



Faculty of Computer Science and Information Technology

***CHEMIMONSTERS: A 2D PUZZLE GAME FOR EXPLORING
THE PERIODIC TABLE***

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**Bachelor of Computer Science With Honours
(Information Systems)**

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**CHEMIMONSTERS: A 2D PUZZLE GAME FOR EXPLORING
THE PERIODIC TABLE**

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This project is submitted in partial fulfilment of the
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ABSTRACT

This report presents the development process of ChemiMonsters, an educational and entertaining game designed to teach players about the periodic table through interactive gameplay. The project aims to address the challenges of traditional methods in learning chemical elements by combining gamification with scientific concepts. The report details the requirements gathering phase, which utilized questionnaires to understand user needs, preferences, and learning challenges. Based on the findings, the game integrates features such as engaging visuals, puzzle-solving mechanics, and real-world applications of elements to enhance user engagement and knowledge retention. System design methodologies, including workflows, context diagrams, and data flow diagrams, are outlined to provide a structured approach to the game's development. Additionally, the report highlights the use of machine learning to predict optimal game challenges and features based on player performance. The result is a cohesive and functional game concept that blends education with entertainment, offering an innovative solution to learning chemistry in a fun and interactive way.

Keywords: Chemistry, Periodic Table, Player, Puzzle-Solving, Student

ABSTRAK

Laporan ini membentangkan proses pembangunan ChemiMonsters, sebuah permainan pendidikan yang menggabungkan elemen hiburan untuk membantu pemain mempelajari jadual berkala melalui permainan interaktif. Projek ini bertujuan untuk mengatasi cabaran kaedah tradisional dalam pembelajaran elemen kimia dengan menggabungkan konsep gamifikasi dan sains. Laporan ini merangkumi fasa pengumpulan keperluan, yang menggunakan soal selidik untuk memahami keperluan pengguna, keutamaan, dan cabaran pembelajaran mereka. Berdasarkan penemuan tersebut, permainan ini mengintegrasikan ciri-ciri seperti visual yang menarik, mekanik penyelesaian teka-teki, dan aplikasi dunia nyata bagi elemen-elemen untuk meningkatkan penglibatan pengguna dan pengekalan pengetahuan. Metodologi reka bentuk sistem, termasuk aliran kerja, rajah konteks, dan rajah aliran data, diterangkan untuk menyediakan pendekatan berstruktur dalam pembangunan permainan ini. Selain itu, laporan ini menekankan penggunaan pembelajaran mesin untuk meramalkan cabaran dan ciri permainan yang optimum berdasarkan prestasi pemain. Hasilnya ialah konsep permainan yang menyeluruh dan berfungsi, yang menggabungkan pendidikan dengan hiburan, menawarkan penyelesaian inovatif untuk mempelajari kimia dengan cara yang menyeronokkan dan interaktif.

Kata Kunci: Jadual Berkala, Kimia, Pelajar, Penyelesaian Teka-Teki, Pemain,

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CHAPTER 1: INTRODUCTION

1.1 Background

Chemistry is a fundamental branch of natural science that explores the properties of substances, their transformations, and the natural laws that govern these changes. The periodic table is central to learning chemistry, as it provides essential insights into the elements and their relationships (Sarita, 2022). However, traditional teaching methods often fail to fully engage students, leading to poor knowledge retention and difficulty applying these concepts to real-world contexts.

The growing popularity of game-based learning presents a unique opportunity to merge chemistry education with interactive entertainment. ChemiMonsters harnesses this approach by fostering curiosity through gameplay, offering players broad insights into elements of the periodic table. Through puzzles and exploration, players can learn about atomic structure, electron configurations, and the practical applications of different elements without the pressures of formal education.

1.2 Problem Statement

Chemistry's abstract concepts and complex relationships between elements and compounds make it one of the hardest topics to teach and learn (Essiam et al., 2023). Although the periodic table is crucial for understanding chemistry, its presentation is often unengaging and highly abstract, which makes the subject feel distant and difficult for learners to relate to. From Pan et al. (2024), factors like game aesthetics, satisfaction, and perceived usability were highlighted as major contributors to the student's overall engagement. Hence, there is a need for a more engaging approach that combines learning with entertainment, offering individuals a way to explore fundamental chemistry concepts outside the constraints of traditional teaching methods.

