Integrating Learning and Serious Game Design: The Development and Application of the Learning and Game Integration (LGI) Framework Using the 'Blackout' Serious Game

Stella Stefany*[1,2], Ling Mei Cong[1], Jessica Helmi [1] and Rickman Roedavan[3]
[1]RMIT University, Melbourne, Australia
[2]Universitas Pelita Harapan, Indonesia
[3]Telkom University, Indonesia

stella.stefany@gmail.com
lingmei.cong@rmit.edu.au
jessica.helmi@rmit.edu.au
rikman@telkomuniversity.ac.id

Abstract: Serious games are increasingly recognised as effective educational tools capable of simulating complex scenarios that traditional methods cannot replicate. This paper introduces the Learning and Game Integration (LGI) Framework, designed to seamlessly integrate educational content with interactive game design. Utilising the "Blackout" serious game, which simulates real world complex problem, this study demonstrates how the LGI Framework can be utilised as learning intervention to enhance learning by teaching Design Thinking to university students. The framework consists of four stages: Educational Content Integration, Theoretical Underpinning, Case Study Selection, and Game Design. The "Blackout" game enables students to engage with various stakeholder perspectives, deeply analyse problems, and develop innovative solutions under crisis conditions. Preliminary feedback from its implementation in an undergraduate business course (N=753) indicates increased student engagement and confidence in applying Design Thinking concepts. This paper contributes to the field of business education by presenting an innovative approach to teaching innovative problem-solving skills through serious games, emphasising the need for holistic educational frameworks that bridge theoretical learning with real-world application.

Keywords: Serious Games, Design Thinking, Business Education, Experiential Learning, Game Design Framework

1. Background

Serious games have emerged as promising educational tools, distinguished from other educational games by their ability to simulate complex scenarios that are unattainable in traditional settings due to various constraints (Susi et al. 2007). As a form of digital pedagogy, serious games leverage technology to create immersive, experiential learning environments where students can apply theoretical concepts in simulated real-world scenarios (Lewin and Lundie 2016; Shachar and Neumann 2003; Smetana and Bell 2012) and provide environments that foster engaging and comprehensive skill development (Cocks 2020; De Jans et al. 2019; Liew et al. 2021; Ritterfeld et al. 2009; Zhang et al. 2019). Existing notable frameworks such as Activity Theory-based Model of Serious Games (ATMSG) integrates principles from activity theory to provide a structured approach to serious game design (Carvalho et al. 2015). It emphasises the alignment of game activities with educational objectives. However, its focus is primarily on the activities within the game rather than a holistic integration of educational content and game design. The Four-Dimensional Framework (De Freitas and Oliver 2006) categorises serious games into: learning, learner, context, and pedagogy. It provides a comprehensive analysis of how these dimensions interact within serious games. However, it tends to compartmentalise these dimensions rather than integrating them into a cohesive framework. The RETAIN Model (Gunter et al. 2007) focuses on evaluating the effectiveness of serious games in achieving learning outcomes. It emphasises the importance of retention, engagement, transfer, and immersion, yet, it lacks guidance on the actual design and integration of educational content within games. The LM-GM Model (Arnab et al. 2015) differentiates between learning mechanics and game mechanics, aiming to bridge the gap between educational goals and game design. It provides valuable insights into how these mechanics interact but does not offer a unified framework for their integration. Furthermore, literature reveals a significant gap between the design objectives of serious games and their educational goals, particularly highlighting a lack of emphasis on preparing learners for future-ready skills (Adams 2023); the integration of real-world cases into gameplay (Papoutsi et al. 2022; Romero et al. 2015); the necessity for an interdisciplinary approach to provide a holistic perspective on the educational value of serious games (Carvalho and Neto 2023) and balancing the educational purpose with entertainment in serious games design (Natucci and Borges 2020). To address this gap, our study introduces the "Learning and Game Integration (LGI) Framework," utilising "Blackout" serious game to demonstrate the framework's application. "Blackout," developed for university students, aims to teach the Design Thinking concept. Design Thinking is

believed to significantly foster innovative problem-solving skills by promoting an empathetic approach, ensuring that solutions not only address problems but also resonate with the intended users (Klaassen et al. 2008). By applying the Design Thinking concept, it is anticipated that solutions will be crafted to not only resolve immediate issues but also to be adaptable, resilient, and considerate of the broader ecosystem (Brown 2008; Razzouk and Shute 2012).

2. Framework Development: LGI Framework

The "Learning and Game Integration (LGI) Framework" proposed in this study is designed to integrate educational content with interactive game design seamlessly. This framework facilitates the integration of theoretical concepts into practical application, enhancing the educational impact of serious games within academic curricula. As presented in Figure 1, the LGI Framework consists of four interconnected stages: (1) Educational Content Integration: Identifies and aligns the educational objectives with the game's design, ensuring that learning outcomes are effectively met through gameplay, (2) Theoretical Underpinning: incorporates relevant learning theories, such as Experiential Learning Theory (ELT), to support the pedagogical aims of the serious game. This stage emphasises the transformation of theoretical knowledge into practical skills through active engagement, (3) Case Study Selection: Involves choosing real-world scenarios that are relevant and challenging, providing students with opportunities to apply their learning in complex, real-life contexts, and (4) Game Design: Focuses on creating engaging and educational game mechanics that reflect the identified educational goals and the selected case study, culminating in a game that is both educative and entertaining.

