The Effects of Gamification on Students' Sense of Accomplishment: A Controlled Experimental Study

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Abstract

Gamification has been widely employed to enhance students' experiences and improve learning outcomes. While gamification often yields positive results in educational settings, there are still inconsistencies in the findings, and several areas remain underexplored (*e.g.*, impact on specific psychological experiences like the sense of accomplishment), and need further investigation. To address this gap, we conducted a controlled between-subjects experiment (N = 65) to examine the effects of gamification on students' sense of accomplishment within a gamified learning management system. Participants were divided into an experimental group, which used a gamified version of the system, and a control group, which used the same system without gamification. Students' sense of accomplishment was assessed using validated measures, and we employed both descriptive and inferential statistics (*i.e.*, Mann-Whitney U test) to analyze the differences between groups. The analysis revealed no statistically significant effect of gamification on students' sense of accomplishment (U = 436.000, Z = -1.209, p = .227), with a small effect size (r = 0.15). These findings suggest that gamification, in its current form, may not directly enhance students' sense of accomplishment. Our study adds to the growing body of literature on game-based learning by highlighting that gamification may not universally impact all aspects of the student experience.

Keywords

Game-based learning, gamification, educational technologies, user experience, experimental study

1. Introduction

Gamification (*i.e.*, "the process in which services, activities, and systems are transfigured to promote similar motivational benefits as found in games" [1, 2]) has emerged as a promising strategy to cultivate positive experiences in education by leveraging game design elements to engage and motivate students [2, 3, 4]. Gamification aims to enhance student motivation, participation, and learning outcomes [2, 5]. This approach capitalizes on the inherent appeal of games, tapping into individuals' natural inclinations for game-like behaviors, thus, aiming to transform educational environments into engaging experiences that promote active participation [6].

Despite the growing popularity of gamification in education [2, 7], research findings on its effectiveness have yielded mixed results, underscoring the need for a nuanced understanding of its impact on student outcomes [8, 9]. While some studies have reported positive effects on engagement, motivation, and learning [10, 11, 12], others have found limited or inconsistent benefits [13, 14]. Moreover, there remains a notable gap in the literature concerning examining students' sense of accomplishment within gamified educational environments [11], a crucial aspect of students' subjective experiences and intrinsic motivation.

In this investigation, we explore the impact of gamification—specifically, a single gamification design comprising ten distinct gamification elements based on Self-Determination Theory [15] on students' sense of accomplishment. We conducted a controlled experiment with two groups: an experimental

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group that interacted with a gamified educational system and a control group that used the same system without gamification. Employing descriptive and inferential statistical methods, we analyzed the differences in students' sense of accomplishment between these two groups.

Our analysis revealed no statistically significant effect of gamification on students' sense of accomplishment (U = 436.000, Z = -1.209, p = 0.227), with a small effect size (r = 0.15). These findings suggest that while gamification has potential in educational contexts, its impact on certain psychological outcomes, such as a sense of accomplishment, may be limited under certain design decisions. This suggests that the effectiveness of gamification is context-dependent and underscores the importance of critically evaluating the suitability between gamification designs and the intended outcomes. Our study highlights these nuances and contributes to the growing literature on game-based learning. It suggests that future research and design efforts should focus on refining gamification strategies better to address the various dimensions of the student experience and optimize certain aspects, such as user engagement.

2. Background

In this section, we present the main topics covered in this study (*i.e.*, gamified education, and sense of accomplishment in educational environments). We also present the main related work.

2.1. Gamified education

Gamified education typically involves applying game design elements and principles within educational contexts, thereby enhancing learning outcomes [16, 9, 17]. The primary aim of gamification in education is to motivate students, increase their engagement, and improve learning outcomes by making educational activities more interactive and enjoyable [18, 19]. By incorporating gaming principles, educators seek to transform traditional learning environments into dynamic and engaging experiences that capture students' interest and sustain their motivation [20]. Gamified education leverages intrinsic motivational factors that make games appealing, such as achievement, competition, and progress, to create a compelling educational experience [21].

The theoretical basis of gamification in education is often grounded in Self-Determination Theory (SDT) [22], which emphasizes the importance of satisfying three basic psychological needs: autonomy, competence, and relatedness [15]. Autonomy refers to the need to feel in control of one's actions and decisions; competence entails a sense of efficacy and skill in one's activities; and relatedness pertains to feeling connected and valued by others [23, 15]. Gamification strategies are designed to fulfill these needs by providing students with choices and control over their learning (autonomy), offering opportunities for mastery and skill development (competence), and fostering social connections and collaborative learning (relatedness) [22].

