Gamification-Based Learning Design to Improve Student Engagement and Conceptual Understanding in Higher Education

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Article Info

ABSTRACT

The integration of gamification in education has gained increasing attention as a strategy to enhance student engagement and learning outcomes. This study investigates the impact of a gamification-based learning design on improving student engagement and conceptual understanding in higher education. A quasi-experimental research method was employed involving 80 undergraduate students enrolled in a computer science course. The experimental group participated in a gamified learning environment incorporating elements such as points, badges, leaderboards, and mission-based tasks, while the control group followed traditional instructional methods. Quantitative data from pre-test and post-test assessments revealed that the experimental group showed significantly higher improvement in conceptual understanding. In addition, results from the Student Course Engagement Questionnaire (SCEQ) indicated increased levels of behavioral, emotional, and cognitive engagement among gamified participants. Qualitative feedback through interviews and focus groups supported these findings, highlighting enhanced motivation, participation, and collaborative learning experiences. The results suggest that gamification, when properly implemented, can create an engaging and effective learning environment. However, thoughtful design is crucial to ensure that gamified elements support learning goals without inducing unnecessary stress or competition. This study contributes to the growing body of evidence supporting gamification as a transformative tool in higher education.

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1. INTRODUCTION

The landscape of higher education is constantly evolving, driven by technological breakthroughs and changing learner expectations. In recent years, gamification—the application of game design elements in non-game contexts—has emerged as a promising pedagogical approach to enhance student motivation and engagement [1], [2]. By integrating elements such as points, badges, leaderboards, and interactive challenges into course design, instructors seek to increase student participation and persistence in learning tasks [3], [4]. Gamification draws on theories of intrinsic motivation and self-determination [5], providing a structured environment where learners can experience competence, autonomy, and relatedness, all of which are essential

for meaningful engagement [6]. Despite the growing adoption of gamification in educational settings, empirical studies on its impact in higher education, particularly concerning conceptual understanding and deeper cognitive engagement, remain limited [7], [8]. This paper addresses that gap by investigating how gamification-based design can foster both engagement and the quality of student learning in university courses, offering valuable insights for educators and instructional designers alike.

Online and blended learning platforms have increasingly incorporated gamified features to improve user experience and learning outcomes [9], [10]. However, not all gamification implementations produce positive outcomes; poorly designed systems may fail to address learners' needs or even demotivate students due to trivial rewards or excessive competition [11], [12]. To be effective, gamification must be aligned with sound instructional design principles, ensuring that game elements support clear learning objectives rather than distract from the content [13], [14]. Research has also shown that gamification's motivational effects may be time-limited unless underpinned by genuine relevance to course material and scaffolded support [15], [16]. Therefore, a thoughtful and systematic design approach is essential—one that integrates gamified mechanics with reflective activities and real-world applications to strengthen conceptual comprehension. This study explores such an integrated design model, combining motivational elements with carefully structured learning sequences to support both engagement and understanding.

Student engagement in higher education is often conceptualized across behavioral, emotional, and cognitive dimensions [17], [18]. Gamification has been found to positively influence behavioral engagement— such as participation in activities—and emotional engagement—such as interest and enjoyment [19], [20]. Yet, the question that remains largely unanswered is whether these affective gains translate into deeper conceptual understanding and transfer of knowledge [21]. Conceptual understanding requires learners to grasp relationships, underlying principles, and the ability to apply concepts in new contexts, not merely recall facts [22], [23]. Without such depth, student learning may be superficial, even if engagement metrics are high. This research, therefore, sets out to examine both surface and deep learning indicators, analyzing whether gamified learning experiences can deliver improvements in students' conceptual mastery, not just their motivation or satisfaction.

Despite the known advantages of gamification, higher education institutions still face challenges in its implementation [24], [25]. Faculty may lack the time, expertise, or institutional support needed to design complex gamified learning environments [26]. Meanwhile, concerns about equity and access persist, as some students may find competitive elements stressful or feel left out [27]. Additionally, scalable assessment strategies that capture both gamification engagement and learning gains are still under development [28]. This study confronts these challenges head-on by presenting a replicable design framework and robust evaluation methods suitable for university settings. By testing this model in real courses with large student cohorts, we provide actionable evidence on both the pedagogical benefits and practical considerations necessary for successful adoption.

In summary, while gamification continues to attract attention across educational levels, its true pedagogical value lies in its ability to elevate conceptual understanding alongside student engagement. This paper contributes to the field by offering a rigorous investigation into how gamification-based learning design can support higher-order learning outcomes while maintaining motivation. The following sections will describe the design principles employed, the research methodology used to evaluate effectiveness, and the results of our empirical study. In doing so, we aim to provide a valuable reference for educators, instructional designers, and institutional leaders exploring innovative ways to improve higher education teaching and learning.

2.   METHOD

This study employed a quasi-experimental design using a mixed-methods approach to evaluate the impact of gamification-based learning on student engagement and conceptual understanding. The research was conducted over one academic semester (16 weeks) in two undergraduate classes from the Faculty of Computer Science, Universitas Negeri Malang. A total of 72 students participated, divided into two groups: the experimental group (n=36), which received gamified instruction, and the control group (n=36), which received traditional instruction.

