The Impact of Different Game Modes in an Educational Web Application on Student Engagement and Performance

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Abstract. *This Work-in-Progress paper presents the design and preliminary classroom evaluation of Edu Bingo, a gamified web application developed to enhance motivation and engagement among lower primary school students. The application features three distinct game modes, Endless (practice-oriented), Reward (badge and XP-based), and Multiplayer (competitive with leaderboard), each tailored to different motivational profiles and learner preferences. Core game elements such as points, badges, and avatars are integrated to promote active learning, while minimizing dependence on extrinsic feedback alone. The initial study involved 24 second-grade students (ages 7–8) using school-provided desktop computers. After engaging with all three modes, students completed a post-session questionnaire, and gameplay data (e.g., task accuracy, XP earned, and mode selection) was collected and analysed. Preliminary findings indicate that offering multiple gamified approaches can improve student engagement and accommodate diverse learning styles. These early results support the potential of personalized gamification as a valuable tool in early primary education.*

Keywords. educational technology, gamification, personalization, game-based learning, engagement

1 Introduction

Gamification has become a widely discussed and increasingly adopted strategy for enhancing student motivation and engagement in educational contexts. Broadly defined as the use of game-like elements in non-game settings (Deterding et al., 2011), gamification has been successfully applied across educational levels to make learning more interactive and rewarding. Numerous studies have demonstrated its positive effects on student motivation, participation, and long-term knowledge retention (Gee, 2003). Commonly used gamified elements include points, badges, leaderboards, avatars, and levels, all designed to transform routine learning tasks into meaningful and enjoyable challenges (Werbach and Hunter, 2012).

In technology-enhanced learning environments, gamification is often embedded within existing e-learning platforms or developed as standalone educational games. For instance, Duolingo incorporates experience points and daily streaks to support consistent language learning (Falk and Götz, 2016), while Prodigy integrates mathematical problem-solving into a fantasy game narrative to sustain learner interest through progression mechanics (Himmawan and Juandi, 2023). New pedagogical frameworks emphasize that gamification should not merely be added onto content but should align with deeper learning principles and student-centric design (Fathi Najafi et al., 2025).

Although most research highlights the benefits of gamification, a growing body of literature points to its limitations. Not all students respond positively to the same game elements; for example, competitive students may be motivated by leaderboards, whereas others may find them demotivating or anxiety-inducing (Buckley and Doyle, 2016). More recent studies have reinforced these concerns, in a systematic mapping of 87 educational software studies, found that elements such as points, badges, and leaderboards can lead to increased anxiety, decreased intrinsic motivation, and even a decline in performance when not properly aligned with learner profiles (Almeida et al., 2023). Furthermore, the novelty effect of gamification tends to wear off over time, especially if the system lacks adaptability or meaningful long-term progression (Hanus and Fox, 2015). In a longitudinal study involving 756 students in a STEM learning environment, observed an initial peak in engagement followed by a sharp drop after approximately four weeks, with only a partial recovery over time (Rodrigues et al., 2022). These findings underscore the importance of designing gamified learning tools that are not only engaging at the outset but also sustainable and responsive to diverse learner needs over time. These issues suggest that "one-size-fits-all" gamified designs may fail to meet the diverse needs of learners in a classroom setting.

To address these challenges, recent research advocates for more personalised and multimodal approaches to gamification, allowing learners to choose

the mode of interaction that best fits their preferences and learning styles (Oliveira et al., 2022). Such designs may offer more inclusive and effective learning environments by better aligning with individual differences in personality, motivation, and cognitive engagement.

In parallel, recent developments in learning analytics highlight the importance of monitoring student progress through visual dashboards, which can provide teachers with actionable insights to support personalised instruction and adaptive intervention strategies (Balaban et al., 2024).