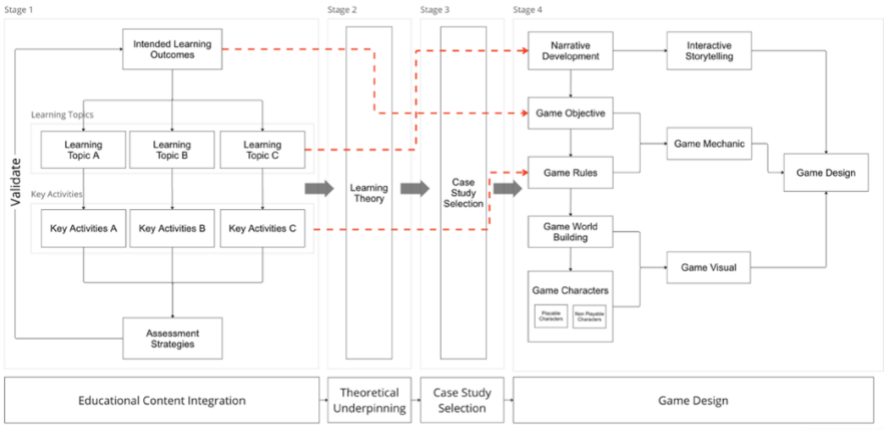

Figure 1: Proposed Framework: Learning and Game Integration (LGI) Framework

3. Application of LTI Framework in developing "Blackout" Serious Game

The "Blackout" serous game serves as a practical application of the LGI Framework, specifically designed to teach Design Thinking through real-world case study. This scenario enables students to assume the role of a problem-solving consultant to the city's mayor. In this capacity, they engage with various stakeholders, deeply analyse problems, and devise innovative solutions under pressure, thereby embodying the skills essential for effective leadership and decision-making in real-world crises.

3.1 Stage 1: Educational Content Integration

This stage is methodically structured to enhance learning outcomes through a constructive alignment (CA) principle (Biggs 1996) which consists of four main components (1) learning outcomes, (2) teaching and learning activities, (3) assessment, (4) feedback. This approach ensures that all components of the educational process—objectives, activities, and assessments—are seamlessly integrated, adhering to the principles of CA, ensuring students are evaluated on tasks that are directly connected to what they are taught and need to learn. The implementation begins with the formulation of intended learning outcomes. These outcomes are detailed into specific topics that follow the stages of the Double Diamond Design Thinking process: Discover, Define, Develop, and Deliver, as developed by the UK Design Council in 2019. As illustrated in Figure 2, each stage is designed to progressively build on the students' innovative problem-solving skills. To reinforce these stages, relevant activities are created to unpack and explore the Design Thinking concept at each phase of the Double Diamond process. This is complemented by the development of targeted assessment strategies that align with the

activities and the overarching educational goals, thereby operationalising the methodology in a practical, application-focused educational setting.