1.3 Aim and Objectives

This project aims to develop an engaging and interactive 2D puzzle-based game that presents general knowledge about the periodic table, focusing on elemental properties, atomic structure, and real-world applications. The objectives of this project are as below:

1. To develop an interactive 2D puzzle game, ChemiMonsters, that enables players to explore and learn about the elements of the periodic table through engaging problem-solving and immersive gameplay.
2. To align with educational curriculums, providing a tool for teachers to supplement their lessons on the periodic table and chemistry fundamentals.
3. To evaluate the usability of the game in enhancing players' understanding of elemental properties and chemistry concepts.

1.4 Scope

The project will develop a 2D puzzle game where players take on the role of a Catcher tasked with retrieving electrons from ChemiMonsters – creatures representing elements from the periodic table. The game is designed for a computer-based interface and will feature puzzles based on elemental properties, including atomic structures, electrons, and real-world phenomena like oxygen's roles in fire. Educational frameworks will not constrain the game but will instead focus on providing general knowledge about chemistry elements. The game is designed for a wide audience including:

- **Secondary school students:** beginner to learn the periodic table in chemistry or science
- **Casual gamers:** players who enjoy puzzle-based games and have an interest in learning general knowledge on chemistry

The game will cover 5 elements from the periodic table, with each level introducing a new ChemiMonsters and a related challenge. The 5 elements that will be covered are Oxygen, Hydrogen, Carbon, Nitrogen, and Helium. These 5 elements are chosen is because:

- Oxygen was selected due to its vital importance for human survival and biological processes.
- Hydrogen was included because it is the most abundant element in the universe and forms the basis of many compounds.
- Carbon was chosen for its fundamental role as the building block of all organic chemistry in life.
- Nitrogen was incorporated as a major component of Earth's atmosphere and for its significance in biological cycles.
- Helium was picked to introduce players to the concept of noble gases and their unique unreactive properties.

1.5 Brief Methodology

The development of ChemiMonsters will follow a structured approach, beginning with game design, where each level will be mapped out to reflect the properties of a specific element from the periodic table. Unique ChemiMonsters will be created for each element, incorporating traits based on their atomic structure and chemical characteristics. The game will be developed using the Unity Game Engine, with puzzle mechanics and a map-based exploration system at its core. Visual assets, animations, and sound effects will be sourced from Unity's asset store, with customizations made using Pro Motion NG for art editing, and other editors for small editions. Once the game prototype is done, playtesting will be conducted with a target group of players, including casual gamers and students. Feedback on user experience, engagement, and learning outcomes will be collected, and adjustments will be made to improve the overall gameplay and educational content.

1.6 Significance of Project

This project offers a unique approach to learning chemistry by moving away from conventional methods and providing an interactive, game-based experience. ChemiMonsters will contribute to increasing interest in chemistry and science in general by making the periodic table fun and accessible. The game will help players build a foundational understanding of elements through puzzles and exploration, all while enjoying an engaging and imaginative experience.

1.7 Project Schedule

The project schedule functions as a framework for guidance to ensure the timely completion of tasks. This project is scheduled from 7th October 2024 to 20 May 2025 as shown in Gantt Chart attached in APPENDIX A.

1.8 Expected Outcome

The project will deliver an engaging 2D puzzle game, ChemiMonsters, that effectively enhances players' understanding of the periodic table and chemistry concepts through interactive and problem-solving gameplay.

1.9 Project Report and Outline

This project will have five chapters including introduction, literature review, methodology, implementation and design, and conclusion.

