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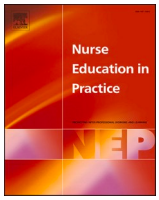

The effectiveness of an Instagram-based educational game in a Bachelor of Nursing course: An experimental study☆

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ABSTRACT

Background: Gamification is a novel educational method that adopts elements of games to motivate students using participatory learning. The objective of this study was to measure the effect of participation in an Instagram-based educational game on learning outcomes.
Method: Experimental design with 291 university students in a first-year course of the Bachelor of Nursing during the 2020–21 academic year.
Results: After ruling out pretest sensitization, we identified a positive effect of participation in the educational game. An average improvement of 0.62 points was observed in the final grade of the students belonging to the experimental groups.
Conclusion: Nursing undergraduate students participating an Instagram-based educational game had better learning outcomes than their counterparts who did not participate in the game.

1. Background

Gamification has become a major topic in studies of higher education, especially in the health professions. Most studies suggest that gamification improves learning outcomes (van Gaalen et al., 2021) and can complement plans of study (Alexander et al., 2019). Deterding et al. (2011) define gamification as "the use of game design elements in non-game contexts" (p. 1). Gamification encourages student participation, in addition to providing opportunities for learning actively, solving clinical problems and gaining experience in a low-risk environment (Akl et al., 2013). Malicki et al. (2020) conclude that gamification has a positive effect on creative thinking and student satisfaction (see also García-Viola et al., 2019; Sarker et al., 2021). In addition, when aligned with learning objectives, it has the ability to increase student motivation and engagement (Gallegos et al., 2017; Sarker et al., 2021). In this sense, in gamification, game elements are designed in alignment with theories of human motivation (Cook and Artino, 2016), which provide a wide range of techniques to involve students in novel ways.

Several studies carried out with university nursing students have analyzed the impact of gamification. Roche et al. (2018) used weekly or biweekly questions with first-year students, based on course objectives. The results show that participants receiving the intervention were significantly more likely to offer a correct answer than those who had not received it. Furthermore, students receiving the intervention had

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significantly better performance on the final exam. Similarly, the study by Wingo et al. (2019), carried out with first-semester students of a fundamental nursing skills course, showed positive results for the use of a game consisting of weekly questions that had to be answered both individually and as a team. Participants perceived that the game increased their knowledge retention and improved their exam preparedness. In this same line, Foss et al. used gamification for simple drug dosage calculation exercises. The average score of the experimental group was higher (Foss et al., 2013).

Digital gamification complements traditional teaching, offering new learning opportunities (Aklet al., 2013; Willig et al., 2021a). Social networking services are web-based platforms that allow people to build a profile and a network of connections with other users (Boyd and Ellison, 2007). They have been progressively integrated into the daily practices of millions of users, due to their accessibility and the evolution of mobile platforms and applications (Obar and Wildman, 2015).

The use of social networking services allows students to share academic content and discuss opinions and clinical experiences (Mesquita et al., 2017). Social networks serve as a channel for students to exchange resources. They can also enhance cooperative learning outcomes and produce positive learning experiences, as well as improving group dynamics (Kim et al., 2021). In addition, the use of social networking sites improves interactions between students and faculty (Chan and Leung, 2018).

Instagram is the fourth most-used social networking service (after Facebook, Youtube and WhatsApp). The largest share of users belongs to the 25–34 age group (31.7%), while the second largest share belongs to the 18–24 age group (30.2%) (Dixon, 2023).

During the academic year 2020–21, a gamification strategy was implemented in the first-year nursing course Dietetics and Nutrition at a Spanish university. We created a private Instagram channel exclusively for the participating students, where challenges related to the course material were presented. The story of the game was set on the International Space Station. Students had to provide diet and nutrition advice to the fictional astronauts (Rosa-Castillo et al., 2022).

Despite the growing interest in gamification and its high degree of acceptance among health professionals (Castro et al., 2019), especially nurses (Arruzza and Chau, 2021; Pet et al., 2019; San Martín-Rodríguez et al., 2020), there are still few experimental studies that evaluate the effects of gamification on students' learning outcomes (Gentry et al., 2019; Walker et al., 2022; Willig et al., 2021). Our objective was to use an experimental design to evaluate the effect on students' learning outcomes of participation in an Instagram-based educational game in a first-year course of the Bachelor of Nursing at a Spanish university.