2.1. Participants

Participants were selected using purposive sampling based on their enrollment in the same subject course ("Information Systems Analysis and Design") and similar academic backgrounds. All students were informed of the research procedures and voluntarily agreed to participate in the study.

2.2. Learning Design and Gamification Elements

The experimental group's learning materials were designed using a gamification framework based on key game elements: points, badges, leaderboards (PBL), challenge-based quizzes, and interactive discussion boards. A gamified learning management system (LMS) was developed to support this structure, integrated with weekly missions, progress tracking, and immediate feedback. The control group followed the same learning content but without any gamified elements.

2.3. Instruments

To measure student engagement, the study utilized the Student Course Engagement Questionnaire (SCEQ), which evaluates behavioral, emotional, and cognitive engagement. Conceptual understanding was measured through a post-test consisting of 15 open-ended questions developed and validated by two subject matter experts. Qualitative data was collected via semi-structured interviews and focus group discussions with a subset of 10 students from each group.

2.4. Data Collection and Analysis

Quantitative data were analyzed using descriptive statistics, independent samples t-tests, and ANCOVA to examine differences in engagement and conceptual understanding between the groups. SPSS 26.0 was used to process the statistical tests. Qualitative data were analyzed using thematic analysis to identify student perceptions, motivational patterns, and barriers during the learning process.

2.5. Ethical Considerations

Ethical approval was obtained from the university's Research Ethics Committee. All data were anonymized, and participants could withdraw at any time without academic penalty.

3. RESULTS AND DISCUSSION

3.1. Quantitative Results

The analysis began with a comparison of pre-test scores, which showed no significant difference in prior knowledge between the experimental and control groups ($p > 0.05$). After the 16-week intervention, post-test results revealed a statistically significant improvement in conceptual understanding in the experimental group (M = 82.36, SD = 6.12) compared to the control group (M = 74.28, SD = 7.45), with a p-value < 0.001. The ANCOVA test confirmed that the improvement was due to the gamification treatment and not other variables.

In terms of student engagement, results from the Student Course Engagement Questionnaire (SCEQ) indicated higher levels of behavioral, emotional, and cognitive engagement in the experimental group. The overall engagement score averaged 4.35 (out of 5) in the gamified class, compared to 3.62 in the traditional class. Among the engagement subscales, the most notable difference was observed in emotional engagement, which increased due to elements such as leaderboards, achievement badges, and interactive weekly missions.

3.2. Qualitative Results

Qualitative findings supported the quantitative data. Interview and focus group responses showed that students in the gamified class experienced increased motivation, participation, and collaborative learning. Several students reported that the point-based system and real-time progress tracking helped maintain focus and encouraged timely task completion.

Students also mentioned that competition and recognition (e.g., leaderboard placement) fostered a more active learning environment. One participant stated, "When I saw my rank increase on the leaderboard, I felt more excited to study and complete the tasks."

However, challenges were also noted. A few students felt anxious about constant competition, and some preferred more narrative-based gamification rather than purely point-based mechanisms. This highlights the importance of balance in gamification design, ensuring it motivates without creating excessive pressure.

3.3. Discussion

The results affirm that gamification can positively influence both engagement and learning outcomes when well-aligned with pedagogical goals. This aligns with previous studies which suggest that gamification enhances intrinsic motivation and knowledge retention [1], [3], [8].

The emotional engagement increase observed is consistent with Deci & Ryan's Self-Determination Theory (SDT), where autonomy, competence, and relatedness drive motivation [15]. The leaderboard and progress mechanics contributed to feelings of competence, while interactive discussions enhanced relatedness.

Furthermore, the integration of immediate feedback through gamified quizzes supported constructivist learning, helping students build knowledge through exploration and reflection. While gamification cannot replace sound instructional design, it serves as an effective enhancement when used appropriately.

These findings suggest that gamified learning designs should be adopted more broadly in higher education, especially in courses that demand abstract thinking or where student disengagement is an issue. However, instructors must tailor gamification strategies to student preferences and learning contexts, ensuring they remain inclusive and flexible.

4.   CONCLUSION

This study concludes that integrating gamification into instructional design significantly enhances both student engagement and conceptual understanding in higher education. The implementation of game elements such as points, badges, leaderboards, and interactive tasks created a more dynamic and motivating learning environment compared to traditional methods. Quantitative analysis demonstrated that students in the gamified class achieved higher post-test scores and reported greater behavioral, emotional, and cognitive engagement. These findings were further supported by qualitative insights, where students expressed increased enthusiasm, focus, and collaboration during learning activities.

While gamification showed clear educational benefits, it is important to design the system thoughtfully to avoid potential drawbacks such as excessive competitiveness or anxiety. Educators are encouraged to balance motivational elements with pedagogical goals, adapting gamification strategies to the learners' characteristics and course context.

In conclusion, gamification is not merely a trend but a viable instructional strategy that, when designed effectively, can significantly support student-centered learning. Future research may explore long-term effects of gamification across diverse disciplines, as well as the integration of adaptive gamification models tailored to individual learning needs.

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