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PAPER

Enhancing Mobile Learning Platforms through Meaningful Gamification: Heatmaps, Quizzes, and Time-Based Rewards

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ABSTRACT

Developing long-term study habits through gamification in educational platforms presents a significant challenge. The approaches taken by modern gamified platforms and researchers to gamify the educational platform often rely on extrinsic rewards akin to video games, which engage students but fail to cultivate the intrinsic motivation necessary for habit development. Educational platforms commonly implement badges, leaderboards, achievements, and points (BLAP) that predominantly reward students for their results rather than their effort, thereby lacking meaningful gamification. To address these issues, this paper proposes alternative strategies such as competitive player-vs-player quizzes, visual time statistics, and a habit-tracking heatmap to foster intrinsic motivation through a competitive environment that enhances self-awareness and cultivates a growth mindset. This research utilized an initial survey and literature review to identify the shortcomings of existing gamification approaches, developed a prototype based on the hypotheses, and engaged participants in interactive sessions to gather qualitative feedback. Subsequently, a quantitative survey measured the effectiveness of the proposed strategies. As an initial exploratory study, this paper aims to lay the groundwork for future empirical validation of these strategies. The findings from this phase provide initial validation that these new features may serve as effective alternatives to traditional gamification elements. While the study suggests these methods have potential, a longitudinal evaluation is necessary to assess their long-term impact on study habits.

KEYWORDS

gamification, badges, leaderboards, achievements, and points (BLAP), player-vs-player quizzes, habit-tracking heatmap, visual time statistics, educational platform

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1 INTRODUCTION

The advancement in technology has helped revolutionize the online educational platform by introducing technology-assisted learning tools like massive open online courses (MOOCs), virtual laboratories, simulations, and dynamic visualization to assist students in learning and understanding new concepts on online educational platforms [28–31]. Likewise, a thorough review of MOOCs from 2012 to 2022 focuses on pedagogical and technological advancements and highlights the influences in transforming global education [28]. Despite the significant evolution of educational platforms, increasing engagement is a huge challenge [1]. Technology has made education more accessible and flexible, but it has not necessarily made it more engaging.

Gamification is the use of game-play mechanics for non-game applications [3]. Any tasks, work, challenges, context, or process can theoretically be gamified [4]. Gamification has found its way into domains like education, marketing, politics, health, and fitness, with analysts having predicted it to become a multi-billion-dollar industry by 2015 [2]. Schools are essentially gamified in that you can earn points for assignments, quizzes, and reading, compete based on some leaderboard, and get a reward. Likewise, the study found that combining the App Inventor programming environment with a game-development approach in secondary education significantly enhanced students' programming skills and motivation compared to traditional methods based on a quasi-experimental study conducted in a Greek public school [27]. However, something about this environment fails to engage students. In contrast, video games and virtual worlds excel at engagement [5]. Video games create a short-term engagement using a lot of extrinsic rewards such as points, visual graphics, leaderboards, badges, and achievements, but these extrinsic rewards help build the skills of the player, which allows for the growth of intrinsic motivation to keep getting better, and the player plays the game regardless of the extrinsic rewards.

The approaches taken by modern gamified platforms and researchers to gamify education platforms use the extrinsic rewards of video games to engage students but fail to build the intrinsic motivation that drives students to keep using the platforms. Nicholson provides the term BLAP to describe the set of badges, levels and leaderboards, achievements, and points that can be easily applied to many settings in educational [6], corporate, and non-profit sectors alike. At the same time, Charles simplifies the term gamification even further to convey awarding "points to students for the successful completion of tasks throughout the course of study" [7]. The distillation of the essence of the game for an education platform seems to have moved away from building a student's knowledge to training the students to keep using the platforms by giving them short-term, immediate rewards. Critics such as Iam Bogost complain that gamification often takes "the least essential aspects of games and presents them as the most essential." He describes it as little more than "pontification" designed to motivate participants with superficial rewards and refers to it as exploitation ware [8].

On the other hand, meaningful gamification is concerned with the long-term benefits of gamification for users, which help participants find a personal connection to a non-game setting [6]. It aims to engage users by increasing their intrinsic motivation instead of using external rewards so interest in the subject can continue after the learner is no longer motivated by the game elements. The basis of meaningful gamification is the self-determination theory (SDT), which implies that intrinsic motivation is driven by autonomy, competence or mastery, and relatedness. In the 21st century, learners must recognize the importance of their education and be motivated to achieve and value it. They must take an active role in meaning-making and the process of learning [17]. In particular, learners need to: (1) Want to learn; (2) Become aware of themselves as learners; and (3) Able to take responsibility for their own learning in and out of school over their lifespans.

"Without a serious focus on students' ownership of their own learning processes, there is always the danger that the focus will be on curriculum delivery and teacher strategies, which are less likely to stimulate the sorts of intrinsic motivation for learning that are so necessary for life in the 21st century" [9]. So, achievements and points that primarily reward students for results rather than effort are insufficient for building intrinsic motivation and fail to align with the principles of meaningful gamification. To address this, we propose a combination of strategies that balance extrinsic and intrinsic motivators. Player-vs-player quizzes introduce the core essence of games—active competition—where the immediate reward of winning against an opponent fosters engagement and drives participation. This real-time competitive element captures the excitement and energy of traditional games, encouraging players to challenge themselves and others. To complement this, we suggest rewarding students for winning and their effort and consistency, using tools like time-tracking visualizations and habit-tracking heatmaps.

These tools measure how time is spent on different aspects of learning, helping students identify areas for improvement while celebrating their strengths. These methods promote intrinsic motivation by tying rewards to effort rather than outcomes, encouraging students to persist in their learning journey. The habit-tracking heatmap, in particular, shifts the focus from maintaining streaks to consistent, long-term habits. Each day's effort is represented as a green dot, acknowledging progress even if a day is missed. Unlike streak-based systems, which can demotivate users after a single lapse, the heatmap provides positive reinforcement for ongoing efforts, cultivating a mindset of steady growth. Together, these approaches aim to create a gamified learning environment that harmonizes the extrinsic motivation to compete and win with the intrinsic motivation to learn and improve, ensuring engagement and meaningful, lasting educational outcomes [23–26].

2 THEORETICAL FRAMEWORKS

The features we propose—head-to-head player vs. player competitive quizzes, rewards based on time statistics, and a habit-tracking heatmap—are specifically designed to address the core psychological elements essential for meaningful learning: fostering a desire to learn, cultivating self-awareness as a learner, and encouraging personal responsibility for one's learning journey. Each feature is underpinned by proven behavioral principles and tailored to engage students in a way that balances extrinsic and intrinsic motivation, aligning with the tenets of self-determination theory.

