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Beyond 'Game Over': Engineering a Failure-Free FSM Architecture for Emotion Regulation in Serious Games

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Abstract:

The increasing prevalence of stress and anxiety among adolescents has highlighted the need for digital learning environments that support emotion regulation and psychological safety. However, many existing serious games still inherit performance-oriented mechanics, including scoring systems and game-over states, which may conflict with reflective and supportive interaction goals. To address this architectural gap, this study presents the design and development of Logisense: Fractured Mind, a narrative-driven serious game that employs consequence-driven interactions rather than punitive failure mechanisms. Using a Design and Development (D&D) framework, the system was implemented in RPG Maker MV through an Event-Driven Finite State Machine (FSM) architecture that manages dialogue progression and environmental transitions. Instead of conventional scoring, player choices dynamically modify a hidden psychological pressure parameter that controls shifts between the stable Virtual Real World and the distorted Logisphere environment. Internal alpha validation through structured scenario walkthroughs confirmed that the architecture correctly executed state transitions, reflective breathing events, and alternative narrative endings without triggering system-enforced game-over conditions. The results demonstrate the technical feasibility of implementing a failure-free interaction model while maintaining logical narrative progression and gameplay continuity. Consequently, the proposed architecture provides a reproducible blueprint for developing psychologically safe serious games and establishes a foundation for future empirical investigations concerning emotion regulation and digital learning environments.

Keywords: *Cognitive Resilience, Emotion Regulation, Finite State Machine, Interactive Narrative, Serious Games.*

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Introduction

The modern educational landscape increasingly acknowledges that psychological wellbeing plays a crucial role in the academic and personal success of students. Adolescents, in particular, are highly vulnerable to various psychological pressures within the school environment, ranging from social dynamics such as verbal bullying to anxiety when performing in public (Nakie et al., 2022; Sood et al., 2024; Wang et al., 2026). This highlights the urgent need for integrating social-emotional development within informatics subjects, blending digital pedagogy with emotional support (Sibta Nadia et al., 2025). Grounded in Emotion Regulation Theory and the concept of Psychological Safety, cognitive resilience can be understood as the capacity to acknowledge negative emotions, maintain clarity of thought, and continue functioning despite stressful experiences (Azpiazu Izaguirre et al., 2021; Defayette et al., 2021; Erdian & Hidayat, 2024; Nook et al., 2021; Yeager et al., 2022). Conventional pedagogical methods that rely on one-way instruction often prove ineffective in engaging socially withdrawn adolescents. Consequently, interactive digital technology, particularly serious games, has emerged as a promising medium for supporting psychological and socio-emotional interventions among adolescents because of its capacity to combine immersive experiences with reflective learning processes (Andrew et al., 2023; Martinez et al., 2021).

Several previous studies have explored serious games and digital interventions for anxiety management and emotion regulation using different interaction paradigms. ReWIND, a story-based serious game developed by Heng et al. (2023), employed cognitive behavioural therapy (CBT) principles and reflective narratives to reinforce anxiety-management strategies; however, progression remained dependent on task completion and structured sequences. Likewise, the interventions reviewed by Martinez et al. (2021) and the meta-analysis conducted by

Abd-Alrazaq et al. (2022) demonstrated the effectiveness of serious games for addressing depression and anxiety among children and adolescents, yet many of the reported systems still incorporated performance-oriented mechanics, reward structures, or progression constraints inherited from conventional game design. More broadly, emotion-regulation-focused psychosocial interventions synthesised by Eadeh et al. (2021) primarily emphasised reflective exercises and coping strategies, but provided limited discussion regarding the software architectures underlying non-punitive interaction mechanisms. Furthermore, the recent systematic review by Rooij S T et al. (2026) highlighted that theoretical rationales and design processes in adolescent mental health serious games are often inconsistently reported, while explicit architectural frameworks that deliberately eliminate punitive failure states remain relatively uncommon. Collectively, these findings suggest that although reflection- and CBT-oriented approaches have been widely adopted, comparatively little attention has been devoted to software architectures that support psychologically safe interaction through consequence-driven narrative progression without relying on traditional game-over mechanisms.

Consequently, despite the growing interest in serious games for emotional wellbeing, recent reviews indicate that theoretical foundations and design rationales are often inconsistently articulated, and relatively little attention has been devoted to software architectures specifically designed to eliminate punitive failure states and prioritise psychologically safe interaction (Edmondson & Bransby, 2023; Rooij S T et al., 2026). Therefore, an architectural gap remains concerning how consequence-driven interactions can be systematically implemented while preserving logical game progression and avoiding system-enforced failure conditions.

