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GAMIFYING THE CURRICULUM: A STRATEGY FOR ENHANCING STUDENT ENGAGEMENT, ACTIVE AND COLLABORATIVE LEARNING, AND SATISFACTION

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Abstract

Gamification, the application of game elements in educational contexts, has demonstrated its efficacy in enhancing student motivation, fostering collaboration, and improving academic outcomes. This project investigated the impact of integrating gamified competition, student-created games, and an inclusive, collaborative environment on the academic performance, engagement, and satisfaction of Biomedical Engineering undergraduates. Three gamification activities (a digital escape room, an educational card game, and a digital snakes-and-ladders game) were developed and implemented for the 2024-2025 cohort. Enjoyment and perceptions of the games were assessed using a GAMEX-based survey, evaluating differences across games, genders, and ethnicities. The effectiveness of these techniques was further assessed through academic performance data, engagement metrics, and the End of Module Survey, which captured students' satisfaction. Overall, the gamification activities were positively received, with students reporting high levels of engagement, creativity, and enjoyment. The 2024-2025 cohort showed marked improvements in student satisfaction, attendance, and academic performance, underscoring the value of gamification as a pedagogical strategy in higher education.

Keywords: Gamification, digital game-based learning, student engagement, student satisfaction, active and collaborative learning.

1 INTRODUCTION

Gamification has gained significant traction in higher education as an innovative approach to enhance teaching and learning [1]. Defined as the integration of game elements and principles into non-gaming contexts [2], gamification seeks to transform traditional educational methods into dynamic, interactive experiences through the application of game mechanics such as competition, rewards, and challenges to engage and motivate learners. In university settings, where students often grapple with complex concepts and heavy workloads, gamification offers a creative means of fostering active participation and deeper understanding [3].

The adoption of gamification in classrooms is underpinned by its potential to address several pedagogical challenges. By incorporating elements such as collaboration, problem-solving, and feedback, gamification can increase student engagement, promote knowledge retention, and create a sense of accomplishment [4]. The inherent interactivity and enjoyment associated with gamified activities have been shown to positively influence students' attitudes towards learning. However, critics argue that the misuse or overemphasis of gamification could lead to extrinsic rather than intrinsic motivation, potentially undermining long-term educational outcomes [5]. Additionally, designing effective gamified experiences that cater to diverse learning needs requires significant effort, creativity, and alignment with learning objectives.

Several theories underpin the implementation of gamification in education, including the Self-Determination Theory, which highlights the importance of autonomy, competence, and relatedness in fostering intrinsic motivation [6]. Similarly, the Flow Theory posits that engaging activities create a state of flow, characterised by deep focus and enjoyment, which can be harnessed through well-designed gamification strategies [7]. These theories, alongside the Multi-Sensory Learning Approach [8] and Cognitive Engagement Framework [9], provide a foundation for understanding how gamification can enhance educational outcomes.

Among the diverse gamification strategies, breakout games or digital escape rooms have become increasingly popular in higher education [10]. These activities involve collaborative problem-solving within a thematic storyline, challenging students to apply theoretical knowledge to solve puzzles or unlock tasks within a set time. Breakout games promote critical thinking, teamwork, and engagement, aligning well with modern pedagogical approaches [10]. Similarly, in-class made games encourage students to explore and consolidate knowledge through interactive learning. These games foster peer collaboration and active discussion, particularly when students are involved in creating their own game content [11]. Competitive games add an element of excitement, combining knowledge-based tasks with gameplay to reinforce key concepts in a memorable way.

The integration of gamification in higher education is not merely a tool for engagement but also a strategy to enhance students' overall experience. Evidence from research suggests that well-designed gamified activities could have a positive impact on students' satisfaction and engagement. Furthermore, the alignment of gamified tasks with specific learning objectives has been demonstrated to enhance academic outcomes by reinforcing knowledge and promoting a deeper understanding of the course material [12].

This study examines the use of three gamification strategies in a university module to explore its influence on students' satisfaction, engagement, and academic performance. By analysing the implementation and reception of various gamification strategies, including breakout games, educational card games, and competitive activities, this research aims to contribute to the growing body of evidence supporting gamification as a valuable pedagogical tool in higher education.