1.9.1 Chapter 1: Introduction

Chapter 1 presents the concept and objectives of this project. This chapter covers the project's purpose, including the background, problem statement, aim and objectives, scope, brief methodology, significance of project, project schedule, expected outcome, project report and outline, and summary. The background provides context to help readers understand the motivations behind the project. The problem statement identifies the core issues addressed. The aim and objectives outline the main goals and specific objectives to be achieved of the project. The scope defines the project's boundaries that will be included in this project. The brief methodology summarises the development process, covering the design, implementation, and testing phases to ensure a systematic approach. The significance of project section highlights

the potential impact of the project. The project schedule provides a timeline that ensures each phase progresses on time. Finally, the expected outcome shows the anticipated results of the project.

1.9.2 Chapter 2: Literature Review

Chapter 2 presents the reviews of similar existing games that are related to ChemiMonsters. This chapter covers reviews that have been made, including review of similar existing game applications, comparison of reviewed game applications, and review of tools and technology. The review of similar existing game applications provides some analysis on elements and game structure of similar existing games. This comparison of reviewed game applications highlights the analysis of strength and weakness of each game. The review of tools and technology provide context on why the technology or tool is used in this project.

1.9.3 Chapter 3: Methodology

Chapter 3 gives insight into the methodology adopted for the project. It covers the overall design approach and the tools and development platforms used. Additionally, it outlines the implementation process and the steps taken for testing and refining the game. This chapter emphasizes the systematic approach used to ensure a cohesive and functional end product.

1.9.4 Chapter 4: Implementation and Testing

Chapter 4 focuses on the design, implementation, and testing aspects of ChemiMonsters. It documents how the game is designed and how each element being developed and tested. The issues found during testing will be fixed to enhance the game's performance.

1.9.5 Chapter 5: Conclusion

Chapter 5 will provide a summary of the outcome of the game. It also includes my opinion and future insights on this project.

1.10 Conclusion

Chapter 1 introduces the ChemiMonsters project which is a 2D puzzle game that makes learning about the periodic table engaging and interactive. Designed to address the challenges of traditional chemistry education, the game allows players to embody a “Catcher” who retrieves lost electrons from creatures called ChemiMonsters, each representing an element with unique properties. As players solve puzzles inspired by real-world chemistry concepts, they gain general knowledge about atomic structures, electron configurations, and the practical roles of elements like Oxygen, Hydrogen, Carbon, etc.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Traditional methods of teaching, such as lectures and rote memorization, often fail to capture the interest of students, particularly when it comes to abstract concepts like the periodic table and atomic structure. According to Khasawneh et al. (2022), the traditional learning format may no longer be the most effective approach to prepare students for the demands of the modern information age. Having personally encountered these challenges, I envisioned a game that blends interactive exploration, problem-solving, and educational content to bridge this gap.

This chapter reviews existing games and technologies that influenced the proposal for ChemiMonsters. Games like Pokémon Scarlet / Violet and Stardew Valley inspire map-based exploration and engaging gameplay mechanics, while the Periodic Table Game highlights the potential for integrating educational content into games. Additionally, tools like Unity and pixel art, along with map-based puzzle systems, provide practical solutions for building a visually appealing and interactive game.

By analysing these inspirations, this chapter identifies key elements and technologies that can be adapted to create a game that is both fun and educational, offering players a unique way to explore chemistry concepts through engaging gameplay.

2.2 Review of Similar Existing Game Applications

While various games have engaging mechanics and exploration features, very few map-based games are designed to focus on educational purposes, particularly in teaching subjects like chemistry. Popular titles like Pokémon Scarlet / Violet and Stardew Valley offer rich exploration and puzzle-solving elements but prioritize adventure and resource management over education. On the other hand, the Periodic Table Game is explicitly educational but lacks the immersive and interactive game feature that appeals to a wider audience. This gap highlights the need for a game that combines engaging mechanics with an educational framework, offering players both entertainment and an opportunity to learn complex subjects actively.

