

Achievement Surfers: A gamified runner-based learning tool for supporting revision and reinforcement of learning outcomes

Anastasiya Larionova

Kazakh-British Technical University
59 Tole Bi Street, Almaty, Republic of Kazakhstan
a.larionova@kbtu.kz

Alexandra Knysheva, Alina Gutoreva

Kazakh-British Technical University
59 Tole Bi Street, Almaty, Republic of Kazakhstan
a.knysheva@kbtu.kz , a.gutoreva@kbtu.kz

ABSTRACT

Gamification is widely discussed as an approach to increasing engagement in educational contexts; however, its effectiveness remains inconsistent and highly dependent on design and implementation. This paper introduces Achievement Surfers, a gamified learning framework implemented as a 3D runner that converts spreadsheet-based question sets into playable revision levels. The paper presents the system and reports results of a playtest conducted with forty-five university students to validate the feasibility of the approach. Results indicate positive engagement and usability, suggesting that the framework can support repeated interaction with learning material and provide a foundation for further experimental evaluation.

Keywords

gamification, game-based learning, runner, higher education, Unity Engine, low-friction integration, Student Engagement, Serious Games, 3D Runner

INTRODUCTION

Digital technologies are widely integrated into higher education; however, instructional practices often remain constrained by rigid and static revision formats such as quizzes, written tests, and slide-based materials. While these formats remain pedagogically valid, research suggests that they may struggle to sustain attention and engagement during extended preparation and revision activities (Dicheva et al. 2019; Oliveira et al. 2020). At the same time, students increasingly expect learning environments that provide immediate feedback, interaction, visible progress, and responsive learning experiences rather than static review formats (Ryan and Deci 2000; Gee 2003).

Gamification is commonly defined as the use of game elements in non-game contexts to influence engagement, participation, and behavioral patterns (Deterding et al.

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2011; Hamari et al. 2014). Prior research indicates that gamified systems can encourage repeated interaction with learning material and support voluntary practice. However, their effectiveness remains strongly dependent on design quality and alignment with learning objectives (Dicheva et al. 2019; Oliveira et al. 2021; Toda, Valle, and Isotani 2018).

Interactive systems that provide clear goals, immediate feedback, and balanced challenges are associated with flow states, which describe deep engagement and focused involvement in an activity (Csikszentmihalyi 1990). Such conditions are particularly relevant for revision tasks that rely on repeated interaction.

Despite these insights, many gamified systems remain difficult to reuse, require significant instructor effort, or are limited to specific disciplines. This creates a gap between the theoretical potential of gamification and its practical implementation in real courses. The system presented in this paper addresses this challenge through the design of Achievement Surfers, a runner-based gamified framework intended to support revision and reinforcement of course material. The system allows instructors to upload structured question sets through spreadsheet files that are automatically transformed into playable revision levels. In this configuration, the framework functions not only as a game prototype but also as a content pipeline and experimental platform that combines runner mechanics, question collection, a post-level answering phase, progression systems, and built-in analytics.

The framework also presents a practical advantage for instructors. Previous research on gamified learning platforms such as OneUp demonstrates that progression systems and visible progress indicators can support student engagement when aligned with learning objectives when they are aligned with learning objectives (Dicheva et al. 2019). The Achievement Surfers game framework extends this idea by introducing a lightweight content pipeline in which educational material can be imported directly through spreadsheet files and transformed into interactive revision levels. This approach reduces the technical burden for instructors and allows gamified learning activities to be integrated into existing courses without requiring manual game development.

The contribution of this work is a reusable game framework for gamified revision and a research platform for evaluating engagement and short-term reinforcement of learning material. Rather than focusing on long-term motivation, the framework is designed to support more measurable and bounded outcomes, including encouraging repeated practice, strengthening short-term consolidation of knowledge, and improving the experience of test-based revision through interactive engagement. In this sense, it is positioned as a low-friction supplement to existing learning environments rather than a replacement for traditional instruction.