2 METHODOLOGY

This research incorporated three gamification activities scheduled at key points during the first semester of the 2024-2025 academic year (weeks 1, 8, and 11). These activities were made available via Moodle to all students enrolled in the "Anatomy and Physiology for Engineers" module at Manchester Metropolitan University. The activities included: a) a collaborative problem-solving task in the form of a digital escape room; b) an interactive learning activity using educational Top Trumps cards created in class; and c) a competitive digital game of snakes and ladders.

The design of these activities was informed by a Multi-Sensory Approach to Learning, the Interaction and Engagement Theory of Learning, the Cognitive Orientation to Learning, and principles of Inclusivity in Teaching and Learning. Each activity was carefully developed to facilitate a comprehensive understanding of the module content, catering to the needs of a diverse student cohort. Additionally, all activities were aligned with the module's learning outcomes and assessments, incorporating exam-style exercises in a gamified context. This approach aimed to familiarise students with the format and complexity of examination questions while maintaining an engaging and supportive learning environment. Feedback for each activity was provided during and after the activities.

It was hypothesised that these gamified activities would improve module metrics, including academic performance (through enhanced knowledge retention), student satisfaction, and student engagement.

2.1 The Games

2.1.1 Week 1: Digital Escape Room Activity

The objective of this activity (Digital Escape Room link) was to evaluate students' knowledge following the lecture, foster engagement, and encourage active and collaborative learning while providing a more stimulating and dynamic educational experience for all participants. Students were organised into inclusive and diverse groups of 3-4 members to collaboratively solve problems within their teams while competing against other groups. The activity was conducted during a one-hour workshop and served as a formative assessment.

To enhance student engagement, the activity was introduced with an engaging video and scenario. In this scenario, a fictional hacker had infiltrated Manchester Metropolitan University's systems, threatening students' bank accounts and academic records. To resolve the situation, students were tasked with restoring the system's security code by solving a series of mysteries and problems hidden within locations across the university's new buildings. These buildings were selected to align with those used during the module, fostering a sense of belonging and preparing students for active engagement throughout the semester.

The introductory video was created using FlexClip, a free online video editing tool, and the digital escape room was developed using Genially, a free platform for creating interactive and animated content. Plans and images of the buildings were sourced from the Manchester Metropolitan University virtual tour to enhance the authenticity of the activity.

2.1.2 Week 8: Educational Top Trumps (card game)

This educational card game was modelled on Top Trumps, a popular game among children that, when tailored to a specific subject, aids in the deeper comprehension of new concepts. For this activity, students were organised into diverse groups of 3-4 participants to collaboratively create a set of 20 Educational Top Trumps cards on the designated topic, using a template with the characteristics to be assessed, and subsequently use these cards to reinforce their understanding. The activity focused on enhancing students' grasp of the cardiovascular system's anatomy and the haemodynamic of blood vessels.

Students were required to discuss the characteristics of various blood vessels and cardiovascular diseases (e.g., blood pressure, flow rate, Reynolds number, vessel diameter, etc.), assigning ratings on a scale from 1 to 5 for each attribute. These ratings were then used to play a competitive game following standard Top Trumps rules. A group discussion of the assigned ratings facilitated by academic staff enabled the identification of variations in understanding, while simultaneously fostering critical thinking and collaboration. This approach also enhanced knowledge retention and allowed students to engage with the material in an interactive manner.

Additionally, the completed card decks served as a valuable revision resource for students. The activity was conducted during a one-hour workshop, with 40 minutes allocated to card development and 20 minutes to gameplay.

2.1.3 Week 11: Digital Snakes and Ladders game

This one-hour formative assessment (Snakes and Ladders link) was designed to reinforce students' comprehension of the entire module and assess their knowledge at the end of the semester. Students were organised into inclusive and diverse groups of 3-4 members to engage collaboratively within their teams while competing against other groups.

The activity comprised a range of tasks, including trivia-style questions, miming, drawing, and calculation exercises, all of which encompassed the module's core content and key components of the final examination. The game was developed using the Genially platform and made accessible via Moodle to all students enrolled in the module during the 2024-2025 academic year.