Player vs player competitive quizzes–self-determination theory: This feature is rooted in the principles of competence and relatedness from self-determination theory [11]. By offering students an opportunity to compete directly or indirectly with peers, the quizzes create a dynamic learning environment where students feel both challenged and socially connected.

Active mode: Real-time or asynchronous competitive quizzes allow students to challenge each other, providing immediate feedback and fostering a sense of achievement.

Passive mode: Students interact with a structured roadmap featuring levels where they can see the progress and standings of their peers. A structured roadmap enables students to compare their progress with others at their own pace, cultivating a sense of community while reducing pressure.

By incorporating these dual modes, the feature ensures inclusivity, catering to students who thrive on direct engagement as well as those who prefer individual pacing. Importantly, this design brings the essence of gaming into the platform–Competition. Unlike traditional BLAP systems, which merely add game-like rewards to an educational context, competitive quizzes make the activity itself a game. Students are no longer passively engaged; they actively strive to win, whether against a peer, the system, or their previous scores. This sense of real-time feedback and achievement serves as an immediate motivator, with secondary rewards such as leaderboard standings or achievements serving to sustain long-term interest.

Effort-based reward system–rationale and implementation: The traditional BLAP system rewards students primarily for outcomes, such as task completion or performance, but fails to acknowledge the effort invested in the process. This approach can discourage learners from facing challenges or setbacks, as their hard work is unrecognized. To address this, we propose an effort-based reward system that emphasizes the recognition of effort over results. The theoretical foundation for this approach lies in the work of Dweck on motivation and growth mindset, which emphasizes the role of effort in fostering intrinsic motivation [10]. By rewarding effort, learners are encouraged to see challenges as opportunities for improvement, promoting resilience and persistence. This directly aligns with the competence component of SDT, which posits that intrinsic motivation is fostered when individuals feel capable and effective in their actions [11]. The system can be implemented through tools such as time-tracking visualizations and feedback dashboards that highlight the time and effort learners dedicate to their tasks. For instance, a visual dashboard could display the amount of time spent on various learning activities, offering students insights into their strengths and areas requiring improvement. This helps cultivate self-awareness, reinforces a growth mindset, and ensures that learners value the process of learning, not just the results.

Habit-tracking heatmap–rationale and implementation: Consistent effort over time is a key driver of long-term engagement, yet traditional streak-based systems often fail to promote sustainable habits. Streak-based systems, which reward unbroken sequences of actions, risk demotivating learners after a single lapse. To overcome this limitation, we propose a habit-tracking heatmap that visually represents consistent effort without penalizing occasional breaks. This feature is rooted in habit-formation research, which emphasizes the importance of gradual and incremental progress in establishing lasting behaviors [12]. The habit-tracking heatmap provides a grid-like visualization, where each square represents a day, and the color intensity corresponds to the time spent on learning activities [13–16]. Unlike streak-based systems, the heatmap focuses on acknowledging consistent effort over time rather than punishing users for missing a day. This approach offers positive reinforcement that encourages learners to focus on their overall progress, cultivating long-term engagement [18–22]. The rationale for this feature aligns with both the autonomy and competence components of SDT. Autonomy is supported by allowing learners to track their habits flexibly in a manner that fits their unique goals and schedules. Competence is fostered as learners see tangible evidence of their progress, motivating them to continue their efforts. By reducing the pressure associated with streak-based systems, the habit-tracking heatmap ensures inclusivity and sustains motivation, even in the face of occasional lapses.

3 METHODS

Our study adopts an exploratory research approach to gather initial user needs and preferences insights. This phase involves a preliminary investigation of the challenges and opportunities in educational gamification, focusing on user feedback to evaluate the effectiveness of proposed features. This phase began with a survey of 128 students to understand their engagement with existing online educational platforms, their experiences with BLAP techniques, and their opinions on our proposed approaches. Based on these findings, we developed a low-fidelity prototype incorporating both BLAP and our suggested methodologies. To evaluate this design, we invited 30 participants to interact with the prototype using a think-aloud protocol and subsequently complete a survey to select their preferred features. The think-aloud method was chosen for its ability to capture real-time feedback and user thought processes, which is particularly beneficial for identifying preliminary trends and themes in an exploratory study. While the sample size of 30 participants provides valuable preliminary insights, it may limit the breadth of findings and generalizability. However, this size is appropriate for an exploratory study to identify key themes and trends. Figure 1 below illustrate the overview of the three methodological phases.

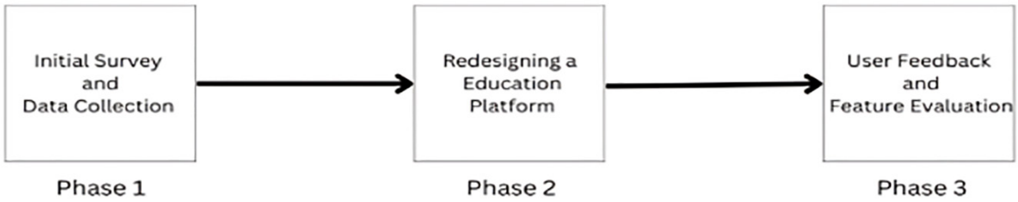

Fig. 1. Overview of the three methodological phases

3.1 Initial survey and data collection

We conducted an initial survey with 128 students to explore their engagement with existing online educational platforms, their experiences with BLAP (badges, leaderboards, achievements, and points) techniques, and their perspectives on our proposed gamification strategies. Prior to participation, all individuals were informed about the study's purpose, how their data would be used, and their right to withdraw at any time without penalty. Participation was entirely voluntary, and strict measures were taken to ensure data confidentiality. This study was conducted in adherence to institutional ethical guidelines and best practices for research involving human participants, ensuring integrity and respect throughout the process.

Participants were recruited using convenience sampling, a practical and effective method for this exploratory study. This approach allowed us to target students who met specific criteria essential for the research objectives, such as active engagement in learning at a university or high school level. By focusing on students aged 18–24, we ensured relevance to our target population, as this demographic is most likely to use gamified educational platforms autonomously. Additionally, we included participants outside this age range to capture diverse viewpoints, with further diversity achieved by selecting students from various institutions, domains of study, academic grades, and genders.