2. Material and methods

2.1. Design

A Solomon four-group experimental study was conducted using two experimental groups and two control groups. The experimental groups received the intervention. Following the Solomon design, a pre-test was given to one experimental group and one control group, and a post-test was administered to all four groups. The effect of the intervention on learning outcomes was evaluated by comparing the experimental groups (pre-test and no pre-test) with the control groups (pre-test and no pre-test) in terms of post-test scores and final course grades.

Exposure to the pre-test could sensitize participants to the intervention, increasing or decreasing its effects. Having two groups that do not receive the pre-test makes it possible to isolate the possible effect of sensitization prior to the intervention. (Martella et al., 2013; Mcgahee & Tingen, n.d.).

2.2. Participants

The population consisted of all students enrolled in Dietetics and Nutrition, a first-year Bachelor of Nursing course at a Spanish university, during the 2020–21 academic year. We excluded students who were retaking the course because they had previously withdrawn or failed. We also excluded students who chose not to participate in the game. Of a total of 298 students, 291 met the inclusion criteria, agreed to participate in the study, and took all the tests assigned to their group.

2.3. Intervention

The course had four sections, two of which met in the morning (GA and GB) and two of which met in the afternoon (GC and GD). A morning group (GA_E) and an afternoon group (GC_E) were randomly selected as experimental groups, and the other two groups were selected as control groups (GB_C and GD_C). See Table 1.

Both the control and experimental groups received the standard course material in lecture-based classes. The experimental groups additionally received the gamified intervention (X).

The intervention (X) consisted of an Instagram-based educational game specifically designed to reinforce the course's learning objectives. The narrative of the game was set at the International Space Station over a four-week timeline (see Fig. 1 for screen shots from the game). Participants had to give diet and nutrition advice to help fictional astronauts choose the most appropriate diet given their individual needs. Participants responded to daily questions related to that week's course content, in addition to preparing a weekly infographic that applied the week's content to the space station setting. Participants could earn individual points for the daily challenges and group points for the weekly challenges. The maximum score that participants could obtain in the game was 1100 (20 points for each correct response to the daily individual challenge and 100 for each weekly group challenge). Individual scores were posted on a daily leaderboard and group scores were posted on a weekly progress bar. A pre-test was administered to the two afternoon groups, one experimental and one control (O1 and O3), and a post-test was administered to all groups (O5, O6, O2, O4).

2.4. Data collection

We collected the sociodemographic variables of age and sex. The pre-test and post-test consisted of an *ad hoc* questionnaire carried out on the course's Moodle platform. Each test contained twenty questions about diet and nutrition related to the basic food groups (grains and cereals; vegetables; fruits; dairy; meat, poultry and fish; oils and other fats). We recorded participants' responses for later analysis.

The pre-test was conducted before the first course session, and the post-test was conducted after the last course session. We additionally collected students' final course grades.

2.5. Data analysis

We analyzed the data using Microsoft Excel and the SPSS 26.0 statistics platform. We established that the intervention could be considered effective if the differences were statistically significant across groups as follows (significance level <0.05 for all cases):

Table 1
Solomon four-group experimental design.

Shift	Group	Pre-test	Intervention	Post-test
Morning (experimental)	GA_E	-	**X**	**O5 (n = 83)**
Morning (control)	GB_C	-	-	**O6 (n = 82)**
Afternoon (experimental)	GC_E	**O1 (n = 60)**	**X**	**O2 (n = 60)**
Afternoon (control)	GD_C	**O3 (n = 66)**	-	**O4 (n = 66)**
	Total	**n = 126**		**n = 291**

Note: G = group, subscript E = experimental, subscript C = control, X = application of intervention, O = measured outcome

Fig. 1. Screen captures from the Instagram game.

1. The GC_E post-test score is higher than the GC_E pre-test score (O2 >O1).
2. The GC_E post-test score is higher than the GD_C post-test score (O2 >O4).
3. The GA_E post-test score is higher than the GB_C post-test score (O5 >O6).
4. The GA_E post-test score is higher than the GD_C post-test score (O5 >O4).

Before starting the statistical analysis of Solomon's four-group design, the assumptions of normality, with the Kolmogorov-Smirnov test (K-S), and equality of variances with the Levene's test, were checked.