2.2.1 Pokémon Scarlet / Violet

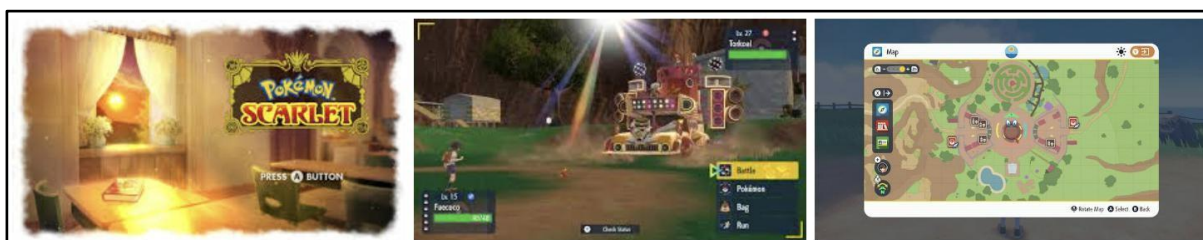


Figure 1 Pokémon Scarlet / Violet Interface

Pokémon Scarlet / Violet are the ninth-generation entries in the Pokémon franchise, developed by Game Freak and published by Nintendo. In the expansive Paldea region, these games introduce an open-world gameplay experience where players can freely explore diverse environments. Players assume the role of Pokémon Trainer, embarking on a journey to capture, train, and battle Pokémon while uncovering the region's mysteries. The Pokémon Champion faces the rebellious Team Star and explores the Titan Pokémon question.

The gameplay combines open-world exploration with turn-based battles, creating a rich blend of strategy and adventure. Unlike previous instalments, Scarlet and Violet allow players to tackle objectives in any order, fostering a sense of freedom and non-linearity. Players

also engage in multiplayer features, allowing co-op exploration with friends. The game introduces new mechanics like the Terastal Phenomenon, which transforms Pokémon into crystalline forms and enhances their abilities during battle. These features make the gameplay dynamic and engaging.

The strengths of this game lie in its map-based exploration system, collection mechanics, puzzles, and the depth of challenges it offers. These features provide an engaging and immersive experience for players, encouraging them to explore diverse environments, solving problems, and achieve rewarding progression through gameplay. The map-based exploration system fosters a sense of adventure, while the collection mechanics keep players motivated by allowing them to catch and train unique Pokémon. Additionally, the inclusion of puzzles and strategic challenges adds layers of depth to the gameplay, making it both dynamic and captivating.

However, the game also has certain weaknesses such as the battle system, the lack of complexity of some puzzles, and the lack of educational content. The repetitive nature of its battle system, particularly in areas with frequent wild Pokémon encounters, can lead to monotony for players over time. Additionally, the lack of complexity of puzzles might reduce engagement for more experienced players. Lastly, while the game excels in entertainment, its lack of direct educational content limits its relevance to learning-focused goals.

2.2.2 Stardew Valley



Figure 2 Stardew Valley Interface

Stardew Valley is a farming simulation and role-playing game developed by ConcernedApe. The game begins with players inheriting a run-down farm in a quiet rural town, promoting them to revitalize it through farming, resource gathering, and social interactions. Players can grow crops, raise animals, fish, mine for resources, and build relationships with the townsfolk. The open-ended gameplay allows players to set their own goals and progress at their own pace, creating a highly personalized experience.

The gameplay integrates exploration and resource management, encouraging players to discover new areas such as caves for mining or fishing spots while strategically managing farm activities. Players can complete quests, attend festivals, and unlock new content as they develop their farm and build their relationships within the community. The game's pixel-art graphics and relaxing soundtrack enhance its immersive and smooth experience.

The strengths of Stardew Valley lie in its open-world exploration, resource management, and diverse gameplay activities. The open-world system provides players with a sense of freedom and discovery, allowing them to engage with the game at their own pace and explore new areas like caves and fishing spots. The resource management mechanics add depth to the gameplay, encouraging strategic thinking as players balance farm activities, mining, and crafting. The social interaction system, where players build relationships with townsfolk, introduces emotional engagement and narrative depth, making the experience more immersive. Additionally, the game's pixel-art visuals and calming soundtrack enhance the aesthetic appeal, creating a relaxing atmosphere. The variety of activities available ensures long-lasting engagement, as players can switch between farming, fishing, mining, and crafting, keeping the gameplay dynamic and engaging.