A recent study further reinforces these insights by demonstrating that personalised gamification, tailored to learners' profiles, significantly outperforms uniform approaches in terms of motivation, engagement, and learning outcomes, particularly in online learning environments (Xiao and Hew, 2024)

This paper presents findings from a small-scale exploratory study conducted in a second-grade classroom using a custom-developed gamified web application, Edu Bingo. The application includes three distinct game modes: Endless (focused on practice and repetition), Reward (featuring badges and experience points), and Multiplayer (emphasizing real-time competition via a leaderboard), each designed to reflect a different motivational approach. Students used the application during a classroom session, after which they completed a short questionnaire. Simultaneously, gameplay data (e.g., accuracy, playtime, and mode selection) were logged for further analysis.

The study seeks to contribute to the growing field of personalised gamification by exploring how different game mechanics influence engagement, motivation, and learning outcomes in early primary education. This study is guided by the following research questions:

- **RQ1:** Which of the three game modes (Endless, Reward, or Multiplayer) is most preferred by second-grade students in a gamified learning environment?
- **RQ2:** How do different game modes affect students' motivation and engagement during gameplay?
- **RQ3:** How does task accuracy differ across the Endless, Reward, and Multiplayer game modes?

2 Related work

Gamification has been widely recognised as an effective strategy for enhancing learning outcomes. It is defined as "a goal-oriented approach that integrates game design elements into learning environments to increase motivation and engagement" (Sailer and Homner, 2020). Meta-analyses highlight that elements such as points, feedback, badges, leaderboards, and narrative are particularly effective in supporting both cognitive and motivational benefits.

Systematic reviews further confirm the positive impact of gamification on student motivation, participation, and academic performance, especially when grounded in clear pedagogical objectives and supported by purposeful and varied game mechanics (Zainuddin et al., 2020).

However, several studies caution that the mere presence of game elements does not necessarily lead to improved learning. Research has shown that individual components, such as points or levels, have little effect on intrinsic motivation unless they are meaningfully embedded within the learning process (Mekler et al., 2017). Similarly, leaderboards have been found to improve performance only when learners understand how their actions influence rankings and progress (Landers et al., 2017). These findings underscore the importance of aligning game mechanics with learning goals and ensuring transparency in their function.

A distinction has also been made between surface-level gamification, where elements like points and badges are simply layered over content, and deeper, gameful designs where mechanics are integrated directly into instructional structures (Seaborn and Fels, 2015). Such findings highlight the need for pedagogically sound and thoughtfully designed gamification strategies.

Traditional gamified systems are often based on the assumption that all learners respond similarly to the same features. Yet longitudinal studies reveal varied engagement patterns, while competitive elements may motivate some students, they can be demotivating for others (Barata et al., 2017). Related research further argues that although extrinsic motivators such as points and badges may boost short-term participation, long-term engagement requires meaningful tasks and user-centred design (Hamari et al., 2014).

Gamification appears particularly effective in procedural and skill-based domains. Integrating game elements into activities such as problem-solving, grammar, and spelling has been shown to enhance both performance and learner satisfaction (Domínguez et al., 2013). These insights align with the focus of this study, which centres on mathematics and language-based tasks. Additionally, gamified tools that align with curriculum content can foster comprehension, creativity, and active engagement among primary school students (Al Ghozali et al., 2024).

Beyond task type, learner personality also plays a key role in shaping engagement with gamified environments. It has been demonstrated that competitive learners benefit from public ranking and recognition, whereas others perform better in non-competitive settings where progress is privately tracked (Buckley and Doyle, 2017). Further studies indicate that extroverted students are more responsive to public-facing features like leaderboards, while introverted and ambiverted learners prefer personalised goals, badges, and private feedback mechanisms. Many in the latter group report

discomfort with publicly visible tracking and favour systems that support internally visible progress (Tlili et al., 2019).

3 Methodology

The classroom study was conducted with a group of 24 second-grade students (ages 7 to 8) from a primary school in Zagreb. The group consisted of 10 girls and 14 boys, all of whom had previous experience using digital devices in class.