Over the years, different game elements and gamification designs have varied widely depending on the educational goals and the target audience [24]. Common game elements include points, which provide a measurable way of tracking progress; badges, which serve as symbolic rewards for achievements; and leaderboards, which introduce a competitive element by ranking participants [2]. Additionally, more complex designs can incorporate narrative features, avatars, and interactive feedback systems, creating a more immersive and engaging learning environment [25].

For example, point-based systems provide immediate feedback and reinforce positive behavior, helping students track their progress and stay motivated. Badges and achievements serve as extrinsic motivators, encouraging students to complete tasks and reach milestones. Leaderboards introduce a competitive element that may drive some students to perform better, although they must be implemented carefully to avoid demotivating others. More complex gamification elements, such as narrative elements and quests, can enhance engagement by providing context and purpose to learning activities, making them more relatable and enjoyable [26, 25]. Ultimately, the effectiveness of gamification depends on how well the chosen design elements align with students' needs and preferences, as well as the overall educational objectives.

2.2. Sense of accomplishment in educational environments

Motivation is influenced by the expectation of success and the perceived value of the task or goal [27]. Students' sense of accomplishment is closely tied to their beliefs about their ability to succeed (self-efficacy) and the perceived importance of the task [28, 29]. When students perceive a high likelihood of success and find the task meaningful, their sense of accomplishment can be positively affected.

Students learn by observing others and adjust their behavior based on the outcomes they observe [30]. A sense of accomplishment arises when students successfully apply learned strategies and observe positive results. A sense of accomplishment is also influenced when people have an agenda and set goals to achieve [31].

SDT, which focuses on intrinsic motivation, is closely related to gamification [15]. When students feel a sense of autonomy, competence, and relatedness, they are more likely to experience accomplishment [29]. Autonomy allows students to choose tasks aligned with their interests. Competence reflects their perceived ability to master those tasks, and relatedness, or feeling connected to others, further enhances their sense of accomplishment.

2.3. Related work

In recent years, some studies have investigated gamification designs in different cognitive experiences of students. In an initial example, Tasadduq *et al.* [32] investigated gamification use in students from rote learning backgrounds. The authors evaluated students' class effort, satisfaction, social comparison, performance, and intrinsic motivation in a programming course. Students in the gamified group were required to submit their programming assignments through an online gamified tool, while the non-gamified group submitted their assignments using the traditional way. Results showed no significant difference in class effort, satisfaction, social comparison, and motivation between both groups over time [32].

Oliveira *et al.* [33] investigated how gamer types from the BrainHex taxonomy moderate the effects of personalized/non-personalized gamification on users' flow experience, enjoyment, perception of gamification, and motivation. The authors conducted a mixed factorial within-subject experiment involving 121 elementary school students comparing a personalized version against a non-personalized version of a gamified education system. They identified no effects between personalization and students' flow experience, perception of gamification and motivation, and enjoyment [33].

Taşkın and Kılıç Çakmak [34] also conducted in a quasi-experimental study where students. Both groups of students studied in an online learning environment for 10 weeks. Findings revealed that gamification enhanced students' achievement by increasing their content interaction in the online learning environment [34].

Alt [35] analyzed how to use game design elements to engage students in mathematics learning activities. Results mainly showed the superiority of the problem-based gamification activity compared to the other activities, in enhancing students' gameful experience and gaming motivation. The lowest results were obtained for face-to-face game-based learning with a non-problem-based activity [35].

Mohammed *et al.* [36] analyzed the effect of badges and leaderboards on the development of cognitive and achievement motivation of elementary school students. The results indicated increased cognitive and achievement motivation among students in both experimental groups. However, there were no significant differences in the effects of badges and leaderboards on the cognitive and achievement motivations of the participants in the two experimental groups [36].

Building on the previous research we mentioned that examined the impact of gamification on cognitive and motivational aspects, our study specifically examined its influence on students' sense of accomplishment. We believe that while recent studies have explored various student experiences with gamified educational systems, not many have focused specifically on how gamification influences students' sense of accomplishment. To the best of our knowledge, this study is the first to examine the effects of gamification on students' sense of accomplishment.

3. Study Design

In this section, we present the study's design (*i.e.*, materials, method, participants, and data analysis).

