Journal of Information Systems Engineering and Management
2025, 10(27s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

Gamification and Chatbots in Education: A Study on the Impact on Student Interaction and Engagement

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ARTICLE INFO

Received: 16 Dec 2024

Revised: 10 Feb 2025

Accepted: 14 Feb 2025

ABSTRACT

Educational management continues to face substantial challenges in addressing student disengagement, particularly when relying on traditional pedagogical approaches. This study explores the impact of gamification, integrating game-based elements and AI-driven technologies such as chatbots, on fostering intrinsic motivation, enhancing student engagement, and improving academic performance. Employing a mixed-method approach that combines AI-based simulations and real-world field research, the findings demonstrate a notable increase in user interaction metrics, with average interaction time and click rates rising by up to 66.7% on a gamified platform. Participants reported heightened engagement and attentiveness, with gamification progressively capturing their focus during routine educational activities. Despite these positive results, the study did not establish a direct correlation between gamification and reduced dropout rates, nor did it conclusively link increased interaction with improved knowledge retention. Nonetheless, the findings underscore the potential of gamification as a transformative educational strategy, particularly in subjects requiring high interactivity, such as mathematics and sciences. This research highlights the need for further investigation into the long-term effects of gamification on knowledge retention and its role in addressing dropout rates across diverse educational contexts. The study contributes to the ongoing discourse on the integration of innovative digital tools in education, providing valuable insights into the capabilities and limitations of gamification within the teaching-learning process.

Keywords: Active methodology, Chatbots, Gamification, Interactivity, Student engagement.

INTRODUCTION

One of the prevailing challenges in education lies in addressing the behavioral dynamics of individuals, as generational differences often lead to misunderstandings regarding what is deemed

necessary versus inappropriate. These differences arise from distinct ways of thinking, acting, learning, and making decisions [1]. This challenge becomes particularly evident in classroom settings, where the teaching-learning process demands a balance between traditional educational practices and engaging, dynamic methodologies. The ultimate goal is to sustain student interest, as reflected in their active participation in subject-specific studies. In mathematics, for example, motivation is a critical factor influencing student engagement [2], [3].

Digital teaching strategies, such as gamification, have emerged as innovative solutions to foster participation while simultaneously gathering real-time data on student comprehension. Experimental designs have proven particularly effective in teaching mathematical statistics, enabling researchers to compare student performance across diverse learning environments and assess the efficacy of these methods [4].

A lack of motivation has far-reaching implications for students' futures, as their disinterest in acquiring knowledge often translates into diminished learning outcomes. Research has consistently shown that student apathy poses a serious threat to education, undermining both academic performance and the quality of learning [5], [6]. Examinations, often perceived as intimidating and anxiety-inducing, contribute to this issue by creating stress and fear among students. This dynamic can foster an adversarial relationship between students and their subjects, whereby exams become perceived as obstacles rather than opportunities for growth [7].

In this context, gamification emerges as a promising pedagogical strategy to make learning experiences more engaging and rewarding, even when the learning objectives remain unchanged. This study addresses the research question of whether gamification effectively enhances student interaction and focus during routine educational activities. Existing studies suggest that gamification can improve intrinsic motivation, foster social comparison, enhance satisfaction and effort, and ultimately boost academic performance [8], [9].

The aim of this research is to evaluate the effectiveness of gamified approaches compared to traditional, non-gamified methods in routine educational activities. Specifically, the study seeks to identify strategies to transform the teaching-learning process into an engaging, gamified experience without exacerbating students' stress or anxiety. The research is justified by the universal need to foster interest in the classroom and to support knowledge construction.

Current literature highlights the importance of considering both social and human factors when implementing digital technologies in education. A comprehensive review of existing studies has established an academic foundation for exploring strategies that integrate digital management, human-machine interaction, and virtual tools in increasingly automated environments [7]. Factors such as teaching methodologies, allocated study time, vocational interests, and institutional support significantly influence how students acquire and retain knowledge.

Innovative teaching approaches, such as flipped classrooms, project-based learning, and student-centered methodologies, have demonstrated their effectiveness in enhancing student engagement and motivation, ultimately improving educational outcomes [10]. Gamification, as a dynamic teaching method, further enriches this landscape by positively influencing both student learning and behavior.

This approach is particularly effective when tailored to align individual personality traits [11].

