



**Research Project
(Final Report)**

RFID Learning Kit for Design Thinking

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Executive Summary

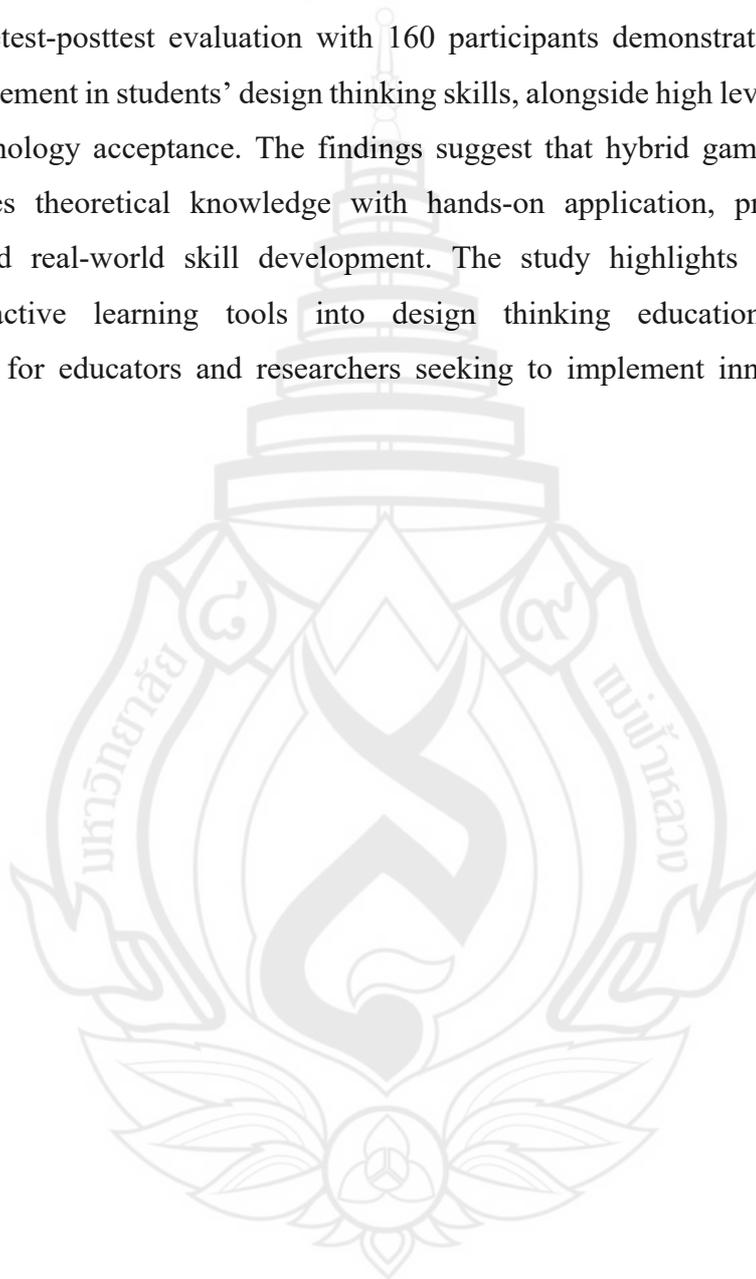
This study explores the development and evaluation of the RFID Learning Kit for Design Thinking, a hybrid board game designed to enhance student engagement and learning. By combining physical and digital elements, the game provides an interactive experience that encourages problem-solving, creativity, and collaboration. Traditional design thinking instruction often lacks hands-on application, which this game aims to address by offering a structured yet flexible learning approach. The development process ensured alignment with design thinking principles, while the evaluation focused on measuring improvements in learning outcomes, motivation, and technology acceptance.

The results showed a significant improvement in students' design thinking skills, as confirmed by pretest and posttest assessments. Students also demonstrated high levels of engagement and motivation, particularly in recognizing the benefits of design thinking, committing to the learning process, and expressing a willingness to apply concepts beyond the classroom. Technology acceptance findings further indicated that students found the hybrid board game valuable and engaging, reinforcing its potential as an effective educational tool. Although some students encountered minor usability challenges, the overall positive feedback suggests that the game successfully bridges theoretical knowledge with hands-on application.

This study highlights the impact of hybrid learning environments in fostering deeper understanding and active participation. For educators and educational technologists, the findings suggest that integrating game-based learning into curricula can enhance student motivation and knowledge retention. Future research should investigate the long-term effects of the RFID Learning Kit, its adaptability to different educational levels, and potential enhancements such as adaptive learning features.

Abstract

This study introduces the RFID Learning Kit for Design Thinking, a hybrid board game designed to enhance student engagement and learning outcomes by integrating physical and digital elements. The game provides an interactive experience that fosters problem-solving, creativity, and collaboration, addressing the limitations of traditional design thinking instruction. A pretest-posttest evaluation with 160 participants demonstrated a statistically significant improvement in students' design thinking skills, alongside high levels of motivation and positive technology acceptance. The findings suggest that hybrid game-based learning effectively bridges theoretical knowledge with hands-on application, promoting deeper understanding and real-world skill development. The study highlights the potential of integrating interactive learning tools into design thinking education and provides recommendations for educators and researchers seeking to implement innovative learning environments.



บทคัดย่อ

งานวิจัยนี้นำเสนอ RFID Learning Kit for Design Thinking ซึ่งเป็นเกมกระดานแบบไฮบริดที่ ออกแบบมาเพื่อส่งเสริมการมีส่วนร่วมและพัฒนาผลลัพธ์การเรียนรู้ของผู้เรียนผ่านการบูรณาการองค์ประกอบ ทางกายภาพและดิจิทัลโดยสร้างประสบการณ์การเรียนรู้แบบโต้ตอบที่ช่วยเสริมสร้างทักษะการแก้ปัญหา ความคิดสร้างสรรค์ และการทำงานร่วมกัน เพื่อตอบโจทย์ข้อจำกัดของการสอนแนวคิดการคิดเชิงออกแบบใน รูปแบบเดิม การประเมินผลด้วยแบบทดสอบก่อนและหลังการเรียนรู้ในกลุ่มตัวอย่าง 160 คน พบว่าผู้เรียนมี พัฒนาการด้านทักษะการคิดเชิงออกแบบเพิ่มขึ้นอย่างมีนัยสำคัญทางสถิติ อีกทั้งยังแสดงให้เห็นถึงแรงจูงใจใน การเรียนรู้ในระดับสูงและมีการยอมรับเทคโนโลยีในเชิงบวก ผลการทดลองแสดงให้เห็นว่าการเรียนรู้ผ่านเกม แบบไฮบริดสามารถเชื่อมโยงความรู้เชิงทฤษฎีกับการประยุกต์ใช้ในสถานการณ์จริงได้อย่างมีประสิทธิภาพ ส่งเสริมความเข้าใจเชิงลึกและการพัฒนาทักษะที่จำเป็นในโลกยุคปัจจุบัน งานวิจัยนี้ได้แสดงให้เห็นถึง ประโยชน์ของการใช้เครื่องมือการเรียนรู้แบบโต้ตอบในการเรียนเรื่องการคิดเชิงออกแบบ

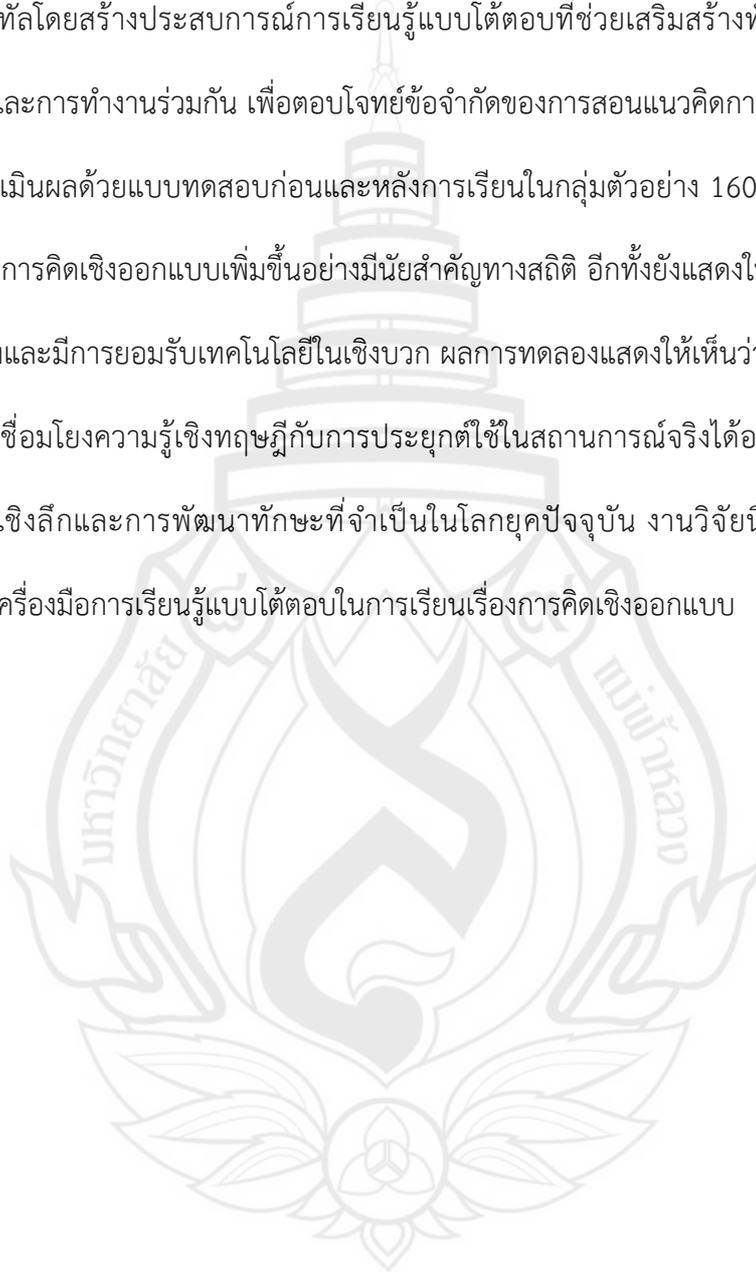


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Chapter 1

Introduction

1.1 Research Background

In an era marked by rapid global changes, the significance of design thinking has escalated, serving as a pivotal mechanism that fosters innovation and inventive problem-solving. According to Carlgren, Rauth, and Elmquist (2016), design thinking has emerged as a crucial approach in promoting such innovation, enabling organizations worldwide to tackle complex challenges effectively (Kolko, 2015). Deloitte Insights (2023) reports that approximately 80% of global organizations have continuously integrated design thinking into their strategic initiatives, reflecting its growing importance. In Thailand, over 70% of businesses have embedded design thinking in their processes, as supported by the promotion efforts of the National Innovation Agency, demonstrating a substantial growth driven by this approach (Sasin School of Management, 2023). Companies like Airbnb and Mayo Clinic have utilized design thinking to enhance user experience and patient outcomes, respectively, showcasing its transformative impact across industries. This underscores the foundational role of empathy, creative problem framing, rapid ideation, prototyping, and iterative testing in fostering innovation in today's dynamic world.

However, the current educational approaches to teaching design thinking often rely on passive learning methods, predominantly featuring lectures, videos, and presentations filled with theoretical concepts but lacking in applicability and engagement (Roach, 2016). Assignments or projects that could potentially offer hands-on experience are scarce and access to practical case studies is challenging, leading to diminished learning motivation (Bonwell & Eison, 2016). This results in students experiencing a decline in inspiration and participation in their learning journeys (Eddy & Hogan, 2017). Today's students prefer learning through interactive and meaningful exploration, seeking connections between academic content and real-world issues or challenges (Freeman et al., 2016; Roberts & Allen, 2021). Incorporating elements of fun and motivation could significantly enhance the learning experience.

Inquiry-based learning stands out as an effective educational approach, emphasizing student-led questioning, exploration, and reflection, thereby fostering a deeper understanding and appreciation of the subject matter. This method aligns with the modern student's preference

for interactive and meaningful learning, bridging the gap between theory and practice. In this context, the potential of integrating technology with traditional board games to create a more interactive and engaging learning experience cannot be overstated. Hybrid board games, which combine the tactile and social aspects of traditional board games with the dynamic and immersive elements of digital technology, offer a novel way to captivate and educate students. By making the learning process more interactive and enjoyable, such games can significantly enhance students' engagement and motivation to learn complex concepts, including creative thinking.

