International Journal of Serious Games

ISSN: 2384-8766
https://journal.seriousgamessociety.org/

Article

Game Architecture in Transmedia Education (GATE): A Framework for Designing Micro-Learning Experiences through Serious Games

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Keywords:

Game Architecture, Transmedia Education, Learning Experiences, Game Development, GATE Framework

Received: July 2025
Accepted: February 2026
Published: April 2026
DOI: 10.17083/w9knn562

Abstract

Designing serious games often faces the challenge of over-scoping, where a single game attempts to address multiple learning objectives simultaneously. This study introduces GATE (Game Architecture in Transmedia Education), a framework for developing focused, lightweight serious games grounded in microlearning design principles. Rather than evaluating effectiveness based on the number of players, the study examines whether multiple novice student teams can consistently produce coherent, pedagogically aligned microlearning games under limited time and resource constraints. Ten independent teams developed 15-level educational games, which were evaluated using the Game Experience Questionnaire (GEQ) during a public exhibition. GEQ scores showed positive experiential outcomes: Competence (M=3.003), Immersion (M=3.080), Flow (M=2.649), Challenge (M=2.288), Tension (M=1.787), Positive Affect (M=3.399), and Negative Affect (M=1.807). Variance analysis demonstrated strong consistency across teams, particularly for Positive Affect (Var=0.0139) and Immersion (Var=0.0616), with moderate variation in Competence and Flow, and higher variability in Tension due to differences in difficulty calibration. Reliability testing yielded acceptable Cronbach's alpha values across GEQ subscales, and a one-way ANOVA comparing mission typologies (Choose/Solve, Configure/Optimize, Find/Obtain) found no significant differences in player experience (F=0.025, p=.975), indicating stable experiential quality regardless of gameplay structure. These findings collectively suggest that GATE provides a reproducible development pathway that helps novice teams build coherent, enjoyable, and microlearning-aligned games. The framework shows strong potential for scalable indie-style development and integration into broader transmedia educational ecosystems.

1. Introduction

Game-based learning (GBL) has become an increasingly popular approach to enhance student motivation, engagement, and retention. GBL refers to the use of game principles and mechanics in educational contexts to foster meaningful learning experiences [1]. Meanwhile, transmedia education expands the reach of learning by distributing interconnected content across various digital platforms, such as videos, websites, games, and social media where each platform contributes uniquely to the learner's understanding [2].

Although using games to promote transmedia storytelling is a promising, very few educators have put this idea into practice due to structural and technological constraints [3,4]. In addition to technological and production constraints, another fundamental complexity in game-based learning is the integration of pedagogical content into gameplay mechanics. Many serious games do not articulate learning objectives within the interactive game context, resulting in a gap between gameplay enrichment and learning objectives. This gap results in players engaging in gameplay that, while entertaining and enjoyable, does not reinforce the expected modes of learning activity. High engagement and low instructional impact highlight the importance of developing frameworks that explicitly charter pedagogical principles into the design of the serious game.

One major constraint lies in the traditional Game Development Life Cycle (GDLC), which is time-consuming and resource-intensive, especially when applied in educational settings with limited capacity [5]. Furthermore, most Learning Management Systems (LMS) are not inherently designed to support third-party interactive game-based content [6]. They tend to prioritize linear module delivery, text-heavy interfaces, and assessment-focused structures, which restrict their capacity to deliver game-driven engagement.

This paper hypothesizes that the integration of microlearning into serious game design can serve as a practical solution to these limitations. Microlearning breaks down content into small, focused units that are easier to develop, consume, and assess making it more feasible to build lightweight games [7,8]. These games can be delivered either through standalone applications or embedded within a broader transmedia learning ecosystem [9]. In practice, this model is already partially reflected in third-party tools like Kahoot, Quizizz, and Wordwall, which gamify specific micro-objectives [10,11]. However, such tools remain limited in gameplay variety and lack story-driven interactivity [12]. By developing game-based microlearning aligned to singular topics or learning goals, it becomes possible to create more contextually meaningful and motivating experiences for learners.

To address this opportunity, we introduce Game Architecture in Transmedia Education (GATE) a structured framework designed to support the creation of microlearning-based educational games within transmedia ecosystems. GATE facilitates modular development through simple mechanics, targeted learning objectives, and scalable storytelling strategies. Rather than designing large and complex games, GATE encourages the creation of smaller game experiences that are easier to produce, customize, and distribute across multiple platforms beyond the constraints of LMS.

This study explores the implementation of GATE by involving ten teams of undergraduate students in the development of educational games, each focusing on a single topic and comprising 15 concise levels. Each game was evaluated using the Game Experience Questionnaire (GEQ) to measure user engagement, immersion, and perceived learning outcomes. The results offer insight into the effectiveness of GATE in balancing educational focus with engaging game interaction.

The remainder of this paper is organized as follows: the next section presents a literature review covering existing research in game-based learning, transmedia strategies, and microlearning theory. The methodology section describes the design and implementation process of the GATE framework in a controlled experimental setting. The discussion section analyzes the results from both game performance and learner experience perspectives. Finally, the paper concludes by summarizing findings, outlining limitations, and proposing future directions for the development of microlearning games in transmedia education.

2. Literature Review

2.1 Transmedia in Education: Concept and Application

Transmedia refers to the practice of conveying a unified narrative or learning experience across multiple platforms and media formats, where each element contributes uniquely to the overall understanding. In the context of transmedia intertextuality, all media contribute equally, creating a cohesive experience across different platforms [13]. On the other hand, transmedia storytelling allows a core narrative to expand through various media, with each medium offering a distinct perspective that encourages deeper engagement across platforms [14]. Additionally, transmedia branding promotes user participation, personalization, and continuity, fostering an interactive relationship between the content and the audience, which aligns well with modern educational needs [15].

In the context of learning, transmedia, particularly transmedia storytelling, can foster more engaging, personalized, and distributed experiences by embedding learning objects into both passive digital content (e.g., articles, videos) and interactive content (e.g., games, discussions). As previously mentioned, transmedia storytelling allows each medium to contribute a unique perspective, which can enhance the learning experience across diverse platforms. The model we present in Figure 1 visualizes this integration: traditional LMS structures learning linearly, while transmedia opens up a Distributed Digital Learning Environment (DDLE) where micro-content can be consumed in modular and meaningful ways. This learning environment complements, rather than replaces, LMS functionality by enabling flexible engagement formats tailored to various learner profiles.

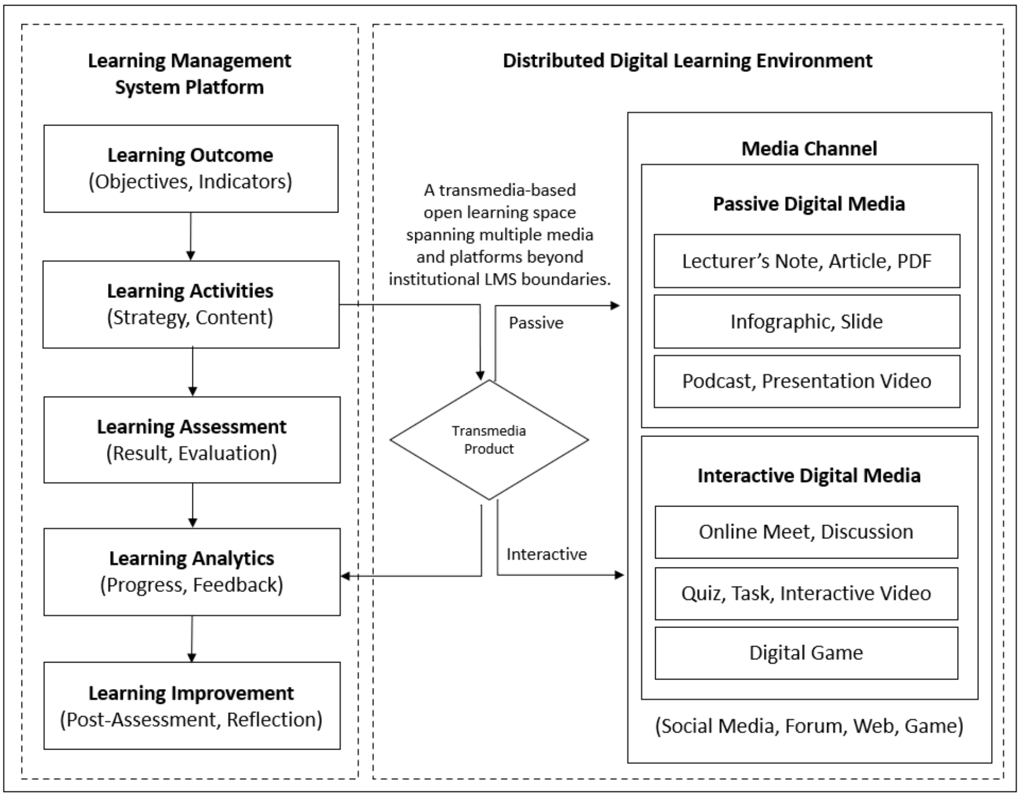


Figure 1. Transmedia Education Guidelines

The figure illustrates how traditional LMS platforms, which are often structured in linear sequences can be extended through a transmedia learning approach. LMS platforms are typically limited to institutional delivery modes, focusing on centralized content distribution with constrained interactivity [16]. DDLE as a transmedia-based open learning space allows educational content to be delivered across multiple media platforms and channels beyond the institutional LMS [17]. At the core of this integration is the Transmedia Product, which originates from the learning activities within the LMS and is then disseminated through two main pathways: passive digital media and interactive digital media.

