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Gamification improves extrinsic but not intrinsic motivation to learning in undergraduate students: a counterbalanced study

La gamificación mejora la motivación extrínseca pero no la intrínseca hacia el aprendizaje en estudiantes universitarios: un estudio reequilibrado

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Abstract

Motivation to learn might be intrinsic or extrinsic, and both are related to academic performance in undergraduate students. Gamification practices can improve academic performance but studies on its effects on motivation are mixed. In this study, we assess the effects of gamification on motivation in undergraduate students. 120 first-year undergraduate psychology students registered in an introductory class participated in 6 quiz games about the basic scientific foundations of Psychology. We designed a counterbalanced study with two groups and three assessment points. Instruments comprised a demographical questionnaire and the CEAP-48 scale to measure extrinsic and intrinsic motivation to learning. A mixed ANOVA was performed to test the main hypothesis. Group 1 improved their scores in extrinsic motivation after gamification (t = -4.46, p <.001, d = -0.58) and were superior to Group 2 at second assessment

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point (t = 3.02, p =.034, d = 0.55). Group 2 also increased their scores in extrinsic motivation at third assessment point after gamification (t = -7.68, p <.001, d = -0.66) and were equivalent to Group 1 (t = -0.46, p =.997, d = -0.08). Gamification increases motivation oriented to reward and avoidance of low academic performance, instead of intrinsic motivation in undergraduate students.

Keywords: gamification, undergraduate students, intrinsic motivation, extrinsic motivation, counterbalanced design.

Resumen

La motivación hacia el aprendizaje puede ser intrínseca o extrínseca y en estudiantes universitarios se relacionan con el rendimiento académico. Éste puede ser mejorado en estudiantes universitarios mediante la gamificación, pero sus efectos sobre la motivación han mostrado resultados divergentes. El objetivo fue evaluar el efecto de la gamificación sobre la motivación de estudiantes universitarios. 120 estudiantes del primer curso del grado de Psicología fueron reclutados. La gamificación consistió en 6 *quiz-games* sobre los pilares básicos de la Psicología científica. Diseñamos un estudio reequilibrado con dos grupos y tres momentos de evaluación. Los instrumentos fueron un cuestionario sobre aspectos sociodemográficos y la escala CEAP-48 para evaluar motivación hacia el aprendizaje. Los datos se analizaron mediante un ANOVA mixto. El Grupo 1 mejoró sus puntuaciones en motivación extrínseca después de la gamificación (t = -4.46, p <.001, d = -0.58) siendo superiores al Grupo 2 (t = 3.02, p =.034, d = 0.55). El Grupo 2 también mejoró sus puntuaciones en motivación extrínseca (t = -7.68, p <.001, d = -0.66) equiparando éstas a las del Grupo 1 en la tercera evaluación (t = -0.46, p =.997, d = -0.08). La gamificación incrementa la motivación orientada a la recompensa, pero no la motivación intrínseca de estudiantes universitarios.

Palabras clave: gamificación; estudiantes universitarios; motivación intrínseca; motivación extrínseca; estudio reequilibrado.

Introduction

After its success in secondary education, gamification practices have exponentially been used to engage undergraduate students in their learning process. Gamification, or game-based learning, is the pedagogical strategy of introducing game elements to non-gaming contexts (Deterding *et al.*, 2011). In higher education, gamification has been successful in increasing cognitive outcomes and engaged learning among medical students (Boeker *et al.*, 2013), in adding fun during learning among civil engineering students (Ebner & Holzinger, 2007), and in helping to increase motivation and academic performance in telecommunication engineering students (Burguillo, 2010), among others. On the other hand, the recent COVID-19 outbreak has speeded up the use of Information and Communications Technologies (ICT) in the classroom (Al-Halabi *et al.*, 2021; Pozo *et al.*,

2021) and helped to overcome the difficulties of distance-learning during the COVID-19 lockdowns (Amorós-Reche *et al.*, 2022; Carrillo & Flores, 2020). Bearing in mind that undergraduate students are familiarized with ICT, its combination with gamification is a straightforward sequence (Clark, Tanner-Smith, & Killingsworth, 2016).