From a research perspective, the framework also contributes to the broader intersection of game design, software architecture, and educational technology. The system treats gameplay mechanics not merely as aesthetic elements but as design variables that structure pacing, repetition, and cognitive interaction with learning material. In this sense, the use of the runner genre is not incidental but reflects its suitability for short, repeatable gameplay cycles that can support iterative learning activities (Deterding et al. 2011; Dicheva et al. 2019; Hamari et al. 2014; Toda, Valle, and Isotani 2018; Oliveira et al. 2021; Tonhão et al. 2021).

LITERATURE REVIEW AND RESEARCH GAP

Research on gamification and game-based learning demonstrates both promising results and important limitations. Gamified systems are frequently associated with increased engagement, higher practice frequency, and more positive perceptions of learning activities. At the same time, empirical results remain inconsistent and strongly dependent on design, context, and implementation quality (Oliveira et al. 2020; Tonhão et al. 2021; Toda, Valle, and Isotani 2018).

A key issue identified in the literature is the alignment between game mechanics and learning objectives. Poorly designed systems may shift attention toward rewards rather than learning outcomes or even reduce motivation (Dicheva et al. 2019; Hussein et al. 2019; Toda, Valle, and Isotani 2018). In contrast, when gameplay mechanics are meaningfully integrated with educational content, game-based systems can support active engagement and repeated interaction with learning material (Hussein et al. 2019; Souza et al. 2018). A key issue identified in the literature is the alignment between game mechanics and learning objectives. Poorly designed systems may shift attention toward rewards rather than learning outcomes or even reduce motivation (Dicheva et al., 2019; Hussein et al., 2019; Toda et al., 2018). In contrast, when gameplay mechanics are meaningfully integrated with educational content, game-based systems can support active engagement and repeated interaction with learning material. A meta-analysis by Sailer and Homner (2020) synthesizing 44 studies found significant positive effects of gamification on cognitive ($g = .49$), motivational ($g = .36$), and behavioural learning outcomes ($g = .25$) compared to conventional instruction, with cognitive gains remaining stable even when only methodologically rigorous studies were included. Crucially, these effects were not uniform: the inclusion of game fiction and the combination of competition with collaboration emerged as significant moderators, particularly for behavioural and motivational outcomes, underscoring the importance of intentional design. At the level of individual experiments, Ortiz-Rojas et al. (2019) conducted a pretest–posttest quasi-experiment with 89 students in an introductory computer programming course and observed a significant improvement in learning performance in the gamified leaderboard condition, though motivational effects were mediated by prior gaming experience and self-efficacy.

Another important issue concerns study design and generalizability. Reviews highlight that many gamification studies rely on small samples, lack control groups, or employ weak experimental designs, making it difficult to draw reliable conclusions (Oliveira et al. 2020). As a result, there is a need for more robust and systematic evaluation of gamified learning systems (Oliveira et al. 2021; Tonhão et al. 2021).

Empirical studies across domains further illustrate these patterns. In software engineering education, gamified environments have been shown to increase engagement, collaboration, and practice frequency (Tonhão et al. 2021; Souza et al. 2018). In entrepreneurship education, serious games support experiential learning and decision-making when gameplay remains aligned with learning objectives (Yeong and Md Deni 2025). At the same time, studies such as Ecoship Endeavour demonstrate that improvements in engagement do not necessarily translate into increased long-term motivation, highlighting the importance of avoiding overstated claims (Hussein et al. 2019).

Theoretical perspectives provide additional insight into these findings. Self-Determination Theory emphasizes the importance of autonomy, competence, and intrinsic motivation in sustaining engagement (Deci and Ryan 2000), while Flow Theory highlights the role of balanced challenge and feedback in creating deep involvement in activities (Csikszentmihalyi 1990). These perspectives suggest that interactive systems combining progression, feedback, and repeated challenges may support engagement during revision tasks.