2.2 Participants and Ethical Consideration

Two student groups were included in this study: a control group comprising students enrolled in the module "Anatomy and Physiology for Engineers" during the 2023-2024 academic year, previous to running these activities, and a test group consisting of students enrolled in the same module during the 2024-2025 academic year. The module was delivered by the same instructor using identical materials and content in both academic years. The sole difference in delivery was the integration of the previously described educational games for the 2024-2025 cohort. The control group included 10 students (6 female and 4 male), with a demographic breakdown of 6 BAME (Black, Asian, and Minority Ethnic) students and 4 non-BAME students. The test group consisted of 15 students (7 female and 8 male), with 7 BAME and 8 non-BAME students. All students belong to the same age range 20-25 years old.

The present study is a pilot study conducted using data collected during the 2023-2024 and 2024-2025 academic years. The full project spans five years (2023-2024 to 2028-2029) and will assess academic performance, student engagement, and student satisfaction over this period.

All participants were fully informed of the study's objectives and provided written, signed consent prior to participation. The research adhered to the ethical standards set forth in the Declaration of Helsinki and received ethical approval from the Manchester Metropolitan University Ethics Committee (Approval Number: 70639). The surveys used in this study were anonymous and voluntary, containing no identifiable questions, thereby ensuring full compliance with GDPR regulations. No incentives, rewards, or payments were offered to participants.

2.3 Data Collection

2.3.1 Comparison between Gamification Strategies

An anonymous Project Survey, based on the GAMEX model, was administered to the 2024-2025 cohort following each gamification activity. The survey included demographic and diversity monitoring questions, such as gender and ethnicity (BAME/non-BAME), alongside 26 statements rated on a 5-point Likert scale. At the conclusion of the project survey, students were given the opportunity to provide open-ended feedback on their experience with the game.

The survey aimed to evaluate dimensions such as enjoyment, absorption, creative thinking, activation, absence of negative affect, and dominance, with responses analysed in relation to gender and BAME/non-BAME classifications. Additionally, the survey facilitated the collection of feedback on each gamification strategy employed. The complete Project Survey is provided in Appendix a).

2.3.2 Effectiveness of Gamification Strategies on Students' Satisfaction and Engagement and Academic Performance

The effectiveness of the implemented techniques was evaluated using institutional data, including academic performance metrics (including attainment differentials), student engagement, and the results of the End of Module Survey to evaluate students' satisfaction. The survey consisted of seven Likert scale questions to assess student satisfaction, as well as open-ended questions designed to capture best practices within the module and areas for improvement. The complete survey is provided in Appendix b).

All data were collected from the university's student records platforms, including PowerBI (Microsoft), Presto (SIMAC IDS), and Tardis.

2.4 Data Analysis

Module performance, student engagement, student satisfaction, and the results from the Project Survey were analysed using Microsoft Excel for graphical representation and SPSS 29.0.1.0 for statistical analysis. Frequency distributions, as well as descriptive and exploratory statistical analyses, were conducted for both the Project Survey and the End-of-Module Survey.

Furthermore, a three-way Analysis of Variance (ANOVA) was performed to examine the effects of the games, gender and ethnicity on the survey items in the Project Survey. And two-way ANOVA were performed to examine the effects of gender and ethnicity on academic results and students' engagement.

To assess the reliability of each construct within the project survey, the internal consistency coefficient was calculated using Cronbach's Alpha [13].

3 RESULTS

This section presents an evaluation of the overall acceptance of the gamification activities, as well as an analysis of each specific game in relation to gender and ethnicity. Additionally, it examines students' satisfaction, engagement, and performance across the 2023-2024 and 2024-2025 cohorts.

3.1 Comparison between Gamification Strategies: Project Survey

Quantitative and qualitative data were analysed to evaluate students' perception of the gamification activities and to identify which games were most positively received.

3.1.1 Quantitative Assessment

In general, the students received positively the games replying that the experience was pleasant and fun, at the same time that enhanced their creativity, felt jittery and excited, and absent of negative feelings. However, the students felt indifferent in terms of dominance and, with the exception of the escape room activity, the students did not forget where they were or lost track of time. A summary with the frequency of the answers for each construct for the three games is presented in Figure 1.