Gamification combines entertainment, enthusiasm, and collaborative activity, making it appealing across various age groups, from adolescents to older adults. By integrating clearly defined objectives, interactive mechanics, and engaging narratives, gamification transforms learning into an enjoyable and interactive process. In classroom settings, gamification serves as a valuable technological tool to enhance the teaching-learning process [12].

Morris et al. [13] observed that students often perceive academic tasks as obligations, a perception that can dampen enthusiasm and reduce engagement. Gamification counters this trend by introducing personalized experiences in the classroom, offering challenges and opportunities for problem-solving. This approach has demonstrated significant potential to improve academic performance and increase classroom participation [14], [15].

As a pedagogical strategy, gamification leverages human-machine interaction through the use of game-based elements in educational contexts. This approach incorporates challenges, immediate rewards, and interactive feedback mechanisms, such as chatbots, to foster critical thinking, problem-solving, and teamwork [16], [17].

Globally, countries like India have embraced digital technologies to popularize programming and automation, highlighting their applicability in education. Enhanced human-machine interactions in educational activities have improved reliability and efficiency [6], [18]. Moura and Moura [19] emphasized that human-machine interaction has significantly reduced learning time in hybrid environments shared by humans and machines. This synergy has transformed how knowledge is acquired and reproduced, particularly through game-based learning approaches [17].

By exploring the role of gamification in the teaching-learning process, this research seeks to contribute to the broader understanding of human-machine interaction in education. The findings aim to provide actionable insights for leveraging gamification as a tool to foster student engagement and improve educational outcomes in the digital age.

MATERIALS AND METHODS

This study employed a combination of simulations and field research to investigate the effectiveness of gamification in enhancing interactivity and increasing students' attention spans. These methods facilitated the identification of key research trends, addressed existing knowledge gaps, and highlighted practical implications while ensuring the long-term preservation of scientific data [20], [21]. Gamification, as an educational strategy, is intrinsically linked to progressive teaching methodologies and positions itself as a forward-looking alternative to traditional pedagogical approaches. However, its effective implementation requires addressing significant infrastructural and contextual challenges, which are summarized in Table 1.

Table 1. Structural and Contextual Challenges in Gamification

Gamification in Education	Structural and Contextual Challenges
Need for teacher training and enablement	Many educators are unfamiliar with gamification tools, creating barriers to technology adoption.
Integrating gamification into curricula	Without proper planning, gamification may become an isolated activity, disconnected from educational objectives.
Methodologies: Traditional vs. Active	Resistance from educators and institutions favoring traditional teaching methods.
Technological support limitations	Requires collaborative efforts among educators, technology developers, and policymakers to address application barriers.
Investment in technology and training	Financial and temporal constraints hinder the adoption, maintenance, and evolution of gamification technologies.

To empirically evaluate the impact of gamification on student interactivity and focus during the learning process, two data collection methods were utilized: simulations conducted in controlled environments to predict outcomes based on established research patterns, and real-world applications designed to mirror these simulations, thus validating the method and comparing empirical results to eliminate potential experimental artifacts. The simulations adopted a persona-based strategy to represent a diverse array of individuals characterized by different opinions, age groups, levels of technological proficiency, and cognitive approaches. To minimize bias and variability, three distinct artificial intelligence (AI) systems were employed: ChatGPT-4 (OpenAI), Gemini (Google), and One (Adapta). These AI tools were selected for their ability to simulate diverse human interactions, thereby facilitating a robust and comparative analysis.

Participants in the study were defined using specific criteria, including attributes such as name, age, occupation, technological preferences, and challenges encountered during educational activities. These parameters, detailed in Table 2, ensured a diverse sample that included individuals from various age groups, professional backgrounds, and levels of familiarity with technology, thereby reducing biases and enhancing the generalizability of the findings.

Table 2. Participants and their attributes

Participants	Attributes
A	Age: 72 years; Occupation: Retired; Technology: Basic smartphone for videos and web browsing; Challenges: Navigating complex interfaces, fear of data loss, and limited patience for learning new technologies.
B	Age: 28 years; Occupation: Software Developer; Technology: Multiple devices, including a high-end smartphone, smartwatch, and tablet; Challenges: Coping with rapid technological evolution, managing time effectively, and avoiding digital distractions.
C	Age: 16 years; Occupation: Student; Technology: Smartphone as the primary device for communication, content consumption, and entertainment; Challenges: Cyberbullying, privacy concerns, managing screen time, and avoiding digital dependency.