Within this context, endless runner games have been explored as educational formats due to their accessibility and simple interaction loops. Runner-based systems have been applied in domains such as mathematics and language learning and are often described as suitable for repeated practice sessions (Azizah and Abdullah 2025; Ghani et al. 2024; Rusmana et al. 2023; Sutmo et al. 2023; Amin et al. 2025). However, many of these implementations remain discipline-specific prototypes, limiting their reuse across different educational contexts.

Taken together, the literature reveals a clear research gap. While gamified systems demonstrate potential for supporting engagement and repeated practice, existing solutions are often difficult to adapt, require significant effort from instructors, or are limited to specific domains. There is therefore a need for lightweight, reusable frameworks that allow instructors to integrate gamified revision into existing courses without requiring programming expertise and that support systematic analysis of learning behaviour. This evidence suggests that the benefits of game-based systems are conditional on how closely mechanics are tied to learning objectives rather than to extrinsic reward structures alone.

The Achievement Surfers game framework is designed as a response to this gap by providing a runner-based system in which structured question sets can be uploaded and automatically transformed into interactive revision experiences.

RESEARCH HYPOTHESIS

The central research hypothesis guiding this study is whether a lightweight gamified runner framework can support engagement and short-term reinforcement of learning material across different academic disciplines without requiring curriculum redesign. In practical terms, the study examines whether an interactive gameplay format can make revision activities more repeatable, engaging, and memorable than conventional preparation methods while remaining feasible for instructors to adopt within existing course structures.

The study examines the hypothesis from two complementary perspectives: student experience and instructor usability.

From the student perspective, the project investigates whether interactive gameplay elements such as movement-based interaction, immediate feedback, and visible progression can encourage voluntary repetition and support short-term consolidation of course content. The game framework does not assume a universal or long-term increase in motivation; instead, it focuses on whether the design can make students more willing to revisit course content and engage with revision as an active process rather than a static review activity.

From the instructor's perspective, the project examines whether a spreadsheet-based content pipeline can reduce the effort required to prepare revision tasks. The system enables structured question sets to be uploaded and automatically transformed into playable levels, allowing instructors to use the game framework without modifying existing course structures. In later stages of the research, this perspective will be evaluated through instructor feedback, usability assessment, and comparison with conventional preparation workflows.

SYSTEM DESIGN AND TECHNICAL ARCHITECTURE

Achievement Surfers is implemented as a 3D educational runner designed as a finite-level learning environment. The player moves automatically forward through a four-lane space, avoids obstacles, collects rotating question objects embedded in the level structure, and completes a question phase after reaching the end of the section. Each level corresponds to a specific learning module and contains a set of questions drawn from an instructor-provided database. The collected questions are answered after the run, creating a loop of movement, collection, recall, and feedback. This finite structure intentionally focuses the experience on revision and reinforcement rather than endless score accumulation, allowing the gameplay cycle to remain clearly connected to learning tasks. Figure 1 illustrates the technical workflow of the Achievement Surfers game framework, including the content pipeline that transforms instructor-provided data into playable levels.