One of the main aims of gamification is to motivate students in their learning process. Yet, at the university level, there is contradictory evidence about the impact of gamification on motivation. For instance, in language learning, Chen and Liu (2021) reported that game-based learning had a significant effect on motivation to learn, especially when students could play rather than design the game (but see Seaborn & Fels, 2015). Similarly, Burguillo (2010) reported that competition-based learning increased students' motivation to learn more about the content of the subject in a game theory tournament. Students in a game-based American History course were found to have performed significantly better and were more motivated compared to the students from a non-game-based course (Hess & Gunter, 2013). Yet gamification had no significant effect on motivation in a sample of 90 second-year students taking Software Engineering (Berkling & Thomas, 2013), nor in a sample of 204 college students from different academic backgrounds (Chen, Yang, Huang & Fu, 2017). Consequently, although it seems to be a well-known fact that gamification increases students' motivation, there is a dearth of detailed accounts of the impact of gamification on motivation. Our study aims to contribute to filling that gap.

Self-determination theory distinguishes between extrinsic and intrinsic types of motivation. Extrinsic motivation refers to doing an activity to achieve some outcome, such as a reward; whereas intrinsic motivation refers to doing an activity for its inherent satisfaction (Ryan & Deci, 2000). Extrinsic motivation has been related to operant conditioning, as the drive to do a specific task comes from external stimuli that influence the likelihood of performing such task. In other words, when extrinsically motivated, people behave in a certain way to obtain a reward or to avoid punishment. On the other hand, intrinsic motivation focuses not on an external outcome, but on the activity itself: the activity itself is rewarding.

This distinction is especially interesting in educational settings. Although both types of motivation foster performance gains (see Cerasoli, Nicklin & Ford, 2014 for an overview), extrinsic motivation is unlikely to motivate students in the long-term (Lee, McInerney, Liem, & Ortiga, 2010, as cited in Xu *et al.*, 2021). Conversely, intrinsically motivated students enjoy the learning process more and get higher grades than extrinsically motivated students (see Deci & Ryan, 2000 for a review). Noteworthy, curriculum seems to affect students' motivation by provoking a shift from intrinsic to extrinsic motivation at the start of school (Byman & Kansanen, 2008, as cited by Hess & Gunter, 2013).

If gamification is expected to increase students' motivation to learn, that should be through its impact on intrinsic motivation, that is, by means of the enjoyment of the activity of learning itself. As a result, its effects would likely be long-lasting. Conversely, if gamification influenced students' extrinsic motivation, then its effects would be reduced to the game context (e.g., competitiveness, avoiding punishment on the exam grades).

Despite the relevance of this distinction, studies on the effects of gamification are mixed. Analyzing the underlying motivational mechanisms of gamification in a controlled online experiment (but in a non-educational context), Mekler, Brühlmann, Tuch, and Opwis (2017) found that gamification elements (such as points, levels and leaderboards) did not enhance participants' intrinsic motivation. In line with this, Hanus and Fox (2015) found that in a gamified course, not only did students not show more intrinsic motivation, but they also showed less intrinsic motivation than those students in a non-gamified class.

However, a recent systematic review provides some evidence that gamification does improve intrinsic motivation (Xu *et al.*, 2021). More specifically, 59% of the articles analyzed showed positive evidence about such a relationship, while the remaining studies provided inconclusive results or no evidence about the effect of gamification on intrinsic motivation. Nevertheless, many of the articles included refer to qualitative studies that conflate intrinsic with extrinsic motivation. In addition, studies conducted on gamification face certain methodological issues such as the lack of a comparison group in a non-gamified context, the short period of time in which gamification is applied, its singular assessments, or the lack of validated measures (Dicheva, Dichev, Agre, & Angelova, 2015; Hamari, Koivisto, & Sarsa, 2014 as cited in Hanus & Fox, 2015; Seaborn & Fels, 2015).

Based on the literature reviewed, in this study we aimed to address the methodological challenges abovementioned and shed some light on the controversy about the impact of gamification on motivation, measuring both students' extrinsic and intrinsic motivation. To face this challenge, we implemented a gamification program using a counterbalanced design which allows us to assess the immediate and prolonged effect of gamification on motivation to learn with a well-established questionnaire.