The Solomon four-group experiment has a 2 × 2 factorial design, meaning that, between groups, analysis of variance (ANOVA) can be conducted. To determine whether the pre-test caused sensitization, two comparisons were made. Among the control groups, we compared the post-test outcome (O6) of GB_C with the post-test outcome (O4) of GD_C. Among the experimental groups, we compared the post-test outcome (O5) of GA_E with the post-test outcome (O2) of GC_E. First, we evaluated the interactions among variables to determine the statistical significance of the overall effect of the pre-test and the intervention. Second, we ignored these interactions to determine only the influence of the pre-test and the intervention (independent variables) on the post-test (dependent variable).

In case we reject the sensitivity effect of the pretest, we will use the measures O1, O2, O3 and O4 to perform a 2 × 2 ANOVA of repeated measures. Significant differences between groups and temporal measures would indicate the effectiveness of treatment.

Subsequently, a two-group covariance analysis (ANCOVA) was also applied on the post-test scores, covarying for pre-test scores. We conducted an independent-samples t-test with the measurements of groups A and B. Subsequently, the p-values of each were transformed into a Z-score to estimate Z_{meta}.

The final statistical analysis was to perform an independent samples t-test and estimate a 95% confidence interval to quantify how much students improved with the intervention.

Fig. 2 is a flowchart depicting the analyses that were conducted to determine the effectiveness of the intervention.

During the 2019–20 academic year, we conducted a pilot intervention to test both the study method and the intervention itself to identify areas for improvement.

2.6. Ethical considerations

Students gave informed consent and were aware that they could revoke their decision to participate at any time. No course points or other rewards were provided in exchange for agreeing to participate.

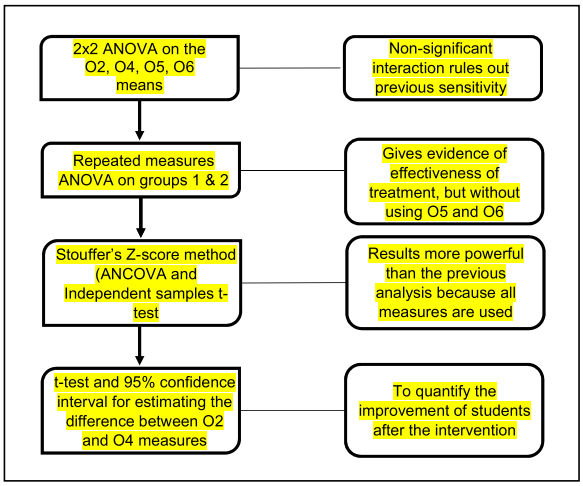

Fig. 2. Analyses conducted to determine the effectiveness of the intervention.

To ensure the participants' confidentiality, the Instagram channel was only open to the students participating in the game. The teacher responsible for the game was the only person who could accept members and was the only channel moderator. Participants created a profile using their student identification number and chose an avatar for use within the narrative of the game. Participants' real names did not appear on the channel.

The project was approved by the Bioethics Committee of the University of Barcelona (Institutional Review Board (IRB00003099).

3. Results

The mean age of the participants was 21.6 years (n = 291), and the vast majority were women (n = 267; 91.8%). Table 2 shows the median scores and standard deviation of the four groups.

Turning to multivariate analysis, we started with the testing of assumptions. The K-S test shows violation of normality in O2 (D (60) = .130, p = .03). However, the ANOVA is robust to slight deviations from normality (Blanca et al., 2017), so the analysis was continued. As for the equality of variance, the assumption is fulfilled (F (3, 287) = 1.865, p = .136).

There were not statistically significant differences depending on whether a pre-test was administered or not (F (1.287) = 0.279; p-value = 0.736) or in the interaction between the score (pre-test and post-test) and the group (experimental or control) (F (1.287) = 5.734; p-value = 0.127). These results allowed us to rule out pre-test sensitization. Next, we proceeded to determine whether the intervention had a significant effect, using two tests: ANOVA and Stouffer's Z-score method for metanalysis to determine the impact of the intervention on participants' final course grades.

Table 2
Median scores and standard deviation.