3.2 Exploratory methodology and foundations for future validation

Convenience sampling was particularly suited to this preliminary investigation because it efficiently gathers data from an accessible cohort. While we acknowledge the inherent limitations of this method, such as potential biases and reduced generalizability, it is appropriate for identifying key themes and trends in an exploratory study. The findings from this phase serve as a foundation for future research, which will adopt more rigorous sampling techniques to validate and expand upon these preliminary insights. This sampling technique is especially appropriate in early-stage research, where the main objective is to ascertain user views, establish hypotheses, and find emerging trends rather than provide conclusions that can be broadly applied. We gathered a wide range of feedback essential for our prototype's iterative development by including a diverse but easily accessible group of students. Future research will expand on these first findings with a confirmatory study to increase the generalizability and rigor of our findings. A more thorough assessment employs stratified random sampling over various educational institutions.

The survey consisted of 14 questions distributed through an online questionnaire over a one-week period. It included quantitative and qualitative inquiries to comprehensively capture student experiences and preferences. Key topics included the time students spent on gamified platforms, what they liked about these platforms, and areas they found lacking. Quantitative questions primarily used Likert scales to measure engagement levels (e.g., "Very Engaging" to "Not Engaging") and perceived usefulness or effectiveness (e.g., "Not Useful" to "Very Useful"). Multiple-choice questions with single or multiple selections were used to gather demographic information (e.g., age group, gender) and preferences for gamification features. Open-ended questions provided qualitative insights, allowing participants to elaborate on their likes, dislikes, and suggestions for improvements. This mix of structured scales and open-ended responses ensured both measurable trends and detailed feedback were captured. The results revealed students' perceptions regarding the limitations of BLAP methodologies and highlighted the potential benefits of our proposed gamification features. These insights are pivotal for refining our prototype design and guiding subsequent studies to foster intrinsic motivation and enhance engagement in educational settings.

3.3 Redesigning an education platform

To test the effectiveness of our proposed features and validate our theoretical framework, we undertook the redesign of an educational platform used at Kathmandu University. This involved integrating both BLAP elements (badges, leaderboards, achievements, points) and the proposed alternative features identified as potentially more beneficial for fostering intrinsic motivation and long-term engagement.

Design considerations: In redesigning the platform, our primary objective was to enhance user engagement without compromising the educational process. This required a careful balance between gamification and the core educational objectives, ensuring that the gamified elements provided meaningful feedback and motivation while supporting, rather than hindering, learning outcomes.

3.4 Integration of selected features

Player vs player competitive quizzes: Implemented within various subjects, these quizzes allow students to challenge their peers in real-time or asynchronously. The design included a leaderboard specific to these quizzes to foster a sense of achievement and social connection. Figure 2 shows the implementation of the proposed feature.

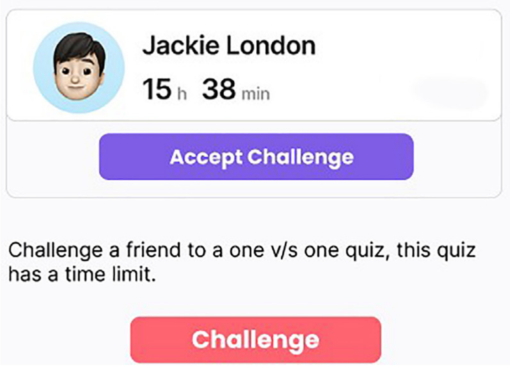

Fig. 2. Player vs. player competitive quizzes

Rewards based on time statistics: A dashboard was created to display detailed time statistics showing students' time on different learning activities. This feature provided personalized insights, helping students identify their strengths and areas needing improvement. Rewards, such as badges or points, were tied to the time invested, encouraging consistent study habits. Figure 3 shows the implementation of the proposed feature.

Habit tracking heatmap: Inspired by GitHub's contribution graph, a heatmap was introduced to track daily learning activities. Each square on the grid represented a day, with color intensity indicating the amount of time spent on learning. This visual representation aimed to reinforce positive behaviors by acknowledging consistent effort and reducing the pressure associated with maintaining unbroken streaks. Figure 4 shows the implementation of the proposed feature.

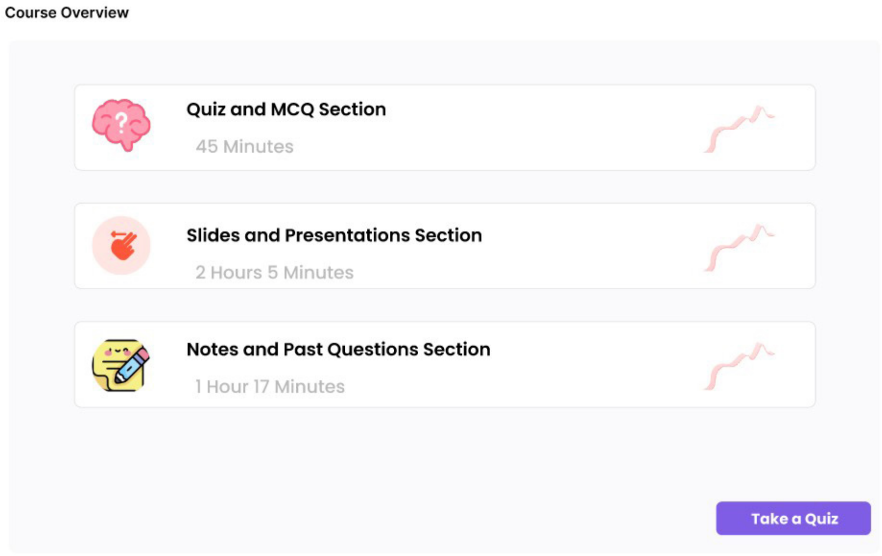

Fig. 3. Reward-based time statistics

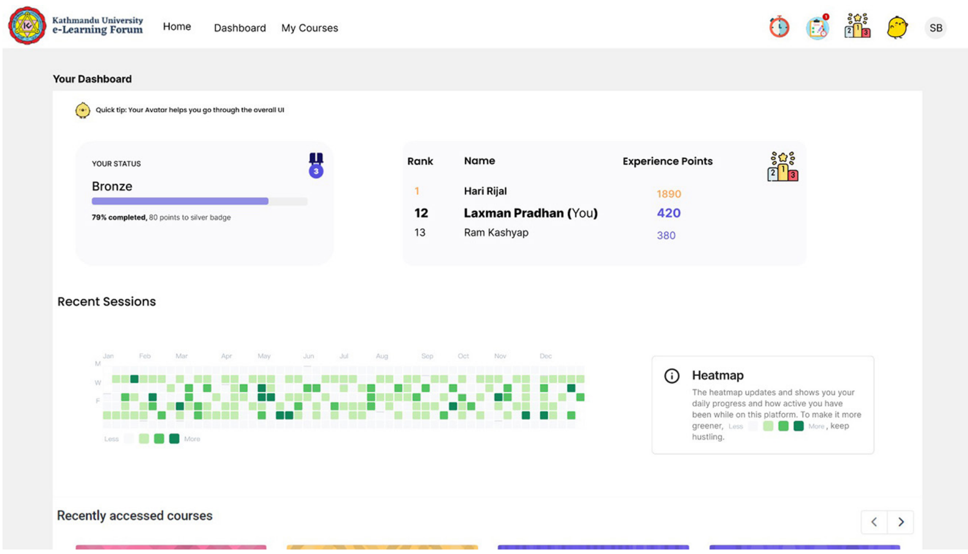

Fig. 4. Habit tracking heatmap

3.5 User feedback and feature evaluation

After the initial implementation of the redesigned educational platform, we conducted a follow-up survey to identify the features that students found most appealing and effective. This phase employed a combination of the think-aloud method and a structured survey to gather comprehensive qualitative and quantitative feedback.

