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The Effects of Gamification on Students' Flow Experience

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Keywords: educational technology | experimental study | flow experience | gamification | user experience

ABSTRACT

Background: Gamification has been used in recent years to enhance the student experience in educational environments and to help students achieve an optimal experience. However, there is limited empirical evidence of the effects of gamification on specific psychological experiences, such as the students' flow experience, which is a highly motivating state associated with the learning process.

Objectives: To address this gap, we examined the impact of gamification on students' flow experience within a learning management system.

Methods: We conducted a controlled between-subjects experiment ($N=65$) in which participants in the experimental group interacted with a gamified version of the system, which incorporated a typical gamification design consisting of a collection of various game elements that constituted a form of meta-game interaction around the learning activity (as opposed to, for example, serious games or game-based learning). In contrast, the participants in the control group used the same system with the same educational tasks but without gamification. We used descriptive and inferential statistical methods (i.e., Mann–Whitney U test) to compare the students' flow experience between the groups.

Results and Conclusions: The results reveal that the influence of gamification on students' flow experience was not statistically significant. These findings suggest that current gamification designs may not effectively facilitate flow in educational contexts, highlighting the need for further research and development to align gamification with desired educational outcomes.

1 | Introduction

Flow, a state of optimal experience characterized by immersion in an activity (Csikszentmihalyi and Csikszentmihalyi 1975), is widely recognized as a cornerstone of learning (Oliveira et al. 2018; Guerra-Tamez 2023). When individuals achieve flow in a learning context, they can become fully absorbed, experiencing effortless action (Zhao and Khan 2022; Lin and Yu 2023; Dewaele and MacIntyre 2024). This state of deep involvement can lead to heightened motivation, improved focus, and a deeper comprehension of the material being learned (Csikszentmihalyi and Csikszentmihalyi 1975; Csikszentmihalyi 1990, 2000).

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. This article is an extension of the conference paper of Brambilla et al. (2024).

Summary

- What is currently known about this topic?
  - Gamification is often used in education to enhance student experiences and improve motivation.
  - The flow experience, a highly motivating psychological state, is linked to effective learning.
  - Despite the popularity of gamification, there is limited evidence showing its impact on specific psychological outcomes, such as the flow experience.
- What does this paper add?
  - This study presents new empirical data from a controlled experiment with 65 students.
  - It examines whether gamification impacts students' flow experience in a learning management system.
  - Results show no statistically significant effect of gamification on flow, suggesting current designs may not promote this desired state.
- Implications for practice/or policy
  - Educators and designers should reconsider how gamification is implemented in learning environments to provide students' flow experience.
  - Further research is necessary to better align gamification strategies with educational goals, especially fostering flow experiences.

Numerous studies have established a positive relation between flow experience and learning outcomes (Shernoff et al. 2003; Liao 2006; Beard 2015; Akbari et al. 2023; Wang et al. 2023).

At the same time, gamification (that is, "the design that provides motivational benefits similar to those games that are usually created" (Hamari 2019; Koivisto and Hamari 2019)), has grown significantly as an area of pedagogy and in educational technology (Zainuddin et al. 2020; Sailer and Homner 2020; Bennani et al. 2022; Khaldi et al. 2023; Hong et al. 2024). Gamification is expected to support positive motivational development among learners in the long term (Putz et al. 2020), and can also help in situ learning through better foundational cornerstones of what is often referred to as the flow state (Hamari and Koivisto 2014; Koivisto and Hamari 2019; Oliveira et al. 2021). However, while previous studies have examined the effects of gamification on students' flow experience from various perspectives, the findings remain inconsistent with theoretical expectations, leaving the impact of gamification on students' flow experience largely uncertain. (Oliveira et al. 2018, 2021; Oliveira and Hamari 2024).

Filling this gap, we conducted a between-subjects experiment ($N=65$) to examine the effects of gamification on students' flow experience during the use of a learning management system, aiming to answer the following research question: Does gamification affect students' flow experience in a learning management system? Participants in the experimental group interacted with a gamified version of the system, which incorporated a typical gamification design consisting of a collection of various game elements that constituted a form of meta-game interaction around the learning activity (as opposed to, for example, serious games or game-based learning), based on Self-Determination Theory (Deci and Ryan 2008). Participants in the control group interacted with the same system (completing the same educational tasks) without gamification. To compare the students' flow experience between the groups, we assessed the participants' flow experience using a consolidated instrument and used descriptive and inferential statistical techniques (i.e., Mann–Whitney U test) Mann and Whitney (1947).

Our findings indicate that the influence of the employed gamification on flow was not statistically significant ($U=453.000$, $Z=-0.987$, $p=0.324$), with a small effect size ($r=0.12$). This result suggests that the specific combination of game elements based on the Self-Determination Theory implemented in this study may not be sufficient to induce a significantly heightened flow experience among the students. Nevertheless, our results open the way for new discussions about the effects of gamification on the flow experience, especially indicating the need to rethink gamification designs to be able to induce psychological experiences, such as students' flow experience.

2 | Background

This section discusses the main topics addressed in this study (i.e., flow experience in educational settings, gamified education, and gamification design in educational settings). We also present and discuss recent related studies.

2.1 | Flow Experience in Educational Settings

Flow Theory, conceptualized by Csikszentmihalyi and Csikszentmihalyi (1975), describes an optimal psychological state where individuals are fully immersed in an activity, experiencing deep enjoyment and engagement (Csikszentmihalyi and Csikszentmihalyi 1975; Csikszentmihalyi 1990; Jackson et al. 2011). This state, often referred to as "being in the zone", occurs when there is a balance between the perceived challenges of a task and the individual's skills (Csikszentmihalyi 1990). In educational contexts, achieving flow is crucial, as it correlates with increased motivation, enhanced learning, and improved performance (Zhao and Khan 2022; Lin and Yu 2023; Dewaele and MacIntyre 2024). Flow is composed of nine different subfactors/dimensions (i.e., (i) challenge-skill balance; (ii) unambiguous feedback; (iii) clear goals; (iv) action-awareness merging; (v) total concentration on the task at hand; (vi) sense of control; (vii) loss of self-consciousness; (viii) transformation of time; and (ix) *autotelic* experience (Csikszentmihalyi 1990, 2000; Jackson et al. 1998)).

Recent studies support the importance of flow in educational contexts, indicating that flow is critical for enhancing student engagement and learning outcomes (Oliveira et al. 2018). Some studies found that satisfying basic psychological needs, autonomy, competence, and relatedness predicts the flow experience in digital gamified learning environments (Xi and Hamari 2019; Abuhamdeh 2020; Chou et al. 2023). Specifically, autonomy and competence were significant predictors of flow, emphasizing the need to provide students with meaningful choices and opportunities to feel effective in their actions (Lüking et al. 2023). Inconsistencies in defining the flow as either a continuous or discrete construct, inherently enjoyable or not, and dependent on task characteristics have hindered (Hackert et al. 2023; Tang et al. 2023; Kirchhoff et al. 2023). It is argued that flow should be exclusively conceptualized as a discrete, highly enjoyable state of consciousness, distinct from the conditions that elicit it (Abuhamdeh 2020).

Educators aim to facilitate flow by designing learning activities that are neither too challenging nor too simple, thereby maintaining student engagement (Oliveira et al. 2018). Recent studies have investigated the relationship between gamification and flow (Oliveira et al. 2021; Oliveira, Hamari, et al. 2022; Zhao and Li 2020). Despite the various studies involving Flow Theory and Education, one of the main challenges remaining related to Flow Theory in education is to analyse what approaches can bring a flow experience (Jackson et al. 1998; Hamari and Koivisto 2014; Lee et al. 2014).

2.2 | Gamified Education

Gamification in education utilises game design concepts (e.g., game elements and mechanics) to create a more engaging and interactive learning environment (Oliveira et al. 2020; Christopoulos and Mystakidis 2023; Zeybek and Saygı 2024). It aims to improve student motivation and learning outcomes (Denden et al. 2021; Vrcelj et al. 2023; Kiron and Vassileva 2024; Capecchi et al. 2024). Achieving a flow state is important for enhancing educational experiences (Staneva et al. 2023; Ananda et al. 2024). Thus, gamification is expected to have the potential to help students reach this optimal state of flow (Lüking et al. 2023; Lampropoulos and Kinshuk 2024). The incorporation of these elements taps into intrinsic motivational factors, encouraging students to participate and persist in their educational activities actively (Nah et al. 2014). Research has demonstrated several key benefits of gamification in education, including enhanced engagement, improved knowledge retention, increased collaboration, and better problem-solving skills (Asmolov and Ledentsov 2023; Zeybek and Saygı 2024).

Recent studies have highlighted the positive impacts of gamification across various educational settings (Oliveira et al. 2018, 2021; Oliveira and Hamari 2024). A longitudinal study involving 1001 higher education students compared traditional, online, and gamified learning environments over three years, indicating that gamified learning significantly improved students' academic performance, engagement, and retention rates compared to both traditional and online learning methods (Lampropoulos and Sidiropoulos 2024). Especially in higher education, gamification has been shown to foster active and participatory learning environments (Chans and Portuguez Castro 2021), providing benefits, including increased student motivation and improved learning outcomes, and emphasizing the need for continued research to understand the impact of gamification on the teaching-learning process fully (Kaufmann 2018).