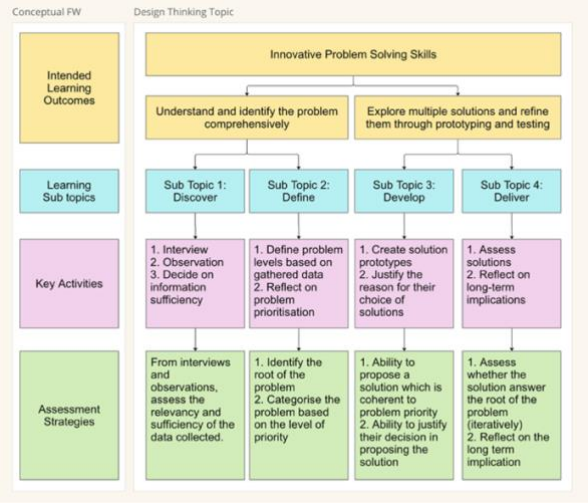

Figure 2: Application of LGI Framework in Blackout Serious Game – Stage 1

3.2 Stage 2: Theoretical Underpinning

In the LGI Framework, Stage 2 serves as the theoretical underpinning that bridges educational content integration (Stage 1) and the selection of a case study (Stage 3). This stage is crucial as it ensures that theoretical concepts are not only understood but are also applied effectively in practical, real-world contexts. The integration provided by this stage is critical for developing learning experiences that are deeply rooted in learning theory while being directly applicable and relevant to the complexities of real-world scenarios. The primary function of this stage is to provide a structured framework that guides how learners engage with the material. By embedding a solid theoretical foundation, this stage ensures that the subsequent educational activities and case study applications are cohesively aligned with the learning objectives, thereby enhancing both the effectiveness and the impact of the learning experience. For this study, Experiential Learning Theory (ELT) was selected as the ideal theoretical framework due to its robust emphasis on learning through experience. Developed by David Kolb (1974), ELT is grounded in constructivist principles, positing that knowledge is constructed through the transformation of experience. This learning paradigm is particularly aligned with the aims of the LGI Framework because it supports a dynamic learning process where students are not merely passive recipients of information but active participants in their learning journey. ELT advocates for a cyclical process of learning consisting of four stages: Concrete Experience, Reflective Observation, Abstract Conceptualisation, and Active Experimentation. This cycle ensures that learning occurs in a structured yet flexible manner, promoting deep engagement and the continuous application of learned knowledge to new and complex situations (Kolb et al. 2014). The theory is celebrated for its effectiveness in fostering critical thinking and adaptive skills, essential for resolving real-world problems by applying abstract concepts to tangible contexts (Morris 2019; Seaman et al. 2017). Further, ELT's application in various educational settings, including product development (Babu et al. 2020), management (Xue et al. 2021), environmental education (Cheng et al. 2019), art (Chiu et al. 2022) demonstrates its versatility and efficacy in enhancing learning outcomes through experiential contexts. These instances underscore ELT's capacity to bridge the gap between theoretical education and practical experience, making it an invaluable asset for integrating serious games into educational frameworks. Recent advancements have extended ELT's application into digital learning environments, utilising technologies such as role-play games, 3D virtual worlds, and real-world event simulations, which further exemplifies its adaptability and relevance in modern educational contexts (de Oliveira et al. 2015; García-Sánchez and Luján-García 2017). However, the integration of actual case studies in digital formats remains underexplored. Our study addresses this gap by embedding ELT within a Design Thinking framework to develop the serious game "Blackout," aiming to enhance the educational realism and impact for students, enabling full immersion in a business environment reflective of real professional settings. However, despite these technological integrations, there remains a gap in studies utilising real-world environments that leverage actual case studies for immersive experiential learning. Addressing this, our study integrates ELT within a Design Thinking framework to inform the development of the web-based serious game "Blackout." This integration is designed to enhance the realism and educational impact of the learning experience, ensuring that students can

fully immerse themselves in a business context that mirrors true professional environments (de Freitas & Neumann, 2009).

3.3 Stage 3: Case Study Selection to design the Serious Game

Stage 3 of the LGI Framework, focused on case study selection, is integral for bridging theoretical learning with real-world application. This stage contextualises learning by having students apply theoretical concepts to complex, real-life situations, thereby enhancing the realism and relevance of their learning experience. Selecting appropriate case studies is pivotal for direct applicability and engagement, representing real-world problems that require innovative, systemic thinking and collective action. This approach ensures that students are not only learning to solve hypothetical problems but are also prepared to tackle real-world challenges that mirror the complexities they will face in their professional lives. Literature suggests that games addressing wicked problems should simulate real-world scenarios necessitating collective action and continuous adaptation to changing circumstances (Fabricatore et al. 2020). The 2012 massive blackout in India serves as an exemplary scenario, encompassing a range of problems from immediate technical failures to long-term strategic vulnerabilities, requiring multifaceted solutions (Jim Yardley and Harris 2012). This simulation challenges students to engage with various stakeholder perspectives, analyse underlying causes, and develop innovative solutions under pressure. Modelled on the Double Diamond Design Thinking process, the game aligns problem-solving stages with practical business scenarios, enhancing students' ability to connect theoretical knowledge with practical application (Classe et al. 2019). This approach prepares students for professional environments by developing skills like innovative problem-solving and strategic decision-making, crucial for seamless transitions into corporate roles (Azadegan et al. 2012). The immersive, real-world scenario of the "Blackout" game boosts engagement and depth of learning, encouraging emotional and intellectual investment. The game's safe and controlled environment allows for risk-free experimentation and iterative learning, fostering confidence and competence in handling real-life challenges (Adisusilo et al. 2018; Taleb et al. 2019).

3.4 Stage 4: Game Design

This final stage is essential for transforming the theoretical insights and case study findings from previous stages into a tangible serious game. It entails the strategic development of the serious game, integrating storytelling, mechanics, visuals design to inform the game design and development. (1) The narrative development shapes the storytelling, ensuring it aligns with the learning topics and engages the players meaningfully. (2) Game mechanics are crafted based on clear game objectives and rules, facilitating a structured yet dynamic gameplay experience that challenges the learners which were informed by key activities in each learning topic. (3) Game Visual, created by designing world building and character design, enhance the immersive quality of the game, making the learning experience both engaging and visually appealing. Each component is tailored to reinforce the educational goals established earlier in the framework, ensuring that the game not only educates but also captivates the audience. In the final stage of the LGI Framework, the integration of Experiential Learning Theory (ELT) and the selected case study crucially informs the overall game design of "Blackout". As presented in Table 1, the integration of ELT into the game design leverages its structured learning cycle—Concrete Experience, Reflective Observation, Abstract Conceptualisation, and Active Experimentation.

Table 1: Conceptual Application of LGI Framework in Blackout Serious Game – Stage 4

ELT	Learning Objectives	Learning Topics	Key Activities	Assessment Strategies
Concrete Experience	Gather extensive information to develop empathy and other related skills	Discover	Interview stakeholders, observe the city, decide on information sufficiency	In-game reflection to consolidate findings and insights; overview explaining the stage and how concepts apply to real life.
Reflective Observation	Identify and categorise the root problems	Define	Define problem levels based on gathered data, reflect on problem prioritisation	Reflective question at the end of the stage to justify prioritisation of issue
Abstract Conceptualisation	Develop solutions for identified problems	Develop	Create prototypes using resources from stakeholders, justify the use of solutions	Answer the question, "Who should be the first to use this solution, and why?" for each developed solution
Active Experimentation	Evaluate the effectiveness and impact of the solutions	Deliver	Assess solutions based on feedback, reflect on long-term implications of the blackout	Overall game explanation at the end, followed by an open reflection question on long-term wicked problems related to the blackout.