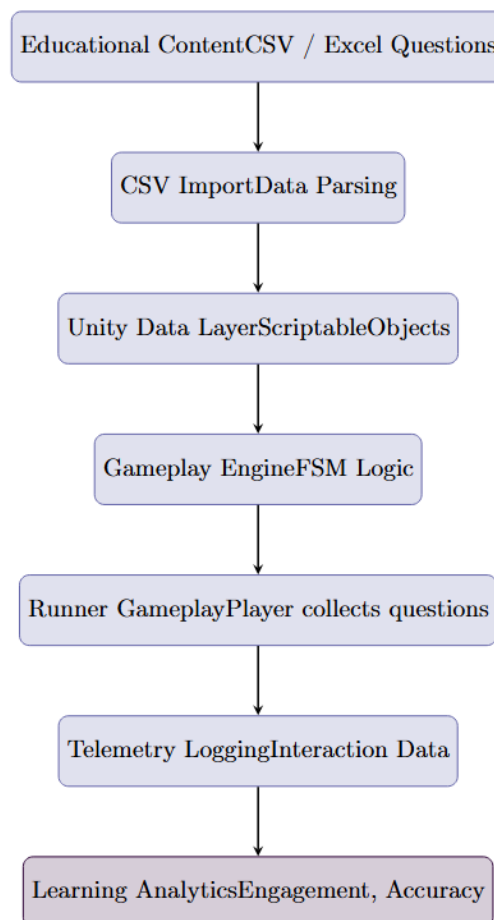


Figure 1: Technical workflow of the Achievement Surfers gamified learning system.

During development, the mechanics of the system evolved to better align gameplay rhythm with educational clarity. Earlier design iterations explored presenting questions directly during movement. However, this approach interrupted the pace of the runner. The current design distributes questions throughout the level as collectible rotating objects that are temporarily stored and answered at the end of the run. This adjustment preserved the continuous movement characteristic of runner games while maintaining a clear and structured educational interaction. The resulting gameplay structure combines movement, anticipation, and post-run reflection, which aligns with recommendations in the gamification literature emphasizing meaningful integration between gameplay and learning tasks rather than attaching rewards to static quizzes (Amin et al. 2025; Deterding et al. 2011; Dicheva et al. 2019; Hamari et al. 2014; Toda et al. 2018; Oliveira et al. 2021; Tonh ao et al. 2021).

Figure 2 shows an early gameplay and interface mockup illustrating the runner environment and question interaction system.

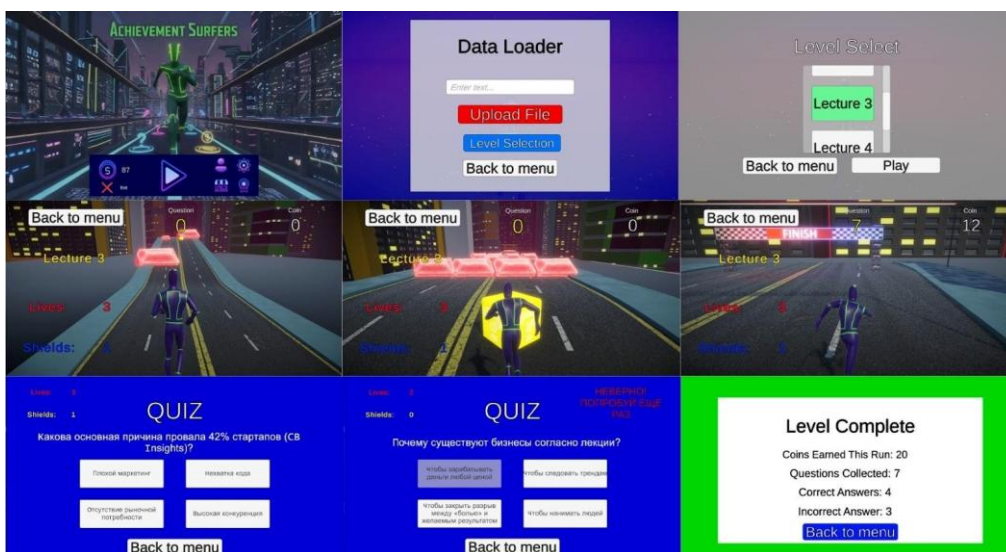


Figure 2: Gameplay interface and question interaction screenshots.

The reward structure combines correctness, survival, and progression systems. Correct answers generate coins that can be exchanged for shields or additional lives, while completing sections unlocks achievement badges with rarity tiers ranging from common to legendary. These mechanics are not presented as replacements for learning objectives but as supporting systems that reinforce repetition, visible progress, and feedback. The interface also records gameplay metrics such as collected questions, correct and incorrect responses, completion time, collisions, remaining lives, and badge progress.