To bridge this architectural design gap, this study presents the design and development of Logisense: Fractured Mind, an interactive narrative-based serious game engineered to support emotion-regulation experiences without employing traditional failure mechanics. Rather than focusing on the psychological evaluation of users, this study emphasises the software architecture required to construct such an environment. The game system is built using an Event-Driven Finite State Machine (FSM) approach to manage a complex dialogue tree structure (Adrian & Akbar, 2025; Nugraha et al., 2025). Within this architecture, player choices do not generate numerical scores but instead influence an internal 'psychological pressure' variable used solely as an interaction parameter for controlling environmental transitions The design rationale is informed by acceptance-oriented coping and paced breathing strategies that have been widely associated with emotion-regulation interventions in adolescents (Eadeh et al., 2021; Georgiou et al., 2021; Suksasilp et al., 2021).

However, these mechanisms are intended only as interaction principles and should not be interpreted as validated psychological interventions or evidence of therapeutic effectiveness. The pressure variable dynamically governs transitions between two primary graphical states: a stable Virtual Real World and a distorted Abstract Psychological World, referred to as the Logisphere. By personifying internal cognitive tendencies through the characters 'Focus', representing rational reflection, and 'Doubt', representing negative self-perception, the system externalises emotional tension into visual and narrative forms. From a software design perspective, this architecture provides a psychologically safe interaction framework that avoids punitive failure states while maintaining logical narrative progression, an approach that aligns with recent developments in affective and adaptive serious game design (Faria & da Silva Ayrosa, 2025; Silva et al., 2025).

This research aims to design and explore the logical architecture and interface interaction design of the Logisense serious game as a reflective learning medium. To achieve this objective and validate the technical feasibility of a psychologically safe game design, the study is guided by two primary Research Questions (RQs):

1. How can an Event-Driven Finite State Machine (FSM) architecture be implemented to manage a psychological pressure variable that dynamically triggers visual transitions between a virtual real world and an abstract psychological world?
2. How can consequence-driven narrative choices be architecturally structured within an FSM to eliminate traditional 'game over' states while maintaining logical game progression?

Materials and Method

This research employs a Design and Development (D&D) framework to engineer Logisense: Fractured Mind, focusing specifically on the software architecture and interaction logic of the serious game (Oliver et al., 2025; Silva et al., 2025). Design-oriented approaches have increasingly been adopted in educational technology and serious game research because they facilitate the systematic transformation of theoretical constructs into functional digital artefacts while supporting iterative refinement and reproducibility throughout the development process (Mäkelä et al., 2022; Vieira et al., 2021). It is important to state clearly that this study represents an architectural prototype development study rather than an empirical effectiveness investigation. Rather than evaluating pedagogical efficacy through in-vivo user trials, this work focuses on the technical framework required to operationalise emotion-regulation principles into functional game mechanics without employing traditional failure states.

2.1. Design and Development (D&D) Phases

The development followed a structured four-phase D&D methodology, consistent with recent studies emphasising iterative design and technical validation in serious game engineering and educational technology development (Mäkelä et al., 2022; Vieira et al., 2021). This ensuring the architectural choices aligned with the psychological safety objectives:

1. Needs Analysis: Identification of the design gap in existing mental health serious games, specifically the detrimental effects of punitive scoring and 'game over' mechanics. The output of this phase was the requirement specification for a failure-free narrative system. The identification of design requirements was informed by recent studies highlighting the importance of reflective interactions and psychologically supportive game environments for emotional wellbeing (Abd-Alrazaq et al., 2022; Rooij S T et al., 2026).
2. System Design: Formulation of the Event-Driven Finite State Machine (FSM) architecture. This phase produced the logic models, state definitions, and mathematical threshold rules for the internal psychological pressure variable. Formal modelling techniques are widely employed in interactive systems and game engineering because they improve behavioural consistency, facilitate debugging, and enhance reproducibility of complex state transitions (Sevcenko et al., 2021; Silva et al., 2025).
3. Development and Implementation: The coding and assembly of the modular architecture (User Interaction Module, Psychological State Module, Narrative Engine, and Visual Rendering Module) using the RPG Maker MV engine.
4. Functional Testing (Internal Alpha Validation): Internal technical testing was conducted to examine the architectural integrity of the proposed system. This phase involved white-box testing of FSM transitions to ensure that environmental changes were triggered correctly when the psychological pressure variable reached predefined thresholds, as well as verifying that all narrative branches progressed without producing system failure states. Internal alpha testing and logical verification are commonly employed during early-stage prototype development to ensure functional correctness prior to conducting user-centred evaluations (Oliver et al., 2025; Vieira et al., 2021). The validation focused exclusively on functional and logical consistency of the software architecture. No empirical evaluation involving students, teachers, psychologists, or domain experts was conducted at this stage; therefore, no claims regarding pedagogical effectiveness, emotional outcomes, or psychological validity are made.