3.1. Materials and method

For our research, we employed the gamified educational system Eagle-edu[1]. We specifically chose this system because of its adaptability, which empowers educators to create diverse educational activities. The system incorporates 21 distinct gamification elements, which align with the Taxonomy of Gamification Elements for Educational Environments (TGEEE) proposed by Toda *et al.* [26]. These elements can be selectively enabled or disabled by teachers, allowing them to personalize the gamification designs. In our study, we utilized two system versions: one without any gamification elements (for the control group) and another featuring 10 gamification elements aligned with Self-Determination Theory (for the experimental group).

In our investigation, we incorporated ten gamification elements aligned with the TGEEE [26]: **Acknowledgment**: This element involves providing feedback that praises specific player actions. In our system, it is represented by the display of student badges. **Chance**: Associated with randomness and probability, this element influences the likelihood of certain actions or outcomes. In our system, players encounter different types of choices (*e.g.*, selecting between chests) that reflect chance-based mechanics. **Competition**: When multiple players vie for a common goal, competition arises. Our system features leaderboards that rank up to ten students, fostering competitive dynamics. **Economy**: Transactions within the game, including monetization of game values, fall under this element. In our system, coins serve as currency for in-game purchases. **Imposed choice**: Players must make decisions to advance in the game. We offer random options to users, allowing them to increase their rewards. **Level**: Hierarchical layers within a game provide gradual advantages as players progress. Our system categorizes levels (*e.g.*, Bronze, Silver, Gold, Ruby, and Diamond) to represent this element. **Objective**: Quantifiable or spatial goals guide players. Our quest tree structure represents objectives in the system. **Point**: Units measuring user performance, such as experience points (XP), contribute to this element. **Progression**: Actions that help players track their progress are essential. Our system includes a progress bar within the activity tree. **Stats**: Visible information related to a player's game results, encompassing all user progress data.

In Figure 1, we clarify some of the gamification elements that were set up for the experimental group. The mission tree, containing the group of educational questions participants had to solve, represents the element (**Objective**). **Competition** was introduced through a leaderboard showcasing up to 10 students ranked up to ten students. The sequential stages offered players incremental benefits as they advanced are the element **Level**. In the specific case of this figure, the student is at the Bronze level - The text below their level indicates what they need to achieve to move up. The metrics used to evaluate students' performance (element **Points**) were represented in the system in terms of experience points accumulated by the participant (represented at the top of the screen on the figure as 30 red hearts). Finally, The element **Acknowledgment** was represented by student badges, which can be seen at the bottom right of the screen.

In Figure 2, a green progress bar is displayed at the top of the screen to show the evolution of a participant in each mission. It is an abstraction for the element **Progression**. The element **Imposed choice** is represented in Figure 3. The participants were asked to make a decision that would grant them an active role in determining their progress in a mission. If they completed all the tasks correctly, a bonus would be added. However, if they made even one error, a severe penalty would be imposed. In our design, players encountered choices (*e.g.*, selecting between chests) reflecting chance-based mechanics. The element **Chance** is represented by chests, which can cause the student to be surprised and win something at some point while using the system (see Figure 4). **Economy** is the capitalization of gaming assets. In the system, coins could be exchanged for virtual goods (see Figure 5).