Each phase of ELT directly influences how the game's narrative, mechanics, and visuals are developed, ensuring that every element of "Blackout" contributes effectively to the learning objectives. The case study of the 2012 India blackout provides a real-world context that enriches the game environment, making the theoretical aspects more tangible and relatable for the players. This real-world grounding not only enhances the realism of the game scenarios but also ensures that the challenges and tasks within the game mirror actual issues that need innovative solutions under pressure. This integration ensures that the game is not only a tool for applying learned concepts but also a platform for developing innovative problem-solving skills, crucial for managing real-life crises.

3.4.1 Narrative Development

The narrative development process for the serious game based on the 2012 India blackout involves a detailed exploration of the incident's complexities. It begins with gathering extensive data about the event's causes, impacts, and stakeholder responses, primarily sourced from old digital news articles from reputable global media outlets (Yin et al. 2012). These real-world elements are integrated into the game's storyline, creating an immersive narrative that challenges players to think critically and make strategic decisions, mirroring real-life crisis management (Naul and Liu 2019). This narrative development uses thematic analysis (Peel 2020) to ensure coherence between the actual case, Design Thinking Framework, and ELT, reflecting intended learning outcomes, key activities, and assessment strategies.

In the ELT learning cycle's first phase, Concrete Experience, players begin their journey as business consultants during a major power outage. They gather information through stakeholder interviews and city observations, providing direct engagement essential for learning (Kolb 2014). Decisions on seeking additional information or proceeding with available data simulate real-life decision-making (Bell and Kozlowski 2008). The game’s time constraints add pressure, enhancing the learning experience. In-game reflection helps consolidate findings, reinforcing learning objectives (Henry 2013).

The second phase of ELT cycle, Reflective Observation corresponds with the game’s “Define” stage. During this phase, players critically analyse and reassess the information gathered during their initial exploration. Players categorise the issues they have encountered into critical, moderate, and slight, based on the collected data. This reflective process compels players to deeply consider their observations and the implications of the identified problems, paving the way for more profound analytical and conceptual thinking (Hughes and Scholtz 2015). This integration of reflection into design thinking equips players to manage challenging situations more effectively by uncovering tacit knowledge and modifying future actions based on gained insights (Grund and Schelkle 2020; Schoormann et al. 2023). Moreover, the act of reflection helps distinguish between high and low-performing students, thereby enhancing their problem-solving capabilities in design-oriented tasks (Hong and Choi 2019). It aligns with recommendations that mapping business process elements into game design elements effectively helps players understand and reflect on process challenges (Classe et al. 2019). Players answer a reflective question at the end of this stage to explain why they selected these issues as their top priorities, which serves as a formative assessment to gauge their understanding and application of the stage's objectives. Building on the reflective insights from the Define stage, players transition into the Abstract Conceptualisation phase which involves cognitive process of synthesising the lessons learned from experience into new ideas, theories, or plans (Kolb et al. 2014). This phase is crucial for learners as it encourages them to think beyond the specific instances of their experiences and formulate generalisable rules or concepts that can be applied to new, different situations (Han 2016). In this stage, players develop actionable solutions to the identified problems. This involves critical and creative thinking as players conceptualise prototypes and strategies on using resources efficiently. They engage in high-level problem-solving and decision-making, directly applying the theoretical knowledge and strategies explored earlier in the game. For each solution they create, players must answer the question, "Who do you believe should be the first to use this solution, and why?" This question assesses their ability to practically apply and justify their designed solutions, reflecting a deep engagement with the Abstract Conceptualisation phase. The final phase of ELT, Active Experimentation, is embodied in the Deliver Stage. Players implement their solutions within the simulated environment of the game to observe and evaluate their effectiveness. This is seen in the game when players have to deliver the solution by reporting back to The Mayor and receiving a response whether the solution proposed is built upon sufficient data collected from stakeholders or not. This stage allows players to experiment with their conceptualised ideas and adjust their strategies based on the outcomes and feedback (Fewster-Thuente and Batteson 2018), particularly the evaluation from the mayor. The game concludes with a reflective question about potential long-term implications of their solutions, encouraging players to think about the broader impact of their decisions and the sustainability of their approaches. This

reflective assessment serves as both a summative and formative tool, helping players consolidate their learning and consider future applications of their skills and knowledge. Figure 3 presented the practical application of LGI framework to the actual “Blackout” game design.