3.1 Application

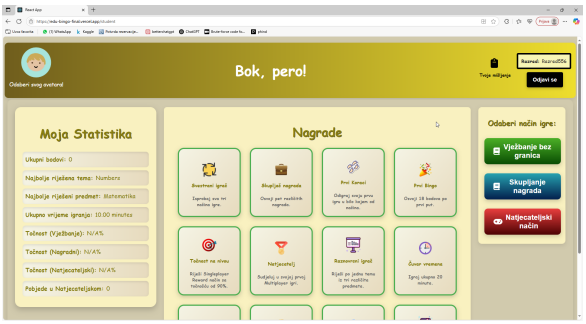

Figure 1. Student dashboard

The web application was developed to support second-grade students in practising educational content through an interactive and gamified e xperience. The application features three distinct game modes, Singleplayer Endless, Singleplayer Reward, and Multiplayer Competitive, which differ in motivational mechanics but share a consistent interface and game logic. Each mode is accessed through the student's profile page which is shown in Fig. 1, where students can also track their statistics and earned badges and choose their avatar. All modes are based on a bingo-style gameboard consisting of a 3×3 grid of numbers, behind which tasks are hidden. Each gameboard is automatically generated with three easy, medium, and complex questions, balancing content difficulty. Easy questions carry 1 point, medium 2 points, and hard questions 3 points. A random number between 1 and 90 is generated upon clicking a button, and students uncover the corresponding task if that number appears on their board. Questions are subject- and theme-specific (e.g., grammar, addition, multiplication, etc.) and must be answered correctly to mark the tile as complete. If the student answers incorrectly as shown in Fig. 2, they automatically see that and the task is replaced with a new one of the same difficulty l evel, a nd t he s tudent may try again. In the Endless Mode, students play continuously with no scores, rewards, or pressure, this mode is intended for repetition and practice. The Reward Mode introduces gamification b y a warding XP points and badges for performance; these elements boost motivation and promote goal setting.

Figure 2. Student view of the Multiplayer mode interface

Earned badges (e.g., "First Bingo") and XP totals are visible on the student dashboard and the gameboard during gameplay immediately when earned.

Multiplayer Mode offers a competitive experience in real time. Students join the same game via a code. The game ends when one player achieves bingo, and all participants are shown a final l eaderboard. A live leaderboard tracks player progress during the game, encouraging quick thinking and friendly competition. Student accuracy and gameplay time are logged for every session. The app also includes a Teacher Dashboard as shown in Fig. 3, allowing educators to view student performance by game mode, monitor progress, and initiate multiplayer games. However, teachers cannot modify or create tasks; the application uses a predefined d atabase o f c urriculum-aligned q uestions prepared in advance. This ensures that all students receive standardised content across game modes. The app aims to promote active learning and analyse how different game mechanics influence e ngagement and educational outcomes.

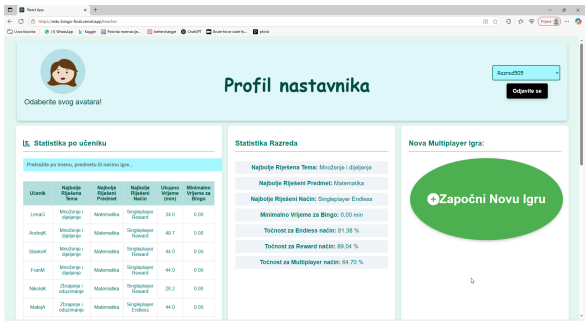

Figure 3. Teacher dashboard

3.2 Experiment Design

After a brief introduction to the application and its purpose, students were given access to the Edu Bingo web application using school-provided desktop computers. All students played through each of the three game modes (Endless, Reward, and Multiplayer) in that order, spending approximately 10 minutes on each mode. Instructions were intentionally kept minimal to encourage intuitive and independent interaction with the game. After completing all three modes, students were allowed to choose their preferred mode. The majority opted for the Multiplayer mode, and the class proceeded to play several additional rounds. This unstructured session was considered and discussed in the interpretation of the results.