Additionally, gamification has been applied effectively in medical education, where it has been shown to enhance clinical reasoning skills and prepare students for professional challenges (Krishnamurthy et al. 2022). For instance, gamified learning environments in medical training have been associated with improved confidence, interest levels, and clarity of learning objectives (Lorenzo-Alvarez et al. 2020; Abuhamdeh 2020; Xu et al. 2023). Moreover, the integration of digital educational games and gamified learning activities can develop essential skills such as problem-solving, collaboration, and strategic thinking (Becker 2021). Continuous innovation and evaluation of gamified teaching practices are necessary to bridge the gap between academic research and practical application, especially in the wake of technological advancements and global challenges (Hou 2023; Asmolov and Ledentsov 2023).

2.3 | Gamification Design in Educational Settings

Gamification appears to be a potential pedagogical approach, stimulating and maintaining student engagement (Koivisto and Hamari 2019; Sailer and Homner 2020). However, there may be caveats such as specificities in the design of the implemented gamification that affect the effectiveness of competition, which hinges on the perception of the reward system's fairness and transparency (Buckley et al. 2017). While research generally shows positive correlations between gamification and learning outcomes like motivation and self-efficacy (Hsu and Chen 2018; Legaki et al. 2020), results, in general, are mixed (Hanus and Fox 2015; Ding 2019; Almeida et al. 2023), indicating a need for further investigation into different gamification designs in educational settings (Koivisto and Hamari 2019).

Studies have emphasized that the impact of gamification on learning outcomes can be significantly influenced by how the elements of the game align with the intrinsic motivations of students and the characteristics of the learning environment Zourmpakis et al. (2023); Jones et al. (2023); Grabner-Hagen and Kingsley (2023). For instance, Khaldi et al. (2023) highlighted that autonomy-based game elements, such as providing students with choices, can significantly enhance perceived autonomy and promote flow experiences. Similarly, competence-based elements, such as challenging tasks and immediate feedback, foster a sense of competence and engagement among learners (Khaldi et al. 2023).

Thus, the gamification design is a crucial factor related to gamification (Deci and Ryan 2008). As an example, autonomy refers to the individual's sense of control over their learning activities, and competence refers to the individual's belief in their ability to complete the task at hand successfully (Niemiec and Ryan 2009). Gamification can be designed to enhance both autonomy and competence (Xi and Hamari 2019; Sailer et al. 2017). Studies have shown that autonomy-based game elements, such as choice, can increase students' perceived autonomy and promote flow experience (Xi and Hamari 2019). In contrast, competence-based game elements, such as challenges and rewards, can enhance students' perceived competence and contribute to flow (Shi et al. 2014; Sailer et al. 2017; Shi and Cristea 2016).

2.4 | Related Work

Over the years, studies have examined the effects of gamification and educational games on students' flow experience. Some systematic reviews have made these studies explicit (Perttula et al. 2017; Oliveira et al. 2018, 2021; Oliveira and Hamari 2024).

Based on the results of these literature reviews and also on recent searches, we present some similar works conducted recently. Marinho et al. (2019), in a mixed method study, explored students' disengagement, examining how individual player profiles might impact the students' flow experience. The main results did not indicate significant differences in the students' flow experience in the proposed settings (Marinho et al. 2019).

Oliveira et al. (2020); Oliveira, Hamari, et al. (2022) investigated in a quantitative study the impact of tailored gamification (i.e., different gamification designs) on elementary school students' flow experience in an educational setting (i.e., comparing tailored and counter-tailored versions of a gamified educational system). The main results did not indicate effects between personalization and students' flow experience (Oliveira et al. 2020; Oliveira, Hamari, et al. 2022). Zhao and Li (2020) explored the efficacy of gamification in enhancing students' flow experience in mathematics classes. The research, conducted within a primary school setting, evaluates how educational games affect learners' flow experience in mathematics tasks. The results indicate that the game setting can improve some particular flow experience dimensions (i.e., loss of self-awareness and neglect of time passing) but not the overall flow experience (Zhao and Li 2020).

Chan et al. (2021) investigated whether game-based learning leads to differentiated gains in students' perceived flow experience in competitive and non-competitive games. Similar to the study conducted by Zhao and Li (2020), the results indicate that game-based learning, when learning in groups, positively affected some particular flow experience dimensions (i.e., feedback, autonomy, goal clarity, and social interaction), but not the overall flow experience (Chan et al. 2021). Thomas and Baral (2023) examined how flow is integral to gamification's impact on behavioural and emotional outcomes, suggesting that well-designed game elements can induce a flow state by balancing challenges and skills, providing clear goals, and offering immediate feedback. Finally, Kaya and Ercag (2023) explored how challenge-based gamified programmes in the learning process of students increase students' flow experience through the generated competition and challenge. Grounded in Flow Theory, the study showed that challenge-based gamified learning increased the flow level of learners but not significantly.

Other studies indirectly analyse the students' flow experience in educational games or gamified systems. These studies analyse the flow experience of students in gamified environments, but gamification is not taken into account or analyse the effect of flow on some external variable (Özhan and Kocadere 2020; Lüking et al. 2023; Issabek et al. 2023; Oliveira et al. 2024; Chen and Mokmin 2024). Table 1 presents a comparison between the studies.

In summary, while previous studies have examined the effects of gamification on students' flow experience from various

TABLE 1 | Related works comparison.

Study	*N*	Game elements	Signification difference	Approach
Marinho et al. (2019)	18	Individual, non-competitive (token and medal); Collaborative, non-competitive (tokens); Individual, competitive (PBL); Collaborative, competitive (tokens + PBL)	No	Gamified educational system
Oliveira et al. (2020); Oliveira, Hamari, et al. (2022)	121	Points (XP), Levels/stages, Badges/Trophies, Ranking/Leaderboards, Progress bars, Storyline, Feedback, Background history, and Avatar (presented separately)	No	Gamified educational system
Zhao and Li (2020)	36	Not available	Yes (Loss of Self-Awareness)	Educational game
Thomas and Baral (2023)	184	Points and leaderboards	Yes (however, a mediating effect)	Gamified educational system
Chan et al. (2021)	142	Not available	Yes (however, only specific dimensions, that is, feedback, autonomy, goal clarity, and social interaction)	Educational game
Kaya and Ercag (2023)	30	One-on-one challenge feature	Yes (however, not significantly)	Gamified educational system

Abbreviation: *N*, sample size.

perspectives, the findings remain inconsistent with theoretical expectations (Chou and Ting 2003; Brühlmann et al. 2013; Admiraal et al. 2011; Whittaker et al. 2021), and empirical knowledge is limited. This situation generates a lack of knowledge about the effects of gamification on students' flow experience. We are one of the pioneers in conducting a between-subjects controlled experimental study examining how gamification (considering a single combination of 10 game elements) influences students' flow experience.

3 | Study Design

In this section, we investigate the effects of gamification on students' flow experience. Thus, we conducted a controlled between-subjects experiment employing inferential statistics to identify the results. In this section, we present the study's design.

3.1 | Materials and Methods

We employed the learning management system Eagle-edu[1] to conduct our study (i.e., present the educational tasks for the participants). We chose this system because of its adaptability, which empowers educators to create diverse educational activities. The system incorporates 21 distinct game elements, which align with the Taxonomy of Gamification Elements for Educational Environments (TGEEE) proposed by Toda, Klock, et al. (2019). Teachers can select or disable these elements, allowing them to personalize the gamification designs. Thus, the system allowed us to assemble the appropriate gamification design for the study (i.e., for both experimental and control groups). At the same time, in addition to being used commercially, allowing it to imitate a real environment as closely as possible, the system has already been used in several scientific studies, for example, (Rodrigues et al. 2021, 2024; Oliveira, Tenório, et al. 2022), thus avoiding biases related to the use of the system.

In our study, we utilized two different versions of the system: the version used with the participants in the experimental group presented a series of educational tasks incorporating a typical gamification design consisting of 10 game elements that created a meta-game interaction around the learning activity (distinct from, for instance, serious games or game-based learning). The version used with the participants in the control group presented the same educational tasks but without gamification. In Appendix A, we present a series of pictures detailing the system design and comparing the versions used in the experimental and control groups.

When accessing the system for the first time, all participants (both in the experimental and control groups) received the same "welcome message", as shown in Appendix A, Figure A1. For the experimental group, the gamification design is comprized of 10 game elements, aligned with the taxonomy proposed by Toda, Oliveira, et al. (2019):

- *Acknowledgment*: This element provides feedback recognizing specific player actions. In our system, this was represented by student badges.
- *Chance*: Linked to randomness and probability, this element affects the likelihood of certain outcomes.
- *Competition*: Arising when multiple players compete for a shared goal.
- *Economy*: This element involves game transactions, including the monetization of values. Our system featured coins as currency for in-game purchases.
- *Imposed Choice*: Players had to make decisions to progress in the game. Our system offered random options to increase rewards.
- *Level*: Representing hierarchical progression, levels in our system were categorized as Bronze, Silver, Gold, Ruby, and Diamond.
- *Objective*: Goals, either quantifiable or spatial, guided players in the game. In our system, a quest tree structure represented the objectives.
- *Points*: Points measure user performance, with experience points (XP) serving as the unit of measurement.
- *Progression*: This element tracked player advancement through a progress bar integrated into the activity tree.
- *Stats*: Displaying a player's results and progress, this element provides visible information on all user progress data.