Figure 3: Practical Application of LGI Framework in Blackout Game Design – Stage 4

3.4.2 Game Objective

A game objective is a specific goal that players aim to achieve within the context of a game. It serves as the primary focus or purpose driving player actions and decisions throughout gameplay. Game objectives can vary widely, from simple tasks like reaching the end of a level or scoring points, to complex missions involving strategy, problem-solving, or narrative progression. Game objectives were designed to align with the intended learning outcomes. As the literature suggests, integrating these intended outcomes as attributes within game mechanics begins with setting clear game objectives (Lameras et al. 2021). As presented in Table 2, in the "Blackout" game, each objective is designed to engage players actively and align closely with the educational goals of fostering critical thinking and problem-solving skills. The first objective, Finding Character, challenges players to locate specific non-player characters (NPCs) scattered throughout the virtual city. Each NPC represents a unique problem related to the blackout crisis and finding them triggers different features in the subsequent level. The number of NPCs found directly influences the conditions and available resources in the next level, integrating the consequences of player actions into the game’s progression. The second objective, Choosing Options, requires players to select the three most appropriate solutions from a set of options. The diversity and number of these options are contingent upon how many NPCs were encountered previously, demonstrating the cumulative effect of earlier decisions and enhancing the game’s complexity. If players successfully locate all NPCs, they are presented with nine options, from which they must judiciously choose three. The third objective, Creating Item, involves players gathering materials to construct a specific item that can mitigate the impacts of the blackout. This task necessitates synthesizing information and resources gleaned from interactions with NPCs and previous levels, underscoring the game’s emphasis on resource management and strategic planning. The final objective, Solving Quest, culminates in players navigating through the game’s challenges to reach the endpoint where they present their created item to Mayor Anderson as a potential solution to the crisis. This sequence of objectives not only enhances engagement through a structured yet flexible gameplay framework but also mirrors real-life processes of crisis management, where understanding problems, making strategic decisions, and implementing solutions are crucial. By integrating these objectives into "Blackout," the game effectively simulates a realistic problem-solving environment, thereby reinforcing the learning outcomes aimed at preparing players for complex, real-world challenges.

Table 2: Conceptual Blackout Game Objectives

Game Objectives	Description	Key Actions
Finding Character	Locate a specific NPC within the game.	• Find one of six NPCs scattered throughout the city. • Each NPC presents a unique problem and triggers a different feature in the next level. • Number of NPCs found affects conditions in the next level.
Choosing Options	Select the three most appropriate options from those provided.	• The number and type of options available depend on the number of NPCs encountered in the previous level. • If all NPCs are found, nine options are available, from which three must be selected.
Creating Item	Create a specific item based on previous choices.	• Gather required materials with clues from NPCs. • A minimum of three different materials is needed to create the target item.
Solving Quest	Reach the endpoint of the game.	• Complete all quest activities from the previous levels. • Return to Mayor Anderson with the created item as a solution.

3.4.3 Game Rules

Game rules are the guidelines and constraints that define how a game functions and how players interact with it (Djaouti et al. 2008). These rules set the structure of the game by establishing what players can and cannot do, the objectives to be achieved, and the consequences of players' actions. They provide a framework that ensures fairness and clarity, guiding player behaviour and helping to create a predictable and enjoyable gaming experience. As presented in table 3, in the "Blackout" game, the rules are designed to structure gameplay and ensure a coherent and engaging experience across various levels. These rules not only define the boundaries within which players operate but also enhance the realism and educational value of the game. One of the fundamental rules is the (1) Time Limitation, where players are given a real-world limit of 30 minutes to simulate a six-hour crisis management scenario. This rule applies to all levels and adds a sense of urgency, pushing players to make quick and effective decisions, thereby simulating the real-world pressure of managing a crisis within tight deadlines. (2) The Third-Person Movement rule utilises the WASD keys for navigation and the mouse for camera orbit, allowing for fluid movement and interaction within the game environment. This setup is consistent across all levels, facilitating a stable and intuitive control scheme that players can easily adapt to from the start. Level Navigation is another crucial rule, with transitions between game levels managed through designated buttons that correlate to different phases of the Design Thinking process. Once players exit a phase, they cannot return, which emphasizes the need for careful planning and decision-making in each phase. Finally, (3) Dialog Interaction is specifically designed for the Discover level, where players can initiate conversations with NPCs by approaching them and pressing the E key. This feature enhances the immersive experience, allowing players to gather crucial information and insights from various stakeholders, which are essential for progressing in the game. Lastly, the Quest User Interface (UI) supports specific gameplay mechanics in later phases, such as drag-and-drop quizzes in the Define phase and crafting in the Develop phase, enhancing interactive learning and application of concepts through hands-on activities.

***T*able 3: Conceptual Blackout Game Rules**

Rule Category	Description	Specific Phase(s)
Time Limitation	The game is time-limited to 30 minutes (real-world), simulating 6 hours (in-game). Players must complete all levels within this period or face a game over with a "failed" status.	All levels
Third-Person Movement	Movement is controlled via WASD keys, with camera orbiting enabled via mouse. This setup supports navigation and responsive action in the game environment.	All levels
Level Navigation	Transition between levels is managed through designated buttons, representing each phase of Design Thinking. Exiting a phase disables its features and blocks return.	All levels
Dialog Interaction	Dialogue with NPCs is possible by approaching and pressing the E key, but this feature is available only during the Discover level.	Discover (Level 1)
Quest User Interface (UI)	Activatable UI features support secondary mechanics: drag-and-drop quizzes in the Define phase and crafting in the Develop phase.	Define (Level 2) and Develop (Level 3)

Overall, the game rules in "Blackout" are integral to shaping a structured yet dynamic learning environment. They guide player behaviour, ensure fairness, and help maintain a focused narrative flow, making the game not only enjoyable but also a powerful tool for learning and applying Design Thinking principles under pressure.