3.6 Think-aloud method

For this phase, we invited 30 participants from the original cohort of 128 students. In selecting these participants, we ensured diversity in terms of age (with the majority aged 18–24 and some participants under 18 and over 24), gender, academic grade, and fields of study. This diversity aimed to capture a broad range of perspectives and enrich the evaluation process. Participants were asked to interact with the redesigned platform while verbalizing their thoughts, reactions, and experiences in real-time. Observers documented both positive and negative feedback related to each feature, including the head-to-head competitive quizzes, time statistics dashboard, and habit-tracking heatmap. The think-aloud method was chosen for its ability to uncover user thought processes, identify usability issues, and highlight immediate reactions to the platform's features. This approach is particularly valuable in exploratory research, where understanding user perspectives and potential challenges is critical for refining design concepts.

3.7 Structured survey

Following the think-aloud sessions, the same 30 participants were asked to complete a structured survey. This survey aimed to quantify user preferences and gather additional insights on each feature's perceived benefits and drawbacks. Quantitative questions primarily employed Likert scales to measure satisfaction levels (e.g., "Strongly Agree" to "Strongly Disagree"), engagement (e.g., "Very Engaging" to "Not Engaging"), and feature effectiveness (e.g., "Very Effective" to "Not Effective"). Multiple-choice questions with single or multiple selections were used to identify the most appealing features and gather demographic information. Open-ended questions complemented the quantitative data by capturing suggestions for further improvements and elaborations on user feedback. The survey included questions on:

- Overall satisfaction with the redesigned platform.
- The perceived impact of head-to-head competitive quizzes on motivation and engagement.
- The usefulness of visual time statistics in identifying strengths and weaknesses.
- The effectiveness of the habit of tracking heatmaps in promoting consistent study habits.
- Any suggestions for further improvements?

Combining the qualitative insights from the think-aloud sessions with the quantitative data from the survey, we obtained a comprehensive understanding of user preferences and areas for improvement. This feedback is instrumental in guiding future iterations of the platform and ensuring alignment with student needs and motivations.

4 FINDINGS

4.1 Findings of the initial survey on problem identification

For the initial survey, 128 participants were selected using convenience sampling. This survey aimed to gather insights into the challenges and perceptions related to gamification elements in educational platforms.

Respondents background: A total of 128 respondents participated in the initial survey. The majority of participants were male (73.3%), with 26% identifying as female and a small number choosing not to disclose their gender. The use of online learning platforms with gamification elements was notably prevalent among younger audiences, with the vast majority of respondents falling within the 18–24 age group. Only a few respondents were below 18 or above 24. Tables 1–4 illustrate sociodemographic characteristics of the participants, and respondents answered 'Yes', 'No', and 'Not Sure'.

Table 1. Sociodemographic characteristics of the participants

	Number	Participants
Female	30	23.4375%
Male	85	66.4%
Others	–	–
Prefer not to say	13	0.1015%
Age		
Less than 18	4	0.03125%
18–24	116	90.625%
24–30	4	0.03125%
30–40	–	–
Above 40	–	–
Didn't State	4	0.03125%

Current engagement with gamified platforms: Our survey revealed that a significant proportion of participants use educational platforms incorporating gamification elements such as points and rewards, badges and achievements, levels and progression, as well as avatars and personalized dashboards with feedback and reward systems. Figures 5–15 illustrate a questionnaire about BLAP platforms, time spent on the current e-learning platform, feedback on the redesigned platform, features chosen by users, player vs. player quizzes, anticipation of using the feature, usefulness of the habit-tracking heatmap, effectiveness of the habit-tracking heatmap, effectiveness of time statistics, and confidence using time statistics.

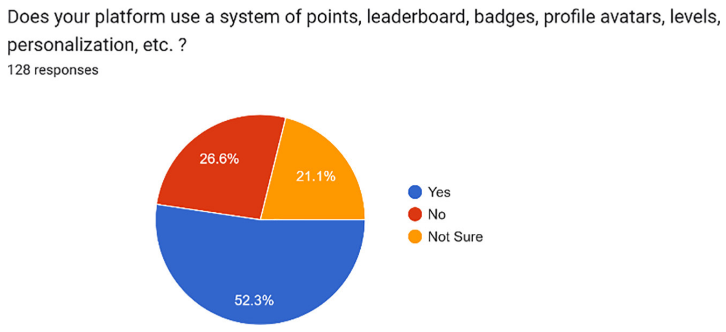

Fig. 5. Questionnaire about BLAP platforms

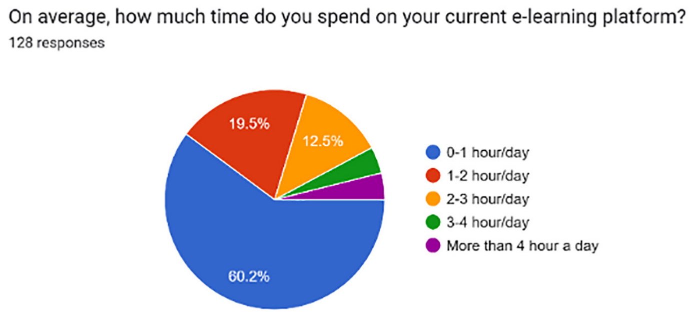

Fig. 6. Time spent on the current e-learning platform

Despite implementing gamification elements such as points, leaderboards, badges, profile avatars, and levels in the e-learning platform, our analysis reveals a lack of sustained user engagement. The data shows that 60.2% of users spend only 0–1 hour daily on the platform, regardless of gamification features. This minimal engagement persists even among users who confirmed the presence of gamification elements in their platform experience (50.9% of respondents).