[1] https://eagle-edu.com.br/

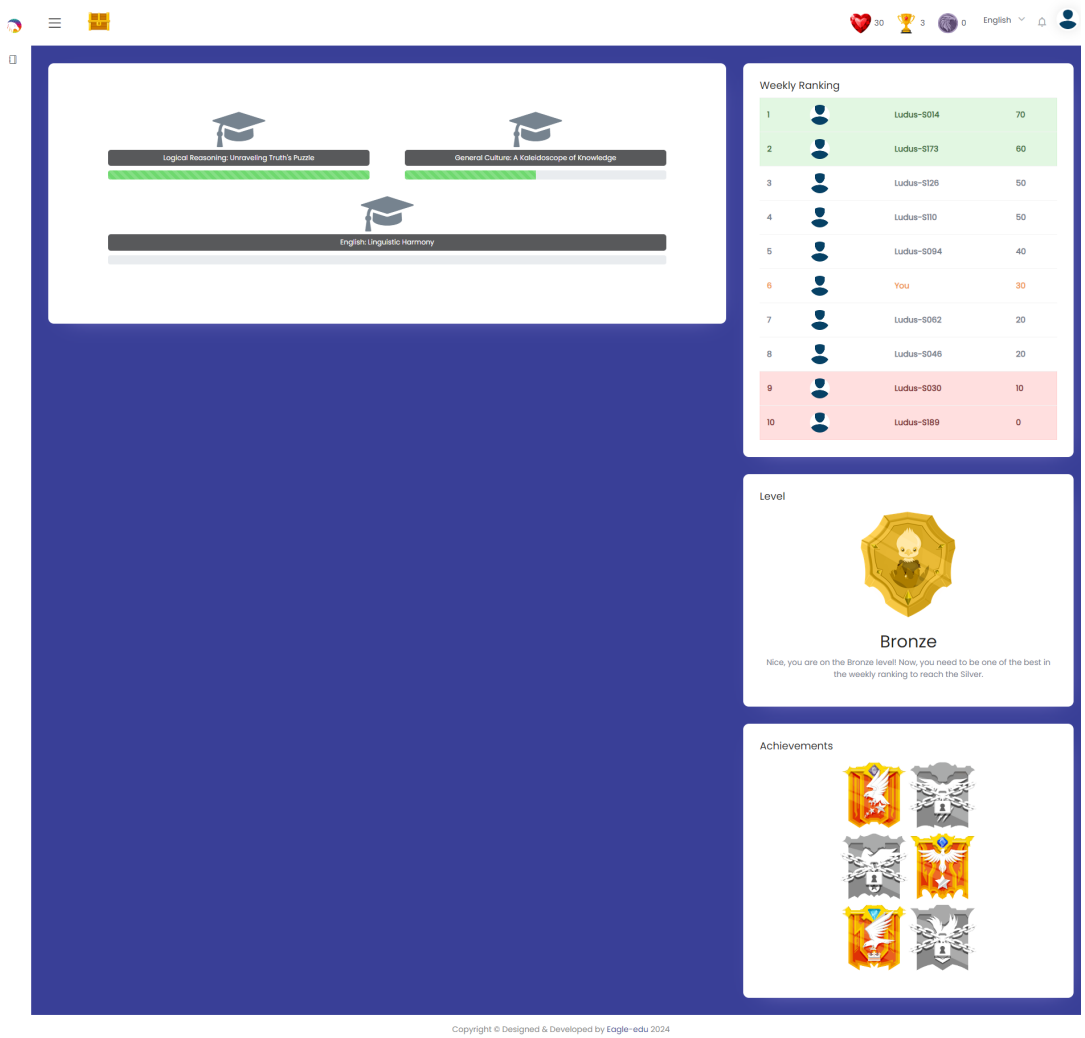

Figure 1: Course home screen (present the elements Objective, Progression, Point, Competition, Level, and Acknowledgment).

The educational activities within the system consist of three distinct missions: *i)* general knowledge, *ii)* logical reasoning, and *iii)* English language. Each mission comprises five tasks. Students could choose where to start and which tasks to complete during the experiment. We deliberately structured the educational activities to reduce potential bias from students' preferences for particular subjects. A teacher experienced in these subjects designed the activities. Participants in both versions of the gamified system and non-gamified system were exposed to identical educational tasks. Figure 2 (logical reasoning) and Figure 6 (English) present examples of two topics covered in the tasks.

The central research question for this study was: *Does gamification affect students' sense of accomplishment?*. To identify the student's sense of accomplishment, we used the Gameful Experience Questionnaire (GAMEFULQUEST) [29]. The GAMEFULQUEST is an instrument specifically designed to measure users' gameful experience while interacting with a service or system and present six different sub-scales (*i.e.*, accomplishment, challenge, competition, guided, immersion, playfulness, and social experience) that can be applied together or separately [29]. In this study, we analyzed the accomplishment sub-scale, composed of eight items. We specially chose this instrument due to its applicability (*i.e.*, the instrument has been widely used by the community [37, 38, 39]) and at the same time, the psychometric properties of the GAMEFULQUEST have been rigorously evaluated, ensuring the robust measurement of gameful experiences [29]. Following the original study's recommendations, the instrument was applied through a seven-point Likert scale [40]. To mitigate threats to validity related to the participants' attention during the study, following the recommendation of Kung *et al.* [41], we added an "attention