To visualize the outcome of the System Design phase, the structural relationship between the developed modules is presented. As illustrated in Figure 1, the architecture integrates four primary components. The User Interaction Module captures dialogue and reflective breathing inputs. These inputs are subsequently processed by the Psychological State Module, which acts as the core mathematical engine by updating the internal pressure variable. This variable state simultaneously triggers environmental shifts in the Visual Rendering Module and syncs the appropriate narrative context within the Narrative Engine.

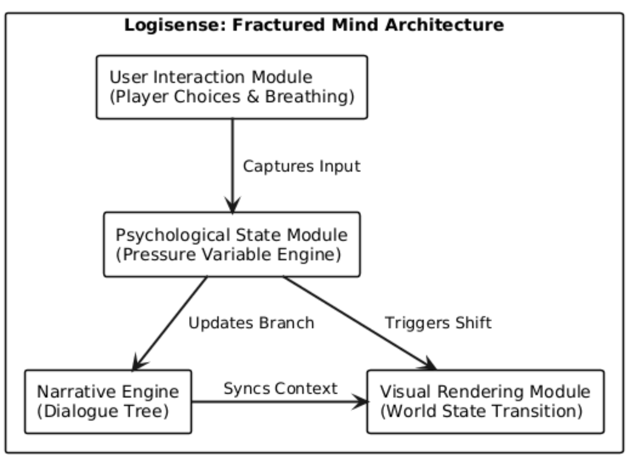


Figure 1. Modular architecture of the interactive narrative system for emotion regulation.

Such modular architectures have been recognised as an effective strategy for improving maintainability and extensibility in educational software and adaptive digital environments (Cabero-Almenara et al., 2024; Mäkelä et al., 2022).

2.2. Finite State Machine (FSM) Specification

To manage visual and narrative transitions without relying on a traditional scoring mechanism, the interaction logic of Logisense: Fractured Mind is modelled as an Event-Driven Finite State Machine (FSM). Finite State Machines have been widely adopted in interactive applications and digital game systems because they provide deterministic behaviour and preserve logical consistency under dynamic user interactions (Adrian & Akbar, 2025; Nugraha et al., 2025; Sevcenko et al., 2021). The FSM dynamically responds to a hidden psychological pressure variable, denoted as P, which functions solely as an internal interaction parameter for controlling environmental transitions and should not be interpreted as a clinical or psychometric measurement. Instead, it functions as an abstract interaction parameter, similar to latent variables frequently employed in adaptive and affective computing systems to regulate system responses without directly representing psychological constructs (Faria & da Silva Ayrosa, 2025). Formally, the FSM is defined as a tuple (S, Σ, δ, s0), where:

a) *S* is a finite set of game states, define as S= {S_vrw, S_ls, S_end}. S_vrw represents the Virtual Real World, which serves as the stable baseline environment. S_ls represents the Logisphere an abstract and visually distorted environment reflecting elevated narrative tension. State S_end represents the narrative conclusion state.
b) Σ is the set of player-triggered input events, defined as Σ = {E_stress, E_breathe, E_resolve, E_yield}. Event Estress corresponds to avoidant or anxiety-related dialogue choices, E_breathe represents guided breathing interactions, E_resolve corresponds to constructive narrative responses, and Eyield represents withdrawal-oriented decisions.
c) s_0 denotes the initial state, where the game begins in S_vrw and the psychological pressure variable is initialised with P=0.
d) δ represents the state transition function governed by a predefined threshold T.

The hidden variable P was designed as an interaction parameter rather than a quantitative indicator of emotional intensity. Its update rules and threshold values were established through iterative prototype calibration during the System Design phase to achieve a balanced pacing between dialogue progression and environmental feedback. Parameter calibration through repeated internal iteration is frequently used during early-stage serious game development to balance responsiveness and interaction pacing before user-centred evaluations are conducted (Silva et al., 2025; Vieira et al., 2021). Specifically, each avoidant dialogue event (E_stress) increments the variable by one unit (P=P+1), representing the gradual accumulation of narrative tension. Conversely, each guided breathing interaction (E_breathe) decrements the variable by two units (P=P−2), intentionally providing a stronger restorative influence so that reflective actions exert meaningful consequences within the interaction flow. Through repeated internal testing, the transition threshold was set to T=5, as lower thresholds resulted in excessively frequent state changes, whereas higher thresholds delayed visual feedback and reduced system responsiveness. Consequently, the values +1, −2, and T=5 should be interpreted as prototype parameters intended to regulate interaction dynamics rather than as validated psychological indicators.