We analyzed linear regression to quantify the relationship between gamification features and user engagement. The methodology involved converting categorical time ranges to numeric values using mid-points (e.g., "0–1 hour/day" = 0.5, "1–2 hour/day" = 1.5, etc.) and encoding gamification responses ("Yes" = 1, "No" = 0, "Not Sure" = 0.5). Using ordinary least squares (OLS) regression, we modeled time spent as a function of gamification feature presence.

Table 2. Respondents who answered "Yes" on having traditional gamification elements

Time Spent on the Platform	Respondents (Yes)
0–1 hour/day	37
1–2 hour/day	13
2–3 hour/day	10
3–4 hour/day	3
More than 4 hours/day	4

Table 3. Respondents who answered "No" on having traditional gamification elements

Time Spent on the Platform	Respondents (No)
0–1 hour/day	22
1–2 hour/day	7
2–3 hour/day	3
3–4 hour/day	1
More than 4 hours/day	1

Table 4. Respondents who answered "Not Sure" about having traditional gamification elements

Time Spent on the Platform	Respondents (Not Sure)
0–1 hour/day	18
1–2 hour/day	5
2–3 hour/day	3
3–4 hour/day	1

Linear Regression Calculation

We calculated the regression coefficient (β) using the OLS method:

$$\beta = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sum_{i=1}^{n}(x_i - \bar{x})^2} \tag{1}$$

Standard error and t-statistic standard error (*SE*) of β was calculated as:

$$SE(\beta) = \sqrt{\frac{\sum_{i=1}^{n}\left(y_i - \widehat{y}_i\right)^2 / (n-2)}{\sum_{i=1}^{n}\left(x_i - \bar{x}\right)^2}} \tag{2}$$

The *t*-statistic was then computed as:

$$t = \frac{\beta}{SE(\beta)} \tag{3}$$

P-value Calculation

The *p*-value was determined using the t-distribution with $(n - 2)$ degrees of freedom:

$$p\text{-value} = 2 \times P(t_{n-2} > |t|) \tag{4}$$

We analyzed the impact of gamification presence on user engagement time, where time spent was coded on a scale from 0.5 (0–1 hour/day) to 4.5 (more than 4 hours/day), and gamification presence was coded as 1 (yes), 0 (no) or 0.5 (not Sure). Using OLS linear regression on a sample of 128 users, we found a positive and statistically significant relationship between gamification and time spent.

While our analysis yielded a statistically significant *p*-value ($p = 0.0407 < 0.05$), it's crucial to interpret this result in context. The *p*-value indicates that there is only a 4.07% probability that we would observe this relationship between gamification and time spent ($\beta = 0.3$) by chance if no true relationship existed. However, statistical significance should not be confused with practical significance. Despite the low *p*-value suggesting the relationship is unlikely to be random, the small effect size ($R^2 = 0.06$) demonstrates that traditional gamification techniques explain only 6% of the variance in user engagement time.

This statistical analysis reinforces our main hypothesis: while a technically significant relationship exists between gamification features and platform usage, the practical impact is minimal. The presence of gamification elements does not substantially increase user engagement time on the platform, suggesting that current gamification strategies may need substantial revision to achieve their intended objectives. This finding challenges the assumption that the mere presence of gamification elements automatically leads to increased user engagement. Our results suggest that educational platforms may need to reevaluate their gamification strategies, focusing not just on implementing game-like features but on ensuring these elements meaningfully connect with learning objectives and help users with intrinsic motivation.

Interest in alternative gamification elements: In response to our inquiry about interest in alternative gamification elements beyond badges, points, leaderboards, and avatars, nearly three-quarters of the participants expressed that the incorporation of such approaches could enhance their engagement with online learning platforms.

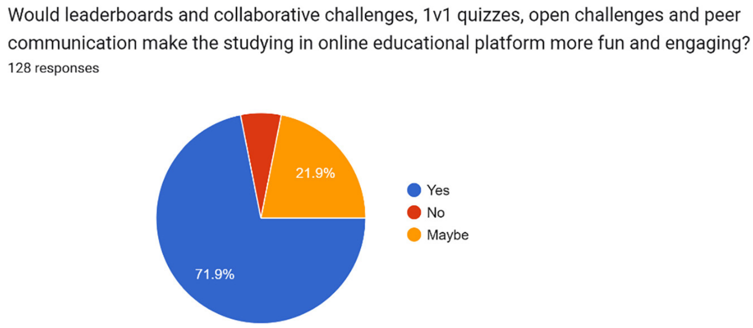

Fig. 7. Responses on current e-learning platform

4.2 Implications for research objectives

These findings provide promising support for our research objectives. Despite the presence of traditional gamification elements, the low engagement levels suggest a need for innovative approaches. The strong interest in alternative gamification strategies indicates the potential for increasing engagement through features such as player vs player competitive quizzes, visual representation of time statistics, and a habit-tracking heat map. While these findings are preliminary, they highlight the potential of these features to address key gaps in current gamified educational platforms. Further studies are required to validate these hypotheses through real-world implementations and longitudinal analyses.

4.3 Findings from user evaluation of redesigned platform prototype

For this study, 30 participants were selected using convenience sampling to engage in a think-aloud survey and follow-up questionnaire for quantitative and qualitative assessment. All participants were students who interacted with the redesigned platform prototype.

Qualitative findings: The think-aloud method was employed to gather qualitative feedback from students interacting with the redesigned educational platform, showcased through an interactive Figma design. The following key insights emerged from this exercise:

Initial impressions. Participants' initial reactions were overwhelmingly positive, with several noting the enhanced visual appeal of the platform. Their comments indicated a strong, favorable response to the aesthetic and engaging redesign.

Interaction with habit-tracking heatmap. The habit-tracking heatmap garnered significant interest. Students actively interacted with it, exploring how the color intensity represented their study activities. This feature intrigued them, and they expressed curiosity about the underlying data, trying to understand how their study habits were visually represented. Additionally, they noted that the heatmap could help them identify patterns in their study habits, making it easier to recognize and adjust their routines for better outcomes.

Perception of time-tracking statistics. The feature tracked time spent on various study activities, such as slides, notes, and quizzes, and received positive feedback. Students appreciated how these statistics were integrated into the heatmap, providing a comprehensive overview of their study habits. They found this detailed tracking beneficial, as it offered insights into their strengths and areas needing improvement, reinforcing the utility of such data for effective learning.

Engagement with competitive quizzes. When participants encountered a challenge notification sent by a friend, they were pleasantly surprised and excited about this feature. Accepting or rejecting challenges added a dynamic, social element that participants found appealing. They expressed enthusiasm for the competitive aspect, noting that seeing the scores of previous one-on-one matches with friends on their profiles motivated them to play more matches to improve their standings.