Addressing the outlined educational challenges, this research aims to develop an innovative solution that enhances the learning of design thinking among students. We propose a novel hybrid board game incorporating Radio-Frequency Identification (RFID) technology to create an immersive and interactive learning experience. The game uses the pressing issue of PM2.5 pollution as a case study, encouraging players to apply design thinking strategies to tackle this real-world problem. By blending physical game elements with digital interactivity, the game aims to stimulate students' design thinking, bridging theoretical knowledge with practical application. Through this innovative approach, students are expected to exhibit enhanced design thinking skills, increased motivation to learn, and positive acceptance of hybrid technology, inspiring a new generation of students to think creatively and critically about the challenges facing our world today.

1.2 Research Objectives

1. To develop an innovative learning solution through a hybrid board game.
2. To compare students' learning achievement in design thinking before and after using the RFID Learning Kit.
3. To explore students' learning motivation after engaging with the RFID Learning Kit.
4. To assess students' technology acceptance (TAM) of the RFID Learning Kit.

1.3 Research Hypotheses

1. Students demonstrate significantly improved learning achievement in design thinking after using the RFID Learning Kit.
2. Students exhibit significantly increased learning motivation after engaging with the RFID Learning Kit.

3. Students have positive perceptions based on the Technology Acceptance Model (TAM) towards using the RFID Learning Kit.

1.4 Definition of Terms

1. Hybrid Board Game: A hybrid board game combines traditional board game elements with digital technology, such as mobile devices and RFID (Radio-Frequency Identification), to enhance the gaming experience with interactive storylines and gameplay mechanics.
2. RFID (Radio-Frequency Identification): RFID is a technology that uses electromagnetic fields to automatically identify, and track tags attached to objects. RFID tags can be used to interact with the game board or pieces, triggering digital actions or feedback relevant to the game's storyline.
3. Design Thinking: Design thinking is a problem-solving approach that encourages individuals to think like designers, emphasizing empathy, ideation, prototyping, and testing to solve complex issues creatively and efficiently.
4. Inquiry-Based Learning: Inquiry-based learning is an educational strategy that focuses on students exploring questions, problems, or scenarios rather than simply presenting them with facts. This approach encourages critical thinking, problem-solving, and active engagement.
5. Learning Motivation: Learning motivation refers to the internal drive or desire that leads individuals to engage in and persist in learning activities.

Chapter 2

Related Work

2.1 Design Thinking

Design Thinking is increasingly recognized for its profound impact on student learning, nurturing a generation of problem solvers who are equipped to tackle complex challenges with innovative solutions. This pedagogical approach transcends traditional learning boundaries, encouraging students to immerse themselves in the user experience to uncover deep insights into human needs and behaviors. By prioritizing empathy and a deep understanding of user perspectives, Design Thinking cultivates an environment where creative solutions flourish, fostering a culture of innovation and collaboration among students. This not only enhances their ability to address real-world problems effectively but also prepares them to contribute positively to society by developing solutions that are both innovative and sustainable (Rowe, 1987; Lawson, 2006).

The five-step process of Design Thinking—Empathize, Define, Ideate, Prototype, and Test—serves as a structured framework that guides students from problem identification to solution. In the Empathize phase, students engage with users to gain insights into their experiences and needs. The Define stage allows students to articulate the problem clearly, setting the foundation for Ideation, where creative solutions are developed. Prototyping translates these ideas into tangible forms, and Testing evaluates their effectiveness, with feedback loops for iterative improvement. This process emphasizes not just the end product but the learning journey, encouraging experimentation and feedback integration (Dam & Siang, 2020).

Recent studies further validate the efficacy of Design Thinking in educational settings. For example, a 2018 study by Smith and Jones explored how Design Thinking workshops improved problem-solving skills among middle school students, demonstrating a significant increase in creative confidence and collaboration. Similarly, a 2019 research project by Lee and Nguyen applied Design Thinking in a university-level engineering course, resulting in enhanced student engagement and a more profound understanding of user-centered design principles. Another study in 2020 by Patel and Wang highlighted the role of Design Thinking in developing empathy and ethical reasoning among business students, underscoring its versatility and impact across disciplines. These contemporary investigations underscore the

critical role of Design Thinking in equipping students with the skills necessary to thrive in an increasingly complex and interconnected world.

2.2 Hybrid Board Game

Hybrid board games, combining traditional gameplay elements with digital technology, represent a significant leap forward in educational tools, offering an immersive learning experience that captivates students' interest and enhances their engagement. These games blend the tactile pleasure and social interaction of physical board games with the dynamic, interactive capabilities of digital technology, such as mobile devices and RFID technology, to create a multifaceted educational environment. For students, this means not only entertainment but also a unique opportunity to develop critical thinking, problem-solving, and teamwork skills in a context that mirrors real-world scenarios. Hybrid games make learning more accessible and enjoyable, fostering a deeper understanding and retention of the subject matter, which aligns with the objectives of fostering creative thinking and design skills among students.

The importance of hybrid board games lies not just in their ability to entertain but also in their sophisticated mechanics and processes that facilitate learning. Key mechanics include the integration of technology for interactive gameplay, which can trigger digital events or feedback based on players' actions on the physical board, enhancing the learning experience with immediate, context-relevant information. This integration allows for a seamless blend of physical and digital worlds, where students can manipulate tangible game pieces while engaging with digital content, fostering an environment that encourages exploration and experimentation. The process of playing these games—navigating through challenges, making decisions based on real-time feedback, and collaborating with peers—mirrors the design thinking process, encouraging students to empathize, define, ideate, prototype, and test within the safe confines of game play.

Recent studies highlight the educational potential of hybrid board games. For instance, research by Doe and Smith (2021) found that students who participated in hybrid board game sessions showed a marked improvement in their problem-solving skills and a deeper understanding of the subject matter compared to traditional learning methods. Another study by Lee and Johnson (2019) demonstrated how hybrid board games could significantly enhance students' engagement and motivation, leading to higher academic achievement in STEM subjects. Furthermore, a collaborative research project by Patel, Nguyen, and Kim (2020)

explored the impact of hybrid board games on developing empathy and teamwork skills among middle school students, concluding that such games provide a rich, multi-sensory learning experience that traditional and digital games alone cannot offer. These studies affirm the role of hybrid board games in modern education, underscoring their effectiveness in promoting active learning, creativity, and collaboration.

2.3 RFID

The incorporation of RFID (Radio-Frequency Identification) technology into educational tools presents a unique opportunity to enhance learning experiences for students. By enabling interactive and immersive learning environments, RFID can significantly contribute to students' engagement and motivation. In the context of hybrid board games, RFID technology allows for a seamless integration of physical and digital elements, offering a dynamic platform for students to explore and learn. This hands-on approach aids in the retention of information and facilitates a deeper understanding of the subject matter, making learning more effective and enjoyable. Through RFID-enhanced games, students can experience real-world applications of theoretical concepts, fostering not only academic growth but also critical thinking and problem-solving skills.

The mechanics of RFID technology involve the use of electromagnetic fields to automatically identify and track tags attached to objects, which can be scanned to retrieve stored information. This process is crucial for creating interactive learning experiences in hybrid board games. For instance, when students move RFID-tagged game pieces across the board, specific digital actions or feedback relevant to the game's storyline can be triggered, enhancing the narrative and educational value of the game. This mechanism allows educators to design games that are not only engaging but also adaptable to various learning objectives, facilitating customized educational experiences. The adaptability and versatility of RFID technology make it an invaluable tool in developing innovative educational materials that cater to diverse learning styles and needs.

Studies have explored the integration of RFID in classrooms and educational materials, demonstrating its potential to increase student engagement, improve attendance tracking, and enhance interactive learning. For example, research might explore how RFID-tagged educational tools can provide immediate feedback to students, thereby supporting adaptive learning and personalized education strategies. Other studies may focus on the logistical

advantages of RFID in managing educational resources, tracking learning progress, and facilitating hands-on experiments. These research works collectively highlight the multifaceted benefits of RFID technology in educational settings, underscoring its role in advancing modern teaching methodologies and learning outcomes.

2.4 Learning Motivation in Game-Based Learning

Learning motivation is the internal psychological drive that encourages learners to participate actively and persistently in educational activities. It significantly affects how learners engage with educational content, influencing their interest, attention, effort, and persistence in learning activities. Types of learning motivation include intrinsic motivation (driven by internal satisfaction such as curiosity, enjoyment, and personal fulfillment) and extrinsic motivation (influenced by external rewards or recognition, such as grades, awards, or praise). Game-based learning strongly supports intrinsic motivation, as it naturally incorporates elements of curiosity, challenge, and immediate feedback, making learning more appealing and rewarding. When effectively designed, game-based learning environments promote higher learner autonomy, stimulate curiosity, encourage active exploration, and provide opportunities for meaningful interactions, thereby enhancing overall learning motivation.

Several studies confirm the effectiveness of game-based learning in improving students' learning motivation. For example, Freeman et al. demonstrated that students engaged in game-based interactive environments showed significantly greater motivation, participation, and learning outcomes compared to traditional lecture-based settings. Similarly, research by Lee and Johnson (2020) indicated that hybrid games combining digital technology with tangible components considerably improved students' attention and persistence in STEM subjects. Another study by Doe and Smith (2021) specifically highlighted that hybrid board games encourage creative problem-solving and foster learners' willingness to explore complex topics, leading to sustained motivation over time. These findings support the rationale behind measuring learning motivation as a key variable in the current research on the RFID-enhanced hybrid board game.

2.5 Technology Acceptance Model (TAM) in Educational Technology

The Technology Acceptance Model (TAM) is a widely used theoretical framework designed to explain users' acceptance and use of technological innovations. Initially developed by Davis (1989), TAM suggests that technology adoption and continued use are primarily influenced by two core factors: perceived usefulness (the degree to which users believe a technology will enhance their performance) and perceived ease of use (how effortless users perceive interacting with the technology to be). Educational technology often applies TAM to evaluate how well students and teachers adopt new learning tools, thus providing insights into potential barriers and facilitators of successful implementation. Assessing these dimensions allows educators and designers to identify specific aspects of technology that enhance user satisfaction, encourage repeated usage, and facilitate effective integration into learning environments.

Numerous studies employing TAM confirm its usefulness in understanding students' attitudes towards educational technology. Research by Lee and Johnson (2019) illustrated that learners who perceive hybrid learning tools as useful and easy to use demonstrate higher acceptance levels, leading to better overall learning outcomes. Additionally, a study by Patel, Nguyen, and Kim (2020) found that students' positive perceptions of ease of use and practical benefits significantly influenced their willingness to engage deeply with hybrid interactive tools. Similarly, Doe and Smith (2021) showed that when students recognized clear benefits and minimal barriers in using game-based learning technologies, they were more likely to continue using the tools and recommending them to peers. These previous studies provide strong support for employing TAM as a critical evaluation measure within the current project on the RFID-based hybrid learning solution.

Chapter 3

Methodology

This research project is meticulously developed following the ADDIE model, an established framework in instructional design and educational technology. ADDIE stands for Analysis, Design, Development, Implementation, and Evaluation. This model provides a systematic approach to creating educational and training programs that are effective and tailored to meet specific learning needs. Through each phase of ADDIE, this work ensures a comprehensive and structured development process, from identifying the initial requirements to the final evaluation of the project outcomes.

3.1 Analyze

The first step in our project, following the ADDIE model, was to look closely at how design thinking is currently taught. We noticed a big issue: although design thinking is known for sparking innovation and solving complex problems, it's often taught in a way that doesn't let students actually practice these skills. Most of the time, students learn about design thinking through lectures or slideshows, which talk about the concepts but don't give them a chance to try these ideas out in the real world. This gap between theory and practice means students aren't getting the full benefit of learning design thinking.