3.3 Questionnaire

After the experiment, a short questionnaire with three groups of questions was completed by the students via Google Forms. The first group consisted of multiple-choice questions about gameplay preferences (e.g., most fun, most difficult, most useful mode). The second group included 5-point Likert scale questions (1 – strongly disagree, 5 – strongly agree) related to overall enjoyment and specific elements like competition. The final group contained open-ended questions, allowing students to explain which topic or game mode they found most interesting, and whether any part of the application was confusing and why.

3.4 Context and Learning Outcomes

The Edu Bingo activities were based on the official second-grade curriculum and designed to support learning in several core subject areas, namely:

- **Mathematics** (addition, subtraction, multiplication, division),
- **Croatian Language** (capital letters and sentence structure),
- **Environmental Studies** (e.g., sorting different types of waste).

The intended learning outcomes (LOs) of the Edu Bingo activities included:

- Correctly solving arithmetic problems of varying complexity,
- Recognizing and applying capitalization rules in written language,
- Demonstrating understanding of basic environmental responsibility through correct waste sorting.

These topics were selected in consultation with the classroom teacher. Mathematics topics had been actively practiced in the weeks prior to the experiment, while grammar and environmental topics had been covered earlier or less extensively. This variation in prior knowledge was considered when interpreting students' performance across different themes (see Section 4.3).

4 Results

Students showed high levels of enthusiasm and curiosity when introduced to the concept of gamified learning.

To explore students' preferences, performance and engagement across different game modes, data were collected from both application logs and a post-experiment questionnaire. Gameplay data included the number of tasks completed and task accuracy per game mode and theme, while the survey captured students' subjective experiences and opinions.

4.1 Game Mode Preferences (RQ1)

Prior research has shown that students differ significantly in how they respond to gamification elements, highlighting the importance of offering diverse interaction styles to match varied motivational profiles (Santos et al., 2021).

Student responses revealed a range of preferences regarding the available game modes. As presented in Table 1, Multiplayer was selected as the most liked mode by 48% of students, followed by Endless mode (36%) and Reward mode (16%). These results suggest that students were generally motivated by social interaction and competition, but a significant number also valued a more relaxed, individual approach to practice.

Table 1. Student preferences and perceptions of game modes

Question	Endless	Reward	Multiplayer
Which game mode did you like the most?	36%	16%	48%
Which game mode was the easiest to understand?	56%	20%	24%
Which game mode helped you best remember what you learned at school?	36%	8%	56%

Beyond enjoyment, students were also asked to indicate which game mode they found easiest to understand. Over half of the class (56%) selected Endless mode, indicating that the absence of points, badges, or time pressure may have helped them focus on the mechanics of the game itself. Multiplayer and Reward modes were considered less intuitive, with 24% and 20% of students respectively identifying them as easiest to follow. This finding may reflect the additional

complexity introduced by competitive or reward-based elements.

When asked which mode best supported their learning and helped them remember the content, Multiplayer again stood out with 56% of responses. Endless mode was the second most helpful in this regard (36%), while only a small percentage (8%) found Reward mode to be most beneficial for knowledge retention. This may be explained by the fact that the excitement and active participation involved in real-time competition helped reinforce memory for many students.

Such variability in preferences aligns with prior research showing that different learner types respond to different gamification elements. For instance, study of 271 students by Pinto et al., 2022, who found that more than one-third identified as "Achievers", who prefer progression mechanics like points and badges, while a smaller share identified as "Socialisers", favouring communication, driven element.

These findings are consistent with recent work by I. Santos et al., 2024, who found that elements such as quests, points, and badges were among the most appreciated by students, whereas competitive elements and time pressure were less well received.