Grupo (n)	Pretest n = 126 Media (SD)	Postest n = 291 Media (SD)
Grupo A_E (83)	-	7,34 (1,55)- **O5**
Grupo B_C (82)	.	6.96 (1.48)- **O6**
Grupo C_E (60)	6.98 (1.71) - **O1**	7.68 (1.47)- **O2**
Grupo D_C (66)	5,91 (1.63) - **O3**	6.74 (1.76)- **O4**
Total	6.42 (1.75)	7.19 (1.59)

Note: n = number of group members, SD = standard deviation, subscript E = experimental, subscript C = control, O = measured outcome

3.1. Two-way ANOVA with scores O1, O2, O3 and O4

With this test, we measured the effect of the intervention through the interaction between the score (pre-test and post-test) and the group (experimental or control). Application of the intervention had a statistically significant effect on mean scores (F (1287) = 12,625; p-value < .001) with a small effect size ($\eta 2$ =.042). Despite not being the highest caliber test to determine the effect of the intervention (since O5 and O6 are ignored), this suggests that the intervention is effective. For the groups that received the gamified intervention (M=7.52. EE=0.132), the mean course grade was significantly higher (DM= 0.657, p-value <.001) than that of the control groups (M=6.85. EE=0.129).

3.2. Stouffer's Z-score method to determine the impact of the intervention on course grades

This meta-analysis combines two different statistical tests. First, an analysis of covariance across two groups (ANCOVA), controlling for the effect of the pre-test measure, showed statistically significant differences (MD = 0.572, $F_{(1.123)} = 4.214$; p-value = .042) between the post-test mean of GC_E (M = 7.49. EE=.198) and the post-test mean of GD_C (M=6.92. DT=.188). The second test was an independent-samples t-test with the mean scores of GA_E and GB_C, in which no significant differences were found (t (163) = 1587; sig.= .115). Subsequently, in the Z_{meta} estimate, the p-value obtained in the ANCOVA (p = 0.042, = Z_{p1}1.73) and in the independent-samples t-test for GA_E and GB_C (p = 0.115, = Z_{p2}1.21) were transformed into Z-values and combined, obtaining $Z_{meta} = \frac{1.73+1.21}{\sqrt{2}} = 2.08$. The gamified intervention was effective at a significance level of α = 0.05.

To finish the analysis, we quantified the impact of the gamified intervention on students' final grade using an independent-samples t-test, comparing the mean final grade of the experimental groups with that of the control groups. There was a statistically significant difference (T (289) = 3368; sig. < 0.001) between the control groups (M=6.86. SD=1.60) and the experimental groups (M=7.48. DT=1.58). On average, students in the experimental groups had final grades that were 0.62 points higher (0.26–0.98) than students in the control groups.

4. Discussion

The purpose of this research was to analyze the effectiveness of an Instagram-based game in a first-year course of the Bachelor of Nursing at a Spanish university. The results of our research coincide with those of other studies carried out with health sciences students (nursing, medicine, dentistry) at various levels (undergraduate, postgraduate and doctorate), which suggest that using a gamified activity as a complement to traditional teaching activities improves academic performance (Alexander et al., 2019; Gentry et al., 2019; Lamb et al., 2017; Neureiter et al., 2020; Pepin et al., 2019; van Gaalen et al., 2021; Walker et al., 2022; Willig et al., 2021b).

In many of these studies, games were hosted on Kahoot! or Kaizen-MSTP. In this format, questions based on the course content were posted periodically and students could respond to receive points and see the correct answers (Alexander et al., 2019; Bai et al., 2020; Sarker et al., 2021; Stacey and Susan, 2016; Subhash and Cudney, 2018; Szeto et al., 2021; Willig et al., 2021b; Wingo et al., 2019). In our study, students could also earn individual and group points that were posted on a daily and weekly leaderboard, and a statistically significantly higher mean final grade was also observed among those who received the gamified intervention, compared to those who did not. The game used in our research was based on a fictional narrative, setting it apart from the games described in the cited publications. A key difference between our study and similar ones is that we used the social networking service Instagram, with a narrative centered on the International Space Station. Further, the game went beyond simply having students answer questions in that they could create their own avatar, daily and weekly questions were set within the narrative, score boards allowed students to compare themselves to their peers, and direct interaction was encouraged. These elements made it more likely that students would participate and feel invested in the game, given that social networking services in general—and Instagram in particular—are widely used among first-year university students.

Our results coincide with those of other studies of gamification and knowledge acquisition among nursing students (Foss et al., 2013; Roche et al., 2018; Wingo et al., 2019) in that the groups that obtained the best course grades and the highest mean scores on the final exam were those that participated in the game.