Passive digital media includes learning materials such as articles, lecturer notes, infographics, slides, podcasts, and video presentations. These media serve as foundational resources that provide learners with background knowledge, conceptual frameworks, or narrative context. In contrast, interactive digital media includes online meetings, discussions, quizzes, interactive videos, and digital games [18, 19]. These forms are designed to foster active engagement, personalization, and feedback-rich learning experiences.

Together, these media channels form a transmedia ecosystem that complements LMS delivery by offering more immersive, distributed, and student-centered learning experiences [20]. This approach is particularly effective for microlearning, where content is delivered in small, focused units tailored to specific learning objectives and learner profiles. Through this architecture, transmedia education bridges formal instructional structures with informal, media-rich learning environments, enhancing accessibility, engagement, and contextual relevance.

Although transmedia learning, serious games, and microlearning have been widely studied, a clear gap remains in how pedagogical content is preserved when learning materials are transformed into interactive gameplay. Prior transmedia research focuses on narrative expansion and media engagement but offers little explanation of how learning outcomes and cognitive demands align with game mechanics and player interactions.

Similarly, serious-game studies highlight motivation and learning effects yet rarely provide methods for embedding learning objectives into rules, feedback structures, or progression systems, often resulting in pedagogical drift. Microlearning literature emphasizes modular content but does not address how such units integrate into cohesive, narrative-driven game experiences. This disconnect reveals the absence of a framework that bridges instructional goals with game-based representations across transmedia channels, a gap that the GATE framework aims to address.

This gap highlights the need to examine not only how transmedia-based instructional content is transformed into playable microlearning experiences, but also whether a structured framework such as GATE can reliably guide multiple novice development teams in producing pedagogically aligned serious games. To address these needs, the present study is guided by the following research questions:

RQ1. How effectively can novice development teams produce lightweight, microlearning-based serious games using the GATE framework under real institutional constraints?

RQ2. How do players perceive the experiential quality of GATE-based microlearning games, as measured by the GEQ?

RQ3. How consistent are the experiential outcomes across independently developed GATE-based games?

2.2 Lessons from Game Development: A Practical Limitation

Prior experimentation with game-based learning in higher education has demonstrated both significant potential and various implementation challenges. At Telkom University, multiple research teams have engaged in the development of educational games to address diverse learning needs across disciplines. These initiatives not only explore the pedagogical affordances of game-based learning but also leverage external funding and institutional partnerships to support innovation. Each project is tailored to specific learning objectives, learner contexts, and gameplay mechanics to enhance both engagement and instructional effectiveness.

Three notable examples include: a 2D personal finance game that teaches basic budgeting and saving skills, developed under a Matching Grant in collaboration with Multimedia University (MMU), Malaysia [21]; a 3D first-person simulation game designed to introduce kitchen standard operating procedures (SOPs) and equipment for hospitality students, funded through the Learning Excellence CELOE grant [22]; and a 3D third-person arithmetic game aimed at early detection of dyscalculia in children, created in partnership with Universiti Teknikal Malaysia Melaka (UTEM) [23]. These diverse efforts demonstrate how game-based approaches can be adapted to various learning goals and target audiences. The resulting games are illustrated in Figure 2.

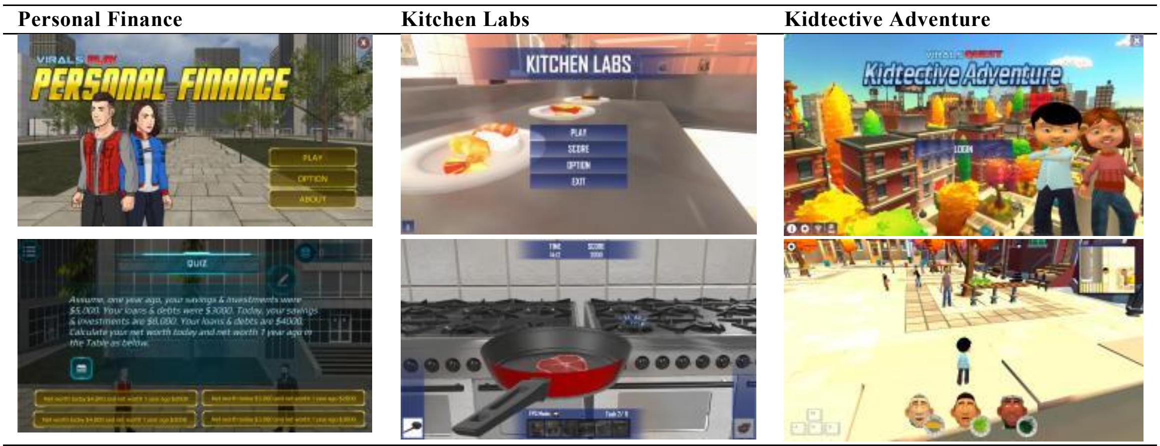


Figure 2. Prior Game-based Learning Experimentation

While the serious games developed in these projects were well-received and grounded in sound pedagogical principles, their production cycles proved to be resource-heavy and time-intensive, ranging from 9 to 18 months. These extended timelines meant that a significant amount of the workload, requiring dedicate considerable amounts of time and expertise to the development process. These challenges illuminated the inherent inefficiencies of the traditional GDLC.

The lengthy development processes, coupled with the considerable resource demands, created a barrier to the integration of educational games into regular learning environments. In institutions with limited budgets, time, and manpower, the complexity of the GDLC made it difficult to introduce serious games. This realization highlighted a key problem: while serious games have significant potential, the traditional development model was not conducive to the fast-paced, ever-evolving demands of modern education.

This challenge underscored the need for a shift towards more agile and modular approaches to game design, ones that align with microlearning principles. Microlearning emphasizes shorter development cycles, scalability, and adaptability key features that enable a more sustainable and efficient educational experience. By adopting these principles, developers can create games that are faster to produce, easier to implement, and more flexible in their application.

2.3 Microlearning, Lightweight Games, and Transmedia Integration

Microlearning has evolved into a dominant instructional strategy for delivering concise and focused learning units that support flexibility and simplicity [24]. Recent studies demonstrate that microlearning enhances cognitive efficiency, fosters learner autonomy, and improves retention particularly within digital ecosystems where short, meaningful engagements are essential [25], [26]. The structured and bite-sized nature of microlearning aligns well with contemporary media consumption patterns, making it highly adaptive to modern educational environments [27], [28].

The integration of microlearning modules into transmedia education ecosystems has become increasingly prominent. Transmedia learning refers to the design of instructional experiences in which multiple media platforms such as videos, interactive games, infographics, chat-based narratives, and AR/VR modules. Each media contribute unique yet interconnected learning opportunities [29]. Current research indicates that higher education increasingly relies on transmedia strategies to deliver seamless, multi-platform learning journeys supported by adaptive and personalized pathways [30], [31].

Within this multi-platform ecosystem, microlearning serves as a structural anchor by providing granular and modular content units essential for transmedia integration. Each micro-unit is self-contained yet conceptually linked to a broader learning arc, allowing it to be distributed across platforms without losing pedagogical coherence [32]. This multi-platform learning journeys is a new ways where learners assemble understanding through distributed yet complementary interactions [33].

Lightweight micro-games play a critical role within this structure by acting as narrative and interactive fragments that enrich learner engagement. These short challenge cycles integrate contextualized feedback and story-based progression, enabling learners to connect micro-interactions with broader educational narratives [34]. Such game-based microlearning interactions reduce cognitive load, support immediate reinforcement, and strengthen learners' comprehension through repeated, situated experiences. Figure 3 illustrates the conceptual intersection of Microlearning, Lightweight Games, and Transmedia Education.

