Gamification in higher education: assessing its impact in on-line and traditional classes

Mohammed Awad†, Khouloud Salameh† & Aneesa Al Redhaei‡

American University of Ras Al Khaimah, Ras Al Khaimah, United Arab Emirates†
Ajman University, Ajman, United Arab Emirates‡

ABSTRACT: Student engagement and motivation impact on academic performance and are essential to guarantee the educational process's success. Gamification is one of the promising methods that has been utilised in the past to increase student engagement and motivation. This study involved undergraduate students undertaking an introductory computer programming course delivered entirely on-line in spring 2021, and also face-to-face (in person) in fall the same year. The study's aim was to compare the impact of gamification in on-line and traditional classes on student engagement, motivation and academic performance. The study's findings show a clear advantage of the use of gamification in a traditional classroom versus an on-line one as in-person classes for computer programming students seem more likely to foster an interactive environment that is more engaging and motivating for the students. Also, the students in the face-to-face class showed consistent improvement in their performance.

Keywords: Gamification, distance learning, on-line education, educational technology

INTRODUCTION

Due to the Covid-19 pandemic, universities and schools were forced to switch to on-line education suddenly. Many of these educational institutions were familiar with learning management systems (LMSs), which permitted a smooth transition to distance education via virtual classrooms. However, faculty struggled to keep their students engaged. In recent literature, gamification has been prescribed as a remedy to overcome this obstacle.

Gamification refers to …*the use of game design elements in non-game contexts* [1]. Points, leaderboards, rewards, badges, levels and feedback are examples of game elements that can be integrated into e-learning systems to be offered to students to support their learning [2].

Nowadays, in higher education environments, gamification is continuously applied [3]. According to the latest MarketsandMarkets report, the educational gamification market value is expected to reach 1.8 billion by 2023 [4]. Furthermore, gamification can significantly impact academic achievement and transform students into successful lifelong learners [5].

In a previous study, the authors investigated the impact of gamification on undergraduate student engagement, learning motivation and academic performance in an on-line computer programming course during the early stages of the pandemic [6]. This study found some correlations between the use of gamification and student engagement, learning motivation and academic performance. Upon resuming face-to-face (in-person) classes, this current study aims to further understand the effectiveness of gamification by comparing its effects on the traditional in-person learning environment versus its virtual counterpart.

The article is organised as follows: the *related work* section summarises recent studies, the *methodology* section outlines research methodology used by the authors, the *results* section presents the outcomes, the *discussion* section critiques this study's findings, and the last section presents *conclusions*.

RELATED WORK

The notion of gamification has gained significant traction since its inception over twenty years ago, permeating through diverse fields and application spaces, including educational environments [3][7].

Ibanez et al developed a gamified platform where students could achieve a learning goal and be recognised for their achievements [8]. They collected and analysed both qualitative and quantitative data, including logs, questionnaires, pre-tests and post-tests. Results showed that most students stayed interested in the learning activity and continued to work even after reaching the learning goal [8].

Wongso et al proposed a framework which focused on linking gamification and Web 2.0 social features with five steps: analysis, design, development, implementation and evaluation [9]. Strmečki et al incorporated some game elements such as badges, points, customisation, leaderboards, levels, challenges, quests and freedom to fail into the Moodle on-line learning platform [10]. In their study, 55 students were divided into experimental groups and control groups. On average, the experimental groups had earned more points than the control groups [10]. The *t*-test for independent samples indicated a statistically significant rate in favour of the gamified (experimental) group [10].

Barrio et al evaluated student motivation, attention, engagement and performance of gamified student response systems (SRSs) over non-gamified SRSs in classrooms [11]. Their study found that the gamified SRSs motivated students to attend classes, increased their attention and improved their performance. However, gamified SRSs did not enormously enhance student engagement over the non-gamified version of the SRS [11]. Although Barrio et al have studied SRSs in the classroom [11], the work presented in this article provides a directly comparable study for understanding virtual versus in-person effects.