Development process

From a software engineering perspective, the game framework is designed as a modular architecture. The system is built around common game development patterns, including ScriptableObjects, event-driven systems, object pooling, finite state machines, modular level segments, and separate subsystems for player movement, lane management, question collection, question interfaces, achievement tracking, economy mechanics, audio management, data loading, and analytics. Such

modularity is important both technically and methodologically. While a rigid prototype may demonstrate a concept only once, a modular framework supports iterative development, experimental evaluation, and adaptation for different platforms or future studies, including mobile and web deployments (Deterding et al. 2011; Dicheva et al. 2019; Hamari et al. 2014; Toda et al. 2018; Oliveira et al. 2021; Tonhão et al. 2021).

The game framework allows instructors to upload CSV or Excel files, after which the system generates level content, records gameplay analytics, and returns a structured practice experience without requiring curriculum redesign. A central component of the framework is the content pipeline that enables lightweight integration into existing courses. Instructors upload structured question sets through CSV or Excel files containing question text, answer options, correct answers, section identifiers, and optional metadata such as difficulty levels or reward values. The system parses these files, converts the content into structured game objects, generates level configurations, and activates the analytics layer. This pipeline externalizes educational content from the game logic, allowing instructors to edit or reuse materials without modifying the underlying code. The approach reflects recommendations in gamification research emphasizing flexible systems that can be configured by instructors without requiring complex development processes (Oliveira et al. 2020; Tonhão et al. 2021).

The development process for the game framework follows principles derived from the Game Development Life Cycle (GDLC), which adapts the traditional Software Development Life Cycle for game production environments. The GDLC model typically includes several stages: initiation, pre-production, production, testing, beta evaluation, and release. During initiation, the concept of the educational runner and its learning objectives were defined. Pre-production involved defining gameplay rules, level structures, and interaction mechanics. The production stage included the creation of game assets, level environments, interface systems, and gameplay logic. Testing phases involve functional evaluation of gameplay systems, interface behaviour, and scoring mechanics, followed by beta testing with real users to identify usability issues and gameplay balance. The GDLC framework is particularly suitable for educational games because it integrates technical development with iterative evaluation of user experience and learning interaction (Rusmana et al. 2023).

The selection of the runner genre is also supported by previous research on educational game design. Studies of runner-based learning games suggest that the genre is effective in educational contexts because it combines simple controls, fast gameplay loops, and high engagement potential. These characteristics make runner games suitable for repeated practice and short learning cycles, which are important for revision-oriented learning activities (Azizah and Abdullah 2025; Ghani et al. 2024; Rusmana et al. 2023; Sutmo et al. 2023; Amin et al. 2025). In addition, research on educational runner games highlights that active interaction mechanisms are often more effective than passive presentation of information, as they encourage continuous engagement with the learning task.

The technological stack used for the framework also follows recommendations from previous educational game development studies. Research on web-based runner mathematics games developed with Unity demonstrates that educational games can create more engaging learning environments, make complex concepts easier to understand through learning-by-play approaches, and increase student motivation

through interactive digital media. The same studies highlight that Unity provides an effective platform for developing educational games that can be deployed across web and mobile environments, increasing accessibility and enabling mobile learning scenarios. Mobile platforms in particular expand the availability of learning activities by allowing students to interact with educational content through personal devices in flexible contexts (Rusmana et al. 2023, Azizah et al. 2025).

These considerations influenced the decision to design the Achievement Surfers game framework for potential deployment across desktop, web, and mobile platforms. Mobile learning environments are widely recognized as an important direction in digital education because smartphones make learning activities more accessible, interactive, and portable. As a result, future development stages of the framework will include mobile adaptation in order to expand accessibility and support learning outside traditional classroom environments.