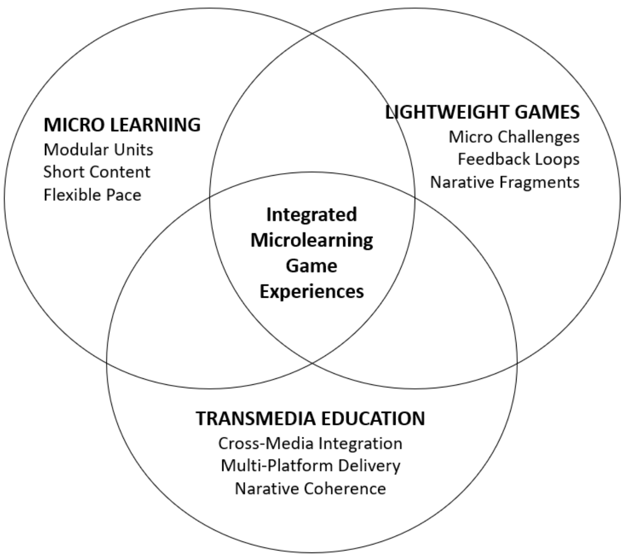


Figure 3. Microlearning, Lightweight Games, and Transmedia Education Integration

Microlearning contributes modular units, short content, and flexible pacing; Lightweight Games add micro-challenges, feedback loops, and narrative fragments; while Transmedia Education supports cross-media integration, multi-platform delivery, and narrative coherence. At the center, these three domains converge to form Integrated Microlearning Game

Experiences, which offer a scalable, flexible, and narratively connected learning ecosystem aligned with contemporary digital learning needs.

2.4 Case Studies and Gap Analysis

Transmedia games have become central examples of how narrative universes expand across multiple media channels, offering cohesive storyworlds that combine novels, films, series, and games into interconnected learning or entertainment experiences. These cases demonstrate how audiences navigate complex cross-platform structures, interpret meaning across media, and engage with narrative fragments that form a larger whole. Within educational research, these models offer valuable insight into how cross-platform engagement can inform the design of distributed learning experiences.

The first case highlights The Witcher franchise, which demonstrates how a literary universe can be extended through video games that introduce new narrative arcs, visual interpretations, and character developments while remaining anchored to the original storyworld [35]. This franchise showcases how players can encounter complementary story elements across different media types, making it one of the clearest models of cross-platform narrative coherence within a transmedia structure.

A second case appears in recent explorations of the "mascot horror" genre, which demonstrates how games, animations, Alternate Reality Game (ARG) elements, and online community content collectively shape an evolving story [36]. This genre exemplifies a hybrid form of transmedia storytelling where tension, mystery, and fragmented storytelling are distributed across interactive and non-interactive channels, turning the audience into active participants in reconstructing the narrative.

A third case can be observed through expansions of the Game of Thrones universe, where supplementary games, prequels, sequels, and interactive media extend the core television and literary canon [37]. This ecosystem illustrates how worldbuilding, backstory development, character arcs, and political dynamics can be distributed across platforms, allowing audiences to explore thematic layers that go beyond the primary texts. Such expansions demonstrate how transmedia worlds sustain engagement through narrative depth, multimodal access points, and sustained participation.

Although these cases provide substantial insights into transmedia narrative construction, a critical gap emerges when considering their applicability to educational design, particularly for microlearning and lightweight games. Existing transmedia franchises focus primarily on narrative expansion, worldbuilding, and fan engagement rather than the preservation of pedagogical intent. None of the reviewed cases provide mechanisms for transforming instructional content into micro-units or embedding learning outcomes within game mechanics, feedback systems, or short-form interactions.

This gap indicates the need for a framework that merges the strengths of transmedia storytelling distributed narrative, multimodal access, and sustained engagement with the constraints and goals of microlearning and lightweight game design. Such a framework must ensure that learning objectives are preserved as content moves across formats and that game interactions meaningfully represent pedagogical constructs rather than merely narrative extensions. Addressing this gap forms the foundation of the present research.

3. Methodology

3.1 Study Design

This study employs a descriptive quantitative research design in which all analyses are based on numerical data derived from the GEQ. The development teams created ten microlearning games using the GATE Framework, and these games were subsequently deployed to public users during a large-scale exhibition. Rather than incorporating qualitative interviews or observational coding, the study focuses exclusively on quantifying user experience through structured GEQ responses. This quantitative emphasis aligns with the study's core aim: to examine the consistency, stability, and variability of player experience across ten independently developed games.

In this design, the GEQ functions as the primary instrument for measuring competence, immersion, flow, tension, positive affect, and negative affect across all game prototypes. Because each game was created by a different novice team but guided by the same GATE design principles, the comparative quantitative results allow the study to test whether the framework produces convergent experiential qualities despite team-to-team variation.

Variance analysis is therefore treated as a central component of the research. By examining the dispersion of GEQ scores across teams and domains, the study evaluates whether GATE effectively constrains design divergence and supports predictable, pedagogically aligned user experiences. Low-to-moderate variance across most GEQ dimensions is interpreted as evidence that the framework provides structural guidance strong enough to produce consistent player experience outcomes, even under distributed development conditions.

3.2 The GATE Framework

This study prioritizes the ability of development teams to create focused, lightweight games, instead of gathering a large number of respondents or players. This aligns with the core goal of GATE framework, which is to support scalable game-creation processes within microlearning constraints. The GATE framework was developed to support the design, production, and evaluation of microlearning-based educational games. It integrates pedagogical objectives with lightweight game mechanics and transmedia distribution strategies.

GATE is structured into three primary layers: Objective, Activity, and Evaluation, each underpinned by foundational theories and design principles. The visual representation of this structure can be found in Figure 4, illustrating the interconnectedness of these layers and how they contribute to the overall learning experience.

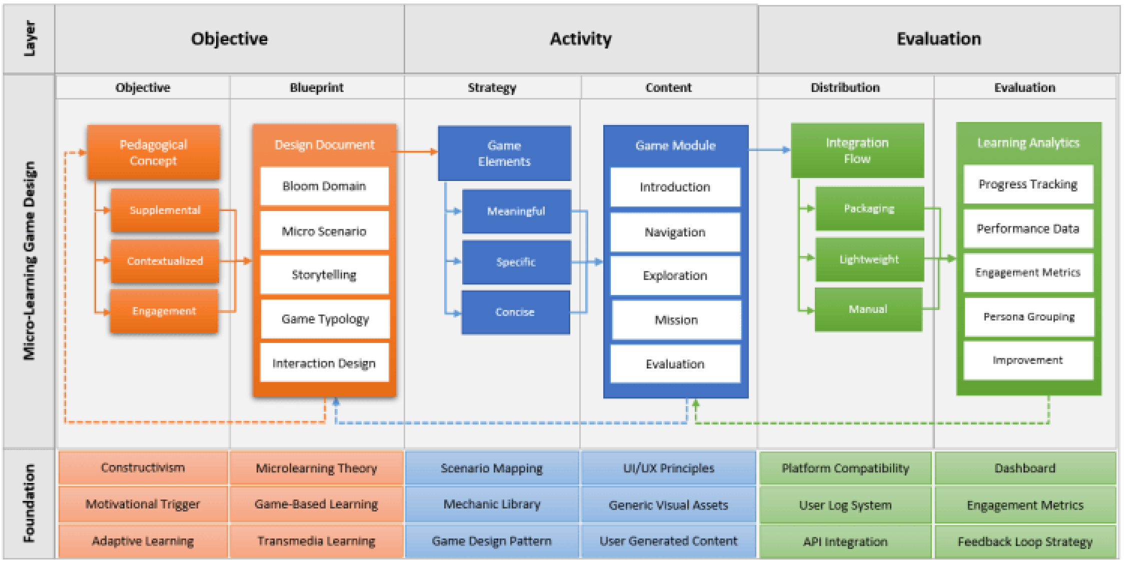


Figure 4. Game Architecture in Transmedia Education (GATE)

The Objective Layer describes the pedagogical intentions behind the design, divided into three key components. The first element is Supplemental, which aims to enhance and support the material taught in the classroom, ensuring that learners can deepen their understanding. The second element is Contextualized, which ensures the learning content is directly relevant to the learner's environment. The final element is Engagement, which focuses on motivating the learners, fostering an environment where they remain actively involved and driven to learn. These components are then integrated into a comprehensive Design Document that consists of six important aspects: Bloom's Taxonomy Domains, Micro Scenario for the learning experience [38], Storytelling elements, the Game Typology that defines the type of game objective[39], and the Interaction Design, which details how learners interact with the content.

The Activity Layer brings the blueprint into actual production by operationalizing the design. The Strategy Section plays a crucial role in defining the purpose of the game, ensuring that its objectives are clearly communicated to the learners. The Content Section follows, detailing the structure of the Game Module, which is organized into five key components: the Introduction, which introduces the learners to the game's context; Navigation, which guides the users through the interface and controls; Exploration, where learners engage with the content and environment; Mission, which sets specific tasks and challenges to achieve within the game; and Evaluation, where learners' progress and performance are assessed. The Distribution Section addresses the game's integration and delivery, ensuring it is packaged in a flexible manner that allows for easy deployment across various platforms.

The Evaluation Layer is responsible for managing player data, providing a comprehensive framework for understanding and improving the learning experience. It incorporates Learning Analytics, which encompass various key components: tracking player progress, analyzing performance data, and measuring engagement through established metrics such as the System Usability Scale (SUS) [40], Game Experience Questionnaire (GEQ) [41], and User Experience Questionnaire (UEQ) [42].

Additionally, the Evaluation Layer includes Persona Grouping, which categorizes players based on their behavior and responses [43]. The feedback loop is also an essential element of this structure, enabling continuous improvement by integrating player input and performance insights into the design process. This approach ensures that game development is not only rapid but also firmly aligned with pedagogical principles.