The literature on gamification applications mostly shows positive results in the education field. Furthermore, a recent meta-analysis of Sailer and Homner supported the positive impact of gamification on cognitive, motivational and behavioural learning outcomes [12]. This finding is consistent with the results of review studies in related literature, which reported that gamification has a positive influence on engagement, attitude, enjoyment and motivation [4][13]. However, some findings indicate that the impact of educational games remains inconsistent and conflicting [14].

According to Zainuddin et al in their literature review, points, levels and leaderboards have contributed to the extrinsic motivation of students yet have not substantially enhanced the competence, desire for satisfaction and intrinsic motivation of students [15]. Furthermore, Toda et al analysed the concept of gamification in education and identified four adverse effects of gamified learning (i.e. indifference, loss of performance, undesired behaviour and declining impacts) [16].

To contribute to the current understanding of gamification, the investigation presented in this article sought to explore the relationships between student engagement, motivation and academic performance in a gamified instructional (on-line and traditional) process using Kahoot! and Nearpod.

Kahoot! is a well-known tool for gamified learning [17]. Using colourful graphics and audio, Kahoot! conjures the feelings of a game show with the instructor as host and students acting as competitors [18]. Moreover, in higher education, Kahoot! has gained worldwide acceptance. Since its launch in 2013, Kahoot! has become extremely popular worldwide, with more than 2.5 billion players [19].

Several research studies in the field of applied gamification in higher education found that utilising Kahoot! increased attendance, assignment completion, engagement and overall academic achievement [18]. Also, it minimises distractions and improves the quality of teaching and learning exceeding what is provided in traditional classrooms [20].

Nearpod is a Web-based tool that helps students to interact with instructors during class [21]. In 2020, students interacted with Nearpod 1.5 billion times across 19.5 million lessons taught [22]. Nearpod easily allows instructors to incorporate interactive polls, material simulations and collaborative environments in slideshow presentations [23]. While studies indicate Nearpod increased student interest and learning in both in-person [24] and on-line settings separately [25], it is less understood how specific learning mechanisms are affected by the shift in environment.

In light of the significance of these gamification tools in the literature in a traditional setting, this current study aimed at investigating and comparing the effectiveness of gamification in traditional and on-line environments. Additionally, in this article, the authors compared Kahoot! and Nearpod based on students' and faculty's viewpoints.

METHODOLOGY

This section defines the research methodology, including participants, design, conditions and procedure.

Participants

The data was gathered over two semesters. In spring 2021, 55 undergraduate students participated in the study undertaking an introductory computer programming course delivered entirely on-line. In fall 2021, 43 students participated in the study using the same course but in a face-to-face format. The course, Introduction to Computer Programming, is compulsory for all engineering students at the institution; therefore, the student demographic in both semesters was similar. Additionally, the course was delivered by the same instructors for both semesters. The majority of the students were familiar with Kahoot!, but had never used Nearpod before.

Experimental Design

The study's objective was to assess the difference in gamification impact between on-line and traditional brick-and-mortar classes. More specifically, the authors wanted to determine whether the use of gamification:

1. increases engagement (hypothesis 1),
2. enhances learning motivation (hypothesis 2),
3. improves the academic performance (hypothesis 3),

of the students in both on-line and in-person classes using a between-subjects study design. A pre-test, post-test, midterm, final examination performance and measurement questionnaires were used to examine these three hypotheses.

In this study, each semester was split into two halves. In the first half, instructors applied the conventional learning process without gamification. In contrast, the instructors used gamification platforms and involved students in a game-based activity in the second half. Each activity (Kahoot! or Nearpod) consisted of recap questions associated with each course chapter.

Gamification Condition

Under the gamification condition, both Kahoot! and Nearpod were used to design gamified instructional material for the course topic: common introductory programming concepts using the C++ language. Instructional material closely mirrored the course textbook and included recap questions for each chapter and an interactive leaderboard (i.e. time to climb). The questions included definitions of basic terms and code scripts with possible outputs to choose from. A discussion followed each game to explain and walk through the game's questions.