No significant differences were identified between the gamified activities for any of the constructs ($P > 0.05$), with the exception of the construct "Absorption," where the escape room activity demonstrated a notable advantage in fostering immersion, as participants reported forgetting their surroundings and losing track of time, possibly due to the engaging video and digital media provided. Significant differences were observed in relation to gender and ethnicity for the escape room, with the activity being more enjoyable for female students compared to male students and for BAME students compared to non-BAME students. For the other gamified activities, no significant differences were found across genders or ethnicities for any of the constructs.

The reliability of each construct was assessed using Cronbach's Alpha. All constructs, with the exception of "Dominance," demonstrated excellent ($\alpha > 0.9$) or good ($\alpha > 0.8$) reliability. Specifically, the "Enjoyment" construct achieved a Cronbach's Alpha of 0.954, "Absorption" registered 0.924, and "Creative Thinking," "Activation," and "Absence of Negative Affect" recorded values of 0.81, 0.854, and 0.810, respectively. However, the "Dominance" construct exhibited a non-reliable Cronbach's Alpha of 0.521, likely due to a significant proportion of students selecting "Neither agree nor disagree" for the related items.

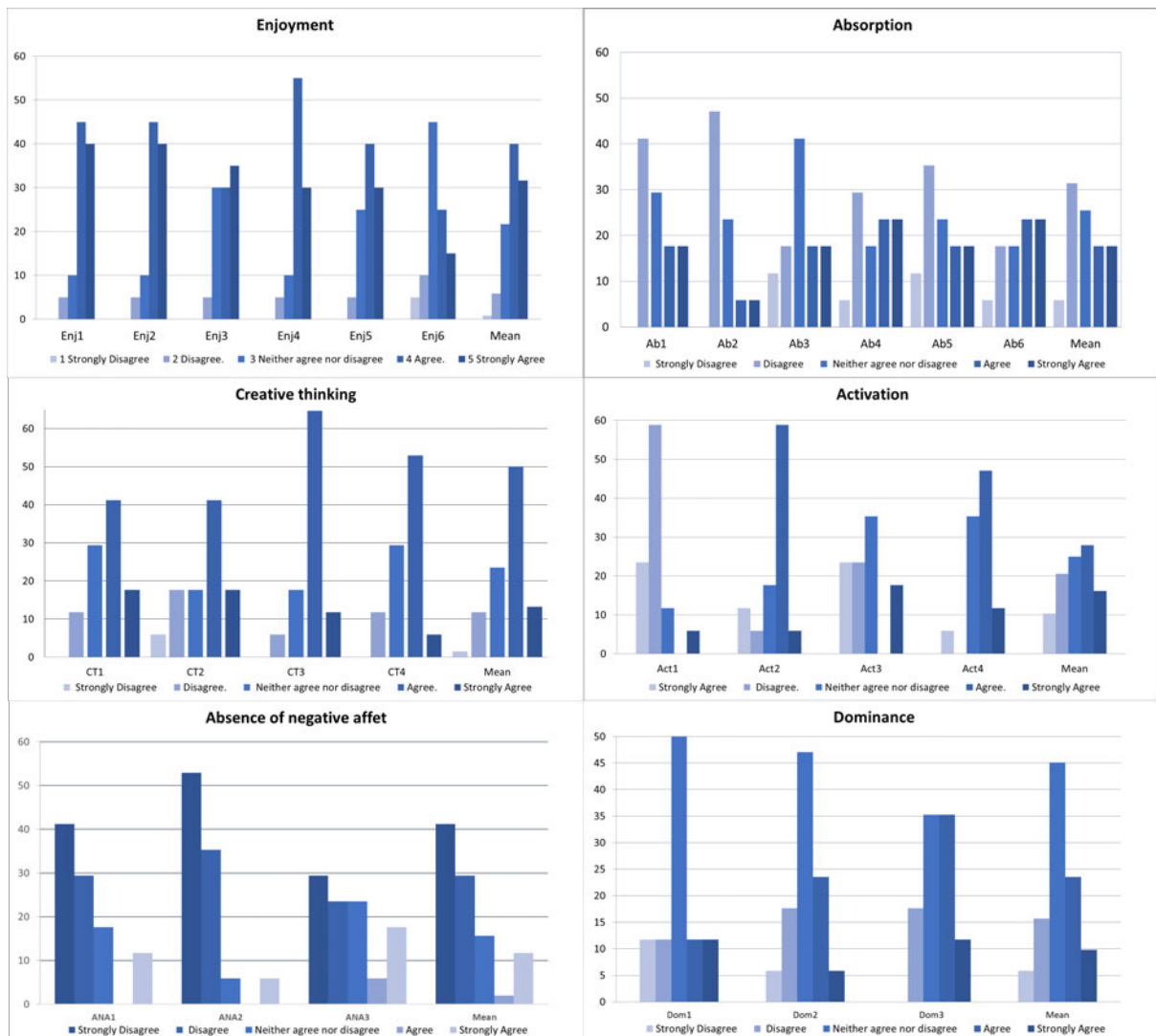


Figure 1. Frequency (%) of Responses for each Construct from the GAMEX Mode for the 3 Games.

3.1.2 Qualitative Assessment

Open feedback for the different games is presented in Table 1.

Table 1. Open Feedback for the Different Games.

<i>Digital Escape Room</i>	<i>Educational Top Trumps</i>	<i>Digital Snakes and Ladders game</i>