Based on these calibrated parameters, the Psychological State Module continuously updates P throughout gameplay while enforcing the constraint P≥0 to prevent negative values and infinite loops. Such boundary constraints are commonly introduced in computational models to prevent invalid states and preserve system stability (Huang et al., 2023). The principal transition rule is defined as follows: when P≥T, the FSM automatically shifts the environment from S_vrw to S_ls. The Logisphere state is maintained until the pressure variable falls below the threshold (P<T), at which point the system restores the environment to S_vrw. This mechanism enables the game to externalise internal narrative tension through environmental changes without introducing punitive scoring or failure states.

In addition to environmental transitions, the FSM also governs consequence-driven narrative progression. Within the Logisphere state, players may either engage in guided breathing interactions to reduce P and gradually return to the Virtual Real World, or proceed towards alternative narrative outcomes through E_resolve and E_yield events. Rather than producing a traditional "game over" condition, these events direct the system to different narrative conclusions while preserving continuity of gameplay. Narrative branching mechanisms have increasingly been explored as alternatives to punitive progression systems, enabling multiple outcomes while preserving player agency and continuity of interaction (Azpiazu Izaguirre et al., 2021; Faria & da Silva Ayrosa, 2025).This approach allows the architecture to maintain logical state progression without enforcing punitive resets. The complete transition mechanism is visually summarised in the state-transition diagram presented in Figure 2.

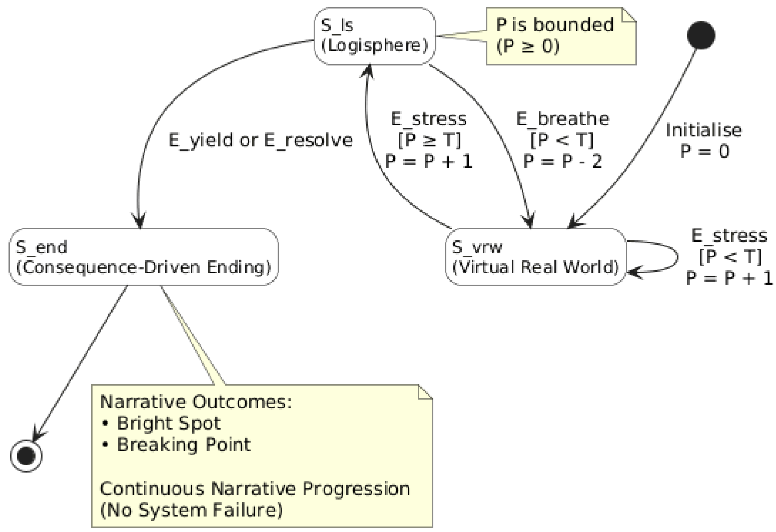


Figure 2. State-transition diagram illustrating the dynamic shifts between the Virtual Real World and Logisphere based on the psychological pressure variable (P).

2.3 Game Engine Implementation

The proposed FSM architecture and modular interaction framework were implemented using RPG Maker MV (version 1.5.0), which provides an event-based visual scripting environment suitable for dialogue-driven serious games. Visual scripting environments have become increasingly popular in serious game development because they simplify prototyping and facilitate reproducibility without requiring complex programming infrastructures (Oliver et al., 2025; Silva et al., 2025). The implementation relied primarily on built-in event commands without requiring external plugins. The hidden psychological pressure parameter P was represented by Variable ID 1 ("Psychological Pressure"), initialised at P=0 at the beginning of each chapter. The threshold value T was fixed at 5, consistent with the calibrated FSM specification described in Section 2.2.

To enable continuous monitoring of the internal state, a Parallel Process Event was configured to act as an event listener. Continuous event monitoring and event-driven processing are fundamental principles in reactive software systems and facilitate asynchronous state management within interactive environments (Sevcenko et al., 2021; Silva et al., 2025). This process repeatedly evaluated the value of P without interrupting player interaction. Conditional Branch commands were used to determine whether P had reached the threshold value. When P≥5, Switch ID 1 ("Logisphere Mode") was activated, triggering the transition from the Virtual Real World (S_vrw) to the distorted Logisphere state (S_ls). Conversely, when reflective breathing interactions reduced P below the threshold (P<5), the switch was deactivated and the environment returned to the Virtual Real World.