This finding aligns with recent research by A. C. G. Santos et al., 2021, who found that learners demonstrate highly diverse user profiles, such as Achievers, Philanthropists, or Free Spirits, each associated with distinct motivational patterns and preferences for gamification features. Their study with over 300 participants showed that no single design suits all learners equally, underscoring the need for flexible and adaptable gamification systems.

Our own results echo these conclusions. While nearly half of the students preferred Multiplayer, a considerable portion favored other modes. This diversity suggests that a one-size-fits-all approach to gamification may be insufficient, and that effective learning tools should allow flexibility and personalization to support different motivational profiles.

4.2 Motivation and Engagement (RQ2)

While preferences reflect functional and cognitive evaluations, students' motivational responses provided further insight into how they experienced the gamified environment. Survey results indicate that students found EduBingo both enjoyable and engaging across game modes.

As shown in Table 2, 84% of students reported that they would like to play EduBingo again, while 64% felt they learned something new, and the same percentage agreed that learning was easier when they were competing with others.

In addition, Likert-scale responses presented in Table 3 show that 64% strongly agreed that EduBingo was more interesting than regular classroom learning, and 56% strongly agreed that they enjoyed the competitive Multiplayer mode. These results suggest that the inclusion of playful and interactive mechanics enhanced students' perception of the learning experience.

Table 2. Student responses to selected survey questions

Question	**Yes (%)**
Do you think learning was easier when competing with others?	64%
Did you learn something new while playing EduBingo?	64%
Would you like to play EduBingo again?	84%

Observationally, many students voluntarily chose to replay the Multiplayer mode during the unstructured portion of the lesson, indicating sustained engagement beyond the scope of the formal experiment. While Multiplayer appears to foster emotional excitement and social involvement, the Reward mode's link to higher accuracy suggests that progress-tracking features may help students stay focused and goal-oriented.

Overall, the findings support prior research indicating that students are not uniformly motivated. While some thrive on social comparison and competition, others are more engaged by achievement markers or individual progress tracking. This diversity reinforces the need to design gamified learning tools that include varied motivational mechanisms.

4.3 Performance and Accuracy (RQ3)

Accuracy was measured as the proportion of correctly solved tasks out of the total attempted tasks, calculated separately for each game mode and academic topic. Log data analysis revealed differences in performance across modes. As shown in Fig. 4, Reward mode resulted in the highest overall accuracy with 54% of students scoring between 91-100%, followed closely by Endless mode, where 50% of students achieved the same level of accuracy. In contrast, Multiplayer mode showed the lowest high-accuracy rate, with fewer than 20% of students scoring in 81-90%. This difference likely stems from time pressure and the competitive nature of Multiplayer play, which may have encouraged students to prioritize speed over correctness. Reward mode, which included XP points and badges, likely supported more careful and goal-oriented gameplay.

Beyond game modes, task performance also varied by academic theme. As illustrated in Fig. 5, students achieved the highest overall accuracy in Addition and Subtraction (54%), followed by Multiplication and Division (38%). Other themes such as Waste Sorting and Capital Letters accounted for only 4% each of total correct answers.

In this context, "overall accuracy" per topic refers

Table 3. Student responses to Likert-scale items (1 = Strongly Disagree, 5 = Strongly Agree)

Question	1	2	3	4	5
Was EduBingo more interesting than regular classroom learning?	8%	4%	8%	16%	64%
Did you enjoy competing with other students in the Competitive mode?	12%	8%	8%	16%	56%

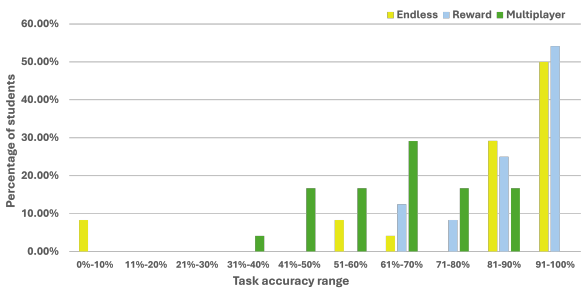

Figure 4. Accuracy per Mode

to the total number of correct answers across all game modes divided by the total number of tasks attempted in that topic. Topics with a larger number of included tasks (such as addition and subtraction) yield more reliable indicators of performance due to increased sample size. In contrast, topics with fewer tasks, such as language and environmental themes, should be interpreted more cautiously, as there were not enough data points to ensure reliable conclusions.