3.3 GATE Objective Layer: From Learning Goals to Micro-Scenarios Design

The Objective Layer in the GATE Framework serves as the foundational stage that aligns pedagogical intent with gameplay design. It ensures that every game module is grounded in measurable educational outcomes, while also maintaining relevance and engagement through meaningful narrative and interaction. The visual representation of this layer and its key components can be seen in Figure 5, highlighting how educational outcomes are integrated into the game design.

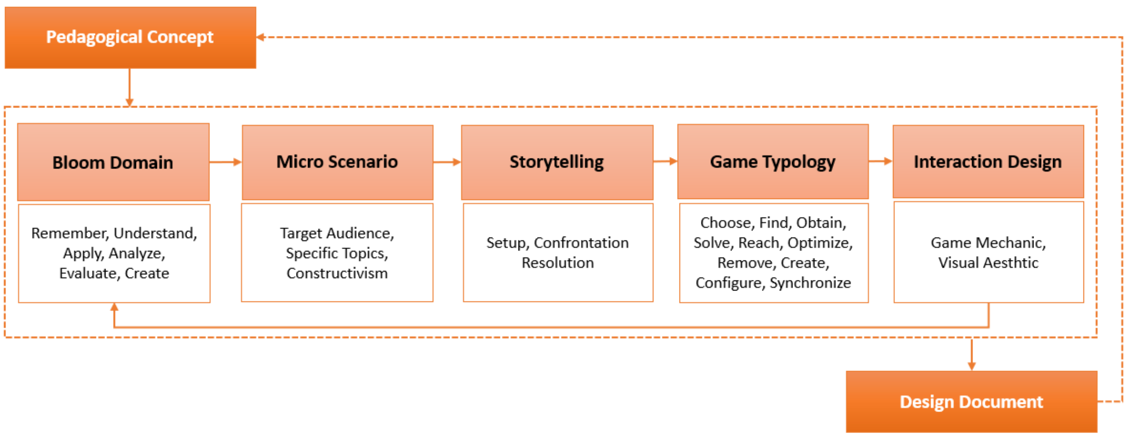


Figure 5. GATE Objective Layer

At the core of this layer is the Bloom Domain, which identifies the cognitive level targeted in each game. Drawing from Bloom's Taxonomy, the framework categorizes learning objectives across six levels: Remember, Understand, Apply, Analyze, Evaluate, and Create. These domains guide the development of learning tasks that can be effectively gamified. For instance, games focused on the “Remember” domain may involve matching or identification tasks, while “Create” may involve constructing new ideas or synthesizing concepts through simulation. Each Bloom domain leads to the construction of a Micro Scenario that designed for granular learning chunks for specific target audience.

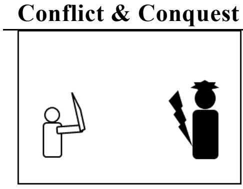
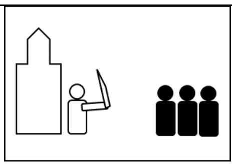
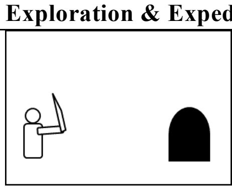
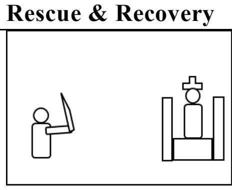
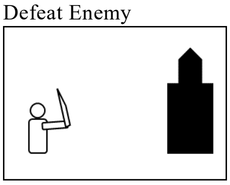
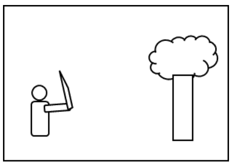
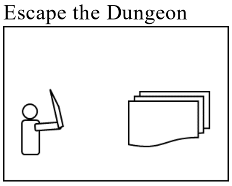
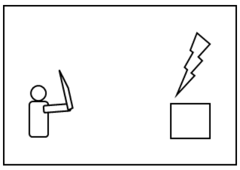
To ensure that each Bloom level translates into a meaningful and pedagogically aligned micro-scenario, this study integrates the established characteristics of microlearning[44]. These characteristics such as short and focused content units, high interactivity, flexible access, and the emphasis on brief, memorable learning cycles, provide a practical foundation for converting cognitive objectives into small, actionable gameplay segments. By aligning Bloom’s cognitive with microlearning principles, the GATE Framework ensures that each learning task is both cognitively appropriate and structurally suited for lightweight game design. Table 1 synthesizes this relationship by mapping Bloom’s levels to microlearning characteristics.

Table 1. Alignment of Bloom’s, Microlearning and Game Implementations Example

Bloom’s Cognitive Levels	Microlearning Characteristics	Game Implementations Example
Remember	1) Short units; 2) interactive quizzes; 3) easy to recall	*Choose / Identify* missions with tap-to-select answers; flashcard-style NPC interactions; quick recall challenges
Understand	1) Suitable for non-complex topics; 2) revisitable content	*Find / Match* missions using contextual cues; narrative explanation nodes; simple classification puzzles
Apply	1) Bite-sized application tasks; 2) requires clear teaching objectives	*Reach / Obtain* missions where learners apply rules to navigate or collect correct items; procedural steps embedded in the micro-scenario
Analyze	1) Interactive formats; 2) careful material selection for deeper tasks	*Configure / Optimize* missions requiring comparison, decomposition, or logical arrangement (grids, sequences, ordering puzzles)
Evaluate	1) Supports brief judgment tasks; 2) flexible, self-paced revisiting; 3) small focused groups	*Solve / Remove Error* missions where players judge correctness, detect inconsistencies, or choose optimal solutions in branching paths
Create	1) Low-cost creation of content; 2) interactive media; 3) supports creativity in short cycles	*Create / Construct* missions involving assembling elements, designing patterns, or generating new combinations within short game loops

This framework emphasizes the use of story-driven scenarios that follow the Three Act Structure, enabling even brief gameplay segments to convey meaningful learning objectives [45]. To streamline the design process, storytelling fondation is categorizes into four primary types: Conflict & Conquest, Defense & Domination, Exploration & Expedition, and Rescue & Recovery. These four narrative categories are summarized in Table 2, providing a reference for aligning story structures.

Table 2. Storytelling Foundation for Micro Scenario

Conflict & Conquest	Defense & Domination	Exploration & Expedition	Rescue & Recovery
 Defeat Enemy	 Defend the Base	 Escape the Dungeon	 Save the Princess
 Conquer the Tower	 Gather Resources	 Uncover the Mystery	 Retrieve the Artifact

Each narrative category encapsulates specific learner roles and challenges. For instance, Conflict & Conquest focuses on active opposition, such as defeating enemies or conquering strongholds. Defense & Domination, often involves safeguarding assets or managing resources. Exploration & Expedition invites learners to discover, uncover, or solve mysteries. Meanwhile, Rescue & Recovery taps into empathetic and restorative motivations, such as saving a character or retrieving an artifact.

From the micro scenario, developers select a suitable Game Typology including Choose, Find, Obtain, Solve, Reach, Optimize, Remove, Create, Configure, and Synchronize. Each typology represents a core gameplay interaction and maps to relevant Bloom domains. For example, a "Choose" game typology aligns with the "Remember" or "Understand" domain, while "Create" supports higher-order thinking tasks. This ensures consistency between instructional goals and player experience.

The selected game typology informs the Interaction Design, composed of two elements: Game Mechanics and Visual Aesthetic. The mechanics determine how players interact with the game world through tapping, dragging, choosing, or constructing; while aesthetics define the visual style, tone, and immersion level. Together, they ensure the game is not only pedagogically sound but also engaging and accessible.

3.4 GATE Activity Layer: Structuring Micro-Learning Through Gameplay

The Activity Layer translates pedagogical blueprints into modular and structured gameplay components. Each microlearning game is composed of five essential elements: Introduction, Navigation, Exploration, Mission, and Evaluation, that together form the instructional and experiential flow of the learning game. This layer serves to ensure that game content is not only educationally relevant but also aligned with engaging and accessible player experiences. The visual representation of this layer and its components can be found in Figure 6, which illustrates how these elements work together to enhance the learning experience.

