), derived from the review of the literature and in-class observations.

Insert Table 1 about here

Students' opinions did not substantially vary from one degree to another (see Table 2) and validate the opinions expressed by the professors in the first meeting. Specifically, areas of improvement relate to the low value-added of classes and the lack of motivation. Specifically, students argued that the subject was difficult and not connected to their future; thus, it was not attractive for them dedicating time and/or effort. To overcome these issues an activity that uses the principles of gamification was designed.

Insert Table 2 about here

4. Description of the activity

Main purpose

This activity has two main goals: i) help students identify and review the main concepts and theories, and ii) encourage autonomous study habits. By introducing elements of games we expected students be more willing to engage in the courses and obtain the maximum profit of in-class time (while improving their grades).

In each course, students were divided into two groups, both with the same planning (i.e. exercises and theoretical explanations). Yet, the game-based activity was only implemented in ones; therefore, this group is considered as the "treatment" group, while the other serves as the "control" group. By comparing the results of the two groups we can assess the impact of the intervention.

Data

The activity was implemented during the second semester of 2015-2016 (Statistics II) and the first semester of 2016-2017 (Statistics I). Table 3 shows the number of students in each group. All students in the treatment group participated in the activity.

Insert Table 3 about here

Detailed description

During the classes the professor poses a series of questions related to the topics discussed (either in the previous class or during the same class). Examples of questions include: "*What is the meaning of the standard deviation?*" or "*What is the most common form of a normal distribution?*".

If the student correctly answers the question (including the justification) s/he is awarded with 1 "extra-point". A total of 5 "extra-points" implies +0.2 points in the next

exam. For example, if a student is graded with a 5, thanks to the extra-points his/her mark will automatically be transformed into 5.2.

The rules of the game were presented at the beginning of the semester:

- Questions (either conceptual or numerical) require short and concise answers.
- Questions might relate to concepts discussed in previous classes or in the current class. This strategy forces students to revise the material at home but also to pay attention during lectures.
- Each answer must be supported with a theoretical explanation. This approach allows controlling for students' overall knowledge and it helps them identify where to put the emphasis when studying.
- The professor is in charge of recording the "extra-points". S/he uses a list which is not made public to students to avoid demotivation and potential discussions (Perryer et al., 2016). Although it is intended to establish a healthy competition system, it seems unfair to only encourage those students who get more points, letting the whole class know who is scoring more points.
- Students' "extra-points" counter is set to zero once a mid-term exam is done. However, if the average of the class in the previous mid-term exam is equal to or greater than 6 points, these points accumulate.

With this activity, students are expected to participate during class discussions, conduct personal work at home and ask for extra help if needed. For those students with steady study habits, this activity is also valuable and has the additional incentive of accumulating points. This activity also aids the professor tracking students' progress over the semester, and helps in the identification of students' frustrations, preventing dropouts. Likewise, it allows adapting the content of the class as necessary (e.g.

reinforcing concepts or enriching explanations) and the introduction of new extra-point questions to make the lecture more dynamic and reduce students' disengagement.

5. Results

5.1. Academic performance

For each student, grades on the continuous evaluation, final exam (first take and, if necessary, the retake) and final grade (computed as 40% the continuous evaluation, and 60% the final exam—the maximum value between the first take and the retake) were gathered and analyzed (see Table 4).

Insert Table 4 about here

From Table 4, Figures 1 and 2, it can be observed that the averages values of the four indicators are significantly higher in the treated group, while the standard deviations are smaller. The average maximum and minimum scores are also informative, revealing that games have a positive impact in either well-performing students and low-performing ones.

Insert Figure 1 about here

Insert Figure 2 about here

To check the validity of the results the Z-Wilcoxon signed rank test was used. Through this procedure it is possible to investigate whether the average results are significantly different for two samples. Results are reported in Table 5 (significance level of 5%).

Insert Table 5 about here

In the first study period (2015-16), the average grades of the continuous evaluation and the final grades are significantly different, being higher in the treated group. In the second study period (2016-17) only the score in the continuous evaluation is significantly different and higher in the treated group. That is, the activity is shown to encourage continuous work throughout the semester. Yet, the effect dilutes in the final exam. This might be due to the weight of the final exam (60% of the total grade). Students in both groups—and regardless of the work done during the course—still devote an extra effort to prepare the final exam, since this is their best chance to pass the subject. These findings are aligned with existent research (Gil-Domènech and Berbegal-Mirabent, 2019) and support our initial intuition that by combining extrinsic and intrinsic motivators, the activity impacts positively on students.