To further support the research, a demonstrative website was developed featuring a cultural-themed game. The design of the website followed best practices in user experience (UX) and incorporated fundamental gamification principles to ensure that readability and design quality did not interfere with the reliability of the results. The gamified version of the website was designed to capture detailed user interaction metrics, including time spent on the platform, the number of clicks, the duration of specific activities, access via direct links, and the frequency of recurring visits. The website was optimized for both desktop and mobile platforms, incorporating gamification elements tailored to accommodate touch and mouse interfaces, thus ensuring accessibility across a range of devices.

To further analyze the impact of gamification, a structured prompt was introduced to the three AI systems, simulating interactions between users and two versions of the website: a static, non-gamified version and a gamified version. This prompt was developed based on data collected from field research and extended to include a broader scope of simulated scenarios. The website was also made available to a real-world audience comprising higher education students and professors from various institutions. This broader application allowed for the validation of the gamification framework in real-world conditions, providing valuable insights into the potential of gamified tools to enhance the teaching-learning process.

RESULTS AND DISCUSSION

Comparative Analysis

The experiments conducted with participants anticipated that the gamified website would result in increased active time and a higher number of interactions (clicks) compared to the non-gamified version. The comparative analysis confirmed these expectations, revealing significant behavioral differences between participants. Notably, the oldest participant (Participant A), who exhibited the lowest engagement time in the non-gamified setting, faced challenges in interacting with the content, as illustrated in Figure 1.

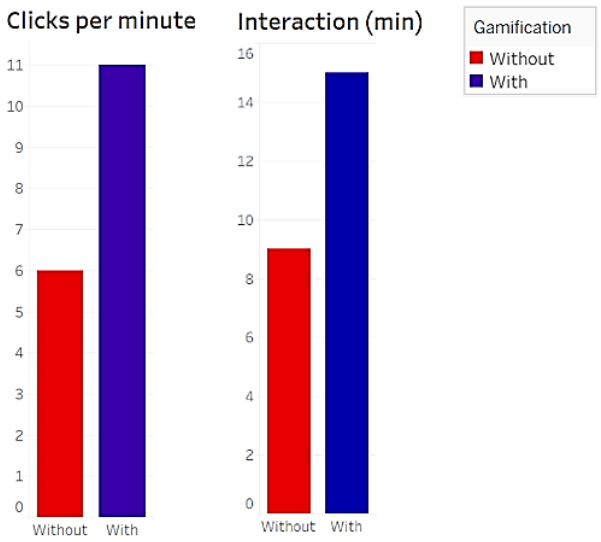

Figure 1. Comparative average interaction times without and with gamification

Time allocation was identified as a critical factor, with engagement categorized as short, medium, or long depending on the stimulation level provided by the activity. The integration of gamification elements doubled the number of clicks on average, with most users engaging in the "treasure hunt" activity embedded in the platform.

The experiments were conducted in a controlled web development environment, ensuring stable traffic and excluding large-scale interventions such as rebranding or promotional campaigns. Data generated from simulations using the three AI systems provided baseline results for the static version of the site, as shown in Figure 2.

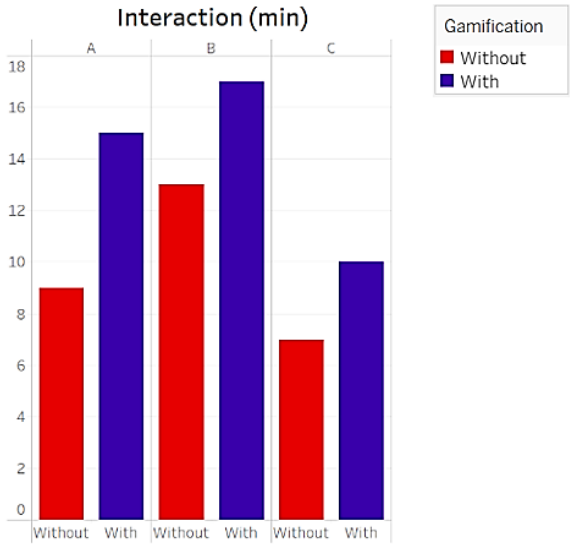

Figure 2. Comparative average interaction times by participant in the static page simulation

Following these initial simulations, gamification elements were introduced, and the prompts were updated to reflect these changes. The comparative analysis of user clicks per minute on the gamified page is presented in Figure 3.