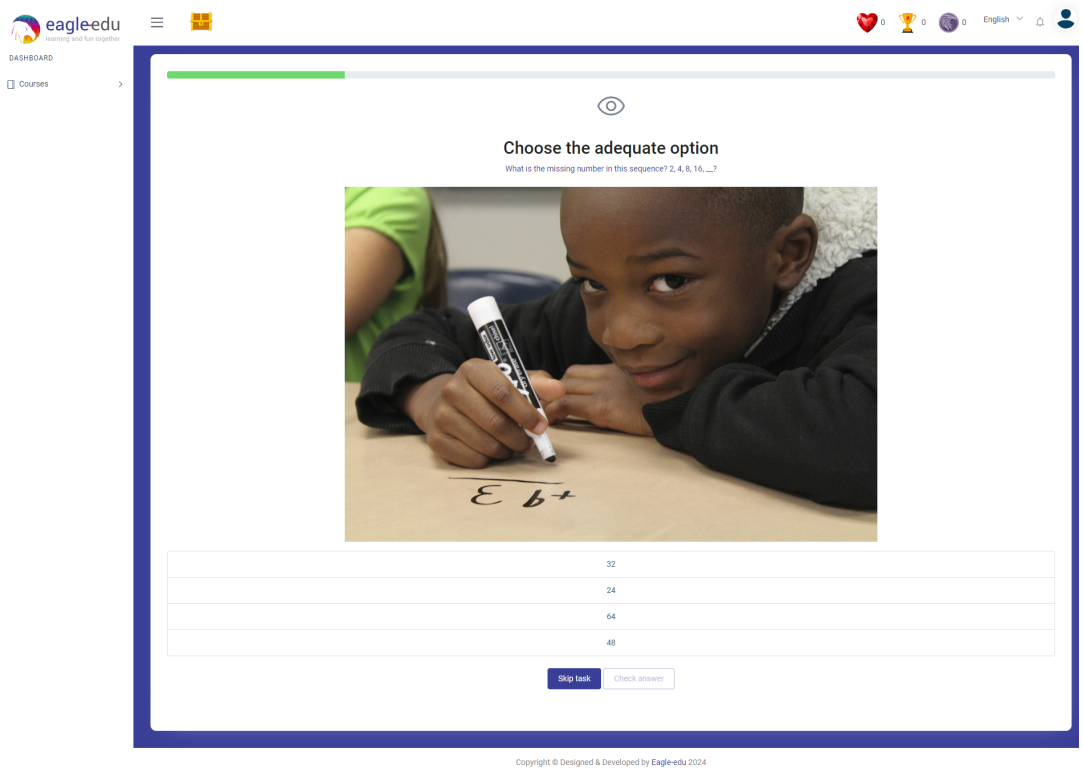

Figure 2: Logical reasoning activity also featuring the element Progression, represented by the green bar showing a participant their progress in a mission.

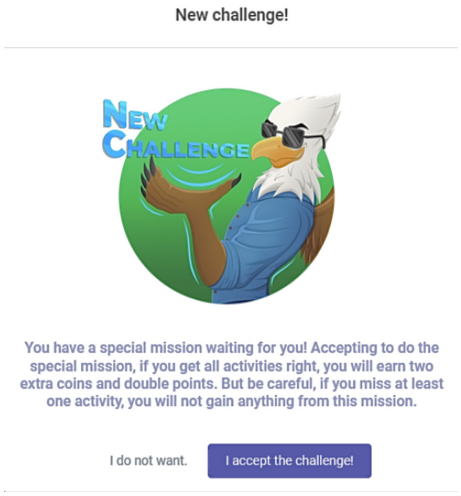

Figure 3: Example of the element Imposed choice, where a participant could accept a specific challenge when carrying out a mission.

check statement" requesting a specific response - "Please, mark the option 'Agree', to let us know that you are paying attention". Data were analyzed using the software SPSS 29.0.1.

The study involved three key steps, *i.e.*, *i)* random assignment, *ii)* system interaction, and *iii)* sense of accomplishment assessment. In the *first step*, random assignment, participants were randomly allocated to either the experimental group or the control group. Participants were randomized immediately before the start of the experiment, as soon as they entered the laboratory. In the *second step*, the system interaction, participants actively engaged with the system for a maximum of 30 minutes, completing educational tasks and exploring its features. In the *third step*, sense of accomplishment assessment, participants promptly responded to the GAMEFULQUEST immediately after their system interaction

to assess their sense of accomplishment during usage.