In Appendix A, Figure A2, we present the main screen of the course used with the students in the experimental group, displaying six different game elements (i.e., Objective, Progression, Points, Competition, Level, and Acknowledgment). The element *Objective* is represented by the mission tree, presenting a group of educational questions that the participants had to solve. The element *Progression* is represented by the progress bar, which is filled as users progress in educational activities. The element *Points* is represented by the metric used to evaluate student performance and is represented in the system in terms of experience points accumulated by the participant. The element *Competition* was introduced through a leaderboard showcasing up to 10 students ranked up to ten students. The element *Level* is represented by sequential stages that offer incremental benefits to users as they advance. In the specific case of this figure, the student is at the Bronze level, and the text below indicates what they need to achieve to move up a level. The element *Acknowledgement* was represented by student badges. In Appendix A, Figure A3, we present the main screen of the course used with the students in the control group. This page only allows access to educational activities. However, it does not display any gamification element.

In Appendix A, Figure A4, we present the element *Imposed choice*, where users are asked to make a decision that would grant them an active role in determining their progress in a mission (i.e., double of rewards). 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 (i.e., not receiving any reward for the mission). For participants allocated to the control group, no options are presented.

In Appendix A, Figure A5, we present the element *Chance*, where users encountered choices (e.g., selecting between chests) reflecting chance-based mechanics. The element is represented by chests, which can cause the student to be surprized and win something (e.g., more points or coins) at some point while using the system (Appendix A, Figure A5).

In Appendix A, Figure A6, we present the element *Economy*, representing the capitalization of gaming assets. Students in the experimental group have the option to access a store and purchase items related to platform benefits, such as earning double points for each completed mission. Students in the experimental group do not earn coins and do not have access to the store.

In Appendix A, Figure A7a, we present the element *Stats*, represented by visual displays, showing users in the experimental group everything received after each mission and listing all achievements accumulated throughout their use of the system. Participants in the control group received only traditional feedback, simply informing them that the mission was completed (see Appendix A, Figure A7b).

The educational activities within the system were organized into three distinct missions: (i) general knowledge, (ii) logical reasoning, and (iii) English language. Each mission consisted of five tasks in a quiz format. 25 tasks were designed, partly based on a famous and standard test for admission to a medical faculty in Italy—a national test covering many different topics. Not all of the questions came from there, especially the general knowledge questions, where we decided to explore a different set of topics.

The task difficulty level was based on a test designed for individuals aspiring to become university students. All modifications to the standard questions were aimed at adapting them for an international context, as our study was conducted at a European university, which had this characteristic. The questions were crafted to be as general and understandable as possible for all participants. During the experiment, students had the freedom to choose where to begin and which tasks to complete. This structure was intentionally designed to minimize potential biases arising from students' preferences for specific subjects. An instructor with expertise in these areas created the activities. Importantly, participants in both the gamified and non-gamified versions of the system were presented with identical educational tasks.

In Appendix A, Figure A8, we present an example of a mission on Logical Reasoning used with participants in the experimental group, where students have access to a progress bar (element *Progression*) at the top of the screen. Participants in the control group do not have access to this progress bar. In Appendix A, Figure A9, we present another example of an activity being answered by participants, while in Appendix A, Figure A10, we present the same task after being answered (correctly) and receiving automatic feedback from the system. Participants in both the experimental and control groups receive this feedback, as in our design, feedback is not considered a game element, but rather a standard basic action of the system.

To assess participants' flow experience, we used the Short Flow Experience Scale (FSS) (Jackson and Eklund 2002), which consists of nine questions representing the nine original flow experience dimensions proposed by Csikszentmihalyi and Csikszentmihalyi (1975), namely: challenge-skill balance, action-awareness merging, clear goals, sense of control, total concentration, transformation of time, feedback, loss of self-consciousness and autotelic experience. The questionnaire was chosen because, according to Oliveira et al. (2018), it is the most used questionnaire in studies related to Flow Theory and technologies in education. Psychometric research has demonstrated sophisticated confirmatory analysis to measure the internal consistency of the FSS (Jackson et al. 2008). Following the "Flow Experience Manual" (Jackson et al. 2011), the instrument was applied through a five-point Likert scale (Likert 1932). To mitigate threats to validity related to the participants' attention during the study, following the recommendation of Kung et al. (2018), we added an "attention check statement" requesting a specific response-"Please, mark the option 'Agree', to let us know that you are paying attention". To assess scale reliability, we calculated Cronbach's Alpha (Cronbach 1951) and McDonald's Omega (McDonald 2013), both of which yielded acceptable values (i.e., Cronbach's $\alpha = 0.754$; McDonald's $\omega = 0.754$). Data were analysed using SPSS software.

The study involved three key steps. *First*, participants were randomly assigned to either the experimental or control group. *Second*, participants used the system for at least 30 min, engaging in completing the educational tasks and exploring the system. *Third*, participants responded to the short FSS (immediately after finishing using the system) to identify their flow experience when using the system. Figure 1 summarises the study method.

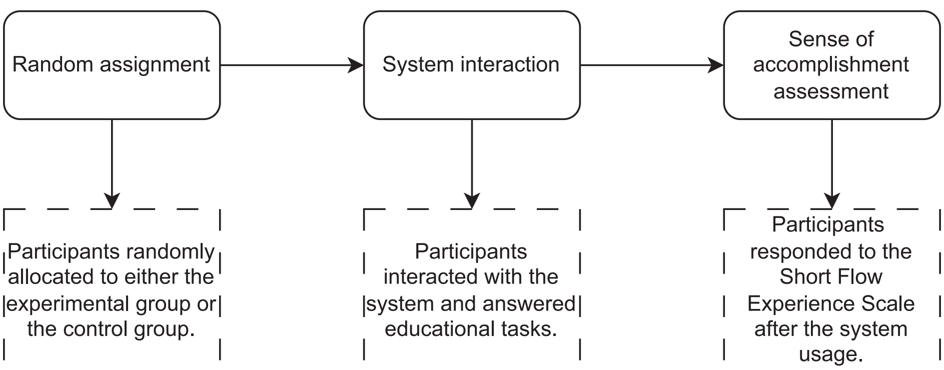

FIGURE 1 | Study's method.

3.2 | Participants and Data Analysis

Participants were recruited via Tampere University DMLab pool, utilizing ORSEE3 software for coordination (Greiner 2015). Of the initial pool, three participants were excluded due to a wrong answer in the "attention check statement". The final sample was composed of 65 students from 19 countries., From the 65 participants, 34 identified themselves as female, 28 as male, two as non-binary, and one preferred not to respond. The average age of the participating students is 25 years old, with a standard deviation of 6.00 and a variance value of 33.00. Each participant received 8.00 euros as compensation for their participation. All research procedures were conducted in strict adherence to the guidelines established by the Finnish National Board on Research Integrity (TENK).

To ensure the selection of appropriate statistical tests, we began by assessing the distribution of the collected data. Given the ordinal nature of the data, obtained through a scale, and the sample size of $N = 65$, we employed the Shapiro–Wilk test (Shapiro and Wilk 1965), a well-established method for normality assessment that is particularly suitable for samples of this size (Field 2013). The results of the test yielded a W statistic of 0.962 and a *p-value* of 0.043, leading us to reject the null hypothesis of normality and conclude that the data exhibited a non-normal distribution. Thus, we opted for the non-parametric Mann–Whitney U test (Mann and Whitney 1947) to compare the means between the experimental (gamified) and control (non-gamified) groups. This test is well suited for our analysis as it offers robustness against violations of normality assumptions and maintains reliability even with small sample sizes (Field 2013). The data were analysed using SPSS software.

4 | Results

To initially characterize our sample and facilitate subsequent group comparisons, we calculated descriptive statistics, including measures of central tendency (i.e., mean, variability (i.e., variance (VAR), and standard deviation (SD))) for the students' flow experience in both experimental (gamified) and control (non-gamified) groups. Participants' flow experience was calculated based on the average of the nine items, as recommended in the "Flow Experience Manual" (Jackson et al. 2011). A summary of the descriptive statistics is presented in Table 2.

TABLE 2 | Descriptive analysis of students' flow experience in the control and experimental groups.

Group	Mean	VAR	SD
Control	3.697	0.347	0.580
Experimental	3.858	0.337	0.571
Overall	3.776	0.343	0.581

Abbreviations: SD, standard deviation; Var, variance.

We then conducted a Mann–Whitney U test to examine potential differences in flow experience between gamified and non-gamified educational systems. The results (see Table 3) demonstrated that while students in the experimental (gamified) group exhibited a numerically higher flow experience score than those in the control (non-gamified) group, the difference was not significant ($U = 453.000$, $Z = -0.987$, $p < 0.324$). The associated effect size was also small ($r = 0.12$), suggesting a limited practical impact of gamification on flow in this context (Field 2013).

4.1 | Discussion

In this study, we faced the problem of understanding the effects of gamification on students' flow experience. We conducted a between-subject controlled experiential study to compare the participants' flow experience in the experimental (i.e., gamified) and control (i.e., non-gamified) groups. Students in the gamified group reported higher flow scores than those in the control group. However, this difference was not statistically significant, thus indicating that the implemented gamification design did not affect the students' flow experience.

Some recent studies have reported that gamified systems can positively affect some dimensions of the flow experience in the perception of the students (Zhao and Li 2020; Chan et al. 2021). For example, Zhao and Li (2020) found significant improvements in loss of self-awareness in students during the use of a gamified environment. Similarly, Chan et al. (2021) demonstrated that gamification enhanced feedback, autonomy, goal clarity, and social interaction (dimensions of flow experience). These studies suggest that gamification can be an effective tool for enhancing flow. However, these studies have in common that they did not find effects on the overall flow experience but only on some specific dimensions.