METHODOLOGY

At the current stage of the project, the paper reports the QA validation of the prototype. The study follows a Design-Based Research (DBR) approach, where the development of the system itself is part of the research process. The framework is designed, implemented, and iteratively refined to explore its use in a real educational context. The study reports the results of a playtest conducted to validate the feasibility of the approach. A playtesting study with students was conducted to evaluate engagement, usability, and the perceived usefulness of the system for revision activities. This stage serves as an initial validation of the viability of the framework before conducting a larger controlled study.

Participants

The student-perspective validation involved n=45 undergraduate students from the third and fourth years of study at Kazakh-British Technical University (KBTU), aged nineteen to twenty-one. Participants interacted with the Windows Minimum Viable Product (MVP) version of the game during a course session.

Procedure

The testing procedure consisted of three phases. First, participants completed an exploration phase in which they became familiar with the lane-switching system, obstacle mechanics, and basic controls. This was followed by an active gameplay phase involving multiple gameplay cycles with question collection and section-based tests. After the gameplay session, participants completed a survey evaluating system stability, interface clarity, and their perception of the learning format. Participants rated several technical aspects of the system on a five-point Likert scale, including system stability, character responsiveness, visual design appeal, and interface convenience.

Instructor evaluation

The task consisted in providing a perspective on the game. In addition to the student perspective, an exploratory usability evaluation with instructors was conducted. While the student-side evaluation followed a quantitative approach due to the need to measure engagement, performance, and interaction patterns across a larger group

of participants, the instructor-side evaluation was designed as a qualitative study. A smaller sample consisting of two lecturers and three tutors from different academic disciplines at the university level (five instructors in total) was selected to allow deeper insight into usability, adoption barriers, and practical workflow integration.

Participants interacted with the system while preparing their own question sets and verbalizing their actions and thoughts using a think-aloud protocol (TAP). This method was chosen to capture real-time cognitive processes, uncover usability issues that may not be visible through observation alone, and better understand how instructors interpret and navigate the system. The sessions were complemented by observation and follow-up interviews, enabling the identification of practical challenges and factors influencing adoption.

Role of QA phase

From a methodological perspective, the QA phase plays an important role in validating the technical reliability of the system before conducting controlled experimental evaluation. In game-based learning research, design flaws such as interface delays, unclear interaction zones, or poorly timed mechanics can significantly influence user engagement and distort subsequent measurements of learning outcomes. The pilot stage, therefore, functions as a necessary step between conceptual game framework development and the implementation of a more rigorous experimental study.

Future experimental design

The broader research design will follow a mixed-method approach combining quantitative and qualitative evaluation. The next stage of the research will involve a controlled between-group study. Students from multiple academic disciplines are expected to be divided into control and experimental groups. The control group will revise the same educational material through conventional preparation formats such as reading resources and standard online quizzes, while the experimental group will prepare using the Achievement Surfers system before completing the same or equivalent assessment tasks. Unlike strictly controlled experimental conditions, interaction within the game will remain partially open, allowing students to select levels and engage with the content in a non-linear way. This approach reflects realistic usage conditions while still enabling comparison between learning approaches.

The study will collect both quantitative and qualitative data, including performance outcomes, engagement metrics, repetition behavior, and user feedback. The goal is to evaluate how the system performs under naturalistic learning conditions rather than eliminating variability entirely.

Figure 3 presents the planned experimental design for the controlled evaluation of the system.