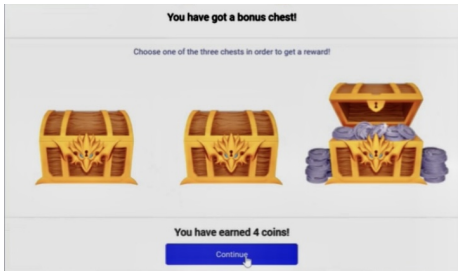

Figure 4: Example of the element Chance, where a participant could open a chest and have a chance to win a reward.

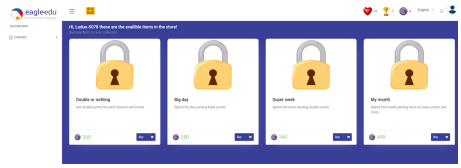

Figure 5: Example of the element Economy, where a participant could exchange their coins to gain benefits.

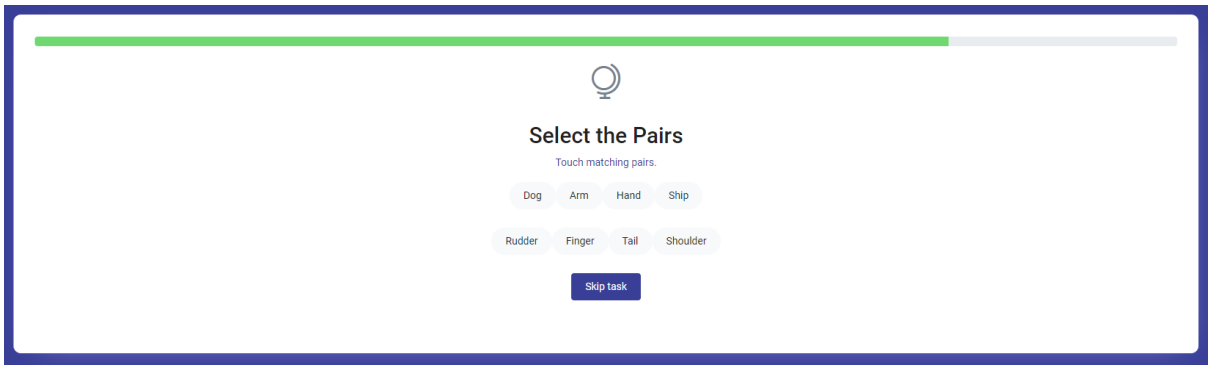

Figure 6: Example of a task relating to English language knowledge.

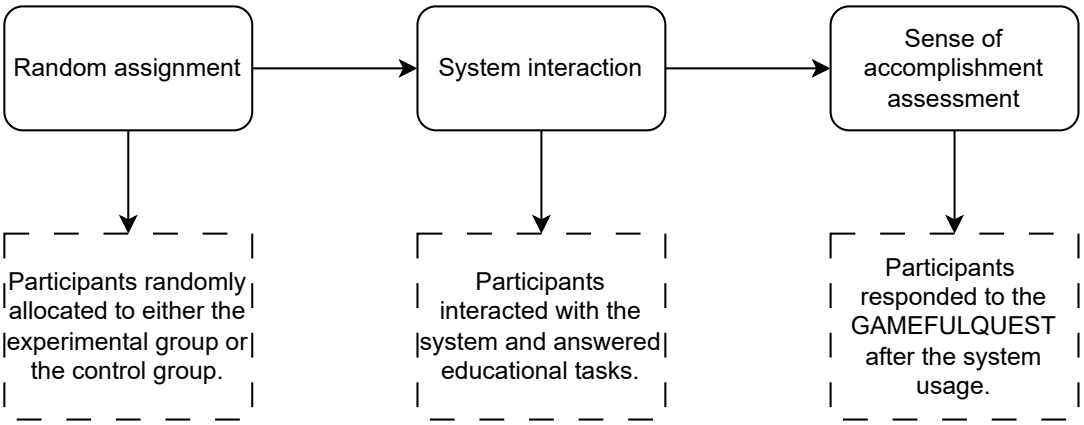

Figure 7: Study's method.

3.2. Participants and data analysis

Participants were recruited via Tampere University DMLab pool, utilizing ORSEE3 software for coordination [42]. From the initial participant pool, three individuals were excluded due to incorrect answers in the "attention check statement". The final sample consisted of 65 students representing 19 countries. Among them, 34 identified as female, 28 as male, two as non-binary, and one participant chose not to respond. The participants in the two conditions were comparable in terms of demographic variables such as age and gender. The average age of the participating students was 25 years old, with a standard deviation of 6.00 and a variance of 33.00. Each participant received 8.00 euros as compensation for their involvement. All research procedures were conducted in strict adherence to the guidelines established by the Finnish National Board on Research Integrity (TENK).