The results presented in these studies indicate that, despite initial appearances, gamification did not significantly affect the flow experience. This could be because, given that the flow experience is a holistic, aggregate, and latent phenomenon, influencing it can be challenging (Csikszentmihalyi and Csikszentmihalyi 1975; Csikszentmihalyi 1990). At the same time, this complexity is also evident in its measurement, which comprises nine distinct dimensions (Jackson et al. 1998, 2011).

TABLE 3 | Inferential analysis.

Group	*N*	M	S	U	Z	*p*	*r*
Control	33	30.73	1014.00	453	−0.987	0.324	0.12
Experimental	32	35.34	1131.00				

Abbreviations: M, mean rank; *N*, number of participants; *p*, *p*-value; *r*, *r*-value; S, sum of ranks; U, Mann–Whitney U; Z, Z score.

The results of the studies show that gamification can help students achieve specific dimensions of the flow experience; however, it does not appear to facilitate the achievement of an overall flow experience. Thus, these findings from recent literature corroborate our results, indicating that the gamification of educational environments does not seem sufficient to lead students to a complete flow experience while using the system.

Similarly, other recent studies conducted under different conditions (e.g., modelling relationships between flow experience and other variables) also indicated that gamification did not affect students' flow experience (Oliveira et al. 2020; Oliveira, Hamari, et al. 2022; Marinho et al. 2019). For instance, both Oliveira et al. (2020); Oliveira, Hamari, et al. (2022) and Marinho et al. (2019) found no significant effects of gamification on students' flow experience in elementary education settings according to their user types. These results also support our new findings, indicating that gamification does not positively affect students' flow experience.

Thinking on the reasons for this repetitive result, uncontrolled factors (e.g., individual characteristics of the participants, or specific aspects of gamification implementation), generally not addressed in this type of study, may have influenced the results. Thus, different aspects related to or not to the gamification design implemented on the platform can affect each individual's flow experience differently. For example, factors such as prior gaming experience, personal interest in the subject matter, and intrinsic motivation levels can significantly influence how gamification impacts flow (Erylmaz and Boicu 2023).

Along the same line, the dichotomy between the subjectively perceived improvement in the flow experience and the lack of statistical significance underscores the imperative to refine our theoretical understanding of the nuanced ways gamification interacts with individual and contextual factors to influence students' learning experience. This calls for a more granular approach to studying gamification, possibly through mixed-method research that combines quantitative flow measures with qualitative insights into student experiences and perceptions.

Theoretical studies carried out over the last few decades indicate that the flow experience is complex (Csikszentmihalyi 2000), difficult to achieve, generally achieved in some specific types of activities (e.g., practicing sports (Locke 2001), games (Shen et al. 2022), and religious rituals (Noh and Shahdan 2020)), and which depends on intrinsic motivation (Kirchhoff et al. 2023). Given this complexity, it is possible that the educational context, with its inherent demands and constraints, presents unique challenges for achieving flow. Educators may need to consider additional motivational strategies alongside gamification to better support students in reaching a flow state. Also, the learning experience is probably more dominant in the user's attention and is probably much stronger in determining the flow state/experience.

It is also necessary to recognize that the game elements implemented in this study functioned more as meta-games rather than full-fledged games. While traditional games require active engagement and concentration, gamification in this context primarily involves peripheral interactions, such as checking badges or monitoring progress. These activities occurred outside the core educational tasks and were not integral to the workflow. As a result, students engaged with these gamified elements during their downtime rather than during active involvement with the educational content. This intermittent and peripheral engagement likely prevented the deep focus and challenge-skill balance (necessary for the emergence of flow (Csikszentmihalyi and Csikszentmihalyi 1975; Jackson et al. 1998; Csikszentmihalyi 2000)).

Furthermore, the expectation that gamification would naturally lead to increased flow experience might stem from a somewhat simplistic understanding of the psychological mechanisms at play (Oliveira et al. 2021; Oliveira, Hamari, et al. 2022). Flow, as described by Csikszentmihalyi and Csikszentmihalyi (1975); Csikszentmihalyi (1990, 2000), is a state that emerges when individuals are fully immersed in an activity that presents a challenging yet achievable goal, where their skills are well-matched to the task's demands. This state is commonly experienced during activities like playing a game, performing music, or solving complex problems (Gold and Ciorciari 2020; Van Der Linden et al. 2021). In contrast, the gamified elements in our study did not necessarily align with these conditions, as they did not demand the same level of skill or engagement. Therefore, the psychological state of flow was less likely to be triggered.

The design of the game elements also played a significant role in this outcome (Oliveira, Hamari, et al. 2022; Brühlmann et al. 2013). In many instances, students interacted with the gamified components during times when the conditions conducive to flow were absent. For instance, checking for rewards or achievements may not provide the immediate feedback, challenge, or deep engagement required to foster flow (Jaftha et al. 2021; Chung and Pan 2023; Lampropoulos and Sidiropoulos 2024). As a result, while gamification can enhance motivation and provide a sense of achievement, it may not always be sufficient to induce the state of flow, especially when the interaction with gamification is separated from the primary educational tasks.

Our results, combined with recent similar results, indicate that it is not easy to achieve the flow experience in an educational environment because even with the use of gameful technologies, such as games and gamified systems, educational systems require intrinsic motivation on the part of students to achieve the flow experience. This suggests that gamification, in its current form, may need to be supplemented with other pedagogical techniques that enhance intrinsic motivation, such as personalized learning paths, real-world problem-solving tasks, and more frequent formative feedback.

Besides, the non-significant difference in flow scores challenges existing theories that suggest a strong link between gamification and enhanced flow experiences, indicating that gamification alone may not be sufficient to enhance flow significantly and that other factors, such as task complexity and individual differences, can play a crucial role. This finding is critical for educators and instructional designers as it highlights the need for a more comprehensive approach to gamified learning. Rather than relying solely on gamification, it might be beneficial to integrate it with other engagement strategies, such as collaborative learning and adaptive learning technologies.

Our study contributes to the growing body of literature on gamification by providing empirical evidence that nuances the understanding of its effects on flow. The findings suggest that gamification is not a one-size-fits-all solution and that its effectiveness may be contingent on multiple factors. This adds to the theoretical development of gamification, indicating the need for a more nuanced understanding of how and why gamification influences flow. It highlights the importance of context and the specific design of game elements in achieving the desired educational outcomes.

4.2 | Threats to Validity and Limitations

Some threats to validity and limitations must be carefully considered when interpreting and generalizing the results. The study was carried out with a relatively small sample (i.e., 65 participants) and for a short period (i.e., at least 30 min), which may limit the generalization of the results to a wider population and type of course (i.e., short courses), potentially influencing the representativeness of the data and compromizing external validity and the ability to extrapolate the results to more diverse educational contexts.

The experiment was conducted in a specific educational environment, and the results may not be directly transferable to other educational contexts. Also, the definition and implementation of game elements can vary. Thus, while the design in this study is rather prototypical, there is variance between the designs universally and the gamification design, making the effects sensitive to the specific characteristics of the elements used. This may also have directly influenced the flow experience, as some elements may lead to a feeling of anxiety, which may have negatively affected the flow experience. Additionally, students in an experimental setting may behave differently than they would in real-world learning scenarios.

While the study focused primarily on the direct effects of gamification on flow, individual factors such as prior gaming experience and learning preferences may act as moderating variables, influencing how students respond. We addressed potential limitations by using techniques such as randomization in participant group assignment and appropriate statistical analysis methods.

4.3 | Recommendations for Future Studies

Based on the results of our study, as well as the identified limitations, it is possible to propose some points to be considered in future studies. In this study, we utilized a relatively small sample size, which poses several limitations. A small sample may not provide a comprehensive representation of the population, potentially leading to biases and reduced generalizability of the findings. Future research should aim to recruit a larger and more diverse sample to enhance the robustness and external validity of the results. Larger samples will allow for more accurate statistical analyses and a better understanding of the phenomena under investigation.

Our research employed a specific gamification design (i.e., based on 10 different game elements), which might limit the applicability of the findings to other gamification frameworks. The particular elements and structure of the gamification used in this study may not resonate with all user groups or contexts. To address this limitation, future studies should explore a variety of gamification designs and compare their effectiveness. This approach would provide a broader understanding of how different gamification strategies impact user behaviour and outcomes.

The study did not take into account individual differences between participants, which can significantly influence the results. Variables such as age, gender, personality traits, and prior experience with gamified systems can affect how participants respond to the intervention. Future research should consider these individual differences by incorporating measures to assess them and analysing their impact on the results. This would help identify subgroups for whom the intervention is particularly effective or ineffective.

Last but not least, this study was conducted in a controlled and monitored environment, which might not accurately reflect real-world conditions. The artificial setting might influence participants' behaviour and responses, potentially leading to different outcomes than those observed in naturalistic settings. Future studies should strive to implement research in more natural and unmonitored environments to better capture authentic user interactions and behaviours within the learning environment. This would enhance the ecological validity of the findings and improve their applicability to real-world scenarios.

5 | Concluding Remarks

This study examined the impact of gamification on students' flow experience using a controlled between-subjects experiment. Although the observed differences in flow between the gamified and non-gamified groups were not statistically significant, there was an indicative trend toward higher flow scores in the gamified group. To further investigate these subtle effects, in future research, we aim to replicate the study with a larger sample to enhance statistical power and will also analyse various gamification designs and explore potential moderating factors, such as individual learning preferences.

Author Contributions

Wilk Oliveira: conceptualization, investigation, writing – original draft, methodology, validation, writing – review and editing, formal analysis, project administration, and data curation. **Pasqueline Dantas Scaico:** conceptualization, investigation, writing – original draft, methodology, validation, writing – review and editing. **Juho Hamari:** conceptualization, investigation, funding acquisition, methodology, validation, writing – review and editing, supervision. **Zhaoxing Li:** writing – original draft, writing – review and editing. **Lei Shi:** writing – original draft, writing – review and editing.