Method

Participants

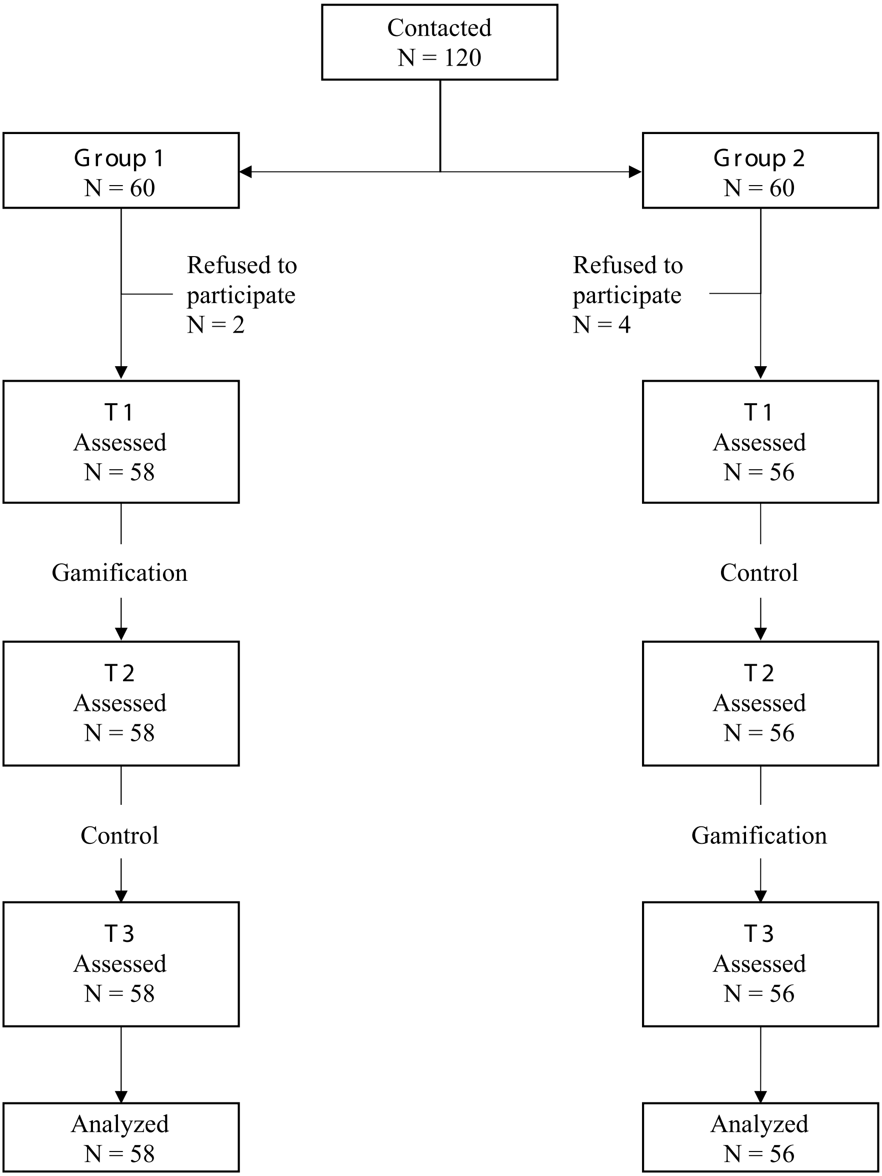
One hundred and twenty students attending an introductory course in a bachelor's degree in Psychology were invited to participate. The participants were enrolled in an introductory subject about the basic foundations of scientific Psychology. The first author informed at the start of the subject what participation would entail for participants. Information was also available during the semester on the online platform of the course, and a member of the research staff answered questions about the study. There was no economic or academic credit reward for participation in the study.

Design

We used a counterbalanced quasi-experimental design to test the effects of gamification based on ICT on motivation to learn. Groups were assigned by the administrative staff of the department to either Group 1 or Group 2. Both groups had the same size and were taught the same contents. Group 1 attended classes in the morning and Group 2 in the afternoon. Group assignation was performed based on students' preference and order of school enrolment. There were three assessment time-points: T1, T2, and T3. T1 took place on the first day of the semester, T2 before completing the midterm exam, and T3 at the end of the semester before the final exam. Both midterm and final exams consisted of 20 multiple choice questionnaires addressing the contents of the subject, and wrong responses were subtracted in the final exam score. Groups were assessed the same day by the first and the second author.