Despite its strengths, Stardew Valley has some weaknesses that may affect player engagement. The lack of a structured progression system can leave players feeling aimless,

particularly those who prefer clear objectives and guided gameplay. The slow pacing of the game, while relaxing for some, might deter players from seeking fast-paced, action-oriented experiences. Moreover, while the game excels in providing a versatile and immersive environment, it lacks specific educational content, limiting its utility as a learning tool.

2.2.3 Periodic Table Game

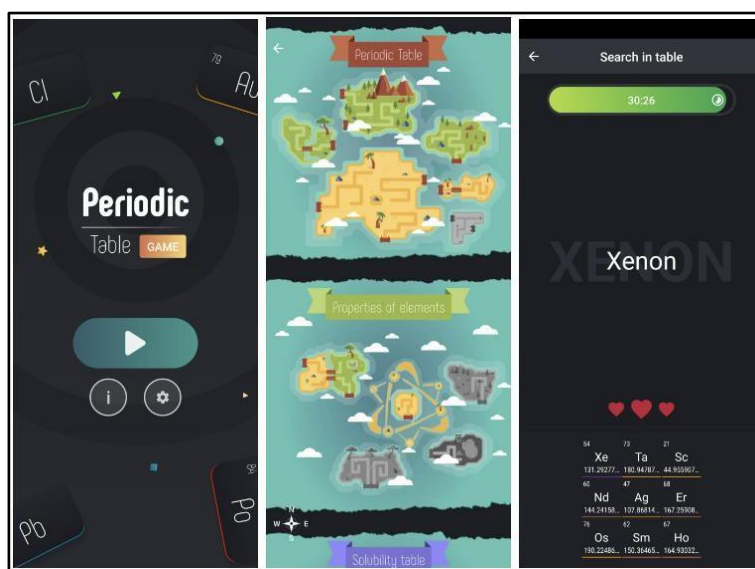


Figure 3 Periodic Table Game Interface

The Periodic Table Game is designed to help students learn and memorize the periodic table and its elements. The game typically involves matching elements with their properties, such as atomic number, symbol, or electron configuration, and often includes quizzes and timed challenges to test players' knowledge. Its straightforward design reinforces chemistry concepts, making it an effective tool for students and educators alike.

The gameplay is structured around tasks like identifying elements, completing periodic table puzzles, and answering chemistry-based questions. The game emphasizes repetition and quick recall, enabling players to improve their understanding of the periodic table in a focused and efficient manner. However, the lack of an engaging narrative or interactive exploration limits its appeal beyond strictly educational settings.

The strengths of this game are it is used for educational purposes, its design is simple and accessible, and it engages in timed challenges. Through quizzes, matching exercises, and timed challenges, the game reinforces knowledge by encouraging repetition and recall, which are crucial for mastering chemistry fundamentals. Its simple and accessible design ensures that it is easy for students and educators to use, making it a practical resource for classroom integration. Additionally, the inclusion of their performance while maintaining their engagement with the learning material.

Despite the strengths, the Periodic Table Game has limitations that may affect its appeal to a broader audience. The game lacks visual appeal and engagement, which can make it less attractive to players who prefer a more dynamic and visually stimulating experience. Furthermore, the absence of narrative or exploration mechanics reduces the game's ability to captivate players for extended periods. Its rigid focus on educational content, while valuable in academic settings, limits its entertainment value, making it less engaging for casual gamers or those seeking a more interactive and immersive experience.

2.3 Comparison of Reviewed Game Applications

The comparison of the three reviewed games reveals their unique strengths and limitations, offering valuable insights into how features from these games can be adapted and enhanced to address existing gaps in educational content can create a more impactful experience. The proposed game, ChemiMonsters, aims to leverage these insights by incorporating elements that enhance entertainment value while integrating real-world chemistry applications to facilitate learning. Table 1 below outlines the criteria used for this comparison.