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Conflicts of Interest

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.

Data Availability Statement

The data that support the findings of this study are openly available in OSF at https://osf.io/97nu4/, reference number 97nu4.

Endnotes

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

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Appendix A

System Design

This appendix describes the system design used in the study, especially comparing the versions used with the experimental and control groups.

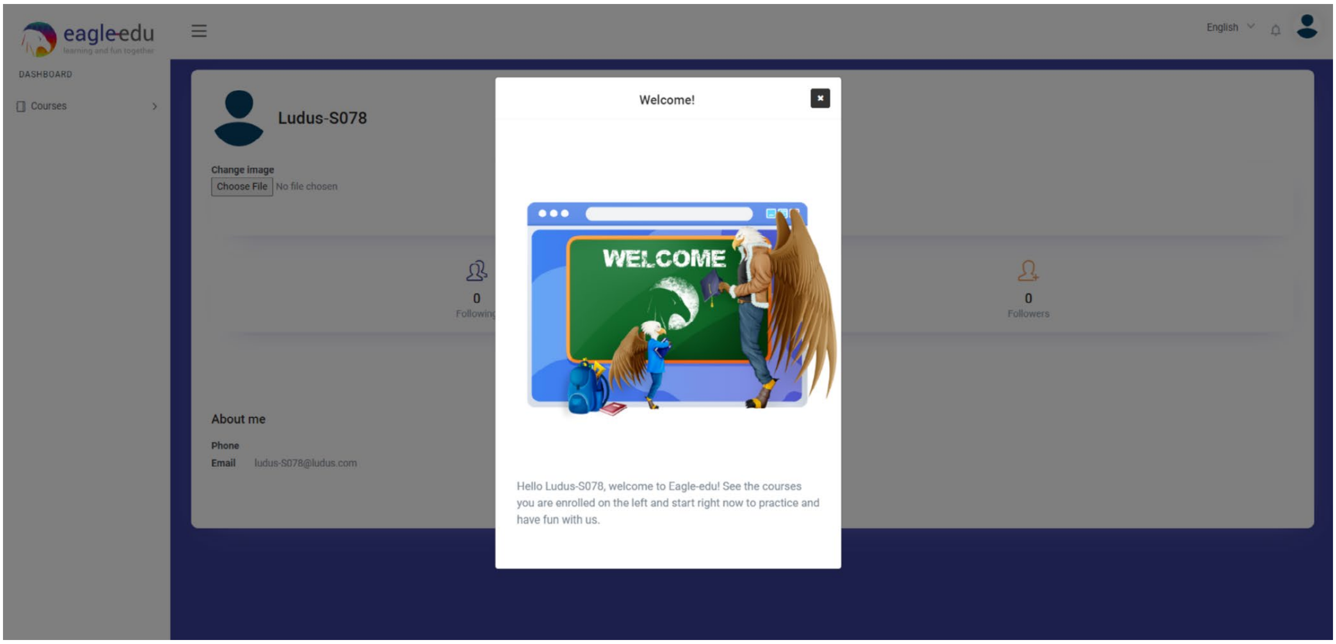


FIGURE A1 | Welcome screen. The figure shows a welcome screen on the Eagle-edu platform. At the top, a large text box with the title "Welcome!" overlays the user profile screen. In the center of this box is an illustration of two eagle-like characters standing in front of a chalkboard with "WELCOME" written on it in large, green letters. The larger eagle character, on the right, holds a graduation cap and points to the board, appearing to teach or guide the smaller eagle character on the left, who is looking up attentively. Below the illustration, the text reads: "Hello Ludus-S078, welcome to Eagle-edu! See the courses you are enrolled on the left and start right now to practice and have fun with us."

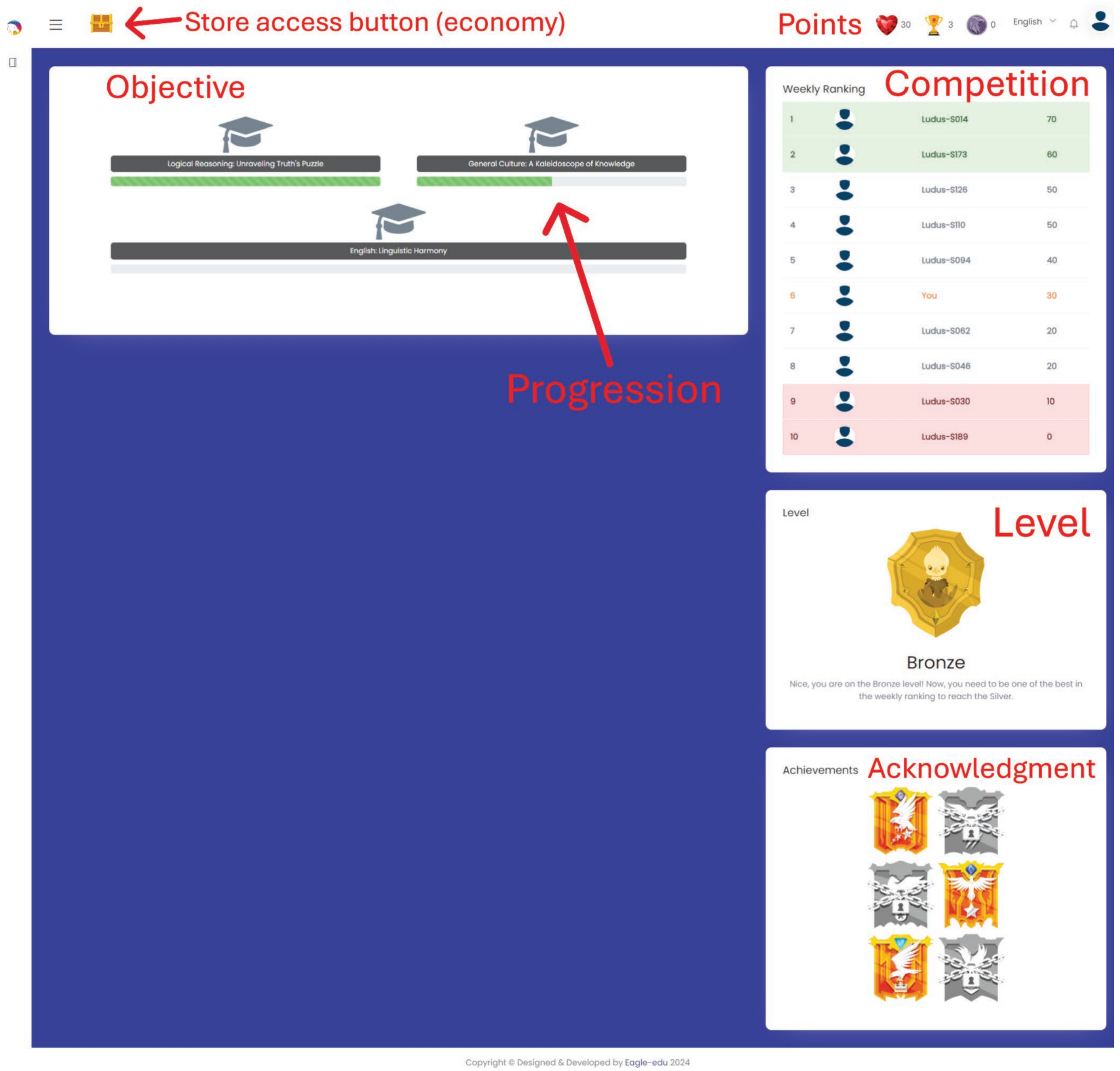


FIGURE A2 | Course main screen used with the students in the experimental group, displaying six different game elements. *Store Access Button (Economy)*—At the top left, there is a button in the shape of a store icon. *Points*—At the top right, a points symbol displays the number of points. *Objective*—The main section of the screen displays course objectives as progress bars. *Progression*—An arrow points to a specific course bar to highlight progression in that objective. *Competition*—On the right side of the screen is a “Weekly Ranking” section, displaying a leaderboard with usernames and corresponding scores. *Level*—Below the leaderboard, the user's current level is displayed with a shield icon. *Acknowledgment*—At the bottom right, an “Achievements” section shows a grid of badges or trophies representing completed milestones.

FIGURE A3 | Course main screen presented for the students in the control group. The figure shows a simplified user interface screen from the Eagle-edu platform with a primary focus on course activities. Centered at the top of the screen, there is a label “Activities” with a graduation cap icon above it. The main background of the screen is a solid blue, creating a visually contrasting area for content to stand out. At the top right corner, language selection (“English”) and a user profile icon are displayed, along with a bell icon for notifications. The overall layout is minimalistic, primarily focusing on the “Activities”.