The gamification practice was implemented in Group 1 between T1 and T2, meanwhile Group 2 did not receive classes using gamification. Between T2 and T3 the gamification was switched, thus Group 2 received gamification while Group 1 did not. This order of gamification implementation allowed us to test the immediate effects of gamification on motivation to learn as well its sustained effects on Group 1. Figure 1 shows the flowchart of the study design.

Figure 1.
Gamification implementation flowchart.



Instruments

The instruments were selected to be fulfilled in a maximum of 8 minutes and be encompassed in the natural rhythm of the classroom and the environment prior to the exams. The instruments used were:

- A record form to collect age and sex. The aim of these variables was descriptive.
- The CEAP-48 scale was used to assess motivation to learn (Barca-Lozano, *et al.* 2005). The CEAP-48 is a 7-point Likert scale that assesses motivation to learn through 24 items that compute three indexes: deep motivation, surface motivation and performance motivation. Deep motivation encompasses satisfaction with the study behavior, the like for discovering new contents, and the personal satisfaction of learning new topics in-depth. In this regard, deep motivation alludes to the classic concept of intrinsic motivation. On the other hand, surface motivation reflects avoidance of academic failure through behaviors and attitudes toward learning such as studying only to pass the test, studying only what could be asked in a test, or being easily deflated by a bad test result. Finally, performance motivation overlaps with the classic concept of achievement motivation. High scores in this subscale would reflect a person that orients his best efforts to get good results in a test but without a true interest in learning. The CEAP-48 has shown appropriate psychometric properties assessing the motivation of undergraduate students (Barca-Lozano, *et al.* 2005).

Gamification

The subject where the gamification was implemented is composed of six units, the first three are tested in the midterm exam and the last three in the final exam. The gamification was implemented using *Kahoot!* (Versvik *et al.*, 2022). *Kahoot!* is an online-gamification software that allows users to create multiple choice questionnaires and record the students' performance. The authors created for each unit of the subject a quiz game consisting of 10 questions covering its contents. Thus, there were a total of 6 quiz games, three to be played by Group 1 and three by Group 2. Each quiz game was played in the week following the completion of a topic, therefore students were encouraged to keep updated and ponder about the contents of the topics.

To foster students' engagement in the gamification we rewarded them based on their performance in the quiz games. At the end of each block of three quiz games, participants were ranked according to their performance and created a ranking. The top three participants were allowed to ignore a penalization of a maximum of three errors in the subsequent exam (midterm or final exam), participants ranked fourth to sixth position could ignore two errors, and participants ranked position seven to ten could ignore one error from the final exam score. After each quizz, participants could consult their ranking.

Data analysis

Descriptive statistics were generated for both groups covering age, sex, and CEAP-48 questionnaire. Before conducting any analysis, assumptions of normality and homogeneity of variances were tested through visual inspection using raincloud forests (Allen *et al.*, 2021) and with Shapiro-Wilk and Levene tests, as recommended by Palmer *et al.* (2022). Sphericity assumption was assessed with Mauchly's test.

To test for group differences, we conducted a 3x2 mixed ANOVA for each CEAP-48 subscale setting group (Group 1, Group 2) as between subjects' factor and assessment time-points (T1, T2, T3) as the within subjects' factor. To analyze components of the interaction between Group and Time we used Bonferroni correction to control Type I errors across multiple comparisons. Following the recommendations of Gambara, Durán, and Santana (2021), eta squared was used for the effect size of the main effects, and Cohen's d was used to estimate effect size of the interaction analysis. If parametric assumptions were not met a bootstrapped ANOVA was performed at 2000 iterations.

Results

120 students were recruited but 6 refused to participate, thus the final sample comprised 114 students with a mean age of 18.47 years (*SD* = 0.5) and women as the most represented sex (76.32%). Table 1 shows the descriptive statistics of demographic features of the sample and CEAP-48 subscales comparison before gamification started.

Table 1

Demographic features and CEAP-48 scores of the sample before starting the gamification.