5.2. Students' satisfaction

A second focus group with students from the treated group was conducted at the end of the semesters. Participation was voluntary. Students were notified by email and with a post in the online platform of the course. Eight students took part in the focus group, and the same professor who designed and implemented the activity acted as the moderator. To make results comparable with those in the previous focus group Table 6 summarizes students' answers.

Insert Table 6 about here

Another source of information was students' satisfaction surveys about the course. A survey based on the SEEQ questionnaire developed by Marsh (1982) was used. Participation in this survey is mandatory (following the policy of the school). Table 7 shows the items of interest and the results.

Insert Table 7 about here

The results endorse the findings of the second focus group. Students believe to have learned enough, that the evaluation activities were well balanced and that the tools provided in class were useful for reaching the learning objectives. Lastly, from question 3 we conclude that students still consider the subject of Statistics to more complex than other subjects.

6. Discussion and conclusions

Students in non-STEM academic programs tend to consider science subjects complex and far from their future careers. It is thus necessary to implement appropriate teaching methods to engage them in the learning process. This study describes a game-based activity that is expected to help students strengthen the key concepts, empower their autonomous study and improve their performance. To achieve these goals, students are provided with timely feedback during lectures through a series of short questions that allows professors to check firsthand and on a weekly basis students' progress.

Note that this activity is not an expensive one—does not imply an extra cost, neither for its design nor for its implementation. However, it requires adapting and reorganizing the theoretical explanations in order to include the questions. The activity can also be

replicated in other subjects, being particularly useful in courses with students exhibiting little motivation and with a lack of a predisposition to study outside class hours.

As in any intervention, the use of a control group is always controversial. However, we believe this strategy to be valid and not discriminatory in our approach. Since, typically, the mid-term exam represents a 40% of the total grade, the impact of the extra-points system in the final grade is minimal—no more than 0.08 in the final grade—thus, with this study we wanted to evaluate the psychological factor of a reward system, and determine its motivational effect on students throughout the semester.

From the responses of the final focus group (see Table 6) some conclusions can be drawn. First, Statistics is perceived as a complex subject, therefore, it is of utmost importance to come up with strategies that not only boost students' motivation, but also facilitate the learning process. Second, the activity proposed helped students to understand the importance of autonomous study. Third, most students considered the activity helpful for reinforcing and clarifying the concepts taught in class. Fourth, the average grades in, at least, the continuous evaluation, were higher in the treated groups (refer to Tables 5).

As the semester progressed and students were more familiar with the dynamics of the class, they started asking more questions over the course. Although we did not collect data on the number of doubts, it was clear that students started devoting time to study outside teaching hours, instead of concentrating their study when examination dates approach, as highlighted in the second focus group. Likewise, during the class breaks, groups of students approached the professor asking questions concerning concepts explained in previous classes, suggesting that students organized study groups.

The above evidences signal an intrinsic change in students' habits (steady pace of study throughout the whole course), expectations (they are trying to improve and

achieve new goals) and the way they study (have discussions in groups outside teaching hours). Moreover, it should be outlined that active participation in this activity was not compulsory, meaning that a student can pass the subject without answering any extra-point question. Therefore, the fact that the number of question raised indicates that students are more engaged, both in the activity and the subject.

In light of the experience, there are still some opportunities for improving the activity. It is important to keep posing "extra-point" questions at least every 30 minutes, otherwise students' attention significantly drop (the main challenge is finding the right balance between time spent in reviewing and in introducing new concepts). Another relevant issue is to connect the course with students' professional careers (Pedraza et al., 2012). If possible, it is highly advisable to include questions that entail solving small practical exercises (individually or in groups), as a strategy to more easily engage students with the subject.