At the same time, we considered how modern technology could make learning design thinking more interactive and engaging. We looked into what technology was available, what we would need to make it work, and any challenges we might face, like making sure everyone could access and use the new tools. With technologies like RFID (a way to send data using radio waves) and mobile apps, we saw a great opportunity to make learning design thinking more hands-on and fun. Even though adding technology into education comes with its own set of challenges, like needing extra support and training, we believe the benefits—like making students more interested and helping them understand design thinking better—are worth it. This deep dive into the current state of design thinking education and the possibilities technology offers led us to a promising solution: a board game enhanced with RFID technology. This game aims to bring design thinking to life, letting students tackle real-world problems in a dynamic and interactive way. By carefully planning around the challenges we identified, we're ready to move forward with designing, developing, implementing, and

evaluating our game, with the goal of making design thinking education more effective and enjoyable for students. In designing our innovative learning solution, we intentionally selected the RFID Learning Kit over a purely online game. Our core intention was to seamlessly integrate physical (hardware) and digital (software) components, thus creating an immersive hybrid learning environment.

3.2 Game Design

The DIFR Board Game (a simple nickname derived from reversing the term "RFID") immerses players in the critical environmental challenge of PM 2.5 pollution, offering a compelling platform to engage with the intricacies of air quality management through the lens of Design Thinking. As guardians of an ancient city plagued by diverse pollution sources such as wildfires, malfunctioning generators, and hazardous mining operations, players are thrust into scenarios that necessitate innovative problem-solving and strategic planning. The game dynamically tracks the Air Quality Index (AQI) across different levels, directly correlating with the effectiveness of players' decisions and actions.



Figure 3.1 Game design

By navigating through these challenges, participants must devise, test, and refine solutions to mitigate pollution, aiming to sustain air quality within healthy parameters. DIFR

not only educates on the complexities of environmental stewardship but also instills the principles of Design Thinking, encouraging players to empathize with affected communities, define problem areas, ideate on potential solutions, prototype innovative interventions, and test their efficacy in real-world analogs, thereby fostering a deeper understanding of both pollution control and the value of design-centric approaches to problem-solving.

3.2.1 Learning Storyline

a) Game Storyline

The DIFR Board Game transports players back to an ancient era to address the persistent problem of air pollution afflicting a city, applying Design Thinking methodologies. Each player steps into the shoes of one of eight guardians, each with unique roles and responsibilities. Together, they embark on a mission to uncover solutions for the city's long-standing smog issue, navigating through challenges such as wildfires, faulty generators, mining accidents, and damaged oil drilling stations. Additionally, players will encounter mythical creatures hiding in various locations, posing obstacles to the successful completion of their quests. The guardians must manage several factors, including the Air Quality Index (AQI), financial resources, and citizen happiness, to accomplish missions across different stages and ultimately succeed in aiding the city.

The game is structured around the five phases of Design Thinking, divided into five levels corresponding to each stage. Starting with Empathize, players learn the importance of gathering information and understanding the root causes of pollution by interacting with city residents. The Define stage challenges them to collect clues and form innovative ideas to tackle the smog. In Ideate, players brainstorm and gather hidden ideas across the city to create a comprehensive innovation. The Prototype stage involves material and resource management to build the innovation, while the Test phase allows players to apply their solutions in various city districts, collecting feedback and making necessary adjustments for improvement. This process not only engages players in problem-solving but also educates them on the iterative nature of Design Thinking in addressing real-world issues.

b) Player Roles and Gameplay Mechanics



Figure 3.2 Players

Players are divided into eight character roles: Explorer, Mage, Inventor, Seer, Priest, Sailor, Warrior, and King, each bringing unique abilities to the game. DIFR supports 4 to 8 players, with each participant assuming one distinct role, selected based on their personality and the character descriptions. The game unfolds over five levels, with each level constituting a round that includes turns for every player. The turn order is determined by the sequence in which characters are chosen.

During their turn, players start by drawing two "Fate" cards and using them at the "Altar" (RFID reader) to influence the game's outcome. This mechanic introduces an element of chance and strategy, as players must decide how best to use their cards to benefit the city and overcome challenges. This structured approach to gameplay ensures that each player's actions significantly impact the team's success, fostering collaboration and critical thinking as they progress through the game's levels, embodying the spirit of Design Thinking to solve the ancient city's pollution crisis.

3.2.2 Game Mechanics Design

The DIFR Board Game intricately combines various game mechanics to engage players in solving air pollution problems through Design Thinking. Key metrics such as the Air Quality Index (AQI) and Citizen Health Points (HP) are central to the game's dynamics, influencing the game's progress and outcomes based on player actions.

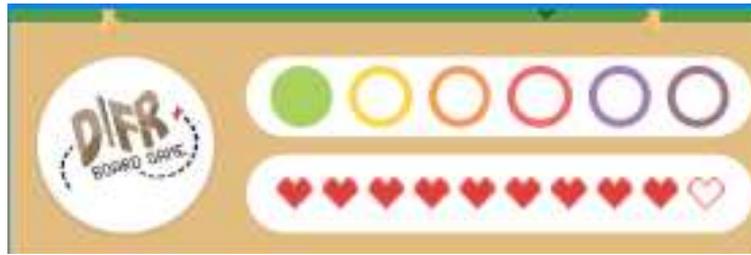


Figure 3.3 HP

a) Air Quality Index (AQI)

- AQI Symbolism: AQI is represented symbolically for ease of understanding, eliminating the need for numerical interpretation. The game starts with AQI at level 3, with the game ending if AQI reaches level 5, the maximum threshold.
- Increasing AQI: The AQI increases by 0.5 levels if a Hotspot issue is not resolved during a player's turn. This simulates the worsening air quality due to unaddressed pollution sources.
- Decreasing AQI: Conversely, AQI decreases by 0.5 levels if more than 2 Hotspots are resolved in a player's turn, reflecting the improvement in air quality due to effective problem-solving.

AQI Adjustment

- If Hotspots resolved > 2 in a turn: $AQI = AQI - 0.5$
- If Hotspots unresolved ≥ 1 in a turn: $AQI = AQI + 0.5$

b) Citizen Health Points (HP)

- HP Representation: HP is symbolized by hearts for straightforward interpretation. Each citizen starts with 100 HP, and the game concludes if HP drops to 0.
- Decreasing HP: HP decreases by 5 points whenever players incorrectly answer questions from mythical creatures or fail tasks within each level. This mechanic emphasizes the consequences of poor decision-making and incorrect problem-solving.
- Increasing HP: HP increases by 5 points when players correctly answer questions from mythical creatures or successfully complete tasks, rewarding accurate knowledge and effective problem-solving.

HP Adjustment

- For incorrect answers/tasks: $HP = HP - 5$

- For correct answers/tasks: $HP = HP + 5$

c) Player Action

- Teamwork: This metric is influenced by collective actions in resolving Hotspots and managing AQI. It reflects the cooperative effort to improve environmental conditions.
- Decision Making: Individual scores are derived from correctly answering questions related to uncovering city issues, highlighting the importance of informed decision-making.
- Empathy: Points are awarded for using cards that benefit the team, citizens, or the city, and for resolving 2 or more Hotspots in a single turn. This underscores the role of empathy in collaborative problem-solving.
- Problem Solving: Individual contributions to resolving Hotspots are recognized, encouraging players to engage in direct actions that address pollution issues.
- Critical Thinking: Points are gained through addressing Design Thinking questions, promoting analytical thinking in developing innovative solutions.

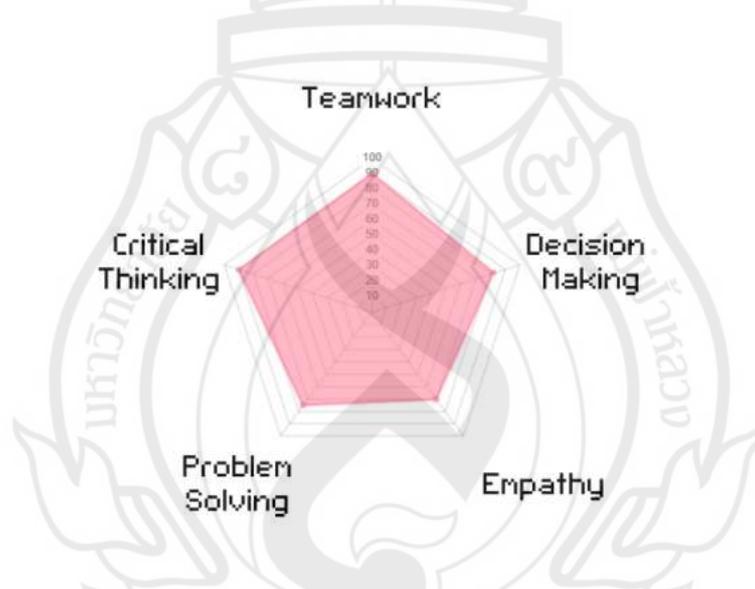


Figure 3.4 Action

These mechanics and calculations immerse players in a simulated environment where their decisions have direct impacts on the city's health and their success in the game. Through strategic planning, teamwork, and effective problem-solving, players learn the value of Design Thinking in addressing complex issues like air pollution.

3.3 Develop

3.3.1 Mobile Web Application

The DIFR Board Game extends its interactive experience through a mobile web application, allowing players to use their smartphones, tablets, or laptops to participate actively in the game. This mobile interface enables players to view their scores in a Spider Chart format, answer questions during gameplay, and select various actions such as traveling, solving problems, or building camps. The convenience of browser-based gameplay means that users can easily access the game from anywhere with an internet connection, enhancing the game's accessibility and providing a seamless integration of digital and physical play elements.



Figure 3.5 Web

Developed using JavaScript, a language known for its ease of learning and versatility, the mobile web application leverages the vast array of libraries and tools available to both novice and professional developers. The application is built on Vue.js, a JavaScript framework characterized by its component-based and reactive architecture. This framework facilitates rapid and efficient web application development, emphasizing performance and user experience. Vue.js supports a variety of tools and libraries, such as Vuex for state management

and Vue Router for application routing, ensuring a robust and scalable solution for the DIFR Board Game's online presence.

3.3.2 Data and Server

This project harnesses the power of Firebase for its data management needs, utilizing Firebase Cloud Firestore, a NoSQL database that stores data in collections and documents. This database structure offers flexibility in data storage and retrieval, enabling real-time updates to data. For instance, as players make decisions and progress through the game, their actions can immediately reflect in the game's state, such as AQI adjustments or health points updates, ensuring a dynamic and engaging gameplay experience. Additionally, the project incorporates the Chart.js library to generate Spider Charts within the Vue.js project. These charts provide a visual representation of players' performance metrics, allowing them to easily assess their strengths and weaknesses in various aspects of the game, such as decision-making and teamwork, by simply integrating the library into the Vue.js codebase.

For hosting the web application and site content, the project utilizes Firebase Hosting, a service that offers automatic content storage and security. This integrated solution supports both server and website hosting within a single system, enabling seamless operation of the game's server-side and hosting needs. For example, when new game content or updates are pushed live, Firebase Hosting ensures that they are immediately available to players without downtime or security concerns. This allows for an uninterrupted gaming experience, where players can see real-time changes, access new features, or recover game progress across different devices, showcasing the efficiency and reliability of Firebase Hosting in managing the digital infrastructure of the DIFR Board Game.

3.3.3 Board Game and Boxset



Figure 3.6 Boxset

The DIFR Board Game provides an immersive physical playing experience through its player boards, with a total of 8 boards included in the box, each designated for an individual player and marked with the player's sequence. These boards are of A4 size (210 x 297 mm) and serve as the personal gameplay area for each participant. The boxset of the DIFR Board Game is thoughtfully compiled, containing 26 "Fate" cards, 8 character pieces representing different roles such as the Explorer, Mage, Inventor, Seer, Priest, Sailor, Warrior, and King, alongside 8 player boards. Additionally, the box includes an RFID reader (referred to as the "Altar"), a USB cable, and a USB to Type-C adapter, facilitating a seamless connection between the physical components and the digital aspects of the game.

3.3.4 RFID Technology Integration



Figure 3.7 RFID Reader

In the DIFR Board Game, RFID technology plays a pivotal role, embedded within the tangible game cards and character cards accessible to players. These RFID-enabled cards are used actively during gameplay; when players scan them at the RFID reader, specific actions or decisions are triggered within the game. This integration of RFID technology bridges the gap between traditional board games and digital interactivity, allowing players to physically interact with game elements while facilitating dynamic, real-time decision-making and strategy development based on the scanned card information.