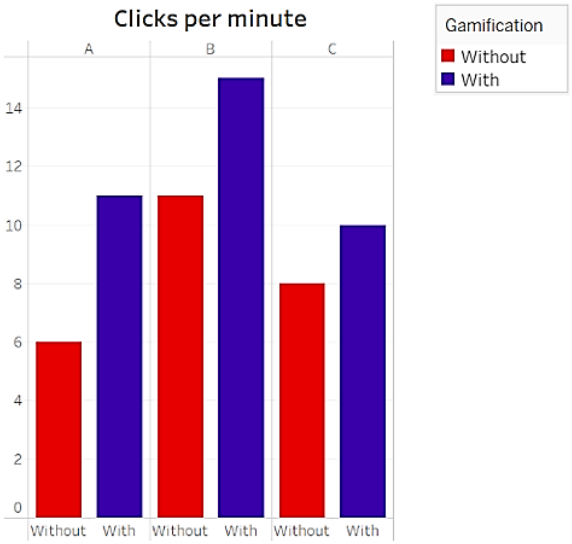

Figure 3. Clicks per minute in interactions on the gamified page simulation

In the non-gamified setup, Participant A, aged 72, spent nine minutes on the site, while Participant C, aged 16, spent only seven minutes. These results highlight the influence of age on attention span and engagement with textual content. Participant B, aged 28 and the most technologically proficient, demonstrated the highest level of interactivity in both settings. Users with greater technological familiarity, such as Participants B and C, clicked more frequently, while Participant A showed limited interest in the gamified elements, although her clicks increased slightly compared to the static version.

The introduction of gamification resulted in notable changes in user behavior, including increased retention and more frequent interactions. However, while these findings suggest greater exploration of content, they do not conclusively establish improved knowledge retention. Although users interacted more extensively with the platform, the link between gamification and enhanced learning outcomes remains inconclusive. Figure 4 illustrates the comparative average time and clicks across participants on the gamified site.

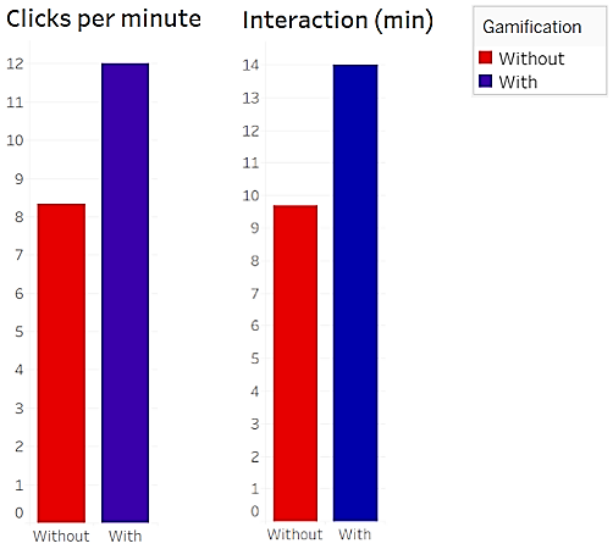

Figure 4. Comparative average time and clicks in interactions on the gamified page

Table 3 presents a summary of the participants' interaction metrics, revealing substantial quantitative differences between the gamified and non-gamified versions. For example, Participant A's interaction time increased by 66.7%, from 9 minutes on the non-gamified platform to 15 minutes on the gamified version, while her click rate rose by 83.3%, from 6 to 11 clicks. Participant B showed a more moderate increase, with interaction time rising from 13 to 17 minutes (30.8%) and click rates increasing from 11 to 15 (36.4%). Participant C exhibited a 42.9% increase in interaction time, from 7 to 10 minutes, and a 25% increase in click rates, from 8 to 10 clicks.

Table 3. Overview of the participants and their attributes

Participant	Age	Interaction (non-gamified)	Interaction (Gamified)	Percentage Increase (%)	Clicks (non-gamified)	Clicks (Gamified)	Percentage Increase (%)
A	72	9 min	15 min	66.7%	6 clicks	11 clicks	83,3%
B	28	13 min	17 min	30.8%	11 clicks	15 clicks	36.4%
C	16	7 min	10 min	42.9%	8 clicks	10 clicks	25%

These results align with previous studies, such as those by Hanus and Fox [8] and Smiderle et al. [11], which highlight gamification's ability to enhance intrinsic motivation by incorporating challenges and immediate rewards. However, while the study demonstrates clear increases in interaction time and click rates, it does not provide definitive evidence of a direct relationship between these metrics and improved knowledge retention or learning outcomes.