3.4.4 Game World Building

This web-based game features a 3D environment where players interact within an immersive world. The game includes five main buildings that represent the core narrative and several NPCs enhancing interactivity. Studies

indicate no significant difference in player engagement between web-based and mobile games (Arif et al. 2022). However, web-based games reduce average network delay by 50% and improve the user's Quality of Experience by 20% in cloud gaming (Zhang et al. 2019). "Blackout" uses a Third-Person Perspective, enhancing player immersion. The WASD control scheme and mouse for camera control provide intuitive navigation in Designville, facilitating smooth gameplay and responsive actions (Tan et al. 2001). Additionally, "Blackout" has a robust backend architecture to monitor and record player activities, capturing gameplay data like login times, decisions, and play duration.

3.4.5 Game Characters

There are two types of characters developed: the player-controlled characters, which consist of three playable characters that players can choose, and six non-playable characters (NPCs) who act as stakeholders. Each game asset character represents diversity and inclusivity of gender, race, and background, reflecting a broad spectrum of the community. This inclusion not only enriches the gameplay by providing a variety of perspectives and solutions but also enhances the realism of the game, making it more relatable and engaging for a diverse player base (Chee et al. 2022). Additionally, interactions with key NPCs in "Black Out" simulate extensive chaos and require immediate, effective responses. These interactions between players and non-player characters in serious games are crucial for enhancing the gaming experience (Baffa et al. 2017; Crenshaw and Nardi 2015), deepen players' understanding of the crisis and fosters empathy (Ho and Ng 2022). This multifaceted interaction enriches the learning experience by effectively merging theoretical knowledge with practical, problem-solving activities, making it more dynamic and impactful.

4. Conclusion

This paper introduces the Learning and Game Integration (LGI) Framework, illustrated using the "Blackout" game as a case study. Implemented in March 2024 in a large, foundational first-year undergraduate business course at the College of Business and Law of an Australian university, "Blackout" has received positive preliminary feedback. Students and staff have highlighted its effective integration into the curriculum, noting increased student enthusiasm, deeper understanding of design thinking concepts, and heightened confidence in reflecting on lessons learned. Educators observed that teaching design thinking through the "Blackout" serious game notably enhanced students' engagement, curiosity, and peer interaction during class. This innovative approach to teaching design thinking through serious gaming has thus made a substantial contribution to business education. Moreover, the LGI Framework, which guided the development of the "Blackout" game, offers a significant advancement in the field of serious games and higher education. Unlike traditional frameworks that focus solely on learning design or game mechanics, the LGI Framework integrates these elements holistically through four interconnected stages. It also promotes continuous improvement by incorporating iterative feedback and assessment strategies, allowing for ongoing refinement of educational outcomes and game design. These features position the LGI Framework as a pioneering tool in the integration of serious games into higher education, enhancing innovative problem-solving skills and seamlessly connecting theoretical learning with practical application.

References

Adams SM (2023) 'Gamification: Game-based Learning/Serious Games and 21st Century Soft Skill Development in Nursing Education'.

Adisusilo AK, Hariadi M, Mulyanto E and Purwantana B (2018) 'Soil porosity modelling for immersive serious game based on vertical angle, depth, and speed of tillage', *International Journal of Advances in Intelligent Informatics*, 4(2).

Arif Z, Kiron N and Vassileva J 2022, *Comparing the Student Engagement with Two Versions of a Game-based Learning Tool*, Academic Conferences International Limited, Reading, 2022, 2049-0992.

Arnab S, Lim T, Carvalho MB, Bellotti F, de Freitas S, Louchart S, Suttie N, Berta R and De Gloria A (2015) 'Mapping learning and game mechanics for serious games analysis: Mapping learning and game mechanics', *British Journal of Educational Technology*, 46(2):391-411, doi:10.1111/bjet.12113. https://bera-journals.onlinelibrary.wiley.com/doi/10.1111/bjet.12113

Azadegan A, Riedel JCKH and Baalsrud Hauge J 2012, *Serious games adoption in corporate training*, Conference paper, https://www.scopus.com/inward/record.uri?eid=2-s2.0-84867592155&doi=10.1007%2f978-3-642-33687-4_6&partnerID=40&md5=2ac67d9127653e46f7aa1d603ed77f55.

Babu AR, Arulanand N and Chandran VS (2020) 'Skill development through experiential learning–A case study for product development scenario', *Procedia Computer Science*, 172:16-21.

Baffa A, Sampaio P, Feijó B and Lana M 2017, *Dealing with the emotions of non player characters*, IEEE, 1538648466.