References

Bouwma-Gearhart, J. (2012). Research University STEM Faculty Members' Motivation to Engage in Teaching Professional Development: Building the Choir Through an Appeal to Extrinsic Motivation and Ego. Journal of Science Education and Technology, 21(5):558-570

Buckley, P., Doyle, E., Doyle, S. (2017). Game On! Students' perceptions of gamified learning. Educational Technology & Society, 20(3): 1-10

Burguillo, J. (2010). Using game theory and competition-based learning to stimulate student motivation and performance. Computers and Education, 55: 566-575

Chen, Y.C. (2017). Empirical Study on the Effect of Digital Game-Based Instruction on Students' Learning Motivation and Achievement. Eurasia Journal of Mathematics Science and Technology Education, 13(7): 3177-3187

Csikszentmihalyi, M. (1990). Flow. The psychology of optimal experience. New York, NY: Harper Perennial

Deci, E.L., Ryan, RM. (1985). Intrinsic motivation and self-determination in human behavior. New York: Plenum

Dicheva, D., Dichev, C., Agre, G., Angelova, G. (2015). Gamification in education: A systematic mapping study. Educational Technology and Society, 18: 75-88

Gil-Domènech, D. and Berbegal-Mirabent, J. (2019). Stimulating students' engagement in mathematics courses in non-STEM academic programmes: A game-based learning. Innovations in Education and Teaching International, 56(1):57-65

Marsh, H.W. (1982). SEEQ: A reliable, valid, and useful instrument for collecting students' evaluations of university teaching. British Journal of Educational Psychology, 52(1): 77-95

Nowell, C. (2017). The influence of motivational orientation on the satisfaction of university students. Teaching in Higher Education, 22(7):855-866

Pedraza, A., Bravo, E., Amante, B. (2012). Development in pedagogical tools: Case study videos on innovative local entrepreneurship. Technics Technologies Education Management, 7(3): 1115-1124

Perryer C, Celestine N.A., Ladd, B.S., and Leighton, C. (2016) Enhancing workplace motivation through gamification: Transferrable lessons from pedagogy. The international Journal of Management Education, 14:327-335

Su, C-H. (2015). The effects of students' motivation, cognitive load and learning anxiety in gamification software engineering education: a structural equation modeling study. Multimed Tools and Application, 75(16): 10013-10036

Varga-Atkins, T., McIsaac, J., Willis, I. (2017). Focus Group meets Nominal Group Technique: an effective combination for student evaluation? Innovations in Education and Teaching International, 54(4): 289-300

Wilson, K.A., Bedwell, W.L., Lazzara, E.H., Salas, E., Burke, C.S., Estock, J.L., Orvis, K.L., Conkey, C. (2009). Relationships between game attributes and learning outcomes. Simulation & Gaming, 40: 217-266

Yildirim, I. (2017). The effects of gamification-based teaching practices on Student achievement and students' attitudes toward lessons. Internet and Higher Education, 33: 86-92

List of tables

Table 1. Focus group – Questionnaire

1) Do you think statistics will be useful in your future career?
2) Do you think you have learned enough in the subjects?
3) Did the methodology of the classes (masterly and problem-solving classes) have helped you learn and make the most of your class time?
4) Have you felt motivated to dedicate time to these subjects (Statistics I and II) at home?
5) Is there an activity that you would have liked to do in class? Or, on the contrary, is there any activity that you would like to eliminate or change (test, controls or final practice case)?
6) What do you think could be improved?

Table 2. Focus group – Questionnaire answers

1) Circa 75% of the students agreed Statistics to be a useful subject for their professional future. However, how the classes were designed made them see the subject disconnected from their life and future.
2) Students did not found a proper balance between the key concepts and time devoted at each lecture, drifting in frustration for not having the right skills for a science-based subject.
3) Although problem sessions helped students clarifying the key contents, lecture were, in general tedious and unattractive. Since they did not spend time at home for personal study, it was necessary to solve basic questions in class, with little time to resolve practical issues.
4) Most of the students admitted not feeling motivated enough to spend enough time at home waiting to answer questions or work in class.
5) Although a vast majority (>80% of the students) considered the continuous evaluation activities appropriate, they agreed not be sufficiently prepared for the evaluation activities over the course.
6) All students preferred reorienting the class examples to practical cases related to their future career.

Table 3. Size of the sample

Groups	2015-2016 Second semester	2016-2017 First semester
Treatment (game-based activity implemented)	28 (47.46%)	31 (32.98%)
Control (without the game-based activity)	31 (52.54%)	63 (67.02%)
Total students enrolled	59	94

Table 4. Descriptives of the average grades per semester (calculated in a 100-points scale), set of evaluation type and group.