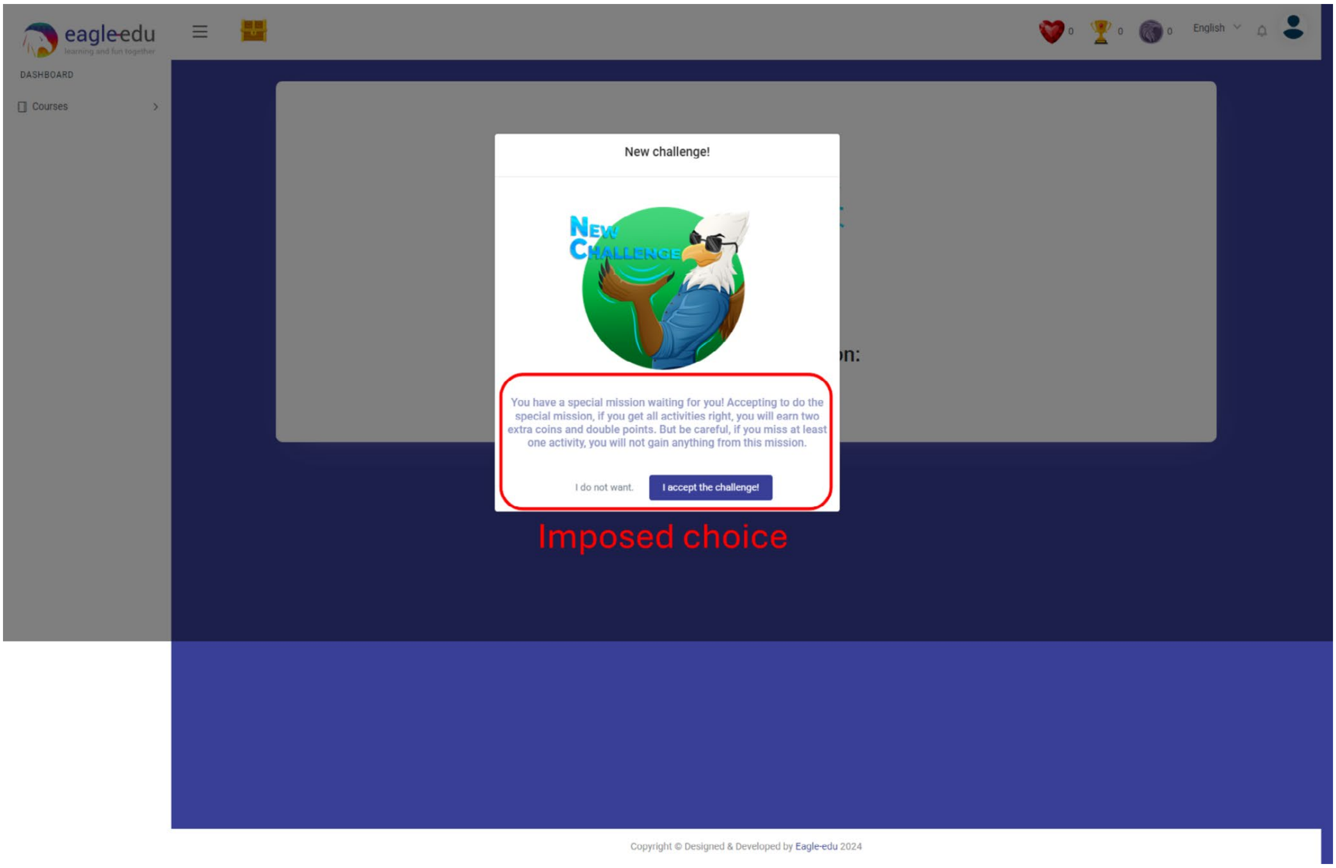


FIGURE A4 | Screen presenting the element *Imposed choice* for the students in the experimental group. The image shows a pop-up challenge notification on the Eagle-edu platform interface, with an imposed choice presented to the user. *Pop-up Challenge Window*—In the center of the screen, a dialogue box labelled "New challenge!" appears. The dialogue box includes an illustration of an eagle character wearing sunglasses, with the text "New Challenge" positioned to the left of the eagle. *Challenge Description*—Below the illustration, a message reads: "You have a special mission waiting for you! Accepting to do the special mission, if you get all activities right, you will earn two extra coins and double points. But be careful, if you miss at least one activity, you will not gain anything from this mission." *Choice Options*—At the bottom of the pop-up, there are two buttons for the user to choose from *The left button* states, "I do not want." *The right button*, in a more prominent blue colour, states, "I accept the challenge!". *Imposed Choice Label*—The term "Imposed choice" is highlighted in red below the pop-up, indicating that the design may encourage or pressure users to accept the challenge. The background of the interface features a dark blue panel overlaying a lighter blue background, with the Eagle-edu interface logo and a navigation menu on the left side. The layout and colour scheme emphasize the pop-up window, making it the focal point of the screen.

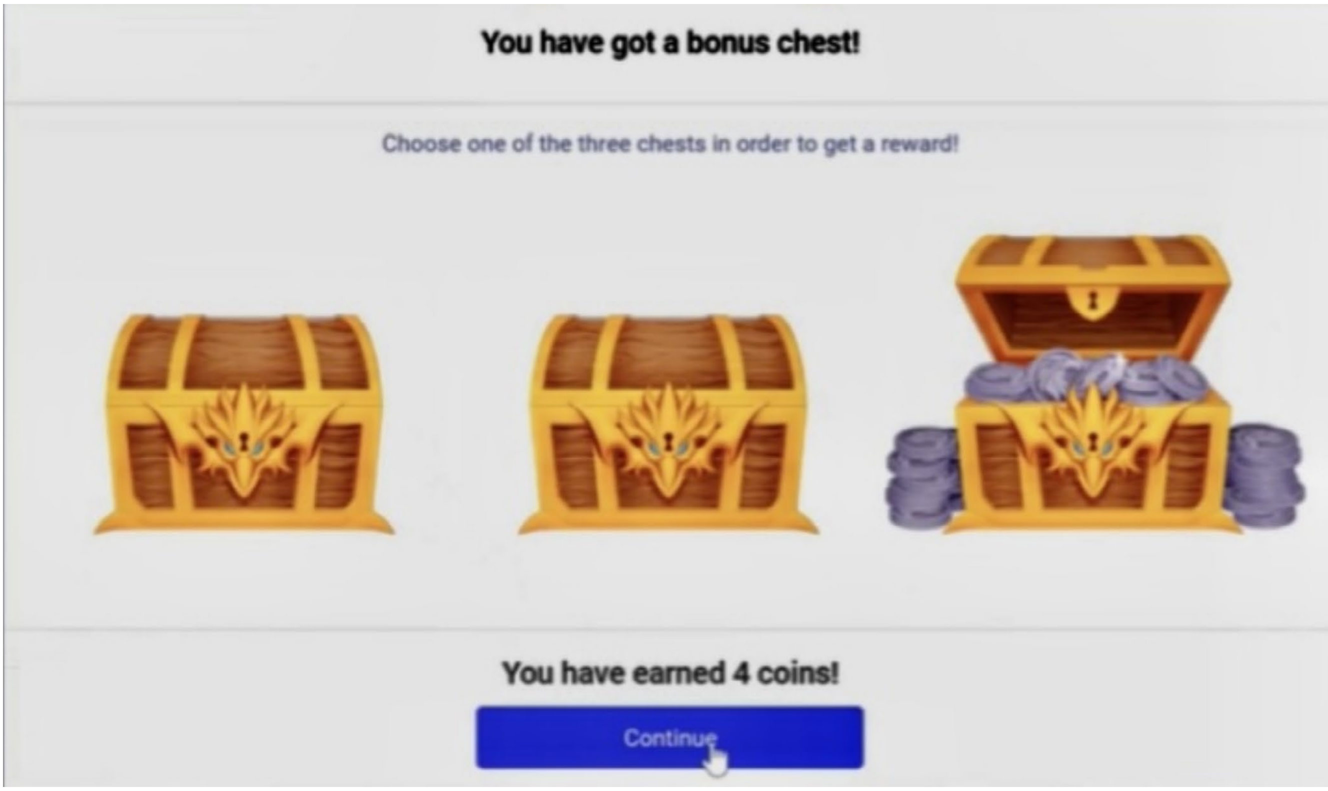


FIGURE A5 | Element *Chance* presented for students in the experimental group. The image shows a reward screen on an educational platform where the user has unlocked a "bonus chest". *Bonus Chest Notification*—At the top, a message reads: "You have got a bonus chest!". Below this, instructions state, "Choose one of the three chests in order to get a reward!" *Three Chest Options*—In the center of the screen, there are three yellow treasure chests with eagle head emblems. The first two chests are closed, while the third chest on the right is open, showing a pile of coins inside. *Reward Notification*—Below the chests, a message indicates the reward: "You have earned 4 coins!" At the bottom, there is a blue "Continue" button, with a cursor icon pointing at it, suggesting that the user can proceed by clicking this button. This layout highlights a gamified element, allowing users to select from mystery chests for a reward, with visual feedback indicating the number of coins won.