It was a great first-time experience that was pretty interactive. However, more instructions would be great as I heard about such a game for the first-time. I enjoyed the new aspect though.	Beautiful experience.	More questions please
It was a lot of fun and I would play the game in my own time!!	Good	I think a change in the answers would be better instead of the same questions on the same box.
It was enjoyable, and I enjoyed playing the game. Maybe add a bit more guidance in some of the rounds to explain what to do.	It was interesting creating the game more than playing it. Made me research more about the vessels in the body.	
It was very interactive, I lost track of time and my surroundings. It created an environment similar to secondary school where I could retain the most information in an easy way		

The gamification activities were well-received overall, each offering unique benefits. The Digital Escape Room stood out for its immersive and interactive nature, effectively engaging students and aiding knowledge retention, though clearer instructions were suggested. The Educational Top Trumps activity was praised for promoting in-depth research during card creation. The Digital Snakes and Ladders game was enjoyed for its replayability and competitive aspect, with suggestions to diversify questions for sustained interest. While all activities enhanced learning, the Escape Room and Snakes and Ladders excelled in engagement, and Top Trumps particularly deepened content understanding.

3.2 Students' Satisfaction: End of the Module Survey

3.2.1 Quantitative Assessment

A comparison of the End of the Module Survey between 2023-2024 and 2024-2025 academic years can be found in Figure 2.