Table 1 Comparison of Reviewed Game Applications

Criteria	Comparison			Proposed Game: ChemiMonster
	Pokémon Scarlet / Violet	Stardew Valley	Periodic Table Game	
Open World	✓	✓	×	✓
Map-based exploration	✓	✓	×	✓
2D Pixel Art	×	✓	×	✓
Education	×	×	✓	✓
Puzzles	✓	✓	✓	✓
Storyline	✓	✓	×	✓
Real-World Chemistry Applications	×	×	×	✓

Table 1 compares features across the proposed game and the reviewed games, emphasizing the importance of incorporating engaging and educational elements. Open World is an essential feature offering players the freedom to explore diverse environments, encouraging discovery and engagement. It is absent in the Periodic Table Game, limiting its scope of exploration and player interaction. Additionally, the map-based exploration feature

provides structured gameplay that encourages progression and interaction and it is also absent in the Periodic Table Game.

2D Pixel Art is a visual style that offers a simple yet aesthetically pleasing look that complements the gameplay. This style allows for creative character and environment design while maintaining a retro charm. From the comparison, only Stardew Valley uses 2D pixel art as its visual. Pokémon Scarlet / Violet uses 3D pixel art and the Periodic Table Game uses a minimalist design. The Periodic Table Game is uniquely designed with educational focus specifically on chemistry, making it a central feature that highlights the potential for integrating educational content effectively.

Puzzles are another important feature that all the reviewed games incorporate but in different ways. Pokémon Scarlet / Violet and Stardew Valley include puzzles primarily related to strategy and resource management, while the Periodic Table Game focuses on quiz-based challenges related to chemistry knowledge. In contrast, puzzles in an educational game could be designed to deepen understanding by directly relating to the learning material. The storyline is a key element that enhances engagement in Pokémon Scarlet / Violet and Stardew Valley as it provides players with a compelling reason to progress through the game.

The final feature, real-world chemistry applications, is not present in all the reviewed games. This feature relates to the use of elements in real-world scenarios, such as oxygen's role in combustion or helium's use in balloons because it is lighter than air. Integrating these real-world applications into educational games can make learning more relatable and engaging by showing how chemistry connects to everyday life.

2.4 Review of Tools and Technology

The development of ChemiMonsters requires the integration of several tools and technologies to ensure smooth gameplay, visually appealing graphics, and engaging puzzle mechanics. These tools have been chosen for their compatibility, ease of use, and ability to support the key features of the game. The following section details the tools used in this project:

2.4.1 Unity

Unity is a widely used game development engine known for its versatility and support for 2D and 3D games. It provides a comprehensive environment for creating interactive and visually rich gameplay. Unity offers several advantages, including a user-friendly interface, robust animation tools, and efficient asset management. Unity also supports cross-platform development, allowing the game to be optimized for various devices. Additionally, Unity was the first professional platform to offer a free license to game developers (Helgason, 2009, as cited in Young, 2021b), providing access to free assets that streamline the development process. This accessibility has made it easier for indie developers to bring their game concepts to life.

2.4.2 Pixel

Pixel art has been selected as the visual style for ChemiMonsters due to its balance of simplicity with aesthetic appeal. This style is created using tools like Pro Motion NG, which provides intuitive tools for creating detailed pixel-based characters and environments. According to Zufri et al. (2022), the simplicity of pixel art, combined with its use of vibrant colours and sharp lines, makes it easy to design memorable and iconic characters and settings that resonate in popular culture. Additionally, pixel art enhances the retro-style charm of games, adding a nostalgic and visually engaging element.

2.4.3 Origin Shift Maze Puzzle

The maze-based gameplay in ChemiMonsters draws inspiration from the Origin Shift Maze Puzzle system. According to Cantwell et al. (2022), puzzle-based game design incorporates activities tied to specific objectives, fostering player engagement and progression. This approach encourages players to navigate intricate pathways to accomplish designated goals. The maze mechanics complement the game's theme by requiring players to solve puzzles to recover scattered electrons and stabilize ChemiMonsters. Origin Shift's principles of increasing complexity and dynamic obstacles will serve as a foundation for designing engaging and challenging puzzles that enhance the overall gameplay experience.