Procedure

The experiment was conducted over two sixteen-week semesters; each semester was split into two halves: an eight-week non-gamification and eight-week gamification period. Tests and surveys were administered at the beginning and end of each period. The tests were validated and examined by discipline specialists. In both surveys, the authors used semantically anchored five-point Likert statements: 1 (strongly disagree) to 5 (strongly agree).

RESULTS

Overall, most of the students reported positive feedback regarding the gamification experience. They also indicated that they would be pleased if more instructors utilised gamification. Furthermore, 60% of the students believe that gamification is more beneficial when conducted in traditional classrooms. This finding reflects the students' performance on the tests. Between Kahoot! and Nearpod, Kahoot! was the platform of choice for students, being preferred by 41.8% of students, followed by Nearpod with 31.6% and by 25.6% of indifferent voters.

Since the pre-survey and post-survey data have ordinal distributions and are not normally distributed, a nonparametric Mann-Whitney U test was used to examine the differences between the two independent groups (the in-person group and the on-line group). Additionally, the independent *t*-test was utilised to measure the significance of the differences between the normally distributed results of academic assessments. Figure 1 shows the mean rank of the three hypotheses, obtained from the Mann-Whitney U test, for the pre- and post-surveys in the on-line classes. As can be seen, by the end of the semester, the gamification's appeal and impact declined in students' opinion.

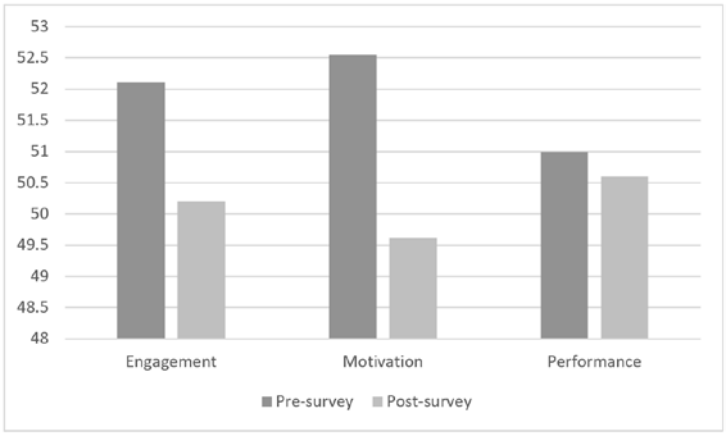

Figure 1: Hypotheses mean rank for on-line classes.

On the other hand, Figure 2 shows the same statistics, but for in-person classes. When comparing the results in both figures, one can see that the ratings of all hypotheses have increased in the in-person group while it decreased in the on-line group. In other words, the students in traditional classrooms had more appreciation for gamification at the end of the semester.

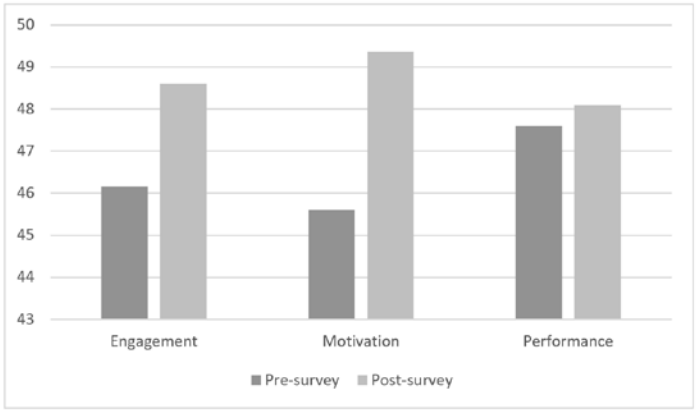

Figure 2: Hypotheses mean rank for in-person classes.