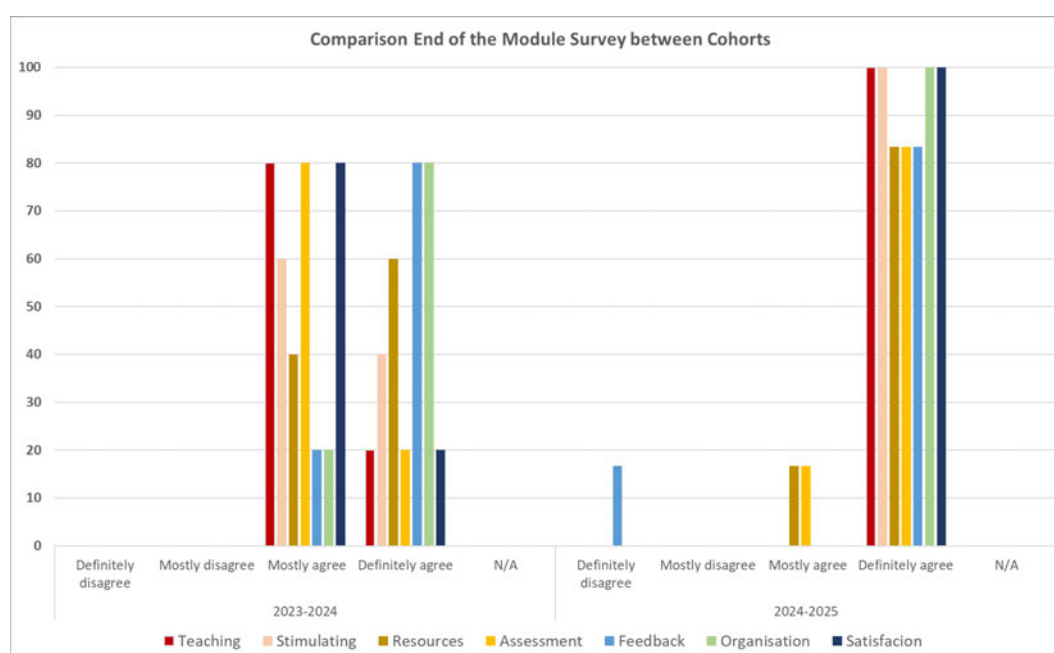


Figure 2. Frequency (%) of Responses for the End of the Module Survey during 2023-2024 and 2024-2025.

A marked improvement was observed across all constructs, with 100% of students responding "definitely agree" to the statements: "The teaching staff on this module are good at explaining things," "I find this module intellectually stimulating and challenging," "This module is well organised," and "Overall, I am satisfied with the quality of this module." Additionally, 83.3% of students responded "definitely agree" to the statements: "I have access to the learning resources I need for this module," "The assessment brief and marking criteria are clear," and "The feedback on this module has helped me improve my work.". This reflects an enhancement in students' satisfaction across multiple areas within the 2024–2025 cohort.

3.2.2 Qualitative Assessment

Both cohorts provided open feedback regarding good practises and ways to improve in the End of the Module Survey. Table 2 shows all gathered feedback.

Table 2. Comparative of Module Feedback between Cohorts.

	<i>What are the best things about this module?</i>	<i>How could this module be improved?</i>
2024-2025	I like the practical learning aspect of the module that was introduced as I haven't done this method of learning since secondary school, and I think it's very effective when trying to retain knowledge in a fun environment	Maybe have condensed lecture notes with key information
	ERC is an amazing teacher, she makes the lectures fun and the workshops are very engaging which helps make what we learned in the lectures more interesting!	As we learn so much from the lecture slides it can sometimes be a little overwhelming with the amount of content, maybe have a slide or two with the most important information like what we need for the exams for example. But other than that, it's an amazing module.
	The workshops are very interactive and interest me in the Anatomy of the body and how it is affected and used in the real world.	Although the Anatomy and Physiology part of the module was very interesting, a bit of how it is related to the Biomedical Engineering field would be appreciated.
	Human body analogy.	I wish there were more exercise.
	I have discovered what I want to do through this module.	Nothing
	I enjoyed the workshop activities and doing the different experiments in the range of labs. The practical activities were really engaging and helpful to understand the applications of the topic.	N / A
2023-2024	The topics are interesting and engaging, comfortable to ask for help and comprehensive unit.	More revision and programming.
	Learn anatomy of the human body, understanding some engineering concepts that relate to the human body and workshops.	More workshops involving MATLAB and coding.
	Applying anatomy to engineering concepts.	More lab workshops.

Although in general comments from both cohorts were positive, for the 2024–2025 cohort, students particularly appreciated the practical learning aspect of the module, noting that it helped reinforce knowledge in an engaging, enjoyable environment. This feedback highlights the effectiveness of hands-on learning to retain knowledge in a fun environment. Students also expressed positive feedback regarding the teaching style, with one commenting on the enthusiasm and engaging nature of the instructor. The interactive workshops were also valued for their ability to make complex topics, such as anatomy, more accessible and interesting.

3.3 Students' Engagement

The engagement during the module was measure by the attendance rate. The attendance rate for students during the 2023-2024 academic year was $56.8 \pm 9.2\%$, whereas the attendance rate for students in the 2024-2025 academic year was $73.3 \pm 14.4\%$, reflecting an improvement of 16.5%. It is noteworthy that overall attendance rates are gradually recovering following the decline experienced during the COVID-19 pandemic; however, the recovery observed in this module surpasses the general

trend. No significant differences were observed in terms of gender or ethnicity concerning student engagement in either cohort ($P > 0.05$).