2.5 Conclusion

This chapter reviewed existing games, tools, and technologies relevant to the development of ChemiMonsters. Through an analysis of Pokémon Scarlet / Violet, Stardew Valley, and the Periodic Table Game, key strengths such as engaging exploration, problem-solving mechanics, and educational focus were identified, along with weaknesses like lack of narrative depth or complexity in some aspects. These insights help shape the design of ChemiMonsters, ensuring it combines entertainment with educational value. Additionally, the tools and technologies chosen such as Unity for development, pixel art for visual appeal, and maze-based puzzle design for gameplay will provide a strong foundation for building a visually engaging, interactive, and purposeful game.

CHAPTER 3: Requirement Analysis and Design

3.1 Introduction

This chapter presents the process of analysing and gathering requirements for the development of the game and designing the system to meet user needs effectively. It begins by identifying the target users, and their specific needs, followed by the methods employed to gather the requirements, including a questionnaire distributed to students and potential players. Additionally, the system design section presents the structural and functional design of the game, including workflows, context diagrams, data flow diagrams, and wireframe, to ensure the game is implemented systematically.

3.2 Requirement Gathering

In this section, user requirements and software requirements are identified. A questionnaire was also made to gather the requirements of ChemiMonsters.

3.2.1 Identify the User

The target users for this game include secondary school students and casual gamers. Secondary school students may benefit from engagingly learning periodic table concepts, while casual gamers might enjoy puzzles and exploration features of the game.

3.2.2 Identify Requirement

The key requirements for the game were determined to include educational content related to the periodic table, interactive gameplay with puzzles, map-based exploration, and real-world chemistry applications. The visual appeal and ease of use were also identified as important game criteria.

Besides, the target use of hardware and software equipment for this game is a desktop or laptop device. The minimum hardware and software requirements are shown in Table 2.

Table 2 Hardware and Software Requirements

Hardware or Software	Requirements
Processor / CPU	At least Intel [®] Core [™] i5
Memory	32MB and above
Storage	32MB and above
Window	Window 10

3.2.3 Requirement Gathering

The requirement gathering process involved identifying the requirement for ChemiMonster and to goal the project objectives. A questionnaire is made to collect and analysis the data. Through the questionnaire, the problem of the learning process of periodic table can be identified.

3.2.4 Questionnaire

A questionnaire was designed to understand user preferences and challenges related to learning the periodic table and the user game preferences. The questionnaire is divided into four sections. Section A is Demographic Information, in this section, respondent is needed to provide their information such as gender, age, and study level. Section B is Knowledge and Interest in Periodic Table where this section is to explore response's current understanding in periodic

table. Section C is Concern in Understanding Periodic Table, in this section, respondent is identified on the challenges faced while studying or learning knowledge on periodic table. Finally, Section D is ChemiMonsters Interest, this section is to check response interest in playing the game and its potential appeal to target audience. The questionnaire questions are stated in APPENDIX B.

3.2.5 Questionnaire Findings

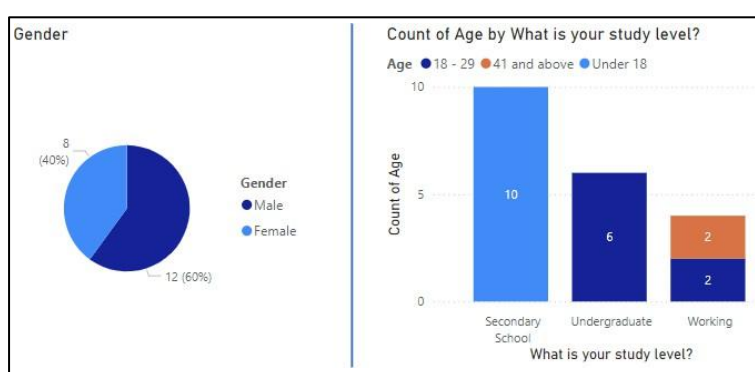


Figure 4 Demographic Information

There are 20 respondents had done the questionnaire and based on the questionnaire, the demographic information reveals that 60% of the respondents are male and 40% of the respondents are female. 50% of the respondents age are below 18 reflecting the secondary school students and 40% of the respondents are aged 18 to 29 and 10% are aged 41 and above reflecting the 30% of undergraduate students and 20% of working professionals.