Reactions to traditional gamification elements. Interestingly, traditional elements such as badges and avatars did not elicit much attention or excitement from the participants. Although these features were part of the platform, they were not a focal point of user engagement. Conversely, the leaderboard feature did attract some interest, suggesting a preference for competition over individual recognition.

These findings underscore the potential of incorporating visually engaging, competitive, and insightful elements into educational platforms to enhance student motivation and engagement. The positive reception of the new features, particularly the competitive quizzes and habit-tracking heatmap, highlights the importance of fostering both social interaction and self-awareness in learning environments. Conversely, the relatively muted response to traditional gamification elements like badges and avatars suggests that while these elements still hold value, they may not fully engage students on their own. The new, more interactive, and competitive features bring a sense of novelty and complement the existing BLAP elements, indicating that adding innovative approaches is necessary to enhance intrinsic motivation and sustained engagement in educational platforms.

Quantitative findings: Additional quantitative feedback was collected using a meticulously formulated survey questionnaire.

User feedback on the redesigned gamified platform: After redesigning the platform to include gamification elements using BLAP methodologies as well as new features. According to the survey, everyone preferred the new design over the old ELF design, which did not include any gamified elements.

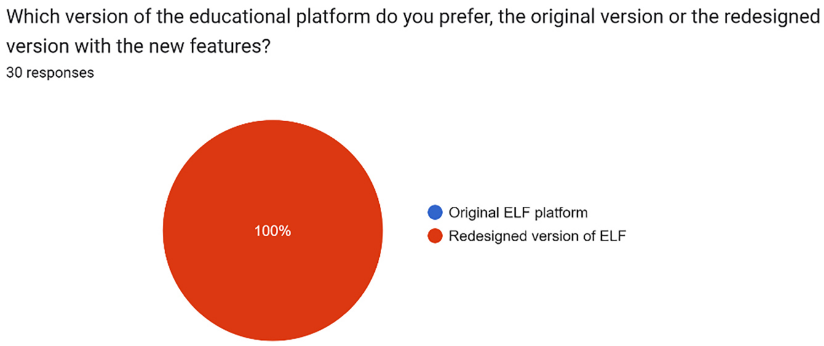

Fig. 8. Feedback on the redesigned platform

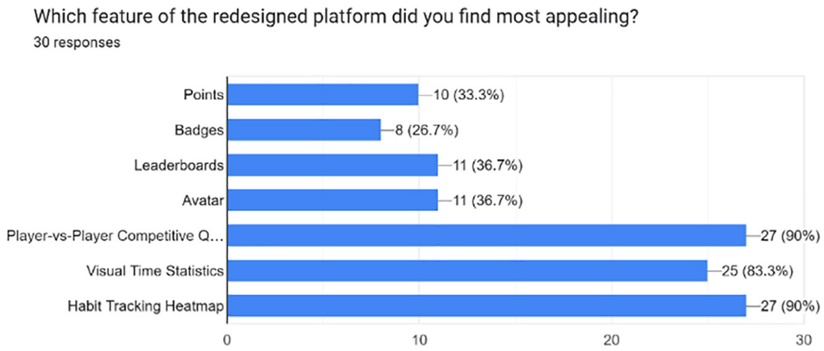

Fig. 9. Most appealing feature chosen by users

Impressions of BLAP, player vs player competitive quizzes, visual time statistics, and habit tracking heatmaps: To determine whether users have a significant preference for the newly proposed features compared to traditional gamification elements (badges, leaderboard, achievements, and points), a chi-square test for independence was conducted.

Hypotheses: Null hypothesis (H_0). Users have an equal preference between the proposed features (player-vs-player quizzes, habit tracking heatmap, and visual time statistics) and BLAP features (badges, leaderboard, achievements, and points).

Alternative hypothesis (H_1). Users prefer the proposed features over BLAP features.

Observed frequencies (*O*)

The observed frequencies based on survey responses from 30 participants are:

Proposed Features:

Player-vs-Player Quizzes: 27 selections

Habit Tracking Heatmap: 27 selections

Visual Time Statistics: 25 selections Total for Proposed Features: 27 + 27 + 25 = 79

BLAP Features:

Badges: 8 selections

Leaderboard: 11 selections

Achievements (Points): 10 selections

Avatar: 11 selections

Total for BLAP Features: 8 + 11 + 10 + 11 = 40

Expected Frequencies (*E*) Assuming equal preference, the expected frequencies are calculated as:

$$E = \frac{79 + 40}{2} = \frac{119}{2} = 59.5$$

Chi-Square Statistic (χ^2) The chi-square statistic is computed using:

$$\chi^2 = \sum \frac{(O-E)^2}{E}$$

For Proposed Features:

$$\frac{(79-59.5)^2}{59.5} = \frac{(19.5)^2}{59.5} = \frac{380.25}{59.5} = 6.39$$

For BLAP Features:

$$\frac{(40-59.5)^2}{59.5} = \frac{(-19.5)^2}{59.5} = \frac{380.25}{59.5} = 6.39$$

$\chi^2 = 6.39 + 6.39 = 12.78$

Decision Rule At a significance level $\alpha = 0.05$, the critical value of χ^2 for 1 degree of freedom is 3.84.

If $\chi^2 > 3.84$, reject H_0.

If $\chi^2 \leq 3.84$, fail to reject H_0.

Conclusion: Since the calculated value of $\chi^2 = 12.78$ exceeds the critical value, **we reject the null hypothesis**.

Interpretation: There is strong statistical evidence that users significantly prefer the proposed features over the BLAP features. This supports the platform redesign's prioritization of player-vs-player quizzes, Habit Tracking Heatmap, and Visual Time Statistics.

Impressions on player-vs-player competitive quizzes: Our survey revealed that participants found player-vs-player competitive quizzes to be highly engaging, with 66.7% rating them as 'Very Engaging' and 30% as 'Engaging'. A small fraction (3.3%) remained neutral. Additionally, 20% of participants anticipated using the quizzes 'Always', 63.3% anticipated using them 'Often', and 28.6% expected to use them 'Sometimes'. These results align well with our qualitative findings, where participants expressed motivation from the competitive aspect, particularly the ability to track and improve their rankings based on previous matches with friends.