Variable	Total sample *N* = 114	Group 1 *N* = 58	Group 2 *N* = 56	Statistics
Age (*M, SD*)	18.47 (0.5)	18.58 (0.49)	18.53 (0.48)	t = 0.44 p =.841
Sex (*n, %)*				
Men	27 (23.68)	14 (24.14)	13 (23.21)	χ^2 = 0.013 p =.908
Women	87 (76.32)	44 (75.86)	43 (76.79)	
CEAP-48 (*M, SD*)				
Deep motivation	35.05 (12.5)	35.02 (12.32)	35.08 (12.82)	t = -0.03 p =.976
Surface motivation	27.24 (9.84)	27.1 (10.2)	27.37 (9.54)	t = -0.15 p =.884
Performance motivation	28.32 (9.99)	28.41 (9.27)	28.23 (10.79)	t = 0.09 p =.923

Normality assumption was not met in CEAP-48 Deep motivation at T1 (W(114) =.965, p =.004), T2 (W(114) =.972, p =.017), and T3 (W(114) =.97, p =.011), nor in CEAP-48 Performance motivation in T2 (W(114) =.977, p =.042). Mauchly's test revealed that sphericity assumption was not met in CAEP-48 Deep motivation (W(114, 2) =.36, p <.001), CEAP-48 Surface motivation (W(114, 2) =.623, p <.001), and CEAP-48 Performance motivation (W(114, 2) =.23, p <.001). Figure 2 displays the raincloud plots for the scores of the CEAP-48 subscales along the three assessment time-points. Considering these results, the mixed ANOVAs were bootstrapped to avoid inflate F-ratio. Table 2 displays the descriptive statistics of CEAP-48 scores across the three assessment time-points.

Figure 2.
Raincloud plots for CEAP-48 scores across the assessment points.

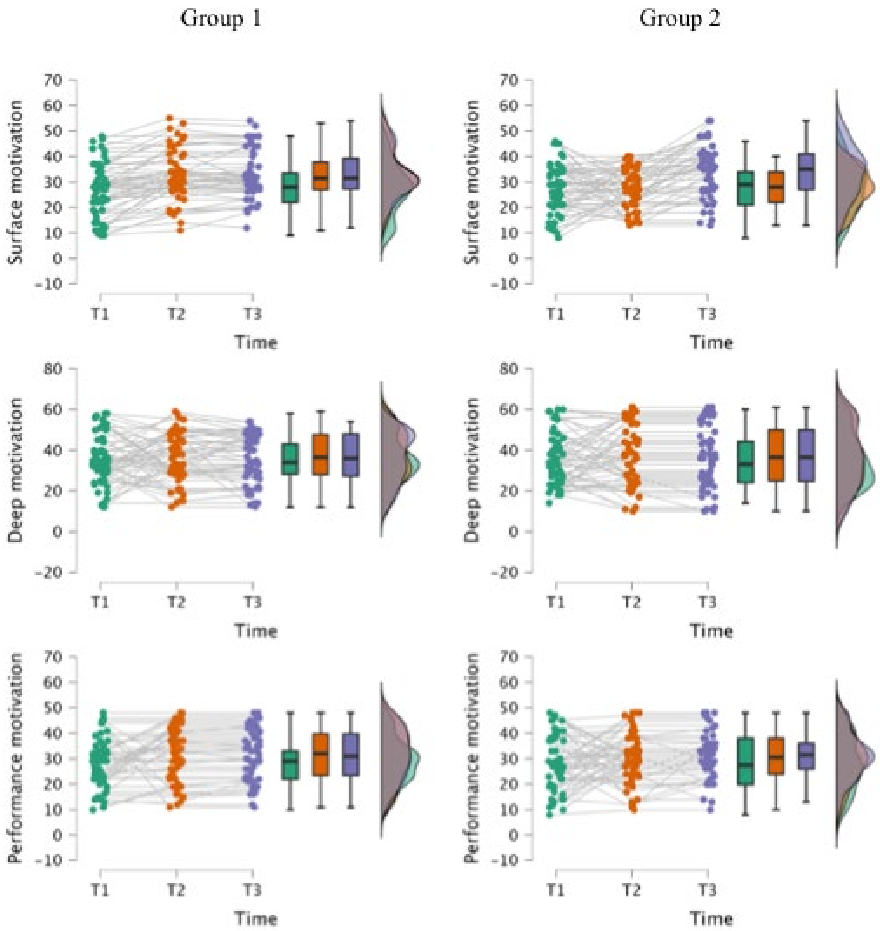


Table 2
Group scores on the CEAP-48 subscales assessing motivation to learn (Mean (SD)).