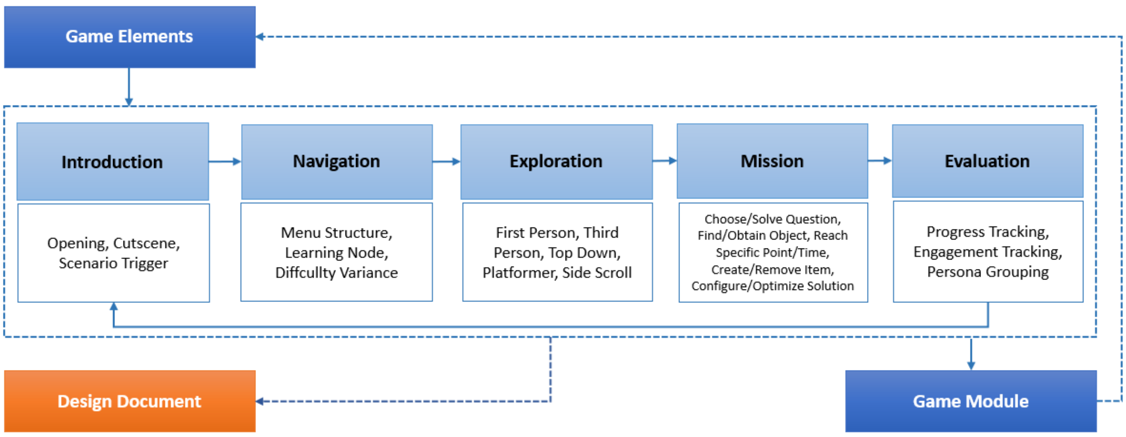


Figure 6. GATE Activity Layer

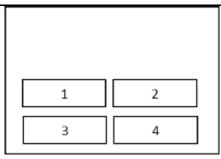
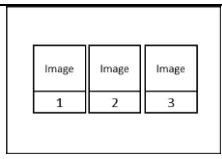
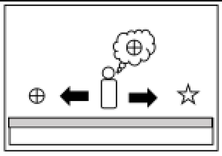
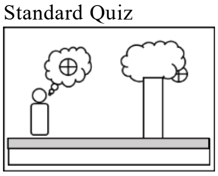
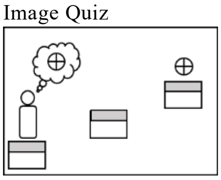
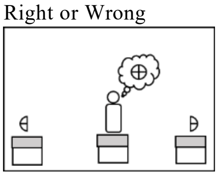
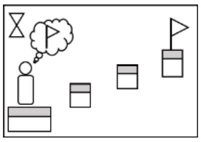
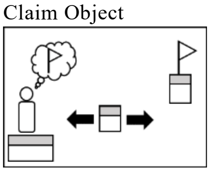
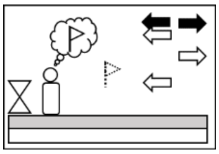
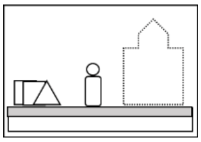
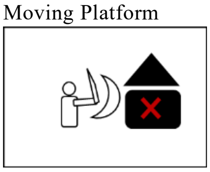
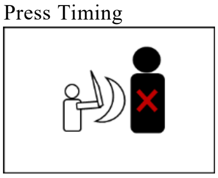
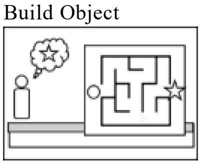
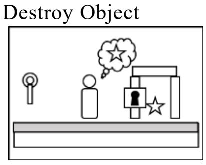
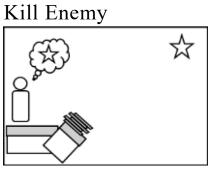
The first component is the Introduction, which provides players with an entry point to the game scenario. At its core is a Scenario Trigger a narrative hook or contextual event that frames the learning situation. This may take the form of a problem to be solved, a situation requiring attention, or a decision point. The introduction helps situate learners and establish the relevance of the forthcoming activity.

Following this is the Navigation stage, which plays a critical role in guiding players through a structured sequence of learning content embedded within the game environment. Players traverse various Learning Nodes, each representing a distinct knowledge segment, challenge, or task. These nodes can be arranged either linearly, to support step-by-step scaffolding, or non-linearly, to encourage exploration and learner autonomy. The flexibility in navigation structure allows instructional designers to tailor the learning flow based on the cognitive complexity of the subject matter and the desired pacing of learner progress.

The Exploration stage defines the player's movement and spatial interaction within the game. Exploration modes support both 2D and 3D formats to accommodate different game genres and learning contexts. In 2D environments, options include Idle, Top Down, Side Scroll, and Platformer modes, each offering unique ways to visualize progression and present tasks [46]. In 3D settings, movement styles such as First Person, Third Person, and Isometric views enable immersive interactions, spatial reasoning, and perspective-driven engagement. This variety ensures that the spatial design of the game aligns with both the learning goals and the player's sense of agency [47].

The Mission stage represents the core learning challenge within the game, acting as a crucial mechanism for achieving the intended educational outcomes. Missions are constructed using a range of gameplay typologies, each strategically selected to align with the desired form of learner interaction. These typologies include: Choose/Solve Question (e.g., quizzes, decision-making tasks), Find/Obtain Object (e.g., scavenger hunts, object retrieval), Reach Specific Point/Time (e.g., navigation or time-based coordination tasks), Create/Remove Item (e.g., simulations or problem-solving activities), and Configure/Optimize Solution (e.g., logic puzzles, optimization, or design challenges). Table 3 illustrates these gameplay typologies, mapping each to corresponding narrative structures.

Table 3. Mission Design for Micro Scenario

Mission	**Generic Mission Design**		
Choose/Solve Question	 Standard Quiz	 Image Quiz	 Right or Wrong
Find/Obtain Object	 Hidden Item	 Claim Object	 Collect Pieces
Reach Specific Point/Time	 Timed Run	 Moving Platform	 Press Timing
Create/Remove Item	 Build Object	 Destroy Object	 Kill Enemy
Configure/Optimize Solution	 Maze Puzzle	 Door & Key	 Problem Solving

Selecting an appropriate gameplay typology not only enhances pedagogical alignment but also facilitates a more efficient and structured game development process. By clearly defining the interaction model early in the design phase, developers can streamline content creation, asset integration, and mechanic implementation. This clarity reduces development complexity and ensures that the game experience remains focused, relevant, and adaptable to various learning objectives.

The Evaluation component plays a critical role by providing mechanisms for reflection, tracking, and feedback. It includes Progress Tracking, which monitors player advancement and completion. Additionally, Persona Grouping classifies learners based on their interaction style, preferences, and gameplay behaviors, facilitating a more personalized approach to learning [48]. Modularizing the learning game structure into these distinct activity components can empowers developers to create games that are scalable, pedagogically aligned, and suitable for deployment across multiple transmedia platforms.

3.5 GATE Evaluation Layer: Measuring Impact and Player Experience

The Evaluation Layer is responsible for assessing the effectiveness of microlearning games from both pedagogical and experiential perspectives. This layer is divided into: Progress Tracking, Performance Data, Engagement Metrics, Persona Grouping, and Improvement. These components work in tandem to gather data, evaluate player engagement, and ensure that the learning outcomes are met. The visual representation of this layer and its components can be found in Figure 7, providing an illustration of how these elements contribute to the ongoing evaluation and enhancement of the educational game experience.

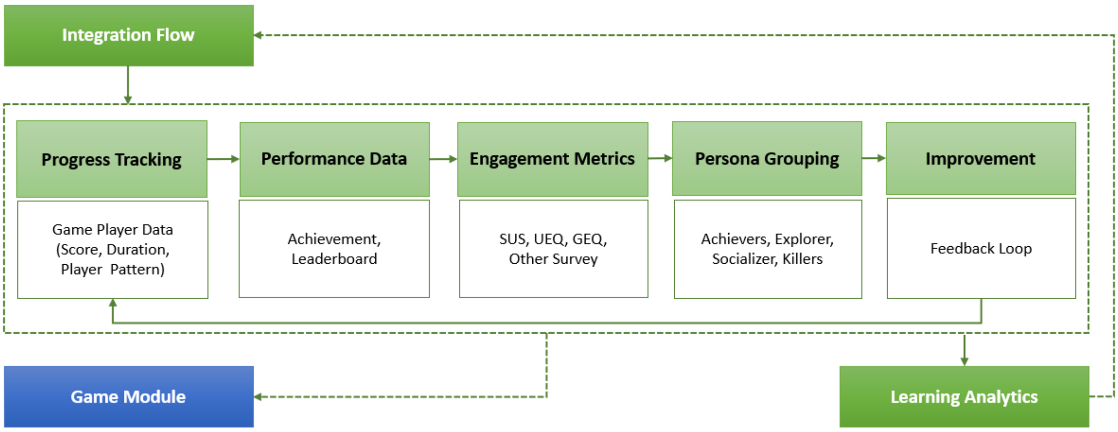


Figure 7. GATE Evaluation Layer

The evaluation process begins with Progress Tracking, which collects in-game behavioral data from learners, including metrics such as task completion, retry attempts, time-on-task, and interaction patterns. These data points, known as Game Player Data, serve as the foundation for understanding user performance and pacing [49]. From this, Performance Data is derived, focusing on measurable outcomes like achievements, scores, milestones reached, level completions, and badges earned. These indicators not only reflect mastery of content but also capture persistence and engagement with the learning process.

Engagement Metrics assess how learners experience the game using validated instruments such as the GEQ, UEQ, SUS, and custom surveys tailored to specific learning and gameplay goals. The collected data feeds into Persona Grouping, which classifies learners based on Bartle's Player Types: Achievers, Explorers, Socializers, and Killers (Competitors) [50]. This classification enables the clustering of learners according to their interaction preferences, learning strategies, and game behavior, helping inform future game content, personalization mechanisms, and pedagogical alignment [51]. The evaluation loop concludes with the Improvement phase, where data-driven decisions are used to revise the game's content and structure.