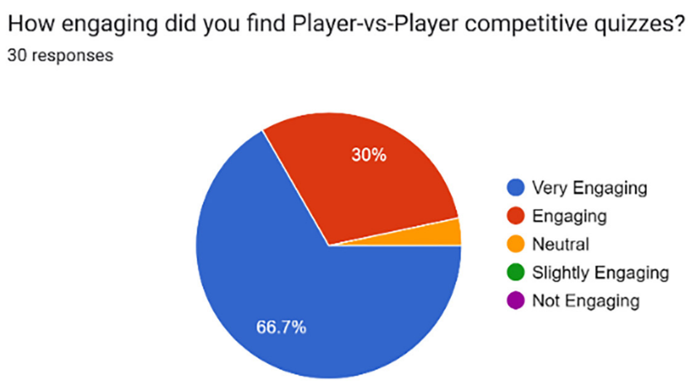

Fig. 10. Player vs player quizzes

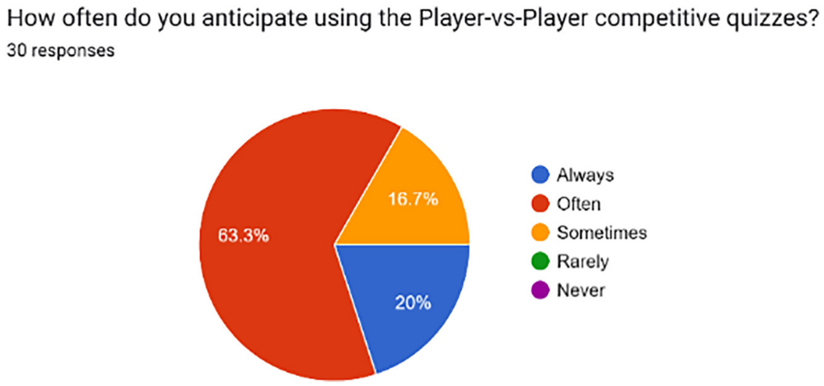

Fig. 11. Anticipation of using the feature

Habit-tracking heatmap for building study habits: Our survey results indicate that a majority of participants found the habit-tracking heatmap to be highly useful for monitoring their study habits, with 60% rating it as "Very Useful", 30% as "Useful", 6.7% as "Neutral" and 3.3% as slightly useful. Additionally, 46.7% of participants found it 'Very Effective', the same percentile found it 'Effective', and 6.6% found it to be 'Neutral' in motivating them to maintain consistent study habits.

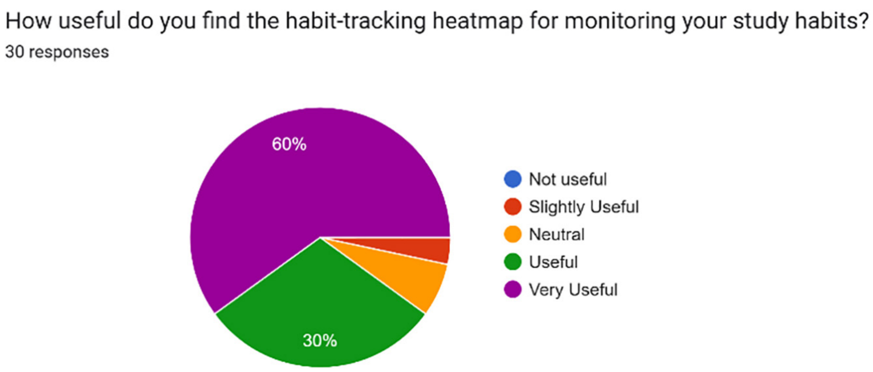

Fig. 12. Usefulness of habit-tracking heatmap

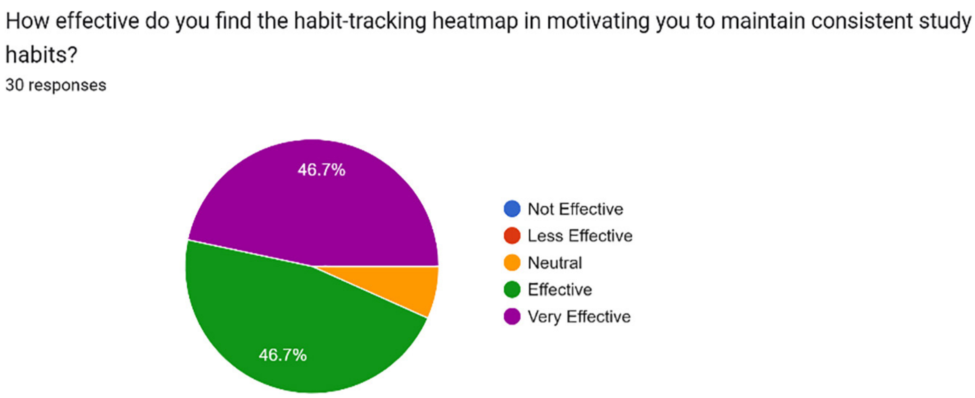

Fig. 13. Effectiveness of habit-tracking heatmap

Time statistics for accountability: Time statistics can potentially help students feel more confident in subjects where they have invested significant effort.

According to a survey, 36.7% of participants "strongly agree," 50% "agree," and 13.3% "neutral" that they feel more confident in areas where they have dedicated substantial effort.