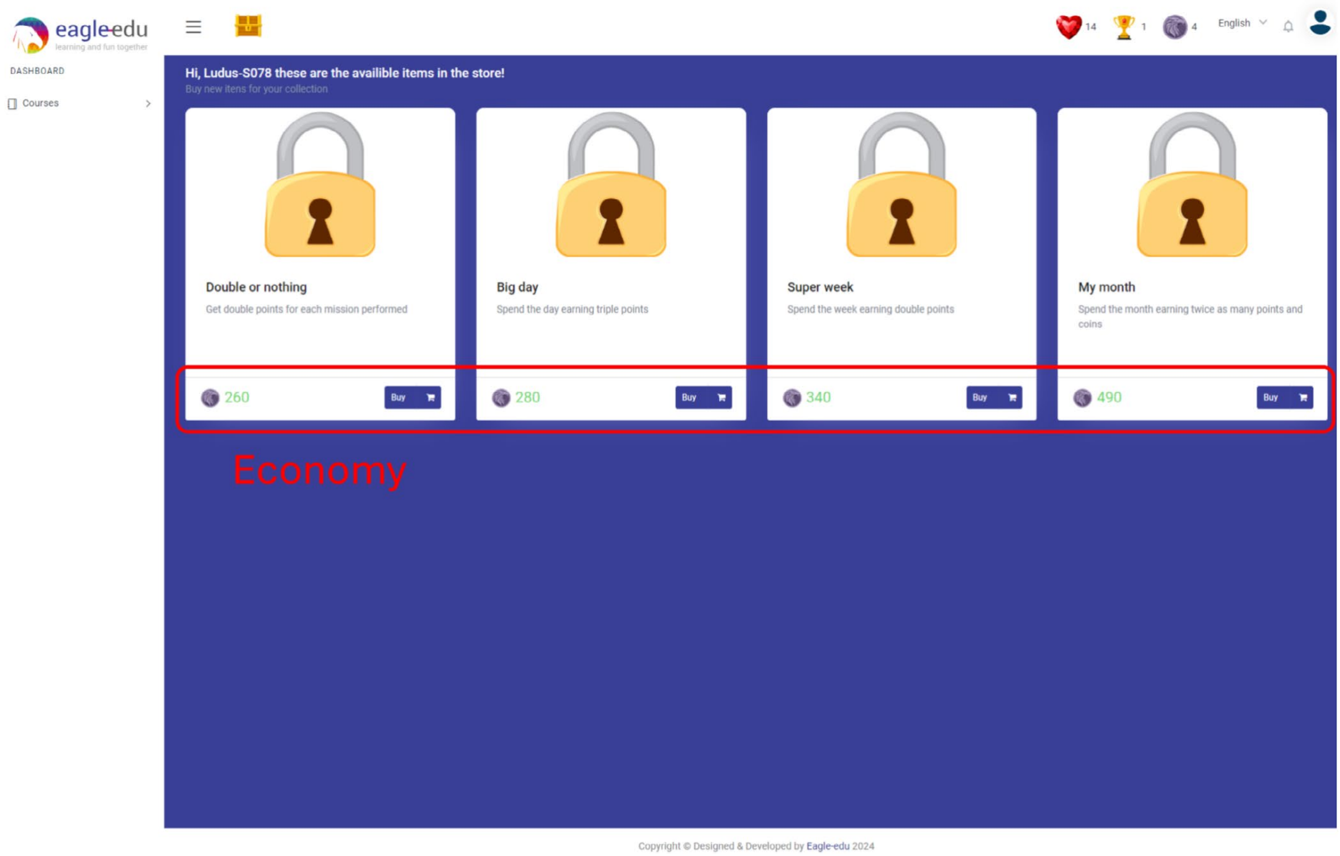
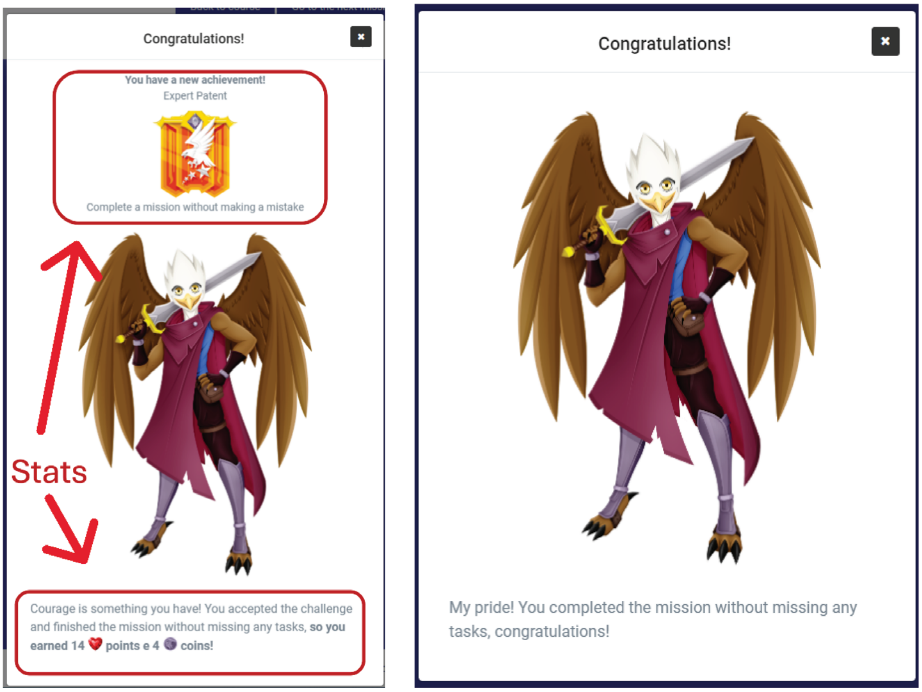


FIGURE A6 | Element *Economy* presented for students in the experimental group. The image shows a store page from the "Eagle-edu" platform where users can purchase various point-boosting items using in-game currency. The page is divided into four locked items, each represented by a card with a lock icon, item name, description, price in coins, and a "Buy" button. The items are listed as follows: *Double or Nothing*—This item doubles points for each mission performed. It costs 260 coins. *Big Day*—This item allows the user to earn triple points for a day. It costs 280 coins. *Super Week*—This item provides double points for a week. It costs 340 coins. *My Month*—This item grants twice as many points and coins for a month. It costs 490 coins. Each item has a purple coin icon with its cost displayed beneath it. At the bottom, the word "Economy" is written in red, possibly indicating the focus on in-game economy.



(a) Element **Stats** displayed for the participants in the experimental group.

(b) Traditional feedback displayed for the participants in the control group.

FIGURE A7 | Feedback with the gamification element *Stats* presented to participants in the experimental group and traditional feedback presented to students in the control group. The figure shows two feedback screens displayed to participants upon completing a mission, illustrating the difference between the feedback given to participants in the experimental and control groups. Figure (a) on the left is labelled "Element Stats" and represents the feedback for the experimental group. At the top, there is a "Congratulations!" message, followed by an achievement badge labelled "Expert Patent" with the description "Complete a mission without making a mistake." Below the character, a red box displays the feedback message: "Courage is something you have! You accepted the challenge and finished the mission without missing any tasks, so you earned 14 points and 4 coins!" Figure (b) on the right shows "Traditional feedback" provided to the control group. It also begins with a "Congratulations!" message, followed by a simpler text: "My pride! You completed the mission without missing any tasks, congratulations!" without the additional stats or earned rewards. The figures highlight the enhanced, gamified feedback for the experimental group with additional visual and textual elements to motivate users.

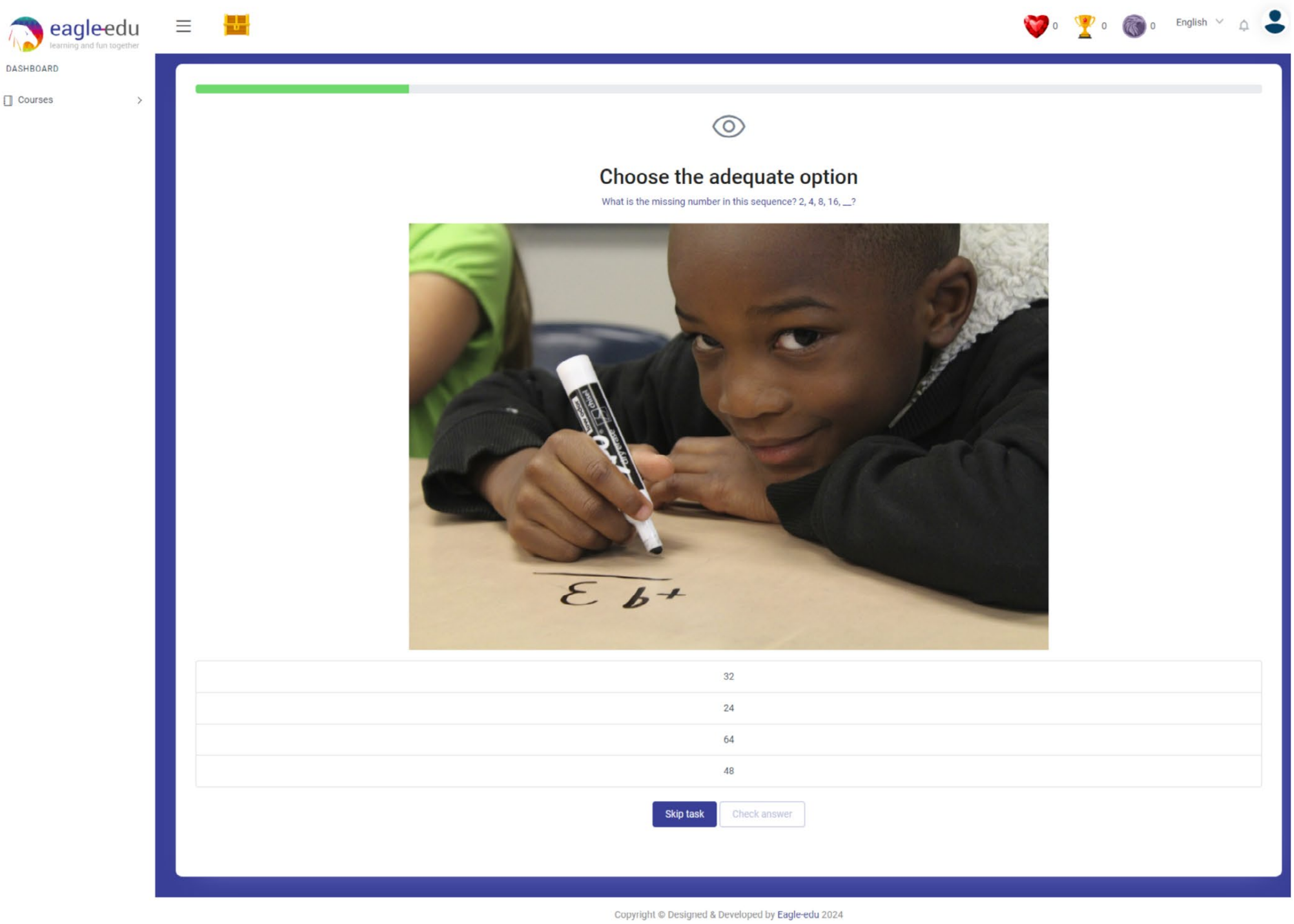


FIGURE A8 | A Logical Reasoning task presented to students in the experimental group, containing the element Progression. The image displays the educational tasks page of the platform "Eagle-edu", specifically, a math quiz. The central question asks, "What is the missing number in this sequence? 2, 4, 8, 16." Below the question are four possible answer options: 32, 24, 64, 48. Below the answer options is a "Skip Task" button and a "Check Answer" button.