To ensure the appropriate selection of statistical tests, we initiated by evaluating the distribution of the collected data. Given that the data were ordinal, obtained through a scale, and with a sample size of N = 65, we employed the Shapiro-Wilk test [43]. This test, developed by Shapiro and Wilk, is specifically designed for small to moderate sample sizes [44]. It calculates a W statistic, which compares the observed data to the expected data assuming a normal distribution. A smaller W value indicates a significant deviation from normality [43].

The results of our Shapiro-Wilk test yielded a W statistic of 0.938 and a p-value of 0.003. Consequently, we rejected the null hypothesis of normality, indicating that the data did not follow a normal distribution. Given this non-normal distribution, we opted for the non-parametric Mann-Whitney U test [45]. This test is well-suited for our analysis because it remains robust even when normality assumptions are violated and performs reliably with small sample sizes [46].

4. Results

To provide the initial characterization of our sample and facilitate subsequent group comparisons, we computed descriptive statistics for the student's sense of accomplishment in both the experimental (gamified) and control (non-gamified) groups. These statistics included measures of central tendency (specifically, the mean) and variability (represented by the variance (VAR) and standard deviation (SD)). Following the recommendation by Högberg *et al.* [29], participants' sense of accomplishment was determined based on the average of the eighth items. A summary of the descriptive statistics is presented in Table 1.

Table 1
Descriptive analysis of students' sense of accomplishment in the control and experimental groups

Group	Mean	VAR	SD
Control	5.064	1.677	1.295
Experimental	5.508	1.106	1.052
Overall	5.283	1.445	1.202

Key: Var: variance; SD: Standard deviation.

Then, we performed a Mann-Whitney U test to investigate potential differences in the sense of accomplishment between gamified and non-gamified educational systems. The results (as shown in Table 2) indicated that while students in the experimental (gamified) group demonstrated a numerically higher sense of accomplishment score compared to those in the control (non-gamified) group, this difference was not statistically significant (U = 436.000, Z = -1.209, $p < 0.227$). Additionally, the associated effect size was small (r = 0.15), suggesting a limited practical impact of gamification on students' sense of accomplishment in this specific context [44].

Table 2
Inferential analysis

Group	N	M	S	U	Z	*p*	r
Control	33	30.21	997.00	436	-1.209	0.227	0.15
Experimental	32	35.80	1148.00				

Key: N: Number of participants; M: Mean rank; S Sum of ranks; U: Mann-Whitney U; Z: Z score; *p*: *p-value*; r: r-value.

4.1. Discussion

Our study investigated the effects of a gamification design composed of 10 different gamification elements on students' sense of accomplishment. Our findings indicate that gamification did not significantly affect students' sense of accomplishment, contrasting with the predominantly positive outcomes reported in much of the gamification literature.

Initially, one possible explanation for the lack of significant effects is the type and implementation of gamification elements used in the study. While gamification can enhance engagement and motivation, the specific elements and their integration into the educational system are crucial in determining their effectiveness [2, 24]. Our study employed a specific gamified approach without isolating the impact of individual elements. It is possible that the combination of elements used did not sufficiently align with the intrinsic motivators necessary to enhance students' sense of accomplishment.

Additionally, individual differences among students may have influenced the results. Factors such as students' intrinsic motivation, prior experience with gamification or games, and personal learning preferences could moderate their response to gamified elements [24]. For instance, students with a high level of intrinsic motivation might not require external gamified incentives to feel a sense of accomplishment, while others might need more personalized gamification strategies to experience significant effects.

The educational context and subject matter also significantly affect the effectiveness of gamification. Our study was conducted within a specific educational setting, which may not represent all learning environments. Different disciplines and learning tasks might interact with gamification elements in varied ways. For example, gamification might be more effective in subjects that naturally lend themselves to competitive or game-like activities than in those that do not.

4.2. Threats to validity and limitations

Our study presents validity threats and limitations that must be considered when interpreting the results. Factors like prior experiences, mood, or external distractions could have influenced outcomes, especially if they differed between the experimental and control groups. Participants' mood, energy, or focus during the 30-minute system usage may have impacted questionnaire responses, leading to differences in the reported sense of accomplishment unrelated to the gamification intervention. Additionally, completing the questionnaire itself may have influenced participants' answers.