Table 1 below shows the assessment tools statistics for on-line classes and Table 2 shows the same statistics for in-person classes. At the eight week, prior to gamification, students were assessed via a pre-test and a midterm examination. Towards the end of the semester, after gamifying the classrooms, students' performance was assessed again via a post-test and the final examination. The pre- and post-tests scores are out of 15, while the midterm and the final examinations are out of 100. The students in the face-to-face class showed consistent improvement in their performance.

Table 1: *T*-test assessment statistics for on-line classes assessment tools.

Assessment tool	Mean	Standard deviation	Standard error mean
Pre-test (week 8)	7.38	2.89	0.39
Post-test (week 15)	6.96	2.88	0.39
Midterm examination (week 8)	72.38	18.62	2.51
Final examination (week 16)	68.42	23.54	3.17

As can be seen in Table 2, the results for the assessments held after the gamification phase were higher than those held earlier in the semester. On the other hand, the performance of on-line students declined on average as the course advanced (see Table 1).

Table 2: *T*-test assessment statistics for in-person classes assessment tools.

Assessment tool	Mean	Standard deviation	Standard error mean
Pre-test (week 8)	7.30	3.47	0.52
Post-test (week 15)	8.86	3.38	0.52
Midterm examination (week 8)	62.14	23.98	3.66
Final examination (week 16)	63.78	19.61	2.99

In this study, two faculty members oversaw the games. Table 3 presents their preferred platform of choice based on various criteria. In general, Kahoot! trumped Nearpod in almost every feature. Other surveyed faculty proposed other gaming platforms that could be integrated with the learning process, such as Raptivity, Edumundo and Alimus. Some students suggested alternative platforms, such as Quizizz.

Table 3: Instructors' platform evaluation.

Features	Instructor 1	Instructor 2
Creating questions	Kahoot!	Kahoot!
Discussing questions	Kahoot!	Kahoot!
Generating reports	Kahoot!	Kahoot!
Better Internet connection	Nearpod	Kahoot!
Which platform did you like more?	Kahoot!	Kahoot!

DISCUSSION

Effects of Gamification in the Traditional Environment

A consistent improvement in performance was seen in the face-to-face delivery mode. This is due to the undeniable impact of gamification in a traditional setting. In-person education is more likely to foster an interactive environment that is more engaging for students. Students were more focused during the lecture, looking forward to a final competitive game to demonstrate their skills to their friends and their instructors. Through gamification, students were able to have fun while learning, tying together the act of learning with the physical classroom, preserving the socially competitive learning experience.

Despite using the same gamification process as in the in-person environment, on-line delivery witnessed a decline in performance. As Table 1 shows, the grades of the post-test were lower than the pre-test and the final examination's average was less than the midterms. This is due to the challenging aspect of on-line teaching, where students feel less engaged, and lack of instant communication, which reduced the competitive component of the games. Sitting in front of a screen alone, students were found to be less motivated to achieve success.

The analysis of the on-line course showed that only 33% showed consistent improvement throughout the semester games. Furthermore, when on-line students were surveyed about their perceived effort, 46% of the students indicated that they put more effort during in-person classes compared to 24% who indicated that they put more effort during on-line classes. Thirty percent believe that they make the same effort regardless of the instruction mode. Furthermore, students enrolled in the in-person class were surveyed on the same question and the majority (56%) also agreed that they make more effort during face-to-face classes. This shows that students on campus are willing to engage more and better utilise gamification deeming it more valuable in traditional learning environments.

Nevertheless, in both the traditional and on-line environments, the majority of the students (95%) appreciated gamification and expressed an interest in using it for other courses, which demonstrates its positive impact on the students. Gladly, faculty share the same perspective. The authors surveyed 40 faculty and asked for their opinions regarding the three hypotheses. Most of the surveyed faculty agreed with the first two hypotheses. However, those who had never utilised gamification before were sceptical about its role in improving academic performance (H3). However, around 89% of the surveyed faculty showed willingness to integrate gamification into their courses.