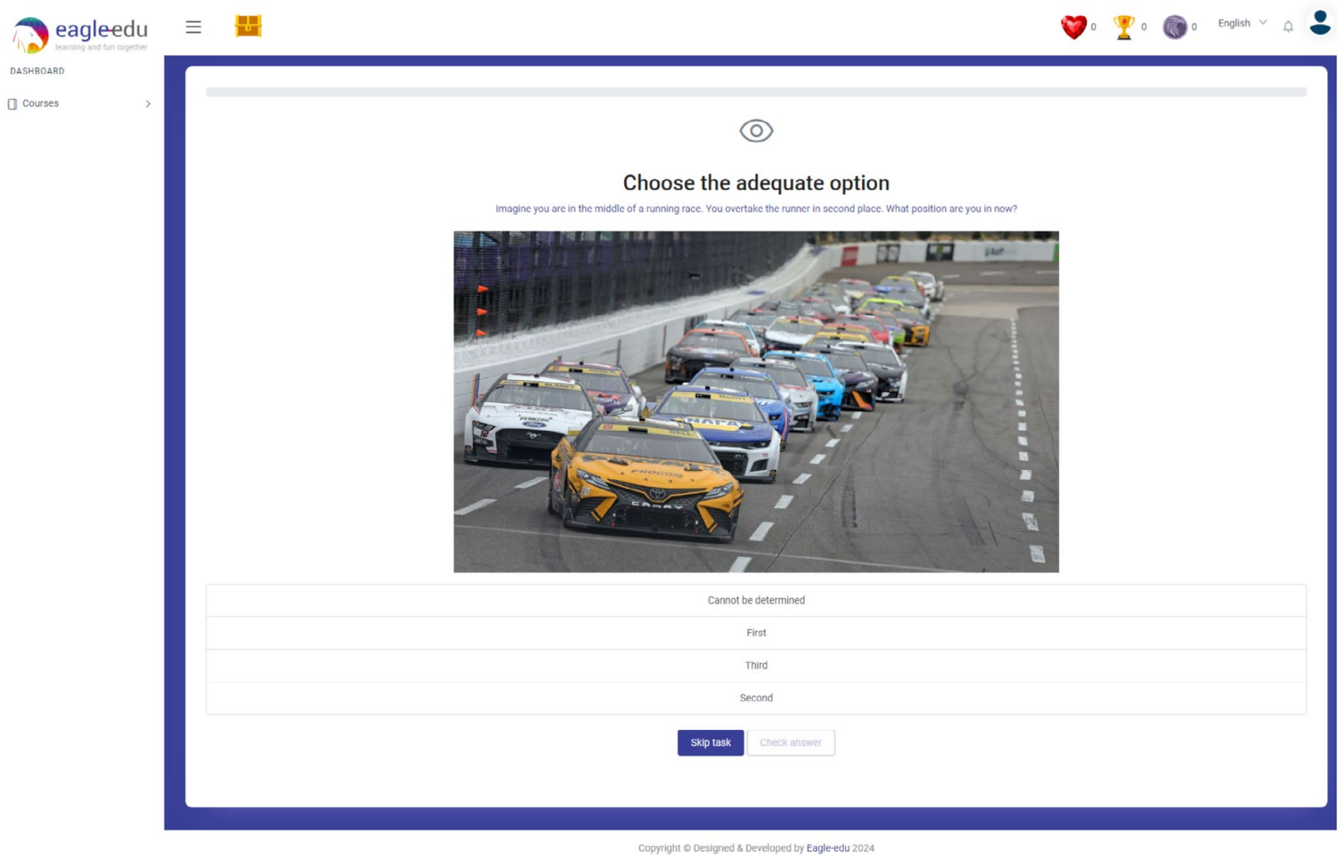


FIGURE A9 | Example of a task before to be answered by the participant. The image displays the educational tasks page of the platform "Eagle-edu", specifically, a math quiz. The central question asks, "Imagine you are in the middle of a running race. You overtake the runner in second place. What position are you in now?" Below the question is a photo of a line of race cars on a track. There are four possible answer options: *Cannot be determined, First, Third, and Second*. Below the answer options is a "Skip Task" button and a "Check Answer" button.

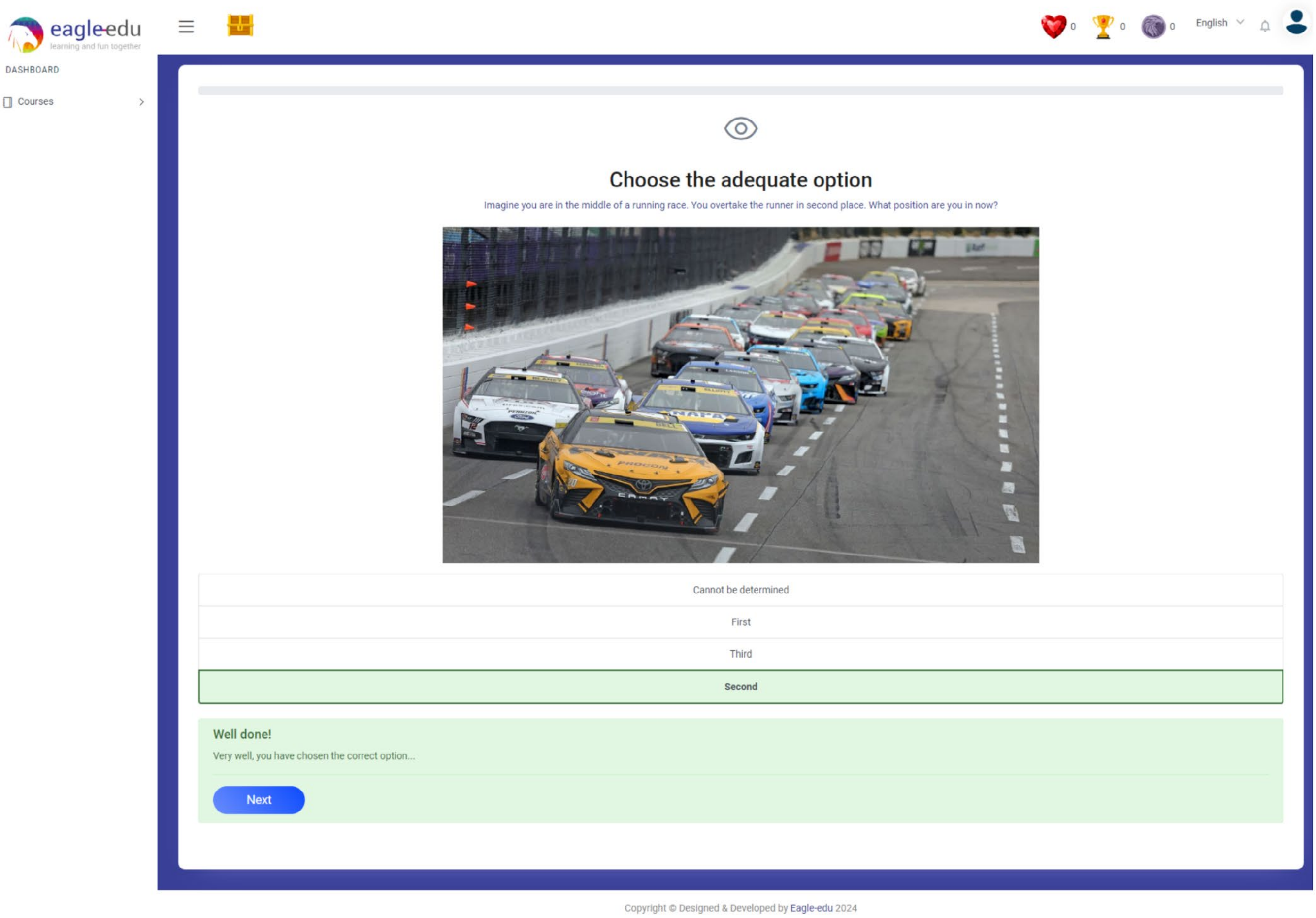


FIGURE A10 | Example of a task after to be answered by the participant and presenting an automatic feedback. The image displays the educational tasks page of the platform "Eagle-edu", specifically, a math quiz. The central question asks, "Imagine you are in the middle of a running race. You overtake the runner in second place. What position are you in now?" Below the question is a photo of a line of race cars on a track. There are four possible answer options: *Cannot be determined, First, Third, and Second*. The correct answer, "Second", is highlighted. Below the answer options is a "Skip Task" button and a "Check Answer" button.