To ensure broad accessibility and technical scalability, the game should be developed with platform compatibility and API integration in mind. This allows seamless connection with existing LMS through standardized protocols, enabling automated data exchange and learning analytics synchronization. Given these requirements, WebGL is proposed as the primary deployment format, as it supports cross-platform browser-based access without the need for additional installation. The recommended system architecture that supports this integration flow and analytics pipeline is illustrated in Figure 8.

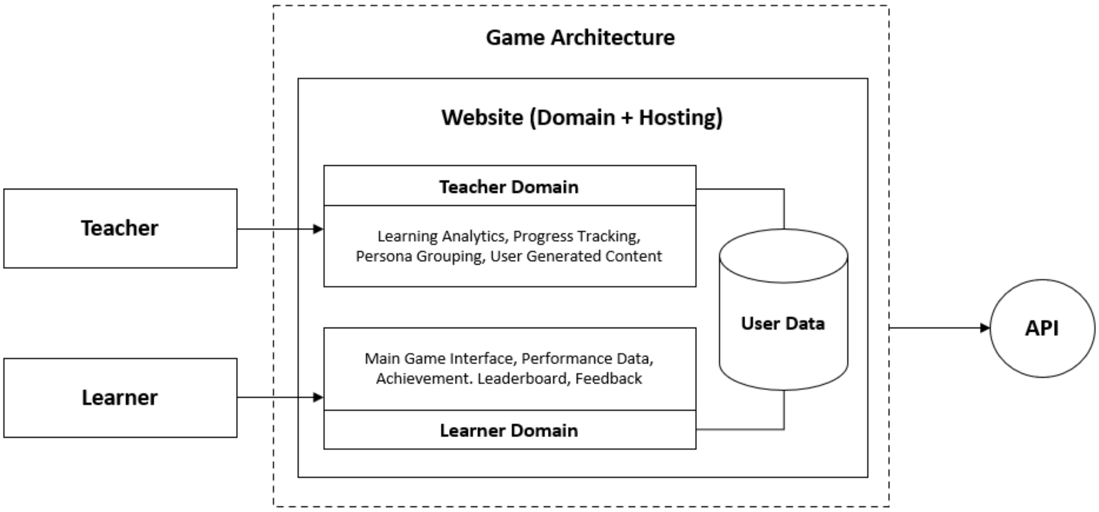


Figure 8. Recommended System Architecture

At the center of this architecture is the Website layer, which encompasses both the domain and hosting infrastructure. Within this platform, two main functional domains are delineated: the Learner Domain and the Teacher Domain. The Learner Domain acts as the primary interface through which students engage with the game. It includes components responsible for delivering the core game experience, tracking performance metrics, logging achievements, maintaining leaderboards, and collecting user feedback. The Teacher Domain provides educators with access to analytics tools that support instructional decision-making. This domain includes functionalities for visualizing learning analytics, tracking individual and class-wide progress, conducting persona grouping, and reviewing user-generated content.

All user interactions across both domains are supported by a centralized User Data layer, which serves as the foundation for system intelligence and feedback. This data layer is linked to an external API service, enabling integration with third-party systems such as LMS platforms.

3.6 Design Exemplars of Student Game Projects

To illustrate how the GATE framework informed the actual design outcomes of novice development teams, this section presents several representative examples of the student-developed microlearning games. These exemplars highlight the diversity of narrative structures, gameplay mechanics, and microlearning strategies that emerged during the four-month development period.

One notable example is Quest for The Cure, which applies the Choose structures emphasized in the GATE Objective Layer. Players walk toward Non-Player Characters (NPC) presenting different numerical options, adding spatial reasoning to the cognitive math challenge. The story follows a young protagonist searching for a mystical healing potion to cure his ailing mother. The game's visual identity is presented in Figure 9.

Figure 9. Game Project Highlight: Quest for The Cure

CanICode demonstrates the use of a Reach Specific Point narrative combined with a Solve mechanic. Players write simple command sequences to guide a robot through a level, reinforcing algorithmic thinking and sequencing skills. This combination of logic tasks and spatial puzzles aligns closely with microlearning principles that emphasize brief, goal-oriented challenges. An example of the game's interface and mechanics is shown in Figure 10.

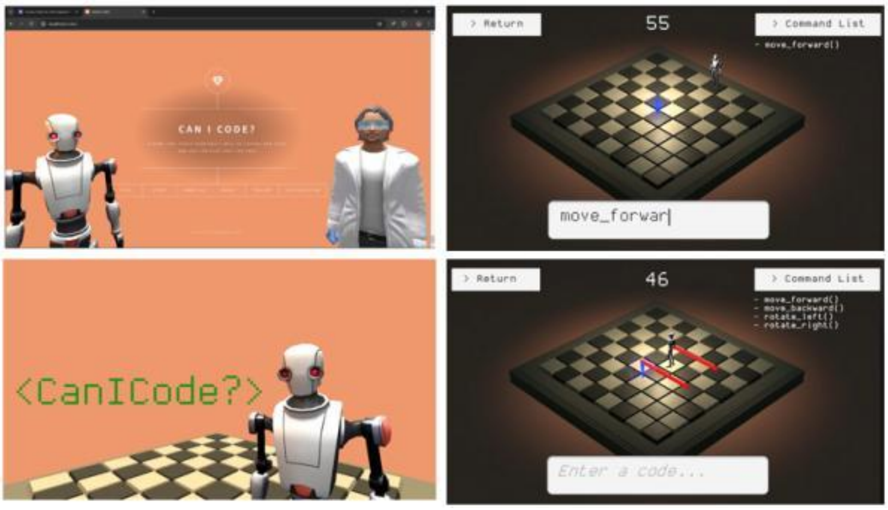
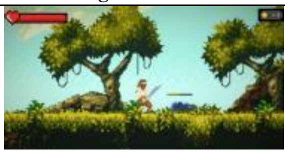


Figure 10. Game Project Highlight: CanICode

The consistent emergence of structured missions, clear task decomposition, and short learning cycles reflects the influence of GATE in helping novice developers create focused and pedagogically aligned microlearning content. A broader overview of the remaining games developed during this study is presented in Table 4. The table serves not only as documentation of project outcomes but also as a foundation for future iterations and research on student-driven educational game development.

Table 4. Student Game Project Result

Mathland	Math Knight	Market Mission	Batagor
			
Catch The Star	**Jungle Jumble**	**Baniban**	**Palette Quest**
			

Most student teams chose mathematics as their primary subject, likely because structured problems such as equations and numerical logic fit well with short microlearning levels. Games like Quest for The Cure, Mathland, Math Knight, Market Mission, Batagor, and Catch The Star reflect this trend. Other teams explored language learning (Jungle Jumble), algorithmic thinking (Baniban, CanICode), and visual arts (Palette Quest). This range of subjects and mechanics demonstrates that, with the structured guidance provided by the GATE Framework, novice developers were able to translate diverse learning goals into focused and coherent serious-game content.

4. Results

4.1 Participants and Data Collection

This study involved two distinct participant groups: (1) student development teams who created the games, and (2) public participants who played and evaluated them using the GEQ

1) Developer Teams

Ten teams consisting of 30 undergraduate students (fifth semester, Multimedia Technology and Informatics programs) participated as developers. All had previously completed coursework in multimedia production, game design fundamentals, and algorithms, providing a baseline competency for serious game creation. Each team was tasked with designing and developing a microlearning game over a four-month period, using Unity 2022.3 as the development environment and WebGL as the primary deployment platform.

In addition to game development, each team was allowed to use generic assets and required to deploy their project through a website hosted on a custom domain. The hosting infrastructure was based on a standardized web template provided by the research team, which included pre-configured API endpoints for user login and dashboard access. Due to time constraints, the API implementation was limited to internal use and did not yet include full integration with the university's LMS.

2) Player Participants

Game testing was conducted during a two-day public exhibition held at main hall of the School of Applied Science, Telkom University in June 2024. The event was attended by an estimated 2,000 visitors, including vocational high school students (SMK), university students from various faculties, and general attendees. Visitors were not pre-recruited; instead, participation followed an open, voluntary, walk-in approach characteristic of exploratory educational technology field testing. At the end of the development phase, a two-day public exhibition was held in mid-June 2024 at the Telkom University campus. During this expo, each team showcased their game to a wide range of visitors, including students from vocational high schools (SMK) and various university faculties.

Although the primary target audience for the games was K–12 learners, the exhibition was used as a preliminary field test environment. Visitors were invited to try each game and submit their feedback by completing the GEQ, which was distributed via Google Forms. While the number of responses varied across projects, each game received feedback from minimal requirement of 100 respondents for this study. Table 5 presents a summary of the games developed by the student teams.