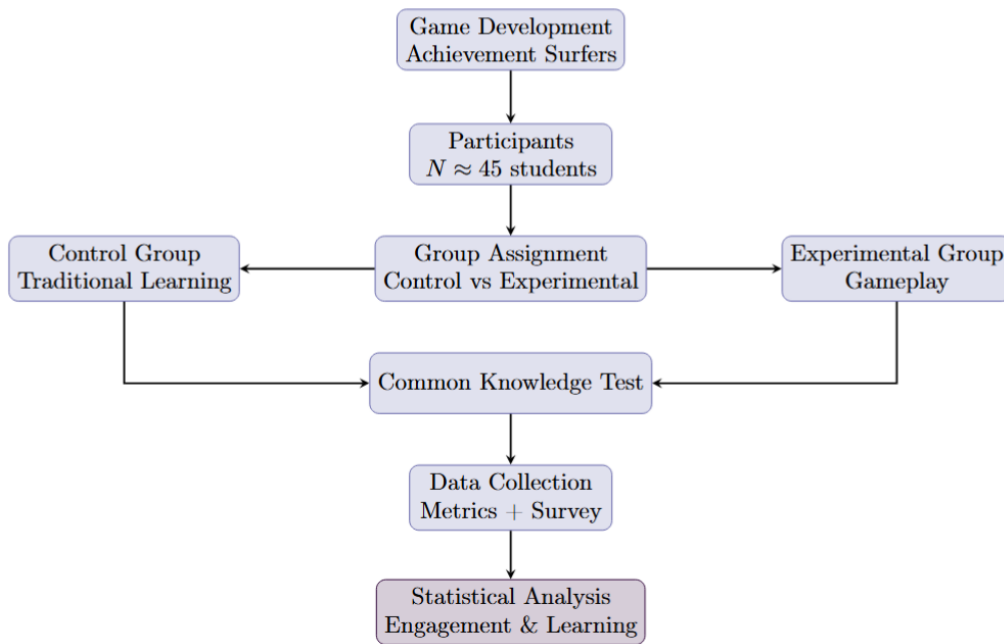


Figure 3: Experimental design used to evaluate the Achievement Surfers game framework.

Quantitative evaluation will include several indicators related to both learning outcomes and gameplay interaction. These measures include post-test accuracy, completion time, number of replays, retries, and gameplay-derived progression indicators such as collected questions and level completion metrics. Qualitative evaluation will include surveys, observations, and student interviews focusing on usability, engagement, and perceived effectiveness of the learning format. In later stages of the study, instructor interviews and usability assessments will also be conducted in order to evaluate the practicality of integrating the game framework into existing courses. The research design also includes a planned delayed retention test, which is intended to examine whether the system contributes not only to engagement but also to the consolidation of knowledge over time.

QA VALIDATION RESULTS

Participants explored the gameplay mechanics and completed several revision cycles involving question collection and answer phases. After the gameplay session, participants completed a survey evaluating usability, system stability, and perceived effectiveness of the learning format.

The results indicated a generally positive reception of the gameplay approach and encouraging levels of engagement. A total of 45 students participated in the session and completed the post-activity survey. The engagement rate was 0.756, with 34 out of 45 participants reporting a positive experience with the system. Perceived support for memorization was also high, with 34 participants (75.6%) indicating that the system helped reinforce learning material. In addition, 26 participants (57.8%) reported that they would consider using the system for real exam preparation. In addition, more than 70% of participants reported that the gameplay format helped them remember material better than traditional slide-based revision.

Usability evaluation also produced strong results for a Minimum Viable Prototype. The mean scores are presented in Table 1. Overall, these results suggest that the prototype was stable enough to support structured gameplay sessions, although further refinement is required before the system can be considered production-ready.

Metric	Mean Score (out of 5)
System stability	4.2
Character responsiveness	3.9
Visual style appeal	4.1
Interface convenience	3.7

Table 1: User experience scores from the QA session (N = 45).

At the same time, the pilot session revealed several friction points typical of early-stage prototypes.

DISCUSSION

The preliminary findings suggest that the proposed framework functions as a viable platform for gamified revision activities, consistent with previous research showing that game-based learning environments can increase participation and voluntary practice when educational content is integrated directly into gameplay mechanics (Dicheva et al. 2019; Tonhão et al. 2021).