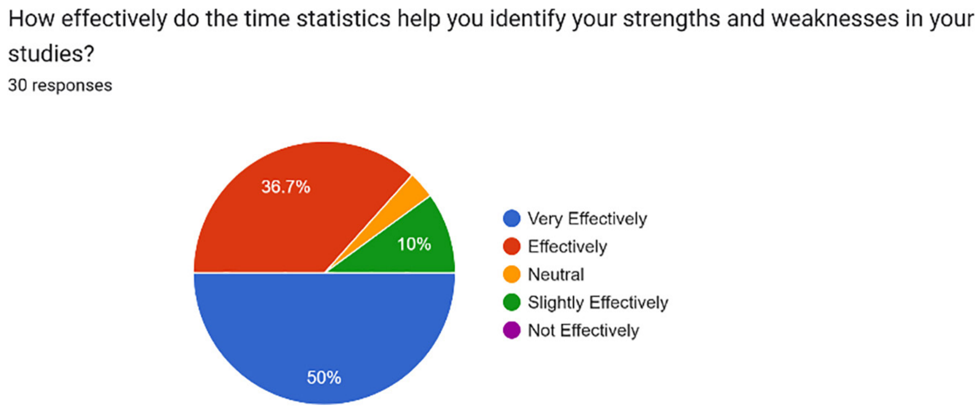

Fig. 14. Effectiveness of time statistics

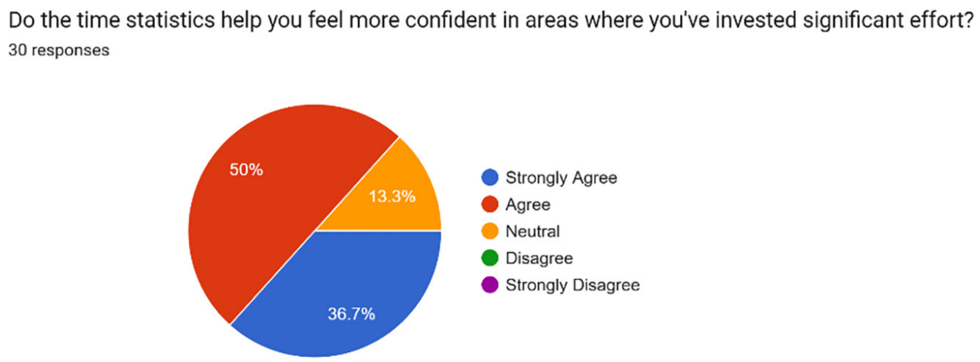

Fig. 15. Confidence using time statistics

4.4 Statistical analysis of proposed features

We used Likert-scale questions to assess participant engagement, usefulness, and effectiveness of gamification features. For instance, *player vs player competitive quizzes were evaluated* for engagement on a scale: (1) Not Engaging–1; (2) Slightly Engaging–2; (3) Neutral–3; (4) Engaging–4; and (5) Very Engaging–5. Responses were numerically coded (1 to 5) to quantify perceptions. Mean scores represent the overall tendency of responses—higher means indicate stronger positive reception. Standard deviation reflects variability; a low standard deviation suggests consensus, while a high one indicates diverse opinions. These metrics provide insights into the effectiveness and appeal of the features. Table 5 presents each measure's mean scores and standard deviations across the three preferred gamification features: player-vs-player quizzes, habit-tracking heatmap, and time statistics for accountability. Higher mean values indicate stronger positive reception, while standard deviation (S.D.) reflects the variability in responses. A lower S.D. suggests general agreement among participants, whereas a higher S.D. indicates diverse opinions.

Table 5. Showing statistical mean and standard deviation of proposed features

Feature	Measure	Mean	S.D.
Player-vs-player quizzes	Engagement Level	4.625	0.5535
	Anticipated Usage	4	0.7184
Habit-tracking heatmap	Usefulness	4.5	0.762
	Effectiveness	4.406	0.6148
Time statistics for accountability	Effectiveness	4.281	0.9241
	Confidence	4.281	0.6832

The quantitative data from our survey revealed that while participants found features such as player-vs-player competitive quizzes and habit-tracking heatmaps engaging and useful, qualitative feedback emphasized the added value of these tools in creating a dynamic and socially interactive learning environment. Participants were motivated by the competitive aspects of quizzes and intrigued by the visual representation of their study habits through the heatmap, which helped them identify patterns and adjust their routines for better outcomes.

These findings suggest that a shift towards meaningful gamification, grounded in the principles of SDT, can significantly enhance the effectiveness of educational platforms. By promoting autonomy, competence, and relatedness, features such as competitive quizzes and habit-tracking heatmaps engage students and can also help build intrinsic motivation for continuous learning.

5 CONTRIBUTIONS TO MOBILE LEARNING TECHNOLOGIES

These features are not limited to desktop web applications; they can also be effectively implemented in mobile learning technologies. Platforms such as Duolingo and Khan Academy already utilize BLAP elements—badges, leaderboards, achievements, and points—within mobile environments to encourage engagement. However, our revised gamification approach introduces features like competitive quizzes, visual time-tracking, and habit-tracking heatmaps, which are equally suited for mobile interfaces. These features are inherently adaptable to mobile devices through intuitive touch-based interactions and responsive design principles.

The same behavioral mechanisms that drive engagement in web-based systems—such as real-time feedback, social elements, and visual progress tracking—function similarly in mobile contexts. Our regression analysis indicated a statistically significant relationship between traditional gamification elements and increased user engagement time and showed that even though there is a positive relationship between these two factors, a revision is required ($R^2 = 0.06$). Since the practical impact of traditional gamification elements is minimal, there exists a relationship between gamification elements and user engagement, which explains that newer gamification elements that boost intrinsic motivation in users (player vs player competitive quizzes, habit tracking heatmap, and time-based statistics) can help in increasing user engagement time in both web and mobile-based learning platforms, thus supporting our original hypothesis. Given that mobile users often engage with learning platforms in shorter, more frequent sessions, we propose that the incremental and effort-based rewards are especially well-matched to mobile usage patterns. Features like the habit heatmap and time statistics can provide quick, meaningful feedback during brief interactions, helping to build consistency over time. Thus, the proposed framework extends naturally to mobile applications, where it can support sustained learning habits and improve motivation as much as on desktop platforms.

6 CONCLUSIONS

Although BLAP features are at the core of gamified designs, they are not the most efficient in building intrinsic motivation for long-term education. Derived from games, these platforms lure students by inducing extrinsic motivation via rewards but fail to provide lasting incentives for intrinsic motivation to thrive. This paper explores strategies that emphasize long-term consistency over short-term rewards to address these limitations. Player-vs-player quizzes leverage competitive elements to enhance engagement, while the habit-tracking heatmap offers a non-punitive approach to encourage regular study habits. The visual representation of time statistics further complements these features by enabling students to identify their strengths and areas for improvement, fostering accountability and self-awareness. Unlike traditional streaks, which can demotivate students upon interruption, the heatmap and time statistics focus on reinforcing ongoing efforts and incremental progress. These features promote a growth mindset by emphasizing the time and effort invested in education, underscoring the value of perseverance and continuous improvement. This exploratory study lays the groundwork for future research, aiming to validate these features through functional prototypes and real-world implementation.

While our study has laid a theoretical foundation and provided initial validation through user feedback on an interactive Figma design, the next step involves developing a fully functional prototype. Future work involves testing this prototype over an extended period within an actual course setting. This would allow for a comprehensive evaluation of the proposed features' effectiveness in fostering intrinsic motivation, engagement, and long-term educational outcomes. Collecting empirical data from real-world usage will be crucial in verifying and refining our findings, ultimately leading to a more robust and impactful gamified educational platform. As an exploratory effort, this paper outlines a conceptual framework and gathers preliminary insights. The work is intended to stimulate further investigation and guide the iterative development of innovative gamification strategies. These early findings are crucial for future research and practical applications.

7 ETHICAL APPROVAL STATEMENT

According to Kathmandu University's criteria, this study did not need formal ethical approval because it involved non-interventional, voluntary participation, anonymized survey data, and little danger to participants. Every procedure used in the study complies with the 1964 Declaration of Helsinki and its subsequent amendments, as well as similar ethical principles and institutional research policies. Before they participated in the study, all individuals gave their informed consent.

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