The findings have limited generalizability due to the small sample size (N = 65) and the specific context of the educational system and gamification intervention studied. Results may not represent broader student populations or other educational settings. Using a self-reported questionnaire to measure the sense of accomplishment introduces limitations, as these measures are subject to biases and may not fully capture the complexity of students' experiences.

This study employed a gamified educational system incorporating 10 gamification elements designed based on the Self-Determination Theory. However, these elements may not fully encapsulate the complexity of gamification design or effectively generate a sense of accomplishment. Additionally, the findings cannot be generalized to other gamification designs. To achieve generalizable results, isolating specific game elements to examine their individual effects would be necessary.

The 30-minute usage duration may have been insufficient to capture the full effects of gamification on students' sense of accomplishment. Longer or repeated exposures might yield different results.

Moreover, the study did not control for confounding variables such as prior experience with gamified systems, individual motivational differences, or external distractions, which may limit internal validity and the interpretation of the findings.

4.3. Implications for researchers and practitioners

The findings of our study, which indicate no significant effects of gamification on students' sense of accomplishment, offer implications for educators, instructional designers, and educational technology developers. These implications can guide the effective implementation of gamification in educational settings and address the mixed results observed in previous studies.

Initially, given that our study found no significant increase in students' sense of accomplishment, educators might consider combining gamification with other pedagogical strategies known to enhance intrinsic motivation and student engagement. This could include providing more personalized feedback, fostering collaborative learning environments, and ensuring that the educational content itself remains challenging and engaging.

The lack of significant effects in our study suggests that not all gamification elements are equally effective in promoting a sense of accomplishment. Designers should prioritize elements that align with students' intrinsic motivations and ensure that these elements complement the overall learning goals.

Our findings highlight the need for a deeper understanding of how different students interact with gamified elements. Developers can engage in iterative design processes that involve students and educators in the testing and refinement of gamification features. This can help create more adaptive and responsive educational technologies that cater to diverse learning styles and preferences.

The mixed results observed in the literature, along with our findings, suggest that a one-size-fits-all approach to gamification may not be effective. Policymakers should support research and professional development initiatives that help educators understand how to implement gamification and integrate it with other instructional strategies effectively.

Isolating and examining the effects of individual elements, such as the progress bar, economy, and imposed choice, could provide more granular insights into which aspects of gamification are most effective in fostering a sense of accomplishment. Future studies can consider exploring different gamification elements individually rather than as a collective whole.

Our study was cross-sectional, measuring immediate outcomes after exposure to the gamified system. Longitudinal research could help determine whether the effects of gamification on a sense of accomplishment evolve over time and whether sustained engagement with gamified systems leads to more significant outcomes.

Variables such as students' intrinsic motivation, prior experience with games, learning preferences, and personality traits might moderate the effects of gamification. Understanding these individual differences can help in designing more personalized and effective gamified learning experiences that cater to diverse student populations.

Our study was conducted with a relatively small sample size (N = 65) and within a specific educational context. Larger-scale studies across different educational levels, disciplines, and cultural contexts could enhance the generalizability of the findings and provide a more comprehensive understanding of how gamification affects students' sense of accomplishment.

Qualitative research methods could uncover nuanced perspectives on how and why gamification elements impact students' sense of accomplishment, thereby informing the design of more effective gamified educational systems.

Lastly, combining gamification with approaches such as project-based learning, collaborative learning, and adaptive learning technologies might create synergistic effects that enhance students' sense of accomplishment and overall learning experience. Investigating these integrative approaches can lead to the development of more holistic educational practices that leverage the strengths of multiple pedagogical innovations.

5. Concluding Remarks

In this study, we investigated the effects of gamification on students' sense of accomplishment. The results indicated that gamification did not significantly influence students' sense of accomplishment. These findings have practical implications for the community and provide recommendations for future studies. In subsequent research, we aim to analyze the effects of gamification on other dimensions of the gameful experience.

Notes

The first author is a partner at the company that granted the rights to use the system Eagle-edu free of charge for research purposes in this project. The authors utilized generative artificial intelligence (*i.e.*, Microsoft Copilot) to improve the grammatical quality of the text.

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A. Study's Dataset

The study dataset can accessed from this link: https://osf.io/ykfqx/