		Treated group				Control group			
		Mean	St. Dev	Min.	Max.	Mean	St. Dev	Min.	Max.
2015-16 Second semester	Continuous evaluation	56.8	14.2	30	78	38.7	14.6	6	73
	Final exam (first take)	46.8	14.2	21	70	42.9	16.8	14	73
	Final exam (retake)	43.9	18.5	16	83	39.4	16.5	8	58
	Final grade	52.7	14.0	21	74	40.4	19.1	0	69
2016-17 First semester	Continuous evaluation	67.7	8.6	47	86	51.0	14.8	10	81
	Final exam (first take)	42.1	14.5	14	76	37.4	19.1	5	80
	Final exam (retake)	39.0	15.6	15	61	38.6	16.7	0	67
	Final grade	51.0	14.9	0	79	46.5	16.0	5	80

Table 5. p-value per each semester and set of evaluation activities (Wilcoxon text)

	p-value	
	2015-16, second semester	2016-2017, first semester
Continuous evaluation	0.0001	0.0004
Final exam (first take)	0.3936	0.6083
Final exam (retake)	0.4326	0.3635
Final grade	0.0114	0.3672

Table 6. Results from the second focus group

1) More than 80% of the students agreed that this subject would be useful for their professional future. However, they still consider the content somewhat disconnected from their future career.
2) More than 75% of the students considered that they were now more aware of the tools taught in class and they knew how to use them for autonomous work.
3) They all agreed that problem sessions helped them to clarify the theoretical fundamentals of the subject. Half of them also commented that thanks to the activity they managed to reinforce concepts in a more enjoyable way.
4) While some students admitted not feeling motived enough to work at home (because of the difficulty of the subject), others recognized that through this activity, they have devoted more time and effort (apart from the lecture hours).
5) A vast majority (>80%) of the students considers the activities in the continuous evaluation appropriate. Regarding the game-based activity, most of them (~75%) considered it useful to maintain attention in class and clarify/reinforce concepts.
6) All students preferred the use of practical cases related to their future career.

Table 7. Survey results for both semesters.

Questionnaire	2015-16 second semester	2016-17 first semester
1. In this subject I have learned things that I consider valuable for my training[a]	3.80	3.50
2. The exams and exercises correspond to the objectives of the subject[a]	4.50	4.00
3. Level of difficulty of this subject, compared to the other ones[b]	1.90	1.70

[a] Items range from 1 (strongly disagree) to 5 (complete agree)
[b] Items range from 1 (very difficult) to 5 (very easy).

List of figures

Figure 1. Average grades. Second semester course 2015-16 for both groups (control and treatment).

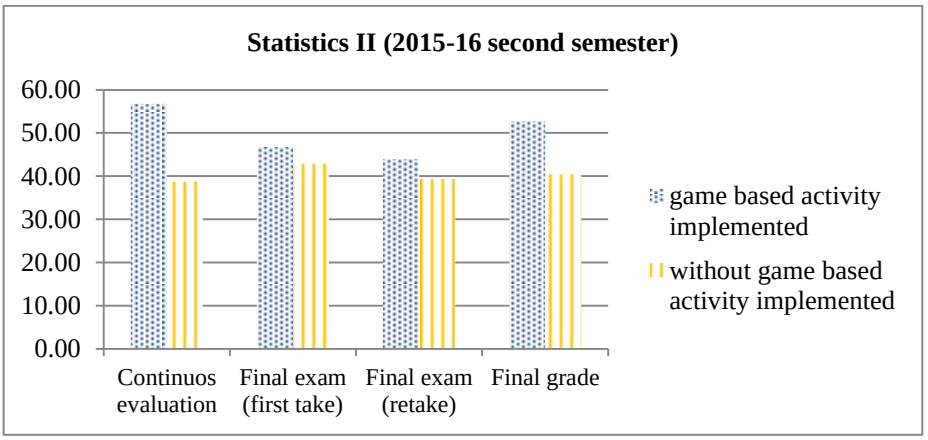

Figure 2. Average grades. First semester course 2016-17 for both groups (control and treatment).