3.4 Academic Performance

During the 2023-2024 academic year, the mean examination score at the first sitting was 60.0 ± 19.4 . The mean scores for female students and male students were 72.5 ± 11.3 and 42.75 ± 14.7 , respectively. For BAME students, the mean score was 61.5 ± 24.3 , while non-BAME students achieved a mean score of 59.25 ± 7.2 . No significant differences were observed between BAME and non-BAME students ($P > 0.05$); however, a statistically significant difference was found between female and male students ($P < 0.05$). All 10 students enrolled in the 2023–2024 academic year participated in the examination at the first sitting.

For the 2024–2025 cohort, the exam results were 68.3 ± 20.4 overall, 75.1 ± 20.8 for female students, 62.4 ± 20.4 for male students, 71.9 ± 20.9 for BAME students, and 65.3 ± 21.1 for non-BAME students. No significant differences were observed between BAME and non-BAME students or between female and male students ($P > 0.05$). All 15 students enrolled in the 2024–2025 academic year attended the exam at the first sitting.

Overall, academic performance improved by 8.3 points in the 2024–2025 academic year, significantly reducing the gender gap compared to the previous year and demonstrating strong performance among both BAME and non-BAME students.

4 CONCLUSIONS

Three gamification strategies were evaluated in this study: a collaborative problem-solving task in the form of a digital escape room; an interactive learning activity using educational Top Trumps cards created in class; and a competitive digital game of snakes and ladders. The three gamification activities were generally well-received by students, with positive feedback highlighting their engagement, creativity, and enjoyment. Notably, the Digital Escape Room demonstrated superior absorption, fostering a sense of immersion and aiding knowledge retention, particularly among female and BAME students. While all activities contributed to learning, Top Trumps enhanced content understanding through research, and Snakes and Ladders excelled in engagement and replayability. Improvements in student satisfaction were evident in the 2024-2025 cohort, alongside significant increased attendance (16.5%) and academic performance (increment of 8.3 points out of 100, reducing gender gap). These findings underscore the potential of gamification to enhance engagement, satisfaction, and learning outcomes in higher education.

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APPENDICES

a) Project Survey based on GAMEX Model

1. Gender: Female / Male / Prefer not to say

2. Ethnicity: BAME / No BAME

3. *Enjoyment*

Enj1 Playing the game was fun.

Enj2 I liked playing the game.

Enj3 I enjoyed playing the game very much.

Enj4 My game experience was pleasurable.

Enj5 I think playing the game is very entertaining.

Enj6 I would play this game for its own sake, not only when being asked to.

4. *Absorption*

Ab1 Playing the game made me forget where I am.

Ab2 I forgot about my immediate surroundings while I played the game.

Ab3 After playing the game, I felt like coming back to the “real world” after a journey.

Ab4 Playing the game “got me away from it all.”

Ab5 While playing the game I was completely oblivious to everything around me.

Ab6 While playing the game I lost track of time.

5. Creative thinking

- CT1 Playing the game sparked my imagination.
- CT2 While playing the game I felt creative.
- CT3 While playing the game I felt that I could explore things.
- CT4 While playing the game I felt adventurous.

6. Activation

- Act1 While playing the game I felt activated.
- Act2 While playing the game I felt jittery.
- Act3 While playing the game I felt frenzied.
- Act4 While playing the game I felt excited.

7. Absence of negative affect

- ANA1 While playing the game I felt upset.
- ANA2 While playing the game I felt hostile.
- ANA3 While playing the game I felt frustrated.

8. Dominance

- Dom1 While playing the game I felt dominant.
- Dom2 While playing the game I felt influential.
- Dom3 While playing the game I felt autonomous.

9. Feedback: Open

b) End of the Module Survey

1. Teaching: The teaching staff on this module are good at explaining things.
2. Stimulating: I find this module intellectually stimulating and challenging.
3. Resources: I have access to the learning resources I need for this module.
4. Assessment: The assessment brief and marking criteria are clear.
5. Feedback: The feedback on this module has helped me improve my work.
6. Organisation: This module is well organised.
7. Satisfaction: Overall, I am satisfied with the quality of this module.
8. What are the best things about this module? Open
9. How could this module be improved? Open