CEAP-48	Time	Group 1 (*N* = 58)	Group 2 (*N* = 56)
Deep motivation	T1	35 (12.3)	35.1 (12.8)
	T2	36.3 (12.2)	37 (14.8)
	T3	36.2 (12.2)	36.6 (15.3)
Surface motivation	T1	27.1 (10.2)	27.4 (9.54)
	T2	32.6 (9.66)	27.6 (7.57)
	T3	33 (9.28)	33.8 (10.1)
Performance motivation	T1	28.4 (9.27)	28.2 (10.8)
	T2	31.3 (10.1)	30.2 (9.81)
	T3	31.6 (9.82)	31.1 (9.03)

ANOVA on CEAP-48 Deep motivation scores found no statistically significant difference in any factor. Conversely, ANOVA on CEAP-48 Surface motivation scores found a statistically significant difference for Time factor associated to a medium effect size ($F = 26.45$, $p < .001$, $\eta^2 = .067$) and for the interaction of Group by Time associated to a small effect size ($F = 6.98$, $p = .001$, $\eta^2 = .018$). Also, on CEAP-48 Performance motivation we found a statistically significant difference for the Time factor ($F = 5.61$, $p = .004$, $\eta^2 = .017$). Table 3 displays detailed information of the main factor analyses for the three CEAP-48 subscales.

Table 3
ANOVA. Main factors analysis on the CEAP-48 subscales.

CEAP-48	Factor	F	p	η^2
Deep motivation	Group	0.04	.855	<.001
	Time	0.92	.401	.003
	Group x Time	0.02	.977	<.001
Surface motivation	Group	0.75	.389	.004
	Time	26.45	<.001	.067
	Group x Time	6.98	.001	.018
Performance motivation	Group	0.16	.687	.001
	Time	5.61	.004	.017
	Group x Time	0.11	.893	<.001

Interaction analyses of the between-subjects' component revealed no difference between groups at any assessment time-point in CEAP-48 Deep motivation and CEAP-48 Performance motivation. However, for CEAP-48 Surface motivation we found a statistically significant difference between groups in T2 associated to a medium effect size (t = 3.02, p =.034, d = 0.55), indicating that the scores of Group 1 were higher than Group 2. This statistically significant difference between groups was not detected in T3 after Group 2 finished gamification (t = -0.46, p =.997, d = -0.08). Table 4 shows detailed information of between-subjects' interaction component analyses.

Table 4.
ANOVA interaction analysis of the between subjects' component across the different assessment points.