The event structure consisted of multiple dialogue pages associated with specific player actions. Avoidant dialogue selections (E_stress) invoked Control Variables commands that incremented P by one unit (P=P+1). Guided breathing events (E_breathe) executed variable subtraction commands (P=P−2). In contrast, the narrative events E_resolve and E_yield did not alter P, but instead activated dedicated switches leading to alternative consequence-driven endings. Rather than forcing a system reset or displaying a game-over screen, both narrative outcomes maintained story continuity and advanced the player to subsequent chapters.

The internal implementation logic is summarised in Table 1, while the continuous event monitoring mechanism is illustrated in Figure 3. These implementation details are provided to improve reproducibility and facilitate future adaptation of the architecture in similar serious game environments.

Table 1. Implementation of Narrative Branching and Cognitive Entities

Current State (S)	Player Event (Σ)	Variable Update	Condition Check	Next State	Pedagogical Function
S_vrw (Baseline)	E_stress (Avoid problem)	$P = P + 1$	If $P≥5$	S_ls (Logisphere)	Visualise increased tension

Current State (S)	Player Event (Σ)	Variable Update	Condition Check	Next State	Pedagogical Function
S_vrw (Baseline)	E_stress (Avoid problem)	$P = P + 1$	If $P < 5$	S_vrw (Baseline)	Maintain baseline state
S_ls (Distorted)	E_breathe (Reflective breath)	$P = P - 2$	If $P < 5$	S_vrw (Baseline)	Represent reflective recovery
S_ls (Distorted)	E_yield (Give up)	No change	Narrative Trigger	S_end (Breaking Point)	Alternative consequence-driven ending
S_ls (Distorted)	E_resolve (Face fear)	No change	Narrative Trigger	S_end (Bright Spot)	Positive narrative continuation

To facilitate reproducibility, the implementation logic described in Table 1 was translated into a continuous event monitoring mechanism within RPG Maker MV. Specifically, a Parallel Process Event was employed to repeatedly evaluate the value of the psychological pressure parameter P and determine whether the threshold condition had been reached. The implementation strategy emphasises consequence-driven interactions rather than score-based punishment, aligning with recent developments in affective and adaptive serious game design (Faria & da Silva Ayrosa, 2025). Figure 3 presents both the event configuration environment and the corresponding event loop used to activate or deactivate the Logisphere mode during gameplay.