CONCLUSIONS

While the majority agreed with the hypotheses about engagement, in-person classes benefitted more as confirmed by the incline in the self-evaluation and assessment tool scores. This was due to the social aspect of the classroom, providing all the competitive and learning elements to students, who would otherwise be easily distracted and not self-reliant in an on-line environment. Having demonstrated gamification's effectiveness in a face-to-face environment, this ongoing research focuses on investigating gamification's impact on student performance by varying the design, style, the expected outcome and the approach of the game questions.

ACKNOWLEDGMENTS

The authors would like to thank Dr Cesar Torres from the University of Texas at Arlington for his insightful input and feedback.

REFERENCES

1. Deterding, S., Dixon, D., Khaled, R. and Nacke, L., From game design elements to gamefulness: defining gamification. *Proc. 15th Inter. Academic MindTrek Conf.: Envisioning Future Media Environments*, Tampere, Finland, 9-15 (2011).
2. Hamari, J., Koivisto, J. and Sarsa, H., Does gamification work? A literature review of empirical studies on gamification. *Proc. 47th Hawaii Inter. Conf. on System Sciences*, Waikoloa, HI, USA, 3025-3034 (2014).
3. Legaki, N-Z., Xi, N., Hamari, J., Karpouzis, K. and Assimakopoulos, V., The effect of challenge-based gamification on learning: an experiment in the context of statistics education. *Inter. J. of Human-Computer Studies*, 144, 1-13 (2020).
4. MarketsandMarkets, Gamification in Education Market by Offering (Software and Services), Deployment Mode (Cloud and On-Premises), End User (Academic (K12 and Higher Education) and Corporate Training (SMEs and Large Enterprises)), and Region - Global Forecast to 2023, Rep. TC 6946, March (2019), 16 June 2022, https://www.marketsandmarkets.com/Market-Reports/gamification-education-market
5. Dicheva, D., Irwin, K., Dichev, C. and Talasila, S., A course gamification platform supporting student motivation and engagement. *Proc. Inter. Conf. on Web and Open Access to Learning*, Dubai, UAE, 1-4 (2014).
6. Al Redhaei, A., Awad, M. and Salameh, K., Assessing the impact of gamification in higher education: an experimental study using Kahoot! and Nearpod during COVID-19 pandemic. *Proc. Advances in Science and Engng. Technol. Inter. Conf.*, 1-6 (2022).
7. Groh, F., Gamification: state of the art definition and utilization. *Proc. 4th Seminar on Research Trends in Media Informatics*, Ulm, Germany, 39-46 (2012).
8. Ibanez, M-B., Di-Serio, A. and Delgado-Kloos, C., Gamification for engaging computer science students in learning activities: a case study. *IEEE Trans. on Learning Technologies*, 7, **3**, 291-301 (2014).
9. Wongso, O., Rosmansyah, Y. and Bandung, Y., Gamification framework model, based on social engagement in e-learning 2.0. *Proc. 2nd Inter. Conf. on Technol., Informatics, Manage., Engng, and Environ.*, Bandung, Indonesia, 10-14 (2014).
10. Strmečki, D., Bernik, A. and Radošević, D., Gamification in e-learning: introducing gamified design elements into e-learning systems. *J. of Computer Science*, 11, **12**, 1108-1117 (2015).