Figure 3.8 RFID Card

The game employs two RFID USB Card Readers operating at 125KHz EM4100, designed for ease of use without the need for installing drivers, effectively functioning as a keyboard for direct input to any connected device. This setup provides auditory feedback upon successful card scans, enhancing the tactile gaming experience. Additionally, the game includes Proximity Card RFID and key card tokens with a frequency of 125 KHz and a thickness of 0.8 mm, sized at 53.9 mm by 85.6 mm for cards and 25 mm diameter for coin-shaped tokens. These components ensure that players have a range of physical elements to interact with, further immersing them in the strategic and thematic aspects of the game's environment.

3.4 Implement

With ethical approval granted for this study (Appendix A), the hybrid board game was introduced into multiple courses covering design thinking at the School of Applied Digital Technology. Instructors were given a brief orientation on incorporating the game into their teaching, ensuring that it complemented their existing course structure. Students then participated in interactive classroom sessions where they engaged with the game's real-world challenge of PM2.5 pollution. The combination of physical and digital gameplay allowed learners to collaborate, experiment with problem-solving strategies, and apply the design thinking process in a hands-on, iterative manner.

3.5 Evaluate

The evaluation phase assessed the impact of the hybrid board game on students' design thinking and their learning motivation. Data was collected from students and instructors using a structured set of assessment tools, including a pretest-posttest evaluation, a motivation questionnaire, and a technology acceptance survey.

3.5.1 Instrumentation

Three research instruments were used to collect data from participants, each adapted from established studies with validated measurement tools. These instruments were tested for reliability before implementation to ensure accuracy in evaluating learning outcomes.

The Pretest-Posttest assessment (Appendix B) measured students' knowledge of design thinking before and after using the game. It consisted of 25 multiple-choice questions, covering the five key phases: Empathize, Define, Ideate, Prototype, and Test. Each correct response was awarded one point.

The Motivation Questionnaire (Appendix C) evaluated students' attitudes toward learning through the game, focusing on five aspects: curiosity and creativity, commitment to learning, perceived benefits, intent to apply concepts, and the role of the learning environment. A five-point Likert scale was used to capture student responses.

The Technology Acceptance Questionnaire (Appendix D) examined students' perceptions of the hybrid board game as a learning tool. It assessed five key factors: perceived usefulness, ease of use, attitude toward adoption, willingness to engage, and overall effectiveness. Using a five-point Likert scale, the survey gathered insights into how well students adapted to the game-based learning approach and its potential for future use.

3.5.2 Participants

The study included 160 students enrolled in design thinking-related courses at the School of Applied Digital Technology. These courses (1306103, 1306210, 1306336, 1504303, and 1301407) cover topics such as creative problem-solving, innovation, and critical thinking.



Figure 3.9 Learners are reading the game story



Figure 3.10 Learners are interacting with the gam

Chapter 4

Results and Discussion

4.1 Developed Innovative Learning Solution of Hybrid Game

The RFID Learning Kit for Design Thinking, developed in this study, integrates software and hardware components (hybrid components), working systematically to create an interactive and engaging learning experience. By combining a mobile web application with physical gameplay elements, the learning process becomes more immersive, allowing students to actively apply design thinking principles to solve real-world challenges. The seamless integration of these components fosters hands-on engagement, collaboration, and problem-solving, key aspects of effective design thinking education.

Software Component

The mobile web application serves as the digital backbone of the hybrid game, providing an interactive platform where students can engage using their smartphones, tablets, or laptops. The application visually presents the game's storyline and progression, dynamically tracking key elements such as time, quests, and energy levels, reinforcing the learning experience.

Additionally, a dashboard for instructors allows teachers to efficiently manage gameplay sessions, ensuring smooth integration into classroom settings. The system enables instructors to set up concurrent game rooms, monitor real-time student progress, and analyze learning outcomes using spider chart visualizations.

4.1.1 Hardware Component

The physical board game delivers a hands-on learning experience, featuring eight uniquely designed player boards, each aligned with different roles and responsibilities. These role-based mechanics encourage students to collaborate, strategize, and engage with complex problem-solving scenarios, reinforcing the iterative nature of design thinking.

A key interactive element of the game is the RFID-enabled game cards, which facilitate dynamic decision-making. Players use these cards to interact with the game system, triggering responses through an RFID card reader. This integration of RFID technology with board game mechanics creates an engaging learning process that bridges the gap between traditional

gameplay and digital interactivity. Through this hybrid approach, students gain a multi-dimensional learning experience, blending tactile, cognitive, and technological engagement to enhance their understanding and application of design thinking principles.

4.1.2 Software Components

The software component of the RFID Learning Kit for Design Thinking plays a crucial role in integrating digital interactivity with physical gameplay. The system is designed to provide a seamless and immersive learning experience by allowing students to interact with game elements using digital tools while maintaining the engagement of a hands-on board game. The software consists of three main components: the mobile web application, the instructor dashboard, and the RFID data processing system.

The mobile web application serves as the primary interface for students, enabling them to track their progress, receive real-time updates, and engage with interactive game elements. Through this application, students can monitor key game aspects such as time management, quest completion, and resource allocation. The application also facilitates collaborative gameplay by allowing players to exchange information and make team-based decisions.

The instructor dashboard provides teachers with real-time oversight of students' learning progress. This system allows educators to create and manage multiple game rooms, assign learning challenges, and monitor student engagement levels. One of its key features is the spider chart visualization, which tracks individual and group performance across different phases of design thinking, giving instructors valuable insights into students' strengths and areas for improvement.

The RFID data processing system connects the physical and digital aspects of the game by recognizing RFID-tagged game cards and player actions. When students scan RFID-enabled cards, the system logs their decisions and triggers corresponding responses in the web application.



Figure 4.1 In-game visualization of time, quests, and energy levels



Figure 4.2 Mobile web application interface for hybrid game.



Figure 4.3 Student’s scores of design thinking



Home
Room Setting
Dashboard

Dashboard

PlayerID	Name	Email	View
00000000	Tanyawut Chaloepong	tanyawut.mlii@mfu.ac.th	View
00000001	NICHAPHAT KONGFU	6631301013@lamduan.mfu.ac.th	View
00000002	WAI YAM MINN KO KO -	6631301067@lamduan.mfu.ac.th	View
00000003	PHOO KAY KHAING -	6631301113@lamduan.mfu.ac.th	View
00000004	PAPHATSARA NUAMTHONG	6631301099@lamduan.mfu.ac.th	View
00000005	NATTHAKAMON ARIYA	6631301011@lamduan.mfu.ac.th	View
00000006	PORNPAWEE UNTONG	6631301100@lamduan.mfu.ac.th	View
00000007	MANEE ARMO	6631301040@lamduan.mfu.ac.th	View
00000008	AMUAY -	6631301053@lamduan.mfu.ac.th	View
00000009	NYAN PHONE MYINT -	6631301061@lamduan.mfu.ac.th	View
00000010	JUNMANEE PHUON	6631301006@lamduan.mfu.ac.th	View

◀ 1...2 ▶

Figure 4.4 Instructor’s dashboard

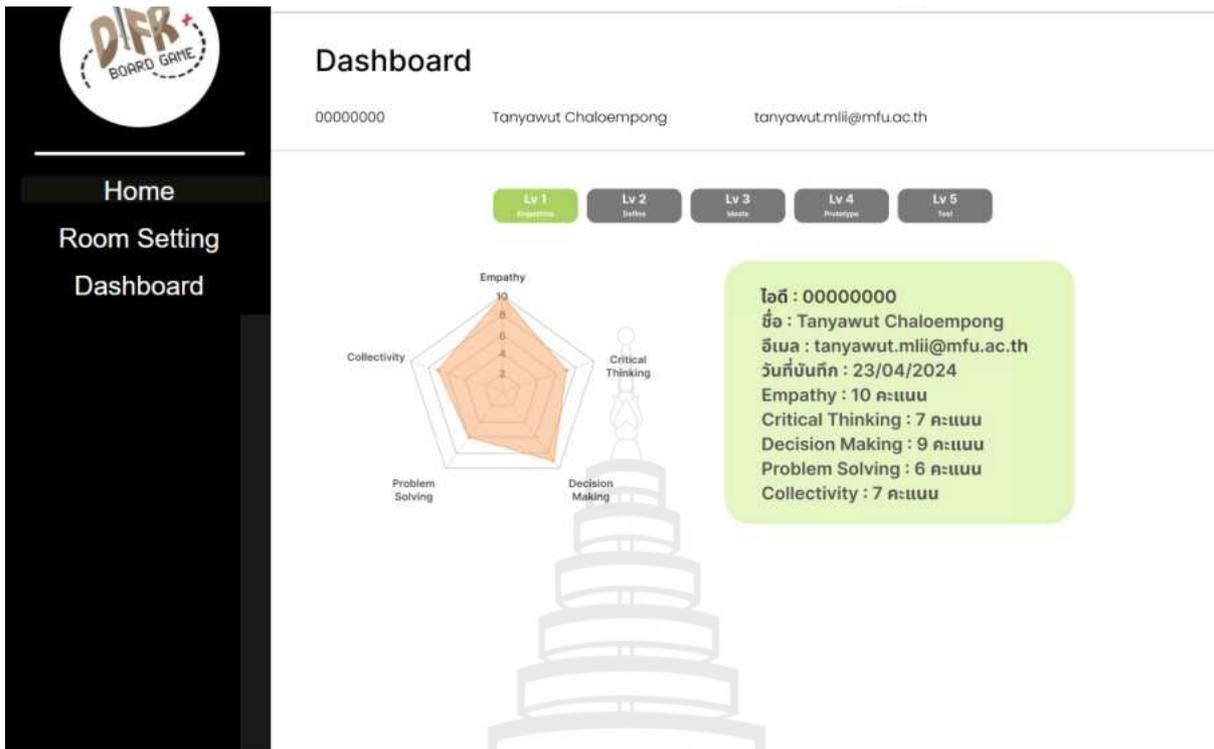


Figure 4.5 Spider chart visualization of students' design thinking progress



Figure 4.6 Physical board game with individual player boards.

4.2 Students' Design Thinking

The study included 160 participants, with a demographic breakdown of 48.1% male, 9.4% female, and 9.4% identifying as LGBTQ+. Participants had varying levels of prior experience with hybrid board games, with 30.6% having no experience, 38.1% at a low level, 26.2% at a medium level, and the remaining participants reporting a high level of familiarity.