Table 5. Student Game Project Summary

Title	Theme	Total	Male	Female
Quest for The Cure	Arithmetic	101	72	29
CanICode	Algorithm	102	61	41
Mathland	Arithmetic	110	76	34
Math Knight	Arithmetic	118	84	34
Market Mission	Arithmetic	108	65	42
Batagor	Arithmetic	103	72	31
Catch The Star	Arithmetic	100	56	34
Jungle Jumble	Language	101	56	45
Baniban	Algorithm	100	66	34
Pallete Quest	Art	121	74	47

To estimate the number of unique participants across all games, email addresses submitted in the GEQ forms were analyzed. Across all datasets, 908 unique participants were identified by email addresses. Most participants engaged with only a single game (n = 763), while smaller groups played two (n = 136), three (n = 7), or four games (n = 2).

Analysis of email domains further indicated that the majority of participants used generic providers such as Gmail (approximately 525 accounts), while around 20 institutional email domains appeared across the datasets, suggesting participation from roughly twenty different schools or educational institutions. To maintain analytical consistency across the ten games, each dataset was normalized to approximately 100 responses per game, meaning that some responses above this threshold were removed to ensure balanced sample sizes.

Although age was not required in the GEQ forms, informal observation during the exhibition indicated that players were predominantly teenagers and young adults (approximately 15–24 years old), consistent with the event's audience composition. All participation was voluntary and conducted in a non-intrusive public setting. No personally sensitive data were collected, and respondents were informed that their feedback would be used for research and evaluation purposes in accordance with institutional guidelines.

4.2 Reliability and Statistical Validation

To ensure that the GEQ data used in this study met accepted standards of psychometric reliability, Cronbach's alpha was calculated for all seven GEQ subscales using the full dataset and 33 GEQ items. Each subscale was computed by grouping its corresponding items according to the official GEQ structure. The resulting coefficients indicate strong internal consistency across nearly all dimensions. Table 6 shows a Cronbach Alpha result.

Table 6. Cronbach Alpha result

GEQ Subscale	Cronbach's Alpha (α)	Reliability Interpretation
Competence	0.883	High
Immersion	0.902	High
Flow	0.874	High
Tension	0.691	Acceptable / Moderate
Challenge	0.861	High
Negative Affect	0.843	High
Positive Affect	0.889	High

The resulting coefficients indicate strong internal consistency across nearly all dimensions. Competence (α = 0.883), Immersion (α = 0.902), Flow (α = 0.874), Challenge (α = 0.861), Negative Affect (α = 0.843), and Positive Affect (α = 0.889) showed high reliability, exceeding the commonly accepted threshold of α ≥ 0.70 for behavioral research. The only dimension with moderate reliability was Tension (α = 0.691), a result that aligns with previous GEQ literature where tension-related items tend to exhibit greater variability due to differences in individual frustration sensitivity.

Additionally, variance analysis was conducted on the GEQ dimensions To better understand how consistently the GATE framework supports novice developers across multiple project teams. Because the central objective of GATE is to evaluate whether multiple independent teams can reliably produce functional, pedagogically aligned microlearning games, the primary unit of analysis in this study is the team, not the number of players. For each GEQ dimension, the sample variance was computed using the standard formula:

$$\sigma^2 = \frac{1}{N-1}\sum_{i=1}^{N}(x_i - \bar{x})^2,$$

Where x_i represents the mean GEQ score of each team, $\bar{x}$is the overall mean across all ten teams, and $N$is the number of teams. Table 7 shows a statistical insight for all development team which calculated across 10 teams, and n=100 respondents per team per GEQ dimension.

Table 7. Variance Analysis Across Teams

GEQ Dimension	Variance
Competence	0.1745
Immersion	0.0616
Flow	0.1289
Tension	0.4392
Challenge	0.1222
Negative Affect	0.2099
Positive Affect	0.0139 (lowest variance)
ompetence	0.1745
Immersion	0.0616
Flow	0.1289
Tension	0.4392

This variance approach provides insight into the stability and reproducibility of experiential quality across independently developed games. The results indicate relatively low variance in Positive Affect ($\sigma^2 = 0.0139$) and Immersion ($\sigma^2 = 0.0616$), suggesting strong consistency across teams, whereas dimensions such as Tension ($\sigma^2 = 0.4392$) show greater fluctuation due to differences in difficulty calibration or interface clarity. By focusing on inter-team variance, this analysis directly reflects the core intent of GATE: evaluating whether a structured microlearning framework can guide multiple novice teams toward producing coherent, enjoyable, and technically feasible game experiences under constrained development conditions.

To complement the descriptive GEQ results, a one-way ANOVA was performed to evaluate whether different mission typology groups Choose/Solve, Configure/Optimize, and Find/Obtain produced significantly different levels of player experience. Mission typology was selected as the comparative factor because it reflects core structural decisions in microlearning-based game design and therefore offers pedagogically meaningful contrasts. The analysis was conducted using the aggregated GEQ mean scores from all ten independently developed games.

Results indicate that the variation across mission types was not statistically significant ($F = 0.025$, $p = .975$), and the effect size was extremely small ($\eta^2 = .007$), suggesting that player enjoyment and experiential quality remained stable regardless of gameplay structure. This finding reinforces the central argument of the study: the GATE framework is capable of enabling multiple novice teams to produce coherent, pedagogically aligned microlearning games with comparable experiential outcomes, even when their mission typologies differ. Table 8 summarizes the descriptive statistics and 95% confidence intervals for each mission group, providing additional transparency for the inferential analysis.

Table 8. ANOVA Summary Across Mission Typologies (Positive Affect)

Mission Typology	n	Mean	SD	95% CI Low	95% CI High
Choose / Solve	4	3.339	0.133	3.068	3.611
Configure / Optimize	4	3.281	0.128	3.019	3.542
Find / Obtain	2	3.271	0.009	3.245	3.298

The absence of significant differences empirically reinforces the earlier variance results: GATE enables novice teams to achieve stable and reproducible experiential quality across independently developed games, regardless of mission design choices or interaction typologies. In other words, the framework not only constrains over-scoping but also standardizes player experience outcomes, demonstrating its value as a pedagogically aligned microlearning design methodology.

4.3 GEQ Interpretation

Post-play evaluation was conducted using the Game Experience Questionnaire (GEQ). This instrument is widely recognized in game research for capturing a nuanced profile of the player's subjective experience across seven dimensions: Competence, Sensory and Imaginative Immersion, Flow, Tension/Annoyance, Challenge, Negative Aspect, and Positive Aspect. Each dimension reflects different cognitive and emotional responses evoked during gameplay.

It is important to note that the primary objective of the pilot implementation was not to measure how many players interacted with the games, but to determine how many independent student teams could successfully develop lightweight, microlearning-based serious games using the GATE framework. A total of ten teams produced 15-level focused games, demonstrating that GATE functions effectively as a development-support framework rather than merely a gameplay-evaluation framework.

Table 9. Student Game Project Result

Title	Competence	Immersion	Flow	Tension	Challenge	Negative Aspect	Positive Aspect
Quest For The Cure	3.434	2.93	2.88	1.633	2.804	1.663	3.492
CanICode	2.442	2.973	2.449	2.007	2.268	1.873	3.432
Mathland	2.154	2.865	2.112	1.733	1.952	1.5	3.216
Math Knight	3.332	3.39	2.489	1.04	1.964	1.47	3.34
Market Mission	3.148	2.93	2.187	1.413	1.85	1.64	3.162
Batagor	3.308	3.287	2.521	1.197	1.944	1.273	3.34
Catch The Star	3.234	2.785	3.264	3.447	2.782	2.843	3.21
Jungle Jumble	3.02	3.477	2.835	1.593	2.278	1.558	3.326
Baniban	2.789	2.90	2.938	1.977	2.544	2.168	3.194
Pallete Quest	3.170	3.268	2.811	1.839	2.271	2.086	3.457
Average	3.003	3.080	2.649	1.787	2.288	1.807	3.399

In this context, the GEQ results serve as qualitative design indicators that reflect whether the microlearning structure short challenge cycles, reduced cognitive load, and clear feedback pathways was successfully embedded into the developed games. Thus, the GEQ data should be interpreted as evidence of framework alignment rather than population-level behavioral outcomes. Table 9 presents the average scores for each dimension across all ten games evaluated in this study.

The analysis of GEQ results provides insight into how different design elements influenced the user experience across the ten games developed. To complement these descriptive comparisons and provide a clearer cross-game visual profile, a GEQ heatmap in Figure 11 illustrate how each game performs across all seven dimensions. The heatmap enables rapid identification of patterns, outliers, and dimension-specific strengths. For example, the visualization highlights the consistently high Positive scores across all titles, the sharp Tension spike seen only in Catch the Star, and the overall clustering of Immersion and Competence values within a similar intensity range. Such visual patterns reinforce the interpretation that, despite thematic and mechanical diversity, the games produced under the GATE framework exhibit comparable experiential structures.