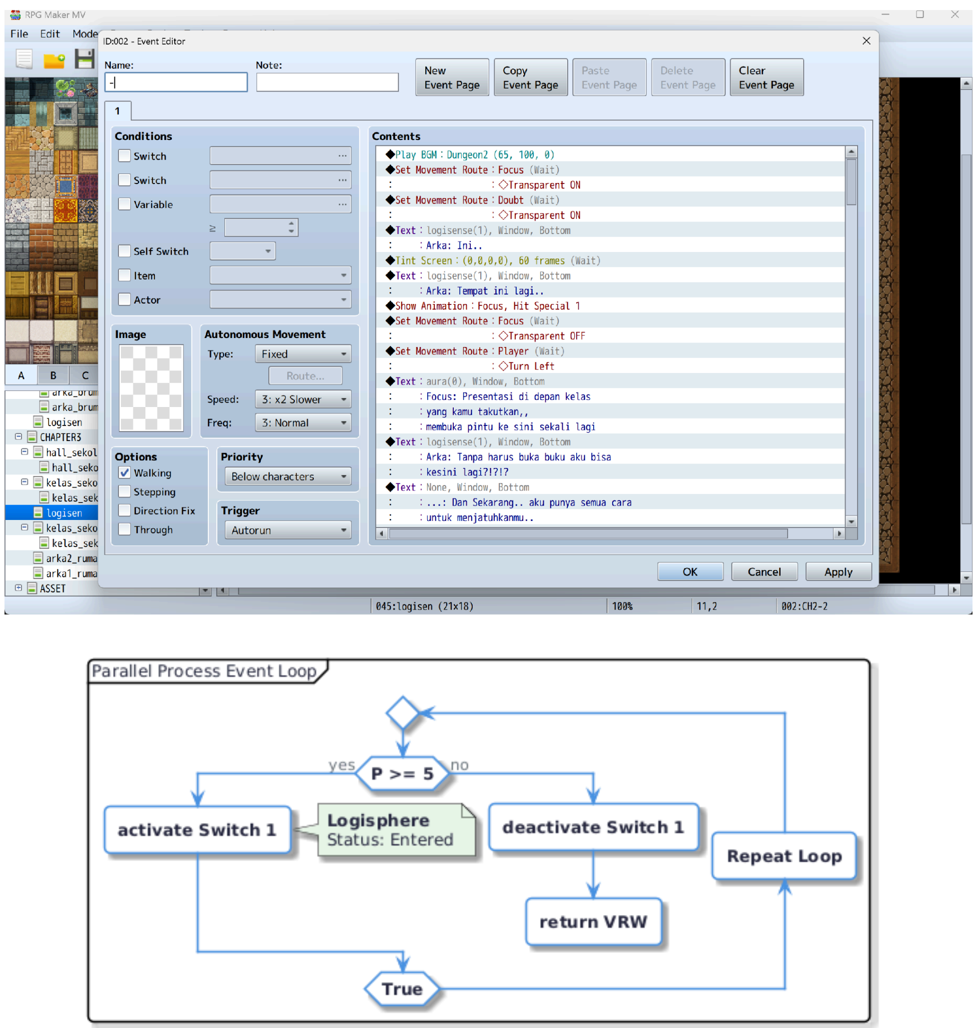


Figure 3. RPG Maker MV Event Configuration and Parallel Process Logic for Continuous Monitoring of the Psychological Pressure Variable.

Result

The functional testing (alpha validation) of the Logisense: Fractured Mind architecture confirmed that the Event-Driven Finite State Machine (FSM) successfully managed the psychological pressure variable (P) and executed state transitions without relying on traditional scoring or failure mechanics. The system was evaluated using structured scenario walkthroughs to verify the mathematical logic and graphical outputs.

3.1. Scenario Validation: Stress Accumulation and Visual Transition

The first test scenario evaluated the system's ability to trigger the abstract environment (Logisphere) when the variable P reached the predefined threshold (T = 5). During the initial gameplay phase, the system correctly maintained the S_vrw state (Virtual Real World), rendering stable school environments as the baseline (see Figure 4). As the test player inputted a sequence of avoidant dialogue choices (E_stress), the parallel process event accurately incremented P. Once P reached 5, the FSM immediately executed the transition to S_ls, replacing the standard background with the abstract grid pattern and spawning the cognitive entity 'Doubt' (see Figure 5). The debugging log confirmed this transition executed smoothly without crashing the dialogue sequence, verifying the core architectural function.

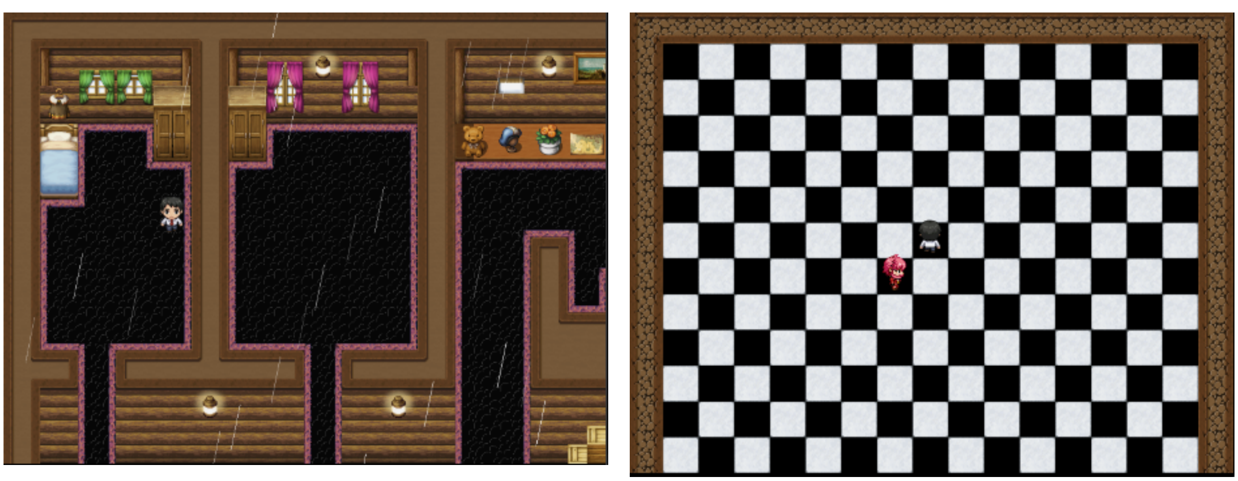
Table 2. Internal Alpha Validation Results for FSM State Transitions and Narrative Branches

Scenario	Initial P	Player Event	Variable Update	Guard Condition	Expected State	Observed State	Status
S1: Initial interaction	0	E_stress	P=1	P<5	S_vrw	S_vrw	Pass
S2: Stress accumulation	4	E_stress	P=5	P≥5	S_ls	S_ls	Pass
S3: Reflective breathing	5	E_breathe	P=3	P<5	S_vrw	S_vrw	Pass
S4: Withdrawal branch	5	E_yield	No change	Narrative trigger	S_end (Breaking Point)	S_end	Pass
S5: Resolution branch	5	E_resolve	No change	Narrative trigger	S_end (Bright Spot)	S_end	Pass