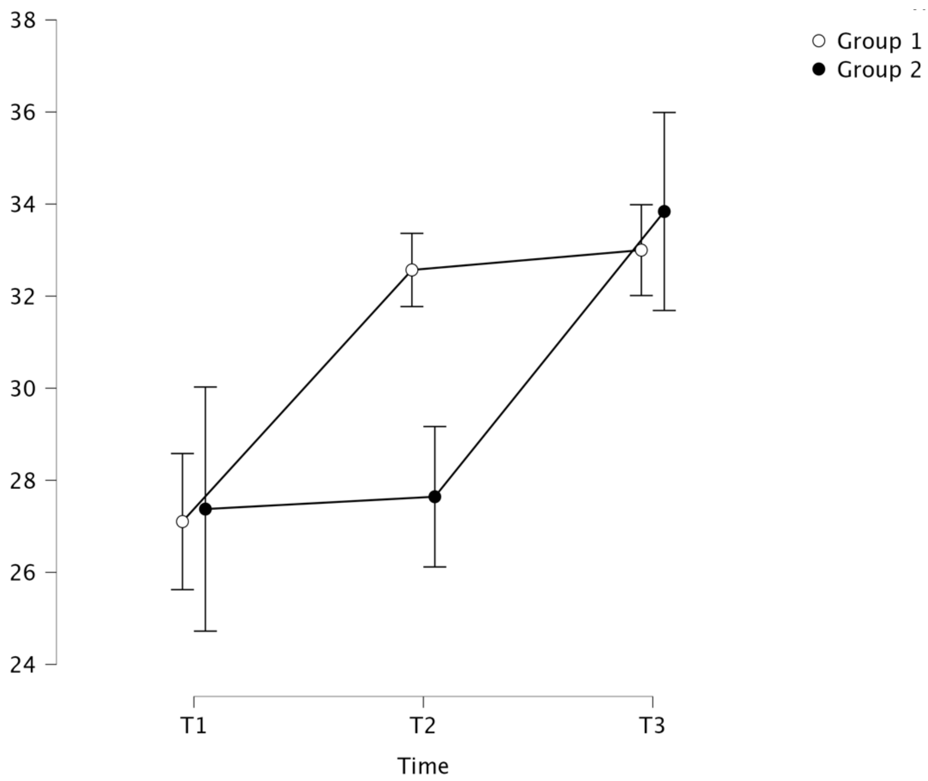
CEAP-48	T1			T2			T3		
	t	*p*	*d*	*t*	*p*	*d*	*t*	*p*	*d*
Deep motivation	-0.03	.999	-0.01	-0.79	.999	-0.05	-0.64	.999	-0.03
Surface motivation	-0.15	.999	-0.02	3.02	.034	0.55	-0.46	.997	-0.08
Performance motivation	0.09	.999	-0.02	0.57	.992	0.11	0.3	.999	0.05

Analysis of the within-subject's interaction component revealed that Group 1 scores on CEAP-48 Surface motivation subscale increased statistically significant between T1 and T2 (t = -4.46, p <.001, d = -0.58) and between T1 and T3 (t = -4.04, p <.001, d = -0.62) which suggests that the effect of gamification was sustained during T3 assessment time-point. Regarding Group 2, there were no differences between T1 and T2 (t = -0.21, p =.999, d = -0.03), but we found a statistically significant increase in the students' scores between T2 and T3 (t = -7.68, p <.001, d = -0.66) and T1 and T3 (t = -4.45, p <.001, d = -0.68). Table 5 shows detailed information of within-subjects' interaction component analyses. Figure 3 displays the evolution of CEAP-48 Surface motivation scores of both groups across the assessment time-points.

Table 5.
ANOVA interaction analysis. Comparison of assessment points across the groups.

CEAP-48	**Comparison**	**Group 1**			**Group 2**		
		t	*p*	*d*	*t*	*p*	*d*
Deep motivation	T1 vs T2	-0.64	0.988	-0.1	-0.89	.948	-0.14
	T2 vs T3	0.19	.999	0.01	0.44	.998	0.03
	T1 vs T3	-0.64	.987	-0.1	-0.69	.982	-0.11
Surface motivation	T1 vs T2	-4.46	<.001	-0.58	-0.21	.999	-0.03
	T2 vs T3	-0.544	.994	-0.05	-7.68	<.001	-0.66
	T1 vs T3	-4.04	<.001	-0.62	-4.45	<.001	-0.68
Performance motivation	T1 vs T2	-1.76	.493	-0.29	-1.19	.839	-0.2
	T2 vs T3	-0.63	.989	0.02	-1.76	.495	-0.08
	T1 vs T3	-2.03	.334	-0.32	-1.77	.488	-0.29

Figure 3.
Scores of the groups on CEAP-48 Surface motivation across the assessment points.



Discussion

The main findings of our study are the following ones. First, gamification delivered through ICT increases extrinsic motivation to learn in undergraduate students. Second, the effect of gamification on extrinsic motivation to learn is prolonged in time even though gamification stops being implemented in the classroom. Third, gamification does not improve intrinsic motivation nor motivation oriented to academic performance.