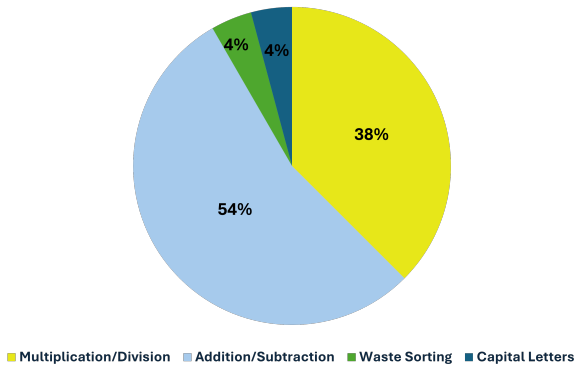

Figure 5. Best performing topic

These findings reflect both the students' curriculum familiarity and the perceived difficulty of each theme. At the time of the study, mathematics topics, particularly addition, subtraction, multiplication, and division, had been actively covered in class. This curricular alignment likely contributed to higher performance in math-based tasks. Moreover, anecdotal feedback from the classroom teacher confirmed that these topics were fresh in students' minds and well-practiced, which may have made solving them feel both accessible and enjoyable.

In contrast, tasks involving capitalisation rules (e.g., recognising proper nouns or sentence starts) were generally more challenging. The teacher noted that many students regularly struggle with this grammar topic, which is consistent with the low percentage of correct answers in that category. Additionally, these language-based tasks tended to be slightly more complex in structure, which may have compounded the difficulty for early readers.

Although the app included a range of topics, these four were among the most frequently encountered and statistically relevant during the session. The results underline the importance of content familiarity and perceived difficulty when evaluating performance in gamified learning environments.

While 4 offers useful insight into students' accuracy per game mode, it cannot fully represent the extent to which the targeted learning outcomes (LOs) were achieved.

5 Conclusion and Future Work

This paper presented the design and classroom testing of Edu Bingo, a gamified web-based learning tool for second-grade students. The application features three game modes—Endless, Reward, and Multiplayer—designed to support different learning styles through varied mechanics such as points, badges, and leaderboards.

Classroom results showed that gamification enhanced student interest and participation. Reward mode produced the highest accuracy, while Multiplayer was rated most engaging. Survey responses confirmed students' preference for gamified learning over traditional instruction, with many reporting that they learned something new.

Findings support the value of offering multiple game modes to address diverse motivational profiles. While some students responded best to competition, others preferred structured progression or relaxed practice, highlighting the need for adaptable gamification strategies in primary education.

The study is limited by its small sample size (N=24) and short duration. The custom-designed questionnaire also requires further validation.

Future work will involve broader testing and the development of adaptive features that personalise the learning experience. Planned improvements include integrating a built-in chat system to support collaboration, peer communication, and group tasks. Such functionality could enhance engagement and provide valuable insights into student thinking and social interaction.

Additionally, enabling teachers to create and cus-

tomise their own tasks, rather than relying solely on a fixed question base, would allow for greater curricular alignment and pedagogical flexibility. Additional features, such as team-based play and teacher-facing analytics, could further support cooperative learning and formative assessment.

This is a noted limitation of the current work. Future research will incorporate formal pre- and post-testing to evaluate learning progress in a more rigorous manner and better align observed in-game performance with curriculum-based outcomes.

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