To verify the consistency of the implemented architecture, five representative scenarios covering the principal state transitions and narrative branches were executed during internal alpha testing. For each scenario, the observed system behaviour matched the expected FSM state, indicating that the event structure and conditional branching logic operated as intended. In total, the prototype implemented three principal states (S_vrw, S_ls, and S_end) and five major event branches (E_stress, E_breathe, E_resolve, E_yield), all of which were successfully executed without producing system crashes or unintended game-over conditions.

Figure 4. The stable Virtual Real World environment serving as the psychological baseline. *(Note: The in-game interface is in Indonesian. Dialogue translation: Mrs. Ratna asks, "Could I ask for your help??". Player choices: "Yes, ma'am" or "Sorry ma'am, I'm in a hurry").*

To illustrate the environmental transition governed by the FSM, Figure 4 presents the initial Virtual Real World state before the threshold condition is reached. Following repeated avoidant dialogue selections (E_stress), the accumulated pressure parameter exceeded the predefined threshold (T=5), causing the parallel process event to activate the Logisphere mode. The resulting distorted environment and the appearance of the cognitive entity "Doubt" are shown in Figure 5.



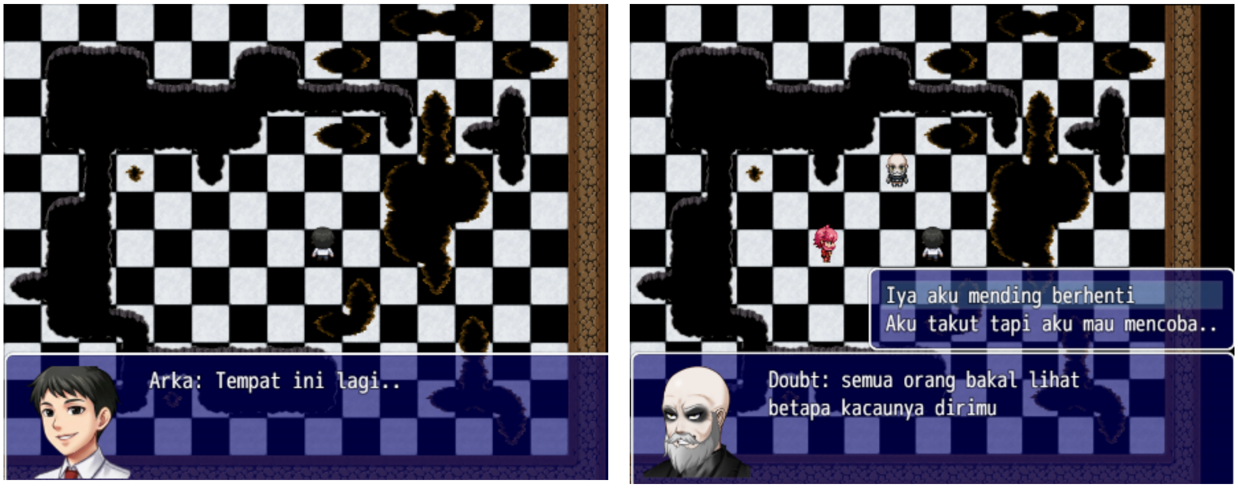


Figure 5. The Logisphere environment featuring visual distortions and the personified cognitive entity 'Doubt'. *(Note: Dialogue translation: Doubt says, "Everyone will see what a mess you are". Consequence-driven choices: "Yeah, I'd better quit" [E_yield] or "I'm scared but I want to try.." [E_resolve], thereby eliminating traditional 'game over' mechanics).*

3.2. Scenario Validation: Recovery and Consequence Resolution

The second phase of testing evaluated the decrement mechanism of the psychological pressure parameter and verified the elimination of conventional game-over states. Within the Logisphere state (S_ls), the reflective breathing mechanic (E_breathe) was implemented as a scripted dialogue interaction rather than a timed challenge. When prompted by the narrative, the player selected the breathing option from the available dialogue choices, triggering a predefined animation sequence accompanied by supportive text. Upon completion of the event sequence, the system automatically executed a Control Variables command that decreased the pressure parameter by two units ($P=P-2$). Successful execution was detected by the completion of the associated event page, ensuring that the decrement operation occurred only after the entire scripted interaction had finished.