Research has also been conducted with medical students who participated in gamified activities, showing positive learning outcomes. In the study by (Walker et al., 2022), students from a first-year microbiology course participated in a game based on a question bank for smartphones. The questions were presented in text, video, image, or audio format and were published daily. As in our study, students played individually and collectively, receiving points and feedback from responses, and in addition, scores could be viewed on an in-app leaderboard. The study design did not include control groups. However, the authors, like us, observed that students who had participated more in the game obtained higher scores on the exams. Similarly, Neureiter et al. (2020) used a Kahoot-based game before and after the standard training that second-year students receive on the systems of the human body. The participants' final exam score was higher compared to that of the previous year's students, who had not used Kahoot.

Alexander et al. (2019) describes the results of a gamification with resident otolaryngologists who answered daily questions online, individually and as a team, and whose scores were shown in classification tables. Participating students obtained a significantly higher mean score on the otolaryngology competence exam compared to the students of the subsequent academic year, during which gamification was not used. Likewise, Pepin et al. (2019) show that a gamified activity used with doctors during their doctoral research years promoted their retention of clinical knowledge. In other health sciences, el Tantawi et al. (2018), evaluated the effectiveness of gamification for the development of academic writing skills among dentistry students. As in our study, students' game scores were listed in a leaderboard that was updated as the different tasks were carried out, and the skills of the students who participated in the gamified activity increased.

Chen et al. (2017) designed a software system to provide online gamification of a chest X-ray module, evaluating the effect of feedback on the learning of medical students and first-year radiology resident physicians. The authors assessed participants' ability to differentiate between normal and abnormal chest X-rays. Students took an exam before and after participating in the gamified activity, showing significant improvement from one to the other. Similarly, our study showed that students who participated in the game obtained a higher score on the post-test than on the pre-test. Additionally, the study by Chen et al. (2017) concludes that the incorporation of mechanics traditionally implemented in video games—such as clearly defined objectives, tests, and time limitations—favors better outcomes among students.

The game employed in our study was hosted on an Instagram channel. Similarly, Lamb et al. (2017) used the social networking service Twitter to encourage learning among surgery residents. Using social networking services such as Instagram and Twitter may favor participation more than other approaches to gamification. These authors' results coincide with ours in that there was a significant increase in the mean final exam score. Notably, Lamb et al. (2017) did not use a control group and, therefore, it is possible that the most motivated students self-selected themselves as game participants.

Several literature reviews suggest that it is possible to improve learning outcomes in the education of health professionals through the use of gamification. However, most studies lacked control groups and therefore, despite encouraging results, it is unclear whether the positive

effects on academic performance can be attributed to the gamified interventions (Kuruca Ozdemir and Dinc, 2022; van Gaalen et al., 2021). Reed (2020) also highlights various methodological weaknesses of the reviewed articles, such as small sample sizes, convenience samples, and a lack of randomization and control groups. In this line, Gentry et al. (2019) proposes that future research on gamification use an experimental design. In answering this call, we used a Solomon four-group design to provide statistical rigor for the results obtained. Our experimental design allowed us to show a causal relationship between participation in our Instagram game and better course outcomes.

5. Limitations

The research was carried out in a short period of time within a single course and at a single university. Most of the participants were women, so it was not possible to analyze the results by gender.

6. Conclusions

Our Instagram-based educational game appears to have been effective in enhancing learning outcomes in the first-year course Dietetics and Nutrition of the Bachelor of Nursing. After a Solomon four-group experiment, participants in the experimental group showed significantly better learning outcomes than those in the control group, as measured by performance on the post-test and final course grades. Future experimental studies should examine longer-term effects on student learning, beyond post-test results and course grades.

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CRediT authorship contribution statement

Antonio Rosa-Castillo: Conceptualization, Methodology, Investigation, Writing – original draft, Writing – review & editing. **Oscar García-Pañella:** Conceptualization, Formal analysis. **Alba Roselló-Novella:** Methodology, Visualization. **Elena Maestre-Gonzalez:** Validation, Investigation. **Anna Pulpón-Segura:** Supervision, Writing – original draft, Writing – review & editing. **Teresa Icart-Isern**: Supervision, Writing – original draft, Writing – review & editing. **Montserrat Solà-Pola:** Supervision, Project administration, Writing – original draft, Writing – review &bediting. All authors meet the criteria for authorship and have approved the final manuscript.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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