Bell BS and Kozlowski SW (2008) 'Active learning: effects of core training design elements on self-regulatory processes, learning, and adaptability', *Journal of Applied psychology*, 93(2):296.
Biggs J (1996) 'Enhancing teaching through constructive alignment', *Higher Education*, 32(3):347-364, doi:10.1007/BF00138871. https://doi.org/10.1007/BF00138871
Brown T (2008) 'Design thinking', *Harvard business review*, 86(6):84.
Carvalho LBd and Neto JDdO (2023) 'Serious games may shape the future of accounting education by exploring hybrid skills', *Accounting Education*, 32(6):670-693, doi:10.1080/09639284.2022.2088241. https://doi.org/10.1080/09639284.2022.2088241
Carvalho MB, Bellotti F, Berta R, De Gloria A, Sedano CI, Hauge JB, Hu J and Rauterberg M (2015) 'An activity theory-based model for serious games analysis and conceptual design', *Computers & Education*, 87:166-181.
Chee FM, Hjorth L and Davies H (2022) 'An ethnographic co-design approach to promoting diversity in the games industry', *Feminist Media Studies*, 22(6):1512-1528.
Cheng SC, Hwang GJ and Chen CH (2019) 'From reflective observation to active learning: A mobile experiential learning approach for environmental science education', *British Journal of Educational Technology*, 50(5):2251-2270, doi:10.1111/bjet.12845.
Chiu MC, Hwang GJ and Hsia LH (2022) 'Promoting students' artwork appreciation: An experiential learning-based virtual reality approach', *British Journal of Educational Technology*, 54(2):603-621, doi:10.1111/bjet.13265.
Classe TMd, De Araujo RM, Xexéo GB and Siqueira S (2019) 'The Play Your Process Method for Business Process-Based Digital Game Design', *International Journal of Serious Games*, 6(1):27-48, doi:10.17083/ijsg.v6i1.269.
Cocks J (2020) 'The Rosetta Wheel: Towards a Shared Language and Framework for Game Design for Health Behaviour Change', doi:10.25907/00483, accessed 2022/12/05/09:52:40. https://research.usc.edu.au/esploro/outputs/doctoral/99462008702621
Crenshaw N and Nardi B 2015, *NPCs as Social Mediators in Massively Multiplayer Online Games*, 4, 2334-0924.
De Freitas S and Oliver M (2006) 'How can exploratory learning with games and simulations within the curriculum be most effectively evaluated?', *Computers & Education*, 46(3):249-264.
De Jans S, Hudders L, Herrewijn L, Van Geit K and Cauberghe V (2019) 'Serious games going beyond the Call of Duty: Impact of an advertising literacy mini-game platform on adolescents' motivational outcomes through user experiences and learning outcomes', *Cyberpsychology: Journal of Psychosocial Research on Cyberspace*, 13(2).
de Oliveira SN, Prado MLd, Kempfer SS, Martini JG, Caravaca-Morera JA and Bernardi MC (2015) 'Experiential learning in nursing consultation education via clinical simulation with actors: Action research', *Nurse Education Today*, 35(2):e50-e54, doi:10.1016/j.nedt.2014.12.016.
Djaouti D, Alvarez J, Jessel J-P, Methel G and Molinier P (2008) 'A Gameplay Definition through Videogame Classification', *International Journal of Computer Games Technology*, 2008:470350, doi:10.1155/2008/470350. https://doi.org/10.1155/2008/470350
Fabricatore C, Gyaurov D and Lopez X 2020, *Rethinking Serious Games Design in the Age of COVID-19: Setting the Focus on Wicked Problems*, Springer International Publishing, Cham, 0302-9743.
Fewster-Thuente L and Batteson TJ (2018) 'Kolb's experiential learning theory as a theoretical underpinning for interprofessional education', *Journal of allied health*, 47(1):3-8.
García-Sánchez S and Luján-García C (2017) 'Ubiquitous Knowledge and Experiences to Foster EFL Learning Affordances', *Computer assisted language learning*, 29(7):1169.
Grund CK and Schelkle M (2020) 'Developing Serious Games with Integrated Debriefing: Findings from a Business Intelligence Context', *Business & information systems engineering*, 62(2):87-101, doi:10.1007/s12599-019-00579-2.
Gunter GA, Kenny RF and Vick EH (2007) 'Taking educational games seriously: using the RETAIN model to design endogenous fantasy into standalone educational games', *Educational technology research and development*, 56(5-6):511-537, doi:10.1007/s11423-007-9073-2.
Han I (2016) '(Re)conceptualisation of ELT professionals: academic high school English teachers' professional identity in Korea', *Teachers and Teaching*, 22(5):586-609, doi:10.1080/13540602.2016.1158467. https://doi.org/10.1080/13540602.2016.1158467
Henry A (2013) 'Digital games and ELT: Bridging the authenticity gap', *International perspectives on motivation: Language learning and professional challenges*, Springer.
Ho JC and Ng R (2022) 'Perspective-taking of non-player characters in prosocial virtual reality games: Effects on closeness, empathy, and game immersion', *Behaviour & Information Technology*, 41(6):1185-1198.
Hong Y-C and Choi I (2019) 'Relationship between student designers' reflective thinking and their design performance in bioengineering project: Exploring reflection patterns between high and low performers', *Educational technology research and development*, 67:337-360.
Hughes S and Scholtz F (2015) 'Increasing the impact of a business simulation: The role of reflection', *The International Journal of Management Education*, 13(3):350-361, doi:https://doi.org/10.1016/j.ijme.2015.06.001. https://www.sciencedirect.com/science/article/pii/S1472811715000294
Jim Yardley and Harris G (31 July 2012) '2nd Day of Power Failures Cripples Wide Swath of India', *The New York Times*. https://www.nytimes.com/2012/08/01/world/asia/power-outages-hit-600-million-in-india.html
Klaassen ROB, Steehouder M, Van Der Geest T and Van Velsen LEX (2008) 'User-centered evaluation of adaptive and adaptable systems: a literature review', *The Knowledge Engineering Review*, 23(3):261-281,

doi:10.1017/S0269888908001379, Cambridge Core database. https://www.cambridge.org/core/product/C77A0D4AE8BAF5808E55214884245965

Kolb DA (2014) *Experiential learning: Experience as the source of learning and development*, FT press.