When the updated value satisfied the condition $P < 5$, the Parallel Process Event correctly deactivated Switch ID 1 (Logisphere Mode), causing the environment to transition from the distorted Logisphere state back to the Virtual Real World (S_vrw). Visual feedback was provided through the restoration of the normal background and the disappearance of distortion-related elements, indicating that the system had returned to the baseline state.

Furthermore, to verify the failure-free narrative structure, the test player intentionally selected the yielding option (E_yield) while the system remained in S_ls. Instead of displaying a game-over screen or forcing a system reset, the FSM directed the interaction towards the consequence-driven ending state (S_end). In this branch, the protagonist withdrew from the stressful situation and the narrative progressed to the subsequent chapter. This behaviour confirmed that the architecture maintained continuity of gameplay regardless of the player's decisions, thereby eliminating punitive failure conditions. These observations further confirmed that both restorative interactions and negative narrative outcomes were handled through controlled state transitions rather than through system-enforced failure mechanisms.

Discussion

The functional validation results address the primary research questions regarding the technical implementation of FSMs and the restructuring of failure mechanics in educational serious games. Regarding the first research question (RQ1), the findings suggest that an Event-Driven FSM architecture constitutes a technically viable approach for translating abstract emotional concepts into visual feedback mechanisms. By manipulating environmental states S_vrw and S_ls through the hidden interaction parameter P rather than through conventional health bars or scoring systems, the architecture is intended to provide non-verbal affective cues. Previous studies in Human-Computer Interaction have indicated that environmental changes can be utilised to communicate affective conditions effectively (Faria & da Silva Ayrosa, 2025). From a software design perspective, the Logisense architecture translates internal emotional tension into a navigable environment, thereby making abstract emotional concepts observable and interactable within the game system.

Addressing the second research question (RQ2), the elimination of the conventional game-over mechanic represents an alternative architectural approach for serious games intended for emotion regulation contexts. Traditional educational games frequently employ punitive resets and failure states to regulate player progression, mechanisms that may be inconsistent with reflective and supportive interaction goals (Jia, 2024; Kashif et al., 2024). The present implementation demonstrates that such resets can be replaced by consequence-driven narrative branches (E_yield and E_resolve) while preserving logical state progression. This design rationale is informed by the concept of psychological safety (Edmondson & Bransby, 2023). Rather than treating the "Breaking Point" branch as a system failure, the proposed architecture is intended to represent feeling overwhelmed as a valid narrative state and to maintain gameplay continuity without enforcing punitive interruptions. However, whether such a design effectively supports emotion regulation or improves users' psychological outcomes remains an empirical question that requires future evaluation involving students and relevant domain experts.

Conclusion

The architectural development of Logisense: Fractured Mind demonstrates the technical feasibility of employing an Event-Driven Finite State Machine (FSM) to construct a consequence-driven serious game without relying on conventional game-over mechanics. By replacing punitive failure states with a hidden psychological pressure parameter and alternative narrative pathways, the proposed architecture provides a reproducible framework for implementing reflective interaction patterns within narrative-based serious games.

From a software engineering perspective, this study contributes a structural blueprint for developers seeking to incorporate emotion-regulation-inspired design principles into digital learning environments. The findings indicate that consequence-driven narrative progression and continuous state monitoring can be implemented successfully through an event-based FSM architecture while maintaining logical consistency and uninterrupted gameplay. Nevertheless, the present study is limited to technical and functional validation. Consequently, no claims are made regarding educational effectiveness, emotion regulation outcomes, or psychological benefits, all of which require future empirical evaluation involving users and relevant domain experts.

Limitation and Future Works

While this study establishes a robust technical architecture, several limitations should be acknowledged. First, the present work is restricted to internal functional validation and does not include empirical evaluation involving real users. Consequently, the pedagogical effectiveness and psychological outcomes of the proposed architecture remain unknown. Moreover, no validation involving students, teachers, psychologists, or other domain experts was conducted at this stage. Therefore, the prototype should not be interpreted as a validated psychological intervention or as evidence of educational effectiveness.

The current findings only demonstrate the technical feasibility and logical consistency of implementing a failure-free, consequence-driven interaction model using an Event-Driven Finite State Machine (FSM). Future extensions of this work should involve comprehensive empirical evaluations and in-vivo testing with middle school students to quantitatively examine the system's potential influence on emotion regulation skills and cognitive resilience. In addition, interdisciplinary collaboration with educators, psychologists, and relevant experts is necessary to establish pedagogical appropriateness and psychological validity. Furthermore, subsequent iterations could explore the integration of real-time biometric feedback to automate the input for the psychological pressure variable and support more adaptive interaction mechanisms.

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