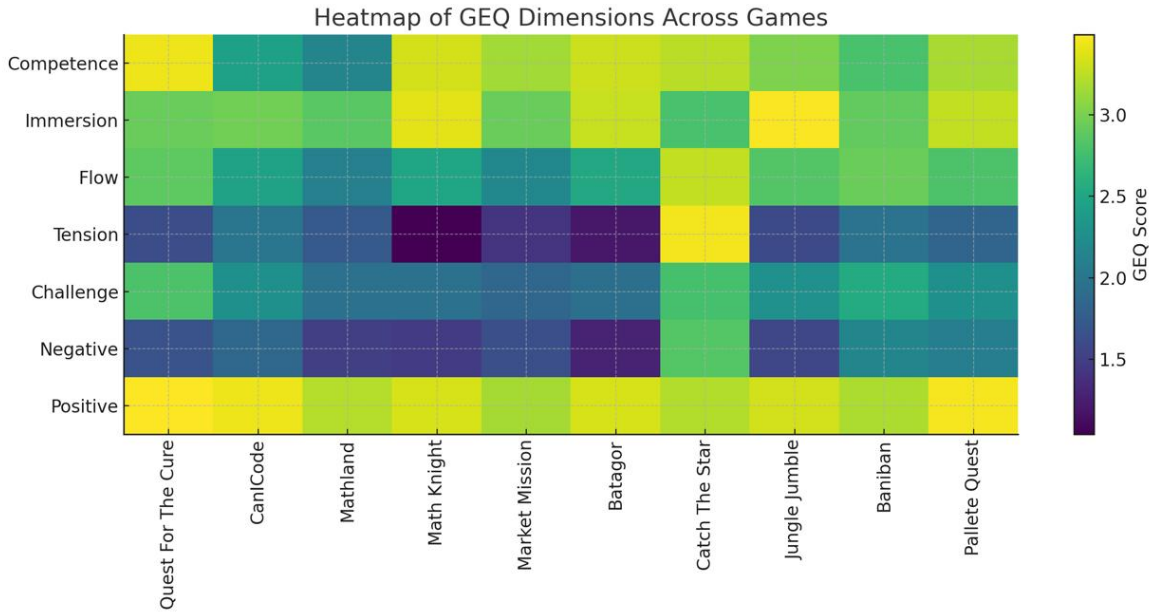


Figure 11. Heatmap of GEQ Dimensions Across Games

Quest for the Cure emerged as the game with the highest Competence score (3.434), suggesting that players felt particularly successful and confident in completing its challenges. Similarly, Math Knight (3.332) and Batagor (3.308) also performed well in this dimension, indicating that structured problem-solving and familiar mechanics helped reinforce a sense of accomplishment.

In terms of Immersion, Math Knight (3.39) and Jungle Jumble (3.477) stood out. These scores reflect how theme consistency, and storyline engagement can foster deeper player involvement. The dimension of Flow, or the sense of being fully absorbed in gameplay, was most strongly reported in Catch the Star (3.264), followed by Baniban (2.938) and Pallete Quest (2.811). These results indicate that players experienced a high level of concentration and seamless engagement.

For Tension/Annoyance, the lowest scores were found in Math Knight (1.04), Batagor (1.197), and Market Mission (1.413), suggesting that these games were user-friendly and minimally frustrating. The Challenge dimension was rated highest for Quest for the Cure (2.804) and Catch the Star (2.782), implying that players found these games cognitively engaging without being overwhelming. In contrast, games like Mathland (1.952) and Market Mission (1.85) were perceived as less challenging, which may reflect simpler task structures or more predictable gameplay.

In terms of Negative Aspect, which captures undesirable experiences such as confusion or irritation, the lowest ratings were reported in Batagor (1.273), Math Knight (1.47), and Mathland (1.5). These outcomes indicate that these games were generally well-received and free of disruptive design issues, likely due to their straightforward interfaces and accessible mechanics. Finally, Positive Aspect, which reflects overall enjoyment and emotional satisfaction, reached its peak in Quest for the Cure (3.492), followed by Pallete Quest (3.457) and CanICode (3.432).

4.4 Interpretation and Research Question Alignment

This section synthesizes the results in relation to the three research questions proposed in Chapter 2, integrating both development outcomes and player experience data to evaluate the effectiveness and reliability of the GATE framework. The results indicate that all ten novice development teams were able to complete and publicly deploy their microlearning games within the required four-month timeframe.

This collective achievement demonstrates that the GATE framework provided sufficient structure, scaffolding, and constraint-driven guidance for students to translate instructional goals into lightweight, playable modules. This outcome directly informs RQ1, as it shows that despite varying levels of design experience, art style preferences, and technical proficiency, every team adhered to the microlearning specification and delivered a functional 15-level game highlighting the feasibility and consistency that GATE enables under real institutional constraints.

Player evaluation data further provide insight into the experiential quality of the games. Across approximately 900 unique participants and 1,064 total responses, GEQ scores show consistently positive patterns: Competence, Immersion, Flow, and Positive Affect were rated highly, while Tension and Negative Affect remained low. These findings speak to RQ2, illustrating that the short-form, low-load nature of microlearning gameplay aligned well with user expectations during the exhibition. The results reinforce that GATE-guided games can deliver engaging educational experiences even when developed by novice creators.

Variance analysis across teams reveals important clues about the framework's reliability. Positive Affect and Immersion showed strong stability, Competence and Flow displayed moderate variation, and Tension exhibited the largest differences. These patterns help address RQ3, suggesting that the experiential variations observed were more closely related to subject complexity and mechanic difficulty than to structural weaknesses in the GATE framework. Taken together, the stability of core experiential dimensions indicates that GATE functions as a reliable, repeatable design model for guiding diverse novice teams toward producing coherent and pedagogically aligned microlearning games.

5. Conclusion

This study introduced the GATE Framework as a structured and modular approach for designing microlearning experiences through educational games. Developed in response to the increasing demand for agile, lightweight, and scalable learning tools particularly in contexts that extend beyond conventional LMS environments GATE integrates instructional objectives, narrative structuring, gameplay typologies, and evaluation mechanisms into a coherent design model. By grounding its components in established learning theories such as Bloom's Taxonomy, microlearning principles, and motivational constructs related to flow and engagement, GATE provides systematic guidance for educators and novice developers aiming to produce pedagogically meaningful and technically feasible digital learning content.

Implemented by ten student teams within a single academic semester, the framework was tested under realistic constraints of limited time, mixed experience levels, and streamlined technical resources. Each team successfully produced a 15-level microlearning game using Unity and WebGL deployment, supported by standardized micro-design and micro-code templates. This indicates that the scaffolding mechanisms embedded in GATE, such as predefined mission typologies, narrative foundations, and simplified API structures, effectively lowered development complexity while maintaining coherence between learning outcomes, game mechanics, and thematic consistency. The teams' ability to produce functional and pedagogically aligned games despite minimal prior experience demonstrates the framework's feasibility and accessibility in educational settings.

The evaluation of player experience using the GEQ provided preliminary evidence of the framework's pedagogical and experiential robustness. While conducted in a time-limited, exhibition-style environment, the results showed strong consistency across games, supported by low inter-team variance, non-significant ANOVA results across mission typologies, and high reliability scores across GEQ subscales. These findings suggest that GATE enables different developers to converge toward comparable levels of player competence, immersion, flow, and positive affect. From a theoretical perspective, this aligns with microlearning literature, which emphasizes short challenge loops, reduced cognitive load, and high action-feedback clarity as mechanisms that support engagement and cognitive processing. Practically, the consistency of results implies that GATE can serve as a replicable blueprint for producing microlearning games that maintain experiential quality even when development teams vary widely in creativity, design choices, and mission structures.

Nonetheless, the findings should be interpreted as exploratory rather than conclusive. The rapid development timeline, simplified deployment infrastructure, and short-duration field testing limit the depth of empirical validation. Moreover, the absence of controlled learning-outcome measurements means that the study evaluates experiential quality rather than instructional impact. These constraints, however, mirror many real-world educational game development conditions, particularly in early-stage prototypes, school-based projects, and resource-constrained institutions. Future research should extend the evaluation to include longitudinal learning assessments, controlled comparisons across subject domains, and deeper analytics on behavioral trace data. Integrating GATE with adaptive learning systems, AI-driven personalization, and LMS-linked pipelines also presents promising directions for expanding its utility in transmedia education ecosystems.

CRediT Author Statement

Rickman Roedavan: Conceptualization, Methodology, Investigation, Writing - Original Draft, Data Curation, Formal Analysis, Funding Acquisition; **Dimas Ramdhan**: Data Curation, Formal Analysis, Writing - Review & Editing, Funding Acquisition; **Bambang Pudjoatmodjo:** Data Curation, Formal Analysis; **Sazilah Salam:** Validation; Supervision; **Agus Pratondo**: Validation; Supervision;

Data Availability

Dataset is available from following repository: https://bit.ly/OpenDataPaper2507

Acknowledgments

This research was supported by the Internal Grant of Telkom University under Grant No. 545/LIT06/PPM-LIT/2024. The authors would like to express their sincere gratitude to Telkom University for the funding and support that made this study possible.

Conflicts of interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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