Kolb DA, Boyatzis RE and Mainemelis C (2014) 'Experiential learning theory: Previous research and new directions', *Perspectives on thinking, learning, and cognitive styles*, Routledge.

Kolb DA and Plovnick MS (1974) 'The experiential learning theory of career development'.

Lameras P, Arnab S, de Freitas S, Petridis P and Dunwell I (2021) 'Science teachers' experiences of inquiry-based learning through a serious game: a phenomenographic perspective', *Smart Learning Environments*, 8(1), doi:10.1186/s40561-021-00152-z.

Lewin D and Lundie D (2016) 'Philosophies of Digital Pedagogy', *Studies in Philosophy and Education*, 35(3):235-240, doi:10.1007/s11217-016-9514-7. https://doi.org/10.1007/s11217-016-9514-7

Liew CP, Puteh M, Lim LL, Yu LJ, Tan J, Chor WT and Tan KG (2021) 'Evaluation of Engineering Students' Learning Outcomes: Creating a Culture of Continuous Quality Improvement', *International Journal of Emerging Technologies in Learning (iJET)*, 16(15), doi:10.3991/ijet.v16i15.23763.

Morris TH (2019) 'Experiential learning – a systematic review and revision of Kolb's model', *Interactive Learning Environments*, 28(8):1064-1077, doi:10.1080/10494820.2019.1570279.

Natucci GC and Borges MA 2020, *Balancing game elements, learning, and emotions in game design*, Springer.

Naul E and Liu M (2019) 'Why Story Matters: A Review of Narrative in Serious Games', *Journal of Educational Computing Research*, 58(3):687-707, doi:10.1177/0735633119859904, accessed 2024/04/30. https://doi.org/10.1177/0735633119859904

Papoutsi C, Drigas A and Skianis C (2022) 'Serious Games for Emotional Intelligence's Skills Development for Inner Balance and Quality of Life-A Literature Review', *Retos*, 46:199-208, Scopus database. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85135222561&partnerID=40&md5=9815424e5bc94657eaf47a65e00ca101

Peel KL (2020) 'A beginner's guide to applied educational research using thematic analysis', *Practical Assessment, Research, and Evaluation*, 25(1):2.

Razzouk R and Shute V (2012) 'What Is Design Thinking and Why Is It Important?', *Review of educational research*, 82(3):330-348, doi:10.3102/0034654312457429.

Ritterfeld U, Cody M and Vorderer P (2009) *Serious games : mechanisms and effects. Routledge.*, Routledge, doi:https://doi.org/10.4324/9780203891650.

Romero M, Usart M and Ott M (2015) 'Can Serious Games Contribute to Developing and Sustaining 21st Century Skills?', *Games and culture*, 10(2):148-177, doi:10.1177/1555412014548919. https://journals.sagepub.com/doi/abs/10.1177/1555412014548919

Schoormann T, Stadtländer M and Knackstedt R (2023) 'Act and reflect: integrating reflection into design thinking', *Journal of Management Information Systems*, 40(1):7-37.

Seaman J, Brown M and Quay J (2017) 'The Evolution of Experiential Learning Theory: Tracing Lines of Research in the JEE', *The Journal of experiential education*, 40(4):NP1-NP21, doi:10.1177/1053825916689268.

Shachar M and Neumann Y (2003) 'Differences between traditional and distance education academic performances: A meta-analytic approach', *International Review of Research in Open and Distributed Learning*, 4(2):1-20.

Smetana LK and Bell RL (2012) 'Computer Simulations to Support Science Instruction and Learning: A critical review of the literature', *International Journal of Science Education*, 34(9):1337-1370, doi:10.1080/09500693.2011.605182.

Susi T, Johannesson M and Backlund P (2007) 'Serious games: An overview'.

Taleb MS, Belayutham S and Ibrahim CKIC 2019, *The Development of Scenarios for Serious Game: A Case for Fire Evacuation*, IEEE, 1728118263.

Tan DS, Robertson GG and Czerwinski M 2001, *Exploring 3D navigation: combining speed-coupled flying with orbiting*.

Xue Y, Chen G, Miao G and Liu C 2021) 'Research on the Design and Effect of Serious Game Technology Transfer in Experiential Education' *2021 IEEE International Conference on Educational Technology (ICET)*.

Yin RK, Clarke C, Cotner B and Lee R (2012) 'Case study methods', *Handbook of complementary methods in education research*, Routledge.

Zhang X, Chen H, Zhao Y, Ma Z, Xu Y, Huang H, Yin H and Wu DO (2019) 'Improving Cloud Gaming Experience through Mobile Edge Computing', *IEEE wireless communications*, 26(4):178-183, doi:10.1109/MWC.2019.1800440.