At this stage, the results should be interpreted primarily as evidence of technical feasibility and user acceptance rather than as definitive proof of improved learning outcomes. Previous research emphasizes that the effects of gamification remain highly context-dependent and may vary depending on design quality, implementation context, and learner characteristics (Oliveira et al. 2021; Toda, Valle, and Isotani 2018). While game elements can increase engagement and practice frequency, they may also fail to produce learning benefits if poorly aligned with educational objectives (Deterding et al. 2011; Hamari et al. 2014).

Contribution

In this context, the study contributes primarily as an engineering and design framework rather than as a completed pedagogical proof. Achievement Surfers introduces a lightweight gamified learning framework that transforms structured question sets into interactive revision levels through a spreadsheet-based pipeline.

The system was developed in response to a practical gap between the theoretical promise of gamification and the operational realities of higher education, where instructors often work within rigid curricula and limited preparation time. By focusing on low-friction integration, the game framework allows instructors to generate playable revision environments without modifying existing course structures.

The current stage of the project includes a technically functional MVP, a documented modular architecture, a spreadsheet-based content pipeline, and a QA validation

involving n=45 university students and instructors. These early results suggest that the game framework has potential to support repetition and perceived reinforcement during revision activities, which aligns with previous research indicating that gamified environments can encourage repeated interaction with course content when gameplay mechanics are aligned with educational objectives (Deterding et al. 2011; Dicheva et al. 2019; Hamari et al. 2014; Toda, Valle, and Isotani 2018; Oliveira et al. 2021; Tonhão et al. 2021).

The findings should be interpreted as preliminary validation rather than definitive pedagogical evidence. The central contribution of the project lies in the design and early validation of a reusable framework that connects spreadsheet-based assessment content, runner-based gameplay mechanics, and learning analytics within a single system. By focusing on scalability and instructor accessibility, the game framework demonstrates a possible pathway for integrating gamified revision tools into existing educational environments while remaining open to further experimental evaluation across disciplines.

Limitations

Several technical limitations were identified during testing. Technical issues reported by participants included Windows-only deployment limitations, inaccurate button hitboxes, interface inconsistencies, jump timing delays, and scaling problems. Participants also proposed several gameplay improvements, such as answer gates, letter-collection mechanics, small challenge-based mini-games, and chase sequences that could integrate educational interaction more directly into the movement phase of the game. These suggestions indicate areas where the gameplay and learning layers can be further aligned rather than representing rejection of the underlying concept.

The instructor evaluation revealed several limitations of the current MVP. The process required downloading the project from GitHub, installing Unity, importing structured data manually, and building the application. In practice, some instructors experienced difficulties with data loading, as CSV files were not always correctly processed in the standalone build and sometimes required interaction within the Unity editor. Additionally, the expected structure of the data table was not sufficiently intuitive, and the required headers and formatting were unclear.

These findings suggest that while the framework is conceptually viable for teaching contexts, further development is required to improve accessibility.

Future studies

Future work will focus on improving accessibility and evaluating the system under controlled conditions. Planned improvements include the introduction of standardized data templates, simplification of the content pipeline, and user interface solutions that allow instructors and students to upload content without requiring technical expertise.

Further studies will involve controlled comparisons with traditional revision methods, delayed retention testing, and evaluation of instructor workload and usability in real course settings. These steps are necessary to determine whether the framework can produce measurable educational benefits beyond engagement and perceived usefulness.

CONCLUSION

Existing literature suggests that educational games can support engagement, practice, critical thinking, and experiential learning, yet these benefits remain highly context-dependent and are often confined to discipline-specific implementations.

This study addresses this limitation by introducing a framework that externalizes educational content through structured data, shifting the focus from game development to content design. By decoupling content from mechanics, the system reduces the technical barrier for instructors and enables flexible reuse across different academic contexts.

Rather than presenting a single-purpose educational game, the proposed approach demonstrates a reusable structure capable of transforming structured learning material into interactive revision experiences. This positions the framework as a scalable and adaptable solution for integrating gamified learning into higher education, while providing a foundation for future experimental validation and broader application.

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