SWOT Analysis

The integration of gamification into education presents a mix of strengths, weaknesses, opportunities, and threats, as summarized in the SWOT analysis shown in Figure 5.

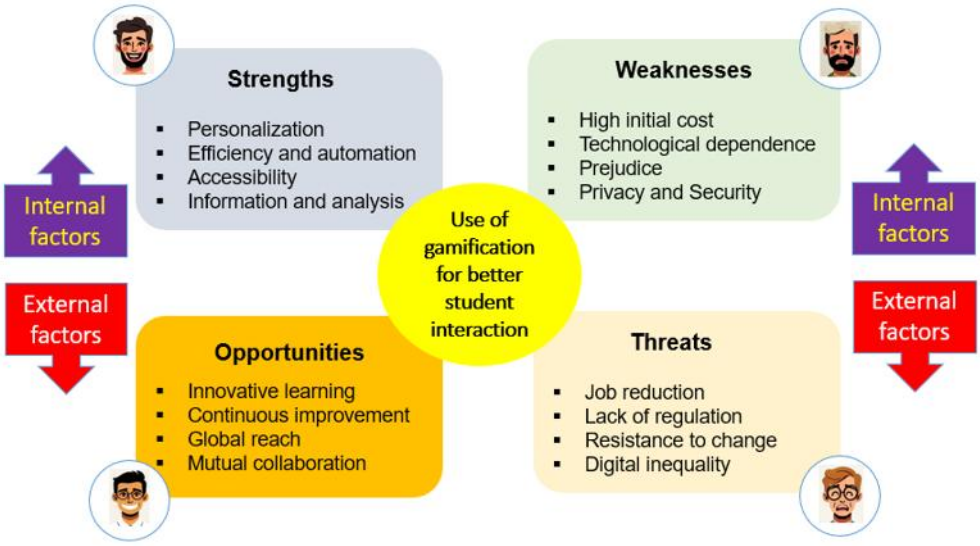

Figure 5. SWOT analysis of gamification in the teaching-learning process

According to Moura et al. [22], digital technologies and human-machine interactions have the potential to fundamentally transform how individuals behave and engage with their environments. Successfully transitioning from analog cultural practices to a fully digital framework is a critical step in modernizing educational systems.

Monitoring global trends and adopting data-driven decision-making processes facilitate remote collaboration and align educational practices with evolving technological standards [1]. However, implementing gamification and other digital innovations comes with significant challenges, including high initial costs, the need for robust teacher training, and the necessity of maintaining constant connectivity to adapt to emerging products and services tailored to human needs [19], [23].

Although the study demonstrated increased interactivity through gamification, it was not possible to determine whether these changes resulted in improved knowledge retention. While gamification holds promise as a pedagogical tool, further research is required to explore its long-term impact on learning outcomes and its ability to support knowledge construction in diverse educational settings.

CONCLUSIONS

The integration of gamification into educational management, combined with advancements in human-machine interaction, represents a strategic approach to addressing the challenges of the teaching-learning process. The results of this study indicate that incorporating a digital gamification framework enhances user engagement and attention, fostering greater participation and involvement in classroom activities. By leveraging gamification, it is possible to establish a proportional relationship between the time students dedicate to academic tasks and their absorption of content, thereby mitigating issues related to distraction and loss of focus.

Gamification serves as an effective tool for progressively capturing students' attention, as evidenced by its positive impact on engagement and performance. The findings suggest that gamified educational

strategies can help keep students attentive, participatory, and motivated throughout their studies. However, the SWOT analysis highlighted certain limitations, including the dependence on technology, which poses challenges related to accessibility and infrastructure. Additionally, while this study demonstrated increased engagement and interaction, it did not produce conclusive evidence, through measurable data, that gamification directly reduces school dropout rates.

Technologies such as chatbots, virtual assistants, personalized recommendations, and other AI-based tools show considerable potential to enhance student engagement and participation. Nevertheless, further research is required to explore the direct relationship between gamification and critical educational outcomes, such as knowledge retention and dropout rates. Although the findings indicate that gamification improves engagement, its broader impact on educational performance and long-term retention remains inconclusive.

This study underscores the versatility of gamification in educational contexts, particularly in subjects that require high levels of interactivity, such as mathematics and the sciences. Future research should focus on the impact of gamification on memory retention and its role in reducing dropout rates across diverse educational settings. Moreover, longitudinal studies would be valuable in assessing the sustained influence of gamified strategies on learning outcomes and student retention, providing a more comprehensive understanding of their effectiveness as an educational tool.

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