11. Barrio, C.M., Munoz-Organero, M. and Soriano, J.S., Can gamification improve the benefits of student response systems in learning? An experimental study. *IEEE Trans. on Emerging Topics in Computing*, 4, **3**, 429-438 (2016).
12. Sailer, M. and Homner, L., The gamification of learning: a meta-analysis. *Educational Psychology Review*, 32, **1**, 77-112 (2019).
13. Koivisto, J. and Hamari, J., The rise of motivational information systems: a review of gamification research. *Inter. J. of Infor. Manage.*, 45, 191-210 (2019).
14. Yu, Z., Gao, M. and Wang, L., The effect of educational games on learning outcomes, student motivation, engagement and satisfaction. *J. of Educational Computing Research*, 59, **3**, 522-546 (2021).
15. Zainuddin, Z., Chu, S.K.W., Shujahat, M. and Perera, C., The impact of gamification on learning and instruction: a systematic review of empirical evidence. *Educational Research Review*, 30, 1-23 (2020).
16. Toda, A.M., Valle, P.H.D. and Isotani, S., The dark side of gamification: an overview of negative effects of gamification in education. *Proc. Researcher Links Workshop: Higher Educ. for All*, 832, 143-156 (2018).
17. Wang, A.I. and Tahir, R., The effect of using Kahoot! for learning - a literature review. *Computers & Educ.*, 149, 1-22, May (2020).
18. Fotaris, P., Mastoras, T., Leinfellner, R. and Rosunally, Y., Climbing up the leaderboard: an empirical study of applying gamification techniques to a computer programming class. *The Electronic J. of e-Learning*, 14, **2**, 94-110 (2016).
19. Kahoot! Vick, I., Training Professionals from Three Countries Share their Kahoot!'ing Experience (10 September 2019), 16 June 2022, https://kahoot.com/blog/2019/09/10/top-training-tips-kahoot-around-world/.
20. Licorish, S.A., Owen, H.E., Daniel, B. and George, J.L., Students' perception of Kahoot!'s influence on teaching and learning. *Research and Practice in Technol. Enhanced Learning*, 13, **1**, 1-23 (2018).
21. Beranek, M., Bory, M. and Vacek, V., Platform for supporting student learning at unicorn college. *Inter. J. of Educ. and Learning Systems*, 1, 119-126 (2016).
22. Nearpodblog. The Nearpod Team, COVID-19's Lasting Impact on K-12 Classrooms, Edtech and Engagement (19 March 2021), 16 June 2022, https://nearpod.com/blog/covid-19-lasting-impact-k-12/
23. Sanmugam, M., Selvarajoo, A., Ramayah, B. and Lee, K., Use of Nearpod as interactive learning method. *Proc. 13th Inter. Technol., Educ. and Develop. Conf.*, Valencia, Spain, 8908-8915 (2019).
24. Shehata, N., Mitry, C., Shawki, M. and El-Helaly, M., Incorporating Nearpod in undergraduate financial accounting classes in Egypt. *Accounting Educ.*, 1-16 (2019).
25. Hakami, M., Using nearpod as a tool to promote active learning in higher education in a BYOD learning environment. *J. of Educ. and Learning*, 9, **1**, 61-67 (2020).

BIOGRAPHIES

Mohammed Awad joined the Department of Computer Science and Engineering in the School of Engineering at the American University of Ras Al Khaimah (AURAK) in the United Arab Emirates in 2013. Dr Awad earned his PhD in computer science from the University of Houston in the United States of America in 2011. Dr Awad's research interests include machine learning, e-learning, educational technologies, CubeSats, and security, more specifically E-voting and I-voting security.

Khouloud Salameh is an assistant professor in the Department of Computer Science and Engineering in the School of Engineering at the American University of Ras al Khaimah (AURAK) in the United Arab Emirates. Prior to joining AURAK, she was a postdoctoral researcher in computer science at the University of Pau & Pays de l'Adour, France. She obtained her PhD in computer science and in control engineering, automation and robotics from the University of the Basque Country in Spain in 2013. Her research interests include data representation and modelling, digital ecosystem optimisation and ontologies.

Aneesa Al Redhaei is a graduate student in artificial intelligence at Ajman University. She received her BSc degree in computer engineering from the American University of Ras Al Khaimah (AURAK) in the United Arab Emirates in 2021. She has been a recipient of the AURAK President Scholarship. Her research interests include data analysis, image processing and machine learning.