Our findings are in line with other studies showing a positive effect of gamification on motivation among undergraduate students (Burguillo, 2010; Chen & Liu, 2021; Hess & Gunter, 2013). Our contribution to the current debate is that the positive impact of gamification practices on motivation is due to its effects on extrinsic motivation. Furthermore, in our study the effect of gamification on extrinsic motivation was prolonged until the end of the semester, and it persisted even after a non-gamified phase. This contrasts with the results reported by Koivisto and Hamari (2014), who found that participants' perceived enjoyment, usefulness and playfulness in gamified, yet non-educational, contexts decreased overtime. Sánchez, Langer, and Kaur (2020) appealed to a novelty effect to explain how gamification's impact on academic performance may not be sustainable. However, because the effects of our gamification practice persisted after a non-gamified phase, the positive effects of gamification on extrinsic motivation found in our study cannot be due to a novelty effect. This is an important finding, suggesting not only that high intrinsic motivation might have long-term effects on performance (Lee *et al.*, 2010, cited in Xu *et al.*, 2021), but also a consistent boost in extrinsic motivation can also be achieved through gamification (as shown by the moderate effect obtained).

As for intrinsic motivation, our gamification practice did not affect intrinsic motivation. This contrasts with the results of the systematic review by Xu *et al.* (2021), whose conclusion was that some gamified experiences improve intrinsic motivation. However, as we mentioned in the introduction, many of the studies included in such review address qualitative data, conflate intrinsic and extrinsic motivation, and face certain methodological issues, such as the lack of a control group or the lack of validated measures (Dicheva *et al.*, 2015; Hamari *et al.*, 2014 as cited in Hanus & Fox, 2015; Seaborn & Fels, 2015). These were some of the challenges we tried to address in our study. Consequently, the negative results obtained regarding the relationship between gamification and intrinsic motivation might stem from addressing some of the previous issues, such as the way to assess intrinsic motivation. For instance, while Hess and Gunter (2013) found a positive effect of gamification on intrinsic motivation measured through interviews, in our study we used a standardized test.

The current data also contrasts with the results reported by Hanus and Fox (2015), who found a decline in students' intrinsic motivation in a gamified course. Yet, in our study, students' intrinsic motivation did not decrease after their participation in the gamification practice. According to Hanus and Fox (2015), students became less intrinsically motivated because the gamification applied had a strong focus on rewards: they used leaderboards and badges, which encouraged competition and social comparison. However, in our study, students were not less intrinsically motivated over the gamified course probably because the practice did not enforce high competition or extreme social comparison among students. For instance, they could only see the leaderboards twice, at the end of each block of three quizzes. Consequently, the use of the leaderboard in our gamification practice probably did not enforce high competition. This is in line with the results reported by Mekler *et al.* (2017) who found that game elements, such as levels, leaderboards and points, did not significantly affect intrinsic motivation, neither positively nor negatively. Anyway, the absence of evidence (in any direction, i.e., positive or negative) is not evidence of absence and, thus, more controlled studies about the possible relationship between gamification and intrinsic motivation are needed.

As we already flagged, our study illuminates on the incongruities found in empirical research and overcomes their methodological limitations (Dicheva *et al.*, 2015; Hamari *et al.*, 2014 as cited in Hanus & Fox, 2015; Seaborn & Fels, 2015). Consequently, the strengths of our study are the experimental design, which allowed us to assess the immediate and sustained effects of gamification on motivation to learn, the use of a robust questionnaire to assess the outcome variable, and the naturalistic environment in which the gamification was implemented. On the other hand, our study has the following limitations: the uneven sex distribution of the sample and its small size, even though it was enough to test the main hypothesis and run a control group, and the lack of a control intervention based on ICT. Apart from addressing the above-mentioned issues, further research should consider the effects of the devices used for the gamification practices, as they could impact engagement (Rodríguez Muñoz & Antino 2021). Secondly, it is worth exploring the influence on gamification of other variables that have been pointed as relevant for academic performance in undergraduate students (Hidalgo-Fuentes, Martínez-Álvarez, & Sospedra-Baeza 2021; López-Navarro *et al.* 2020; Moix *et al.* 2021). Finally, further studies should explore the effects of gamification on motivation to learn by focusing on those students who were intrinsically motivated to learn from the beginning of the course. According to cognitive evaluation theory, gamification could have negative effects on those students that were intrinsically motivated prior to a gamified intervention (Hanus & Fox, 2015).

In short, our study provides support for the use of gamification delivered through ICT to increase extrinsic motivation to learn in a university environment. However, gamification in undergraduate students could be a double-edged sword as it does not increase intrinsic motivation to learn.

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