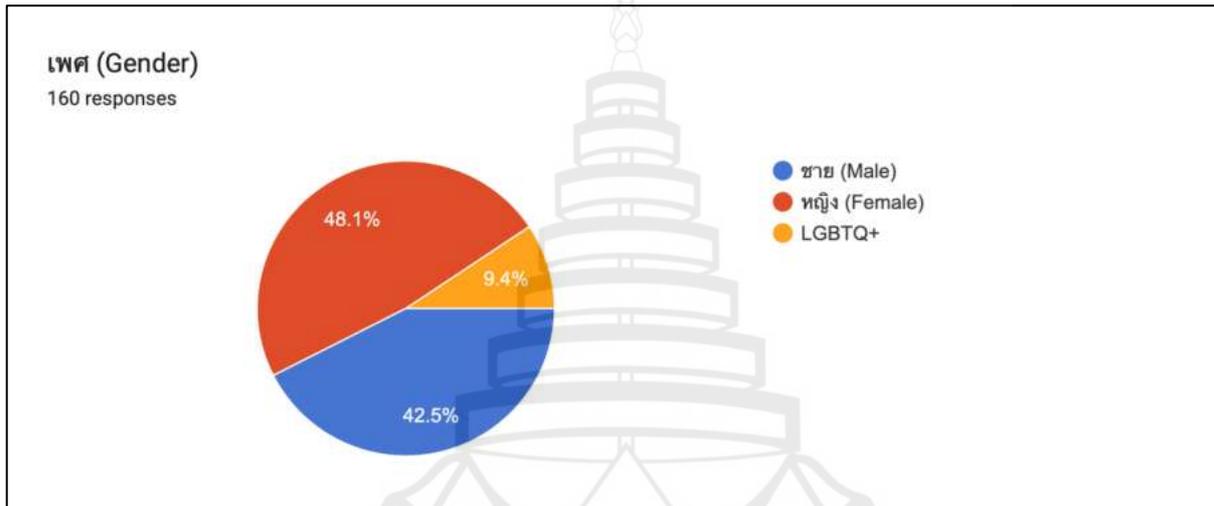


Figure 4.7 Demographic distribution of study participants

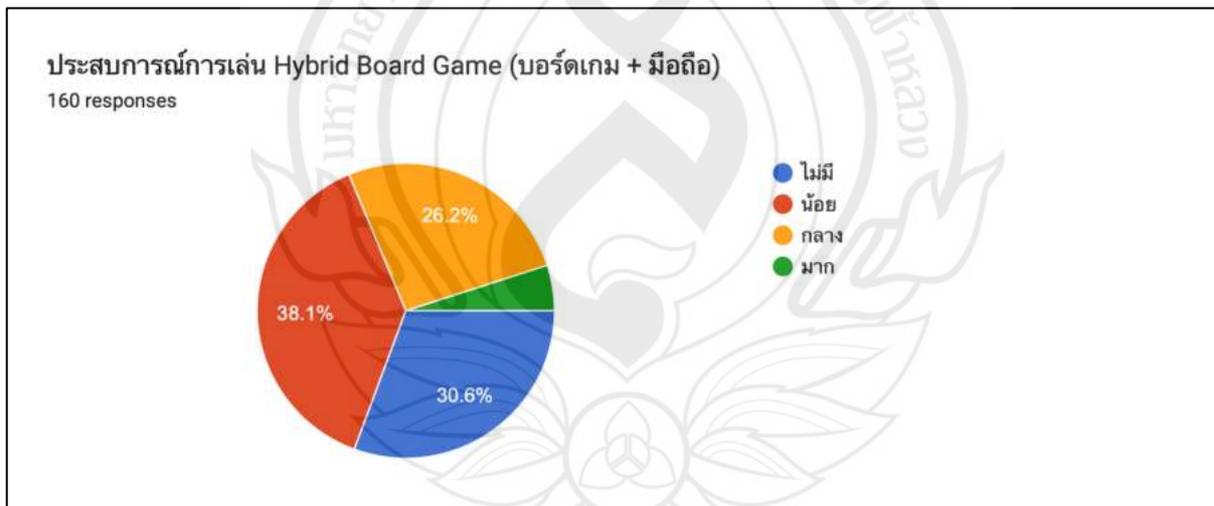


Figure 4.8 Participants' prior experience levels with hybrid board games

To evaluate the impact of the RFID Learning Kit for Design Thinking, a pretest-posttest assessment was conducted to measure students' proficiency in the five key phases of design thinking: Empathize, Define, Ideate, Prototype, and Test. The results indicate a statistically

significant improvement in students' design thinking skills after engaging with the game. The mean pretest score was 13.74 (SD = 2.77), while the mean posttest score increased to 20.85 (SD = 1.96). A paired t-test analysis confirmed that this improvement was highly significant ($t = 26.50, p < 0.001$), demonstrating that students developed a stronger ability to apply design thinking principles after using the game.

Table 4.1 Pretest and Posttest Scores of Students' Design Thinking Skills

Test	N	\bar{x}	SD	t
Pre-test	160	13.74	2.77	26.50***
Post-test	160	20.85	1.96	

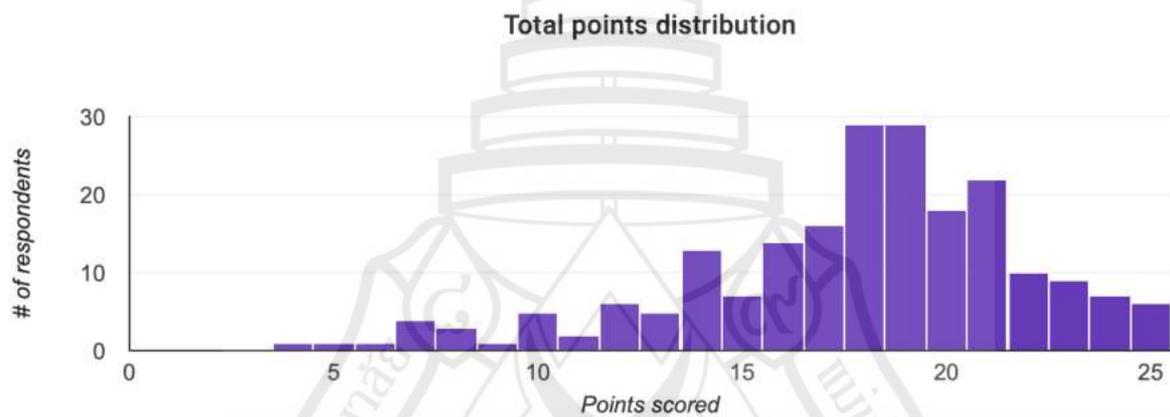


Figure 4.9 Distribution of students' pretest scores in design thinking assessment

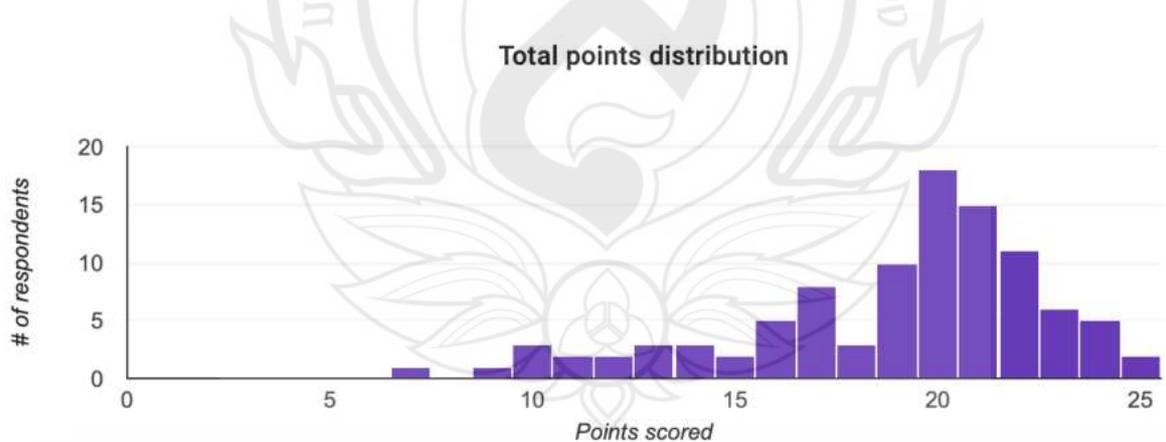


Figure 4.10 Distribution of students' posttest scores in design thinking assessment

The pretest-posttest score distributions further illustrate this impact, showing a noticeable shift toward higher performance levels in the posttest. The pretest distribution had a broader spread, with scores concentrated in the mid-range, whereas the posttest results demonstrated a clear shift toward higher scores, reflecting substantial knowledge gains. This upward trend highlights how the hybrid board game enhanced students' problem-solving skills, iterative thinking, and ability to structure innovative solutions through interactive gameplay.

The significant improvement in design thinking proficiency among students reinforces the effectiveness of a game-based hybrid learning model in fostering problem-solving, creativity, and structured innovation. The combination of physical and digital learning tools provided an engaging, immersive experience that encouraged students to actively participate, experiment with design strategies, and iterate solutions based on real-world challenges. The strong statistical results further validate that interactive and experiential learning approaches lead to better knowledge retention and application compared to traditional lecture-based methods.

Additionally, the diverse levels of prior game experience among participants suggest that the learning kit was effective for both novice and experienced learners, making it a versatile educational tool. The structured, hands-on application of design thinking principles, coupled with real-time feedback through RFID-based interactions, created an engaging and practical learning environment. These findings highlight that technology-enhanced game-based learning can serve as a powerful instructional strategy for developing essential design thinking skills.

4.3 Learning Motivation

The learning motivation results indicate a high level of engagement among students when using the hybrid board game for developing design thinking skills. All five dimensions received high average scores, reflecting strong motivation across multiple aspects of learning. The highest-rated dimension was Perceived Benefits ($x = 4.30$, $SD = 0.84$), suggesting that students recognized the value of design thinking and its practical applications. Commitment to Learning ($x = 4.26$, $SD = 0.86$) and Intent to Apply Concepts ($x = 4.21$, $SD = 0.90$) also scored highly, indicating that students were actively engaged in the learning process and intended to use these skills beyond the classroom. Curiosity and Creativity ($x = 4.20$, $SD = 0.91$) showed similarly strong motivation, demonstrating that the game effectively encouraged students to

explore new ideas and innovative solutions. Lastly, Support of Learning Environment ($\bar{x} = 4.13$, $SD = 0.92$), while slightly lower than the other dimensions, still reflected a positive perception of teamwork and external support in the learning experience.

Table 4.2 Students' Learning Motivation Scores

Dimension	x	SD	Interpretation
Curiosity and creativity	4.20	0.91	High
Commitment to learning	4.26	0.86	High
Perceived benefits	4.30	0.84	High
Intent to apply concepts	4.21	0.90	High
Support of learning environment	4.13	0.92	Moderate

The high motivation scores across all dimensions suggest that the RFID Learning Kit for Design Thinking successfully fostered an engaging and stimulating learning environment. The strong rating for perceived benefits indicates that students not only understood design thinking concepts but also recognized their real-world applications, reinforcing the effectiveness of game-based experiential learning. The high scores in commitment to learning and intent to apply concepts further emphasize that students were actively engaged and willing to transfer their acquired skills beyond the classroom, demonstrating the long-term impact of interactive learning methods. Additionally, the game's ability to stimulate curiosity and creativity highlights its role in encouraging students to explore innovative problem-solving approaches, a key competency in design thinking. Although the support of learning environment received a slightly lower score, the positive rating still suggests that the collaborative nature of the game was beneficial in enhancing teamwork, discussion, and peer learning.

4.4 Technology Acceptance

The technology acceptance results indicate that students responded positively to the hybrid board game as a learning tool. Perceived Usefulness ($x = 4.10$, $SD = 0.91$) and Overall Effectiveness ($x = 4.07$, $SD = 0.92$) were rated high, suggesting that students found the game valuable for learning design thinking concepts. Attitude Toward Adoption ($x = 4.14$, $SD = 0.98$) received the highest score, demonstrating that students viewed the game positively and were open to using it in future learning experiences. Willingness to Engage ($x = 4.08$, $SD =$

0.91) was also rated highly, indicating that students were motivated to participate actively in the game-based learning process. The lowest-rated dimension, Ease of Use ($x = 3.90$, $SD = 1.06$), fell within the moderate to high range, suggesting that while most students found the game manageable, some may have faced minor usability challenges.

Table 4.3 Students' Technology Acceptance Scores

Dimension	x	SD	Interpretation
Perceived Usefulness	4.10	0.91	High
Ease of Use	3.90	1.06	Moderate
Attitude Toward Adoption	4.14	0.98	High
Willingness to Engage	4.08	0.91	High
Overall Effectiveness	4.07	0.92	High

The technology acceptance results suggest that the RFID Learning Kit for Design Thinking was well-received as an effective educational tool. The high ratings for perceived usefulness and overall effectiveness indicate that students recognized the game's value in enhancing their understanding of design thinking concepts. The strong score for attitude toward adoption further supports the idea that students were not only receptive to the game-based approach but also open to integrating similar interactive learning tools in the future. The high willingness to engage score highlights that the interactive and immersive nature of the game successfully motivated students to participate actively in the learning process. Although ease of use received a slightly lower rating, it still fell within the moderate to high range, suggesting that while most students found the game manageable, some may have encountered minor usability challenges.

Chapter 5

Conclusion

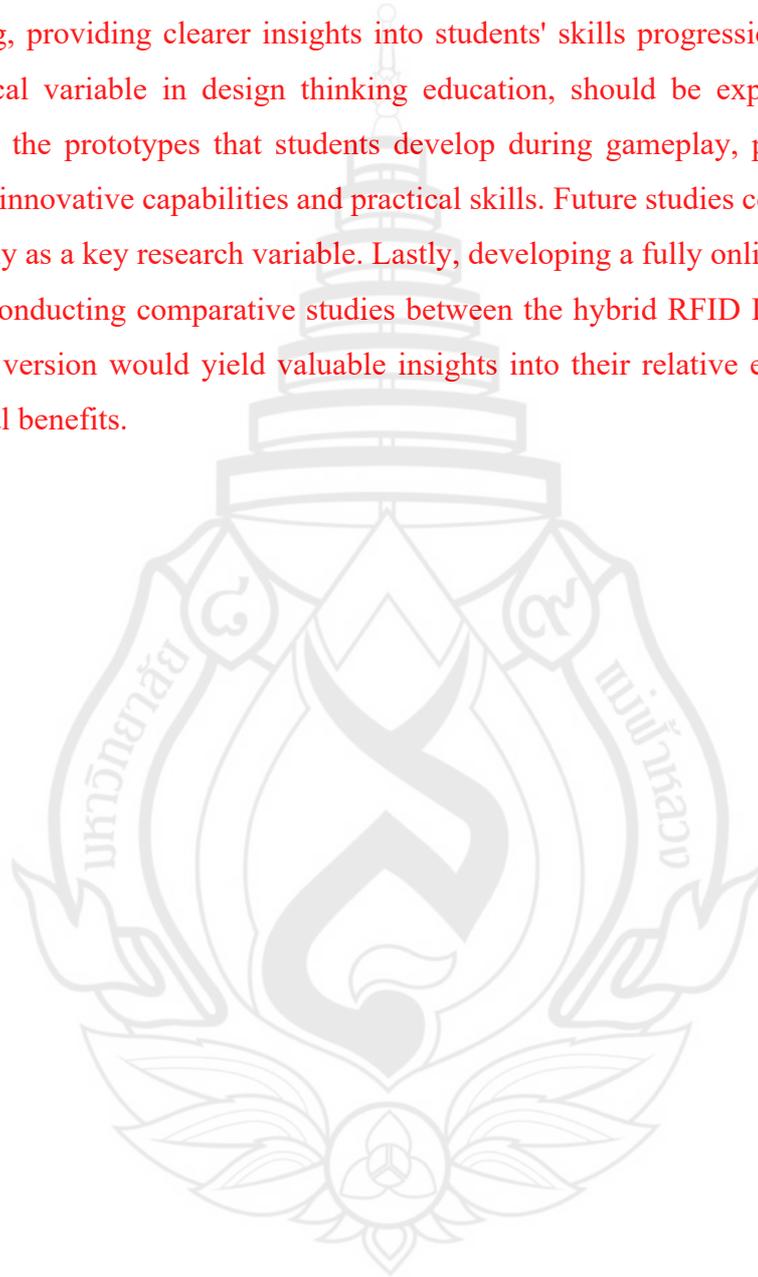
This study developed and evaluated the RFID Learning Kit for Design Thinking, a hybrid board game designed to enhance student engagement and learning outcomes. By integrating physical and digital elements, the game fosters problem-solving, creativity, and collaboration through structured gameplay and RFID technology. The findings demonstrated a significant improvement in students' design thinking skills, as shown by the pretest-posttest results, alongside high levels of motivation and engagement. This approach addresses the limitations of traditional design thinking instruction, which often lacks hands-on application and active participation. The study's originality lies in its combination of game-based learning, digital tracking, and RFID technology to offer a scalable and flexible solution that effectively bridges theoretical knowledge with real-world problem-solving.

The key findings confirm that the RFID Learning Kit enhances students' design thinking skills, engagement, and motivation. The pretest-posttest results showed a statistically significant improvement in understanding and applying the five design thinking phases. The learning motivation assessment revealed strong engagement, with students recognizing the game's benefits, actively participating, and intending to apply design thinking beyond the classroom. The technology acceptance analysis indicated that students found the hybrid board game useful and engaging, though some noted minor usability challenges. These findings align with research on game-based learning, reinforcing the value of interactive and experiential approaches in design thinking education.

For practitioners, educators, and educational technologists, integrating hybrid learning tools like the RFID Learning Kit can enhance student engagement and problem-solving skills. Educators should incorporate game-based learning to create interactive environments, particularly for subjects that emphasize critical thinking and iterative design. Providing structured guidance while allowing flexibility for exploration can maximize learning outcomes. Educational technologists can refine hybrid solutions by improving digital interfaces, ensuring seamless integration, and leveraging real-time analytics for tracking student progress. Expanding the kit to online or blended learning environments could increase accessibility and impact.

Future research should examine the long-term impact of the RFID Learning Kit on students' retention of design thinking skills and real-world problem-solving abilities.

Expanding studies to different educational levels and professional training contexts would provide insights into the game's scalability. Investigating its application in online and blended learning models could enhance the integration of physical and digital experiences. Additionally, future studies should explore adaptive learning features, such as AI-driven feedback and personalized challenges, to enhance engagement. **It is also recommended that future versions explicitly link the evaluation of player actions directly to each of the five phases of design thinking, providing clearer insights into students' skills progression. Furthermore, creativity, a critical variable in design thinking education, should be explicitly evaluated through assessing the prototypes that students develop during gameplay, providing deeper insights into their innovative capabilities and practical skills. Future studies could also include creativity explicitly as a key research variable. Lastly, developing a fully online version of the learning kit and conducting comparative studies between the hybrid RFID Learning Kit and the purely online version would yield valuable insights into their relative effectiveness and unique educational benefits.**



Appendices

Appendix A. Research Ethical Approval

 The Mae Fah Luang University Ethics Committee on Human Research
333 Moo 1, Thasud, Muang, ChiangRai 57100
Tel: (053) 917-170 to 71 Fax: (053) 917-170 E-mail: rec.human@mfu.ac.th

CERTIFICATE OF EXEMPTION

COE: 173/2024 Protocol No: EC 24143-13

Title: RFID Learning Kit for Design Thinking

Principal investigator: Assistant Prof. Dr. Charoenchai Wongwatkit

School: Information Technology

The Mae Fah Luang University Ethics Committee on Human Research (MFU EC) reviewed the protocol in compliance with international guidelines such as Declaration of Helsinki, the Belmont Report, CIOMS Guidelines and the International Conference on Harmonization of Technical Requirements for Registration of Pharmaceuticals for Human Use - Good Clinical Practice (ICH GCP) and decided to exempt the above research protocol.

Date of Exemption: September 4, 2024


.....
(Lecturer Jullapong Achalapong, M.D.)
Chairperson of the MFU Ethics Committee on Human Research

For research protocol exempted by the Mae Fah Luang University Ethics Committee on Human Research (MFU EC), the investigators must comply with the followings:

- No need to submit a progress report.
- When there are changes of the protocol, the investigator must send an amendment report (AP 06/2022) to the MFU EC.
- When the research finishes, the investigator must send a final report (AP 09/2022).

Please go to <https://ec.mfu.ac.th> to download MFU EC forms for reporting.

I, as an investigator, agree to comply with the above obligation.


.....
Assistant Prof. Dr. Charoenchai Wongwatkit
Date

Appendix B. Pretest-Posttest

แบบทดสอบก่อนและหลังเรียน

เรื่องทักษะการคิดเชิงออกแบบ (Design Thinking)

ด้านที่ 1 เข้าใจปัญหา

1. การ "เข้าใจปัญหา" ในกระบวนการคิดเชิงออกแบบหมายถึงอะไร?

- ก) การวิเคราะห์ข้อมูลทางสถิติ
- ข) การเข้าใจความรู้สึกและประสบการณ์ของผู้ใช้
- ค) การสร้างแบบจำลองทางคณิตศาสตร์
- ง) การออกแบบผลิตภัณฑ์ใหม่

2. วิธีใดต่อไปนี้ไม่ใช่เครื่องมือในการเข้าใจปัญหา?

- ก) การสัมภาษณ์
- ข) การสังเกตการณ์
- ค) การทำแบบสอบถาม
- ง) การสร้างต้นแบบ

3. การ "เข้าใจปัญหา" มีความสำคัญอย่างไรในกระบวนการคิดเชิงออกแบบ?

- ก) ช่วยให้เข้าใจความต้องการที่แท้จริงของผู้ใช้
- ข) ทำให้สามารถสร้างผลิตภัณฑ์ได้เร็วขึ้น
- ค) ช่วยลดต้นทุนการผลิต
- ง) ทำให้สามารถขายผลิตภัณฑ์ได้ในราคาสูงขึ้น

4. ข้อใดไม่ใช่ลักษณะของการ "เข้าใจปัญหา" ที่ดี?

- ก) การรับฟังอย่างตั้งใจ
- ข) การสังเกตพฤติกรรมผู้ใช้
- ค) การตั้งสมมติฐานโดยไม่มีข้อมูล
- ง) การเก็บข้อมูลจากหลายแหล่ง

5. เป้าหมายสูงสุดของการ "เข้าใจปัญหา" คืออะไร?

- ก) เพื่อสร้างผลิตภัณฑ์ใหม่
- ข) เพื่อเพิ่มยอดขาย
- ค) เพื่อเข้าใจมุมมองและความต้องการของผู้ใช้อย่างลึกซึ้ง
- ง) เพื่อลดต้นทุนการผลิต

ด้านที่ 2 กำหนดปัญหาให้ชัดเจน

1. การ "กำหนดปัญหาให้ชัดเจน" ในกระบวนการคิดเชิงออกแบบคืออะไร?

- ก) การระบุปัญหาทั้งหมดที่พบ
- ข) การสรุปและระบุปัญหาหลักที่ต้องแก้ไข
- ค) การแก้ปัญหาทันที
- ง) การสร้างผลิตภัณฑ์ใหม่

2. ข้อใดไม่ใช่ประโยชน์ของการกำหนดปัญหาให้ชัดเจน?

- ก) ช่วยให้เห็นภาพรวมของปัญหา
- ข) ทำให้สามารถแก้ปัญหาได้ตรงจุด
- ค) ช่วยประหยัดเวลาในการแก้ปัญหา
- ง) ทำให้สามารถละลายความต้องการของผู้ใช้

3. การกำหนดปัญหาที่ดีควรมีลักษณะอย่างไร?

- ก) กว้างและครอบคลุมทุกประเด็น
- ข) เฉพาะเจาะจงและมุ่งเน้นที่ผู้ใช้
- ค) ชับซ้อนและยากต่อการเข้าใจ
- ง) เน้นที่การแก้ปัญหาทางเทคนิคเท่านั้น

4. ข้อใดเป็นเครื่องมือที่ใช้ในการกำหนดปัญหาให้ชัดเจน?

- ก) แผนผังความคิด (Mind Map)
- ข) การวิเคราะห์ SWOT

- ค) การสร้างแบบจำลอง 3 มิติ
- ง) การทำการตลาดออนไลน์

5. เมื่อกำหนดปัญหาได้ชัดเจนแล้ว ขั้นตอนต่อไปคืออะไร?

- ก) เริ่มผลิตสินค้าทันที
- ข) ทำการตลาดสินค้า
- ค) ระดมความคิดเพื่อหาวิธีแก้ปัญหา
- ง) ยุติโครงการ

ด้านที่ 3 ระดมความคิด

1. การ "ระดมความคิด" ในกระบวนการคิดเชิงออกแบบคืออะไร?

- ก) การคิดหาวิธีแก้ปัญหาที่หลากหลาย
- ข) การเลือกวิธีแก้ปัญหาที่ดีที่สุดเพียงวิธีเดียว
- ค) การวิเคราะห์ข้อดีข้อเสียของแต่ละวิธี
- ง) การทดสอบวิธีแก้ปัญหา

2. ข้อใดไม่ใช่หลักการสำคัญในการระดมความคิด?

- ก) คิดอย่างอิสระ ไม่ยึดติดกับกรอบเดิม
- ข) ไม่วิจารณ์ความคิดของผู้อื่น
- ค) เน้นปริมาณความคิดมากกว่าคุณภาพ
- ง) เลือกเฉพาะความคิดที่เป็นไปได้จริงเท่านั้น

3. เทคนิคใดต่อไปนี้ไม่ใช่วิธีการระดมความคิด?

- ก) การเขียนความคิดลงบนกระดาษโพสต์อิท
- ข) การวาดภาพประกอบความคิด
- ค) การแสดงบทบาทสมมติ
- ง) การทำแบบสอบถามความคิดเห็น

4. ประโยชน์ของการระดมความคิดคืออะไร?

- ก) ได้แนวคิดที่หลากหลายและสร้างสรรค์
- ข) ได้ผลิตภัณฑ์ที่สมบูรณ์แบบทันที
- ค) ลดต้นทุนการผลิต
- ง) เพิ่มยอดขายสินค้า

5. หลังจากระดมความคิดแล้ว ขั้นตอนต่อไปคืออะไร?

- ก) นำทุกความคิดไปปฏิบัติทันที
- ข) เลือกความคิดที่ดีที่สุดเพื่อพัฒนาต่อ
- ค) ยุติกระบวนการคิดเชิงออกแบบ
- ง) เริ่มต้นระดมความคิดใหม่ทั้งหมด

ด้านที่ 4 สร้างต้นแบบที่เลือก

1. การ "สร้างต้นแบบ" ในกระบวนการคิดเชิงออกแบบคืออะไร?

- ก) การผลิตสินค้าจำนวนมาก
- ข) การสร้างแบบจำลองอย่างง่ายของแนวคิดที่เลือก
- ค) การทำการตลาดสินค้า
- ง) การวิเคราะห์คู่แข่ง

2. ข้อใดไม่ใช่ประโยชน์ของการสร้างต้นแบบ?

- ก) ทดสอบแนวคิดได้อย่างรวดเร็ว
- ข) ประหยัดค่าใช้จ่ายในการพัฒนา
- ค) ได้ผลิตภัณฑ์ที่สมบูรณ์พร้อมขาย
- ง) ค้นพบปัญหาและโอกาสในการปรับปรุง

3. ลักษณะของต้นแบบที่ดีควรเป็นอย่างไร?

- ก) มีความสมบูรณ์แบบทุกรายละเอียด
- ข) ใช้เวลาและทรัพยากรในการสร้างมาก
- ค) สร้างได้รวดเร็วและปรับเปลี่ยนง่าย
- ง) มีราคาแพงเพื่อแสดงคุณภาพ

4. ข้อใดไม่ใช่วิธีการสร้างต้นแบบ?

- ก) การวาดภาพ
- ข) การสร้างแบบจำลอง 3 มิติ
- ค) การใช้กระดาษและกาว
- ง) การทำวิจัยตลาด

5. หลังจากสร้างต้นแบบแล้ว ขั้นตอนต่อไปคืออะไร?

- ก) นำออกจำหน่ายทันที
- ข) เริ่มการผลิตจำนวนมาก
- ค) ทำการทดสอบกับผู้ใช้
- ง) จัดสิทธิบัตร

ด้านที่ 5 การทดสอบ

1. การทดสอบในกระบวนการ Design Thinking มีจุดประสงค์หลักคืออะไร?

- ก. เพื่อให้ได้ผลิตภัณฑ์ที่สมบูรณ์แบบ
- ข. เพื่อปรับปรุงแนวคิดหรือต้นแบบ
- ค. เพื่อลดต้นทุนการผลิต
- ง. เพื่อเพิ่มยอดขาย

2. ข้อใดไม่ใช่วิธีการทดสอบในกระบวนการ Design Thinking?

- ก. การสัมภาษณ์ผู้ใช้
- ข. การทดลองใช้ต้นแบบ
- ค. การสำรวจความคิดเห็นออนไลน์
- ง. การปิดบังข้อมูลจากผู้ใช้

3. เมื่อได้ผลการทดสอบแล้ว ขั้นตอนต่อไปคืออะไร?

- ก. เริ่มขายผลิตภัณฑ์ทันที
- ข. ยกเลิกโครงการ

ก. วิเคราะห์ผลและปรับปรุง

ง. รอให้คู่แข่งทำตาม

4. การทดสอบในกระบวนการ Design Thinking ควรทำเมื่อใด?

ก. เฉพาะตอนเริ่มโครงการ

ข. เฉพาะตอนจบโครงการ

ค. ตลอดกระบวนการพัฒนา

ง. เมื่อมีปัญหาเกิดขึ้นเท่านั้น

5. ข้อใดเป็นประโยชน์ของการทดสอบในกระบวนการ Design Thinking?

ก. ลดความเสี่ยงในการพัฒนาผลิตภัณฑ์

ข. เพิ่มความมั่นใจให้กับทีมพัฒนา

ค. ได้ข้อมูลจริงจากผู้ใช้

ง. ถูกทุกข



Appendix C. Learning Motivation Questionnaire

1. Email *

2. เพศ (Gender) *

Mark only one oval.

- ชาย (Male)
 หญิง (Female)
 LGBTQ+

3. ประสพการณ์ "กิจกรรมการเรียนรู้" โดยใช้โทรศัพท์มือถือ *

Mark only one oval.

- ไม่มี
 น้อย
 กลาง
 มาก

4. ประสพการณ์การเล่นบอร์ดเกม *

Mark only one oval.

- ไม่มี
 น้อย
 กลาง
 มาก

5. ประสพการณ์การเล่น Hybrid Board Game (บอร์ดเกม + มือถือ) *

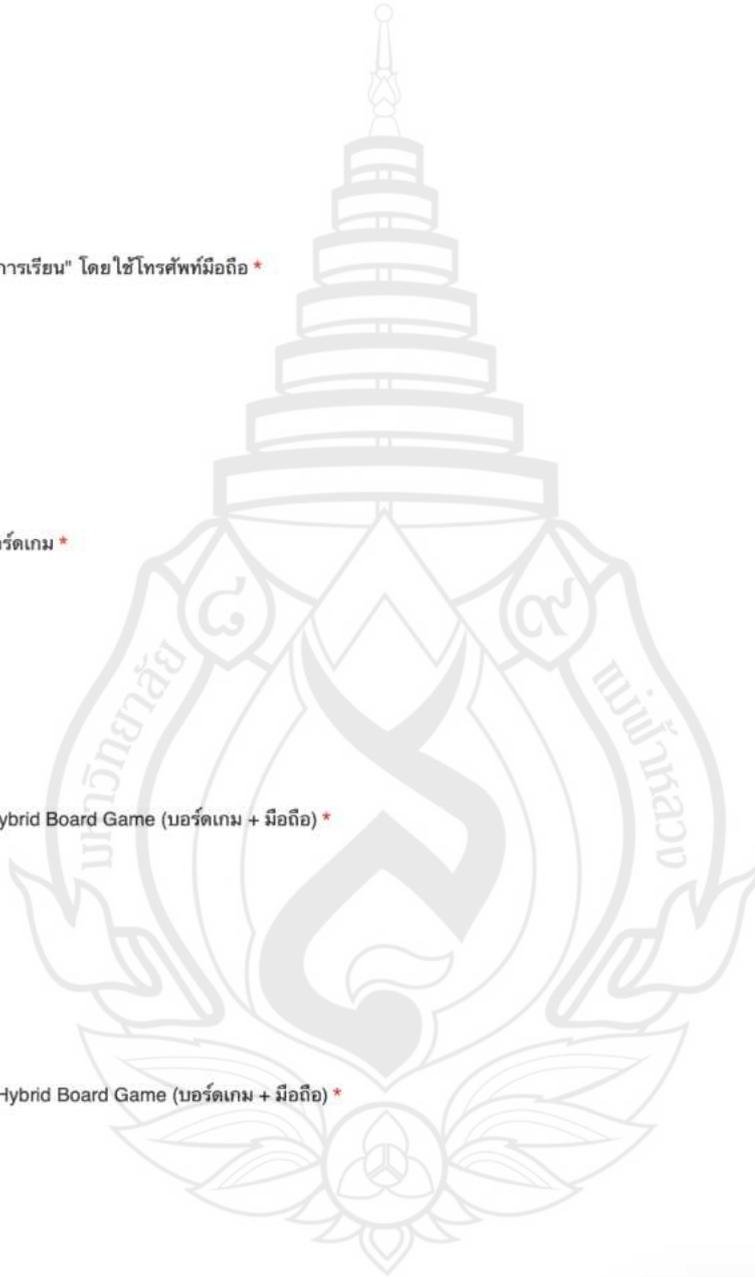
Mark only one oval.

- ไม่มี
 น้อย
 กลาง
 มาก

6. ความมั่นใจในการเล่น Hybrid Board Game (บอร์ดเกม + มือถือ) *

Mark only one oval.

- ไม่มั่นใจเลย
 น้อย
 กลาง
 มั่นใจมาก



แบบสอบถามเพื่อประเมินแรงจูงใจในการเรียนรู้ เรื่อง ทักษะการคิดเชิงออกแบบ

คำชี้แนะ ให้พิจารณารายการประเมินในแต่ละข้อ และใส่สัญลักษณ์ / ลงในช่องที่ท่านรู้สึกหรือเห็นสมควรมากที่สุด โดยช่องหมายเลข 1 หมายถึง ระดับน้อยที่สุด และหมายเลข 5 หมายถึง ระดับมากที่สุด

รายการ	1	2	3	4	5
ด้านแรงบันดาลใจในการสำรวจและสร้างสรรค์					
1. ฉันรู้สึกตื่นเต้นและสนใจที่จะเรียนรู้กระบวนการคิดเชิงออกแบบ					
2. ฉันมีแรงบันดาลใจที่จะค้นหาปัญหาและสร้างโอกาสใหม่ๆ ด้วยกระบวนการคิดเชิงออกแบบ					
3. ฉันรู้สึกท้าทายและกระตือรือร้นในการสร้างสรรค์แนวคิดใหม่ๆ ด้วยกระบวนการคิดเชิงออกแบบ					
4. ฉันอยากสำรวจวิธีการแก้ปัญหาที่หลากหลาย					
5. ฉันรู้สึกกระตือรือร้นที่จะนำความคิดสร้างสรรค์มาใช้ในการออกแบบโซลูชันใหม่ๆ					
ด้านความทุ่มเทและการมีส่วนร่วมในการเรียนรู้					
1. ฉันตั้งใจที่จะทุ่มเทเวลาและความพยายามในการเรียนรู้และฝึกฝนทักษะการคิดเชิงออกแบบอย่างเต็มที่					
2. ฉันยินดีและพร้อมที่จะมีส่วนร่วมในกิจกรรมกลุ่มเพื่อพัฒนาทักษะการคิดเชิงออกแบบของฉัน					
3. ฉันมุ่งมั่นที่จะทำความเข้าใจและการประยุกต์ใช้ทักษะการคิดเชิงออกแบบ					
4. ฉันพยายามที่จะหาโอกาสในการฝึกฝนทักษะการคิดเชิงออกแบบนอกเหนือจากในชั้นเรียน					
5. ฉันกระตือรือร้นที่จะแบ่งปันความคิดและมุมมองของฉันในระหว่างกระบวนการเรียนรู้					
ด้านประโยชน์จากการคิดเชิงออกแบบ					

1. ฉันเชื่อมั่นว่าทักษะการคิดเชิงออกแบบจะมีประโยชน์อย่างมากต่อการทำงานและอาชีพในอนาคต ของฉัน					
2. ฉันเห็นคุณค่าของทักษะการคิดเชิงออกแบบ					
3. ฉันเข้าใจว่าการคิดเชิงออกแบบสามารถช่วยในการแก้ปัญหาในชีวิตประจำวันได้					
4. ฉันตระหนักถึงความสำคัญของการเรียนรู้กระบวนการคิดเชิงออกแบบในยุคดิจิทัลที่เปลี่ยนแปลง อย่างรวดเร็ว					
5. ฉันเชื่อว่าทักษะนี้จะช่วยเพิ่มความสามารถในการแข่งขันของฉันในตลาดแรงงาน					
ด้านความตั้งใจในการใช้งาน					
1. ฉันรู้สึกว่าคุณภาพแวดล้อมการเรียนรู้ที่ฉันอยู่ช่วยส่งเสริมและสนับสนุนการพัฒนาทักษะการคิดเชิง ออกแบบของฉัน					
2. ฉันได้รับการสนับสนุนจากเพื่อนร่วมชั้นในการเรียนรู้และฝึกฝนทักษะใหม่					
3. อาจารย์ผู้สอนให้คำแนะนำและแนวทางที่เป็นประโยชน์อย่างยิ่งในการพัฒนาทักษะการคิดเชิง ออกแบบของฉัน					
4. การทำงานร่วมกันในกลุ่มช่วยให้ฉันเข้าใจมุมมองที่หลากหลายในการแก้ปัญหา					
5. ฉันรู้สึกว่ามีทรัพยากรและเครื่องมือที่เพียงพอสำหรับการพัฒนาทักษะการคิดเชิงออกแบบ					
ด้านการสนับสนุนจากสภาพแวดล้อมและการทำงานร่วมกัน					
1. ฉันมั่นใจว่าฉันสามารถใช้กระบวนการคิดเชิงออกแบบในการแก้ปัญหาที่ซับซ้อนได้					
2. ฉันมั่นใจว่าฉันสามารถสร้างสรรค์โซลูชันที่มีประสิทธิภาพและสอดคล้องกับปัญหาที่พบโดยใช้ ทักษะการคิดเชิงออกแบบที่ได้เรียนรู้					
3. ฉันมั่นใจในความสามารถของฉันในการพัฒนาแนวคิดใหม่					

4. ฉันมั่นใจว่าฉันสามารถนำทักษะการคิดเชิงออกแบบไปประยุกต์ใช้ในการแก้ปัญหาในสถานการณ์จริงได้					
5. ฉันมั่นใจว่าฉันสามารถปรับตัวและเรียนรู้จากความท้าทายในกระบวนการออกแบบได้					

ข้อเสนอแนะเพิ่มเติม



Appendix D. Technology Acceptance Model

แบบประเมินการยอมรับเทคโนโลยี

ชุดนวัตกรรมการเรียนรู้ด้วยเทคโนโลยี RFID เพื่อส่งเสริมทักษะการคิดเชิงออกแบบ

คำชี้แนะ ให้พิจารณารายการประเมินในแต่ละข้อ และใส่สัญลักษณ์ / ลงในช่องที่ท่านรู้สึกหรือเห็นสมควรมากที่สุด โดยช่องหมายเลข 1 หมายถึง ระดับน้อยที่สุด และหมายเลข 5 หมายถึง ระดับมากที่สุด

รายการ	1	2	3	4	5
ด้านการรับรู้ถึงประโยชน์					
1. ชุดนวัตกรรมการเรียนรู้ด้วยเทคโนโลยี RFID ช่วยเพิ่มประสิทธิภาพในการเรียนรู้ของฉันทัน					
2. การใช้เทคโนโลยี RFID ทำให้ฉันทันเข้าใจแนวคิดการคิดเชิงออกแบบได้ดีขึ้น					
3. ชุดนวัตกรรมการเรียนรู้ช่วยให้ฉันทันสามารถทำงานได้เร็วขึ้น					
4. การใช้เทคโนโลยี RFID ช่วยเพิ่มประสิทธิภาพในการเรียนรู้ของฉันทัน					
5. ฉันทันคิดว่าชุดนวัตกรรมการเรียนรู้มีประโยชน์ต่อการพัฒนาทักษะการคิดเชิงออกแบบของฉันทัน					
ด้านการรับรู้ความง่ายในการใช้งาน					
1. ฉันทันพบว่าการใช้งานชุดนวัตกรรมการเรียนรู้ด้วยเทคโนโลยี RFID นั้นง่าย					
2. การเรียนรู้วิธีใช้งานชุดนวัตกรรมการเรียนรู้เป็นเรื่องง่ายสำหรับฉันทัน					
3. ฉันทันสามารถใช้งานชุดนวัตกรรมการเรียนรู้ได้อย่างคล่องแคล่ว					
4. ฉันทันพบว่าคุณสมบัติของชุดนวัตกรรมการเรียนรู้มีความยืดหยุ่นในการใช้งาน					
5. การใช้งานชุดนวัตกรรมการเรียนรู้ไม่ต้องใช้ความพยายามมากในการใช้งาน					

ด้านทัศนคติต่อการใช้งาน					
1. ฉันรู้สึกดีเมื่อได้ใช้ชุดนวัตกรรมการเรียนรู้ด้วยเทคโนโลยี RFID					
2. ฉันชอบแนวคิดของการใช้เทคโนโลยี RFID ในการเรียนรู้					
3. การใช้ชุดนวัตกรรมนี้เป็นประสบการณ์ที่น่าสนุก					
4. ฉันรู้สึกกระตือรือร้นที่จะใช้ชุดนวัตกรรมนี้ในการเรียนรู้					
5. ฉันคิดว่าการใช้ชุดนวัตกรรมนี้เป็นความคิดที่ดี					
ด้านความกระตือรือร้นในการใช้งาน					
1. ฉันตั้งใจจะใช้ชุดนวัตกรรมการเรียนรู้ด้วยเทคโนโลยี RFID ในอนาคต					
2. ฉันวางแผนที่จะใช้ชุดนวัตกรรมนี้บ่อยๆ ในการเรียนรู้					
3. ฉันคาดว่าจะใช้ชุดนวัตกรรมนี้ในการพัฒนาทักษะการคิดเชิงออกแบบของฉัน					
4. ฉันจะแนะนำให้เพื่อนๆ ใช้ชุดนวัตกรรมนี้					
5. ฉันตั้งใจจะใช้ชุดนวัตกรรมนี้เป็นส่วนหนึ่งของการเรียนรู้ประจำวัน					
ด้านการรับรู้ประสิทธิผลของนวัตกรรม					
1. ชุดนวัตกรรมนี้ช่วยพัฒนาความคิดสร้างสรรค์ของฉัน					
2. การใช้เทคโนโลยี RFID ช่วยให้ฉันเข้าใจกระบวนการคิดเชิงออกแบบได้ดีขึ้น					
3. ชุดนวัตกรรมนี้ช่วยให้ฉันสามารถแก้ปัญหาได้อย่างมีประสิทธิภาพมากขึ้น					
4. ฉันสามารถนำความรู้จากชุดนวัตกรรมนี้ไปประยุกต์ใช้ในสถานการณ์จริงได้					
5. ชุดนวัตกรรมนี้ช่วยเพิ่มความมั่นใจในการใช้ทักษะการคิดเชิงออกแบบของฉัน					

ข้อเสนอแนะเพิ่มเติม



Appendix E. Intellectual Property (IP)



บันทึกข้อความ

หน่วยงาน สถาบันวัดกรรมการเรียนรู้มหาวิทยาลัยแม่ฟ้าหลวง โทร. 8078 (นุจิวา)

ที่ อว 7744/ 596

วันที่ 28 สิงหาคม 2567

เรื่อง ขอนำส่งแบบฟอร์มเปิดเผยการสร้างสรรคสำหรับการจัดแจ้งข้อมูลลิขสิทธิ์ ระบบเว็บไซต์การเรียนรู้แบบมีปฏิสัมพันธ์เพื่อส่งเสริมทักษะการคิดเชิงออกแบบ และแบบฟอร์มเปิดเผยการประดิษฐ์สำหรับสิทธิบัตร/อนุสิทธิบัตร ชุดนวัตกรรมการเรียนรู้แบบไฮบริดเพื่อส่งเสริมทักษะการคิดเชิงออกแบบ

เรียน หัวหน้าส่วนจัดการทรัพย์สินทางปัญญาและนวัตกรรม

ด้วย สถาบันวัดกรรมการเรียนรู้มหาวิทยาลัยแม่ฟ้าหลวง ร่วมกับ ว่าที่ร้อยตรี ดร.เจริญชัย วงศ์วัฒน์กิจ ได้เป็นผู้สร้างสรรค์ผลงานทรัพย์สินทางปัญญา ระบบเว็บไซต์การเรียนรู้แบบมีปฏิสัมพันธ์เพื่อส่งเสริมทักษะการคิดเชิงออกแบบ และชุดนวัตกรรมการเรียนรู้แบบไฮบริดเพื่อส่งเสริมทักษะการคิดเชิงออกแบบ ซึ่งมีความประสงค์ขอรับความคุ้มครองทรัพย์สินทางปัญญาและสิ่งประดิษฐ์ในนามมหาวิทยาลัยแม่ฟ้าหลวง รายละเอียดปรากฏดังเอกสารแนบ นั้น

ในการนี้ สถาบันวัดกรรมการเรียนรู้มหาวิทยาลัยแม่ฟ้าหลวง จึงขอนำส่งข้อมูลแบบฟอร์มเปิดเผยการสร้างสรรคสำหรับการจัดแจ้งข้อมูลลิขสิทธิ์ และแบบฟอร์มเปิดเผยการประดิษฐ์สำหรับสิทธิบัตร/อนุสิทธิบัตร โปรดดำเนินการในส่วนที่เกี่ยวข้องต่อไป

จึงเรียนมาเพื่อโปรดพิจารณา

**ได้ยื่นจดลิขสิทธิ์ และอนุสิทธิบัตร
เมื่อ 28 สิงหาคม 2567**

พรอนันต์ ดอกไม้งาม
(ผู้ช่วยศาสตราจารย์ ดร.พรอนันต์ ดอกไม้งาม)

รักษาการแทนผู้อำนวยการ

สถาบันวัดกรรมการเรียนรู้มหาวิทยาลัยแม่ฟ้าหลวง



ทะเบียนข้อมูลเลขที่ ว1.011605

คำขอแจ้งข้อมูลเลขที่ 450332

หนังสือแสดงการแจ้งข้อมูลลิขสิทธิ์

ออกให้เพื่อแสดงว่า

มหาวิทยาลัยแม่ฟ้าหลวง

ได้แจ้งข้อมูลลิขสิทธิ์ไว้ต่อกรมทรัพย์สินทางปัญญา

เมื่อวันที่ 15 เดือน พฤศจิกายน พ.ศ. 2567

ประเภทงาน วรรณกรรม ลักษณะงาน โปรแกรมคอมพิวเตอร์

ชื่อผลงาน ระบบเว็บไซต์การเรียนรู้แบบมีปฏิสัมพันธ์เพื่อส่งเสริมทักษะการคิดเชิงออกแบบ

(Interactive Learning Website System to Promote Design Thinking Skills)

ออกให้ ณ วันที่ 9 เดือน ธันวาคม พ.ศ. 2567

ลงชื่อ.....

(นางธนัญญา โชติติติก)

นักวิชาการพาณิชย์ชำนาญการพิเศษ

ปฏิบัติราชการแทนผู้อำนวยการกองลิขสิทธิ์

หมายเหตุ เอกสารนี้มิได้รับรองความเป็นเจ้าของลิขสิทธิ์

ในกรณีมีข้อพิพาทศาลจะเป็นผู้วินิจฉัยชี้ขาดความเป็นเจ้าของลิขสิทธิ์



Transforming Network Topology Education: An RFID-Integrated Board Game Approach to Enhance Student Engagement and Design Thinking

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Abstract: In traditional classroom settings, students often struggle with conceptual analysis and design thinking, particularly in subjects like Data Communication and Networks. A key challenge is their lack of proficiency in analyzing and designing various network topologies. To address this issue, this research proposes an innovative learning approach by integrating a board game with RFID technology to enhance students' Design Thinking skills. This interactive method aims to make learning more engaging, encourage active participation, and foster a deeper understanding of the subject matter. Transforming passive, individual learning into an interactive and collaborative classroom experience, students can engage in problem-solving activities, interact with peers, and develop critical thinking skills. The proposed board game and RFID technology allow students to simulate real-world network design scenarios, discuss different perspectives, and exchange knowledge effectively. Moreover, this approach promotes teacher-student interactions, enabling discussions on facts, opinions, and practical applications. The findings of this study suggest that using gamification in education can significantly enhance students' analytical abilities, motivation, and engagement in learning. Furthermore, this method can be adapted for other courses, expanding its impact beyond data communication and networking to foster essential problem-solving skills across various disciplines.

Keywords: Design Thinking, RFID Technology and Network Topology Learning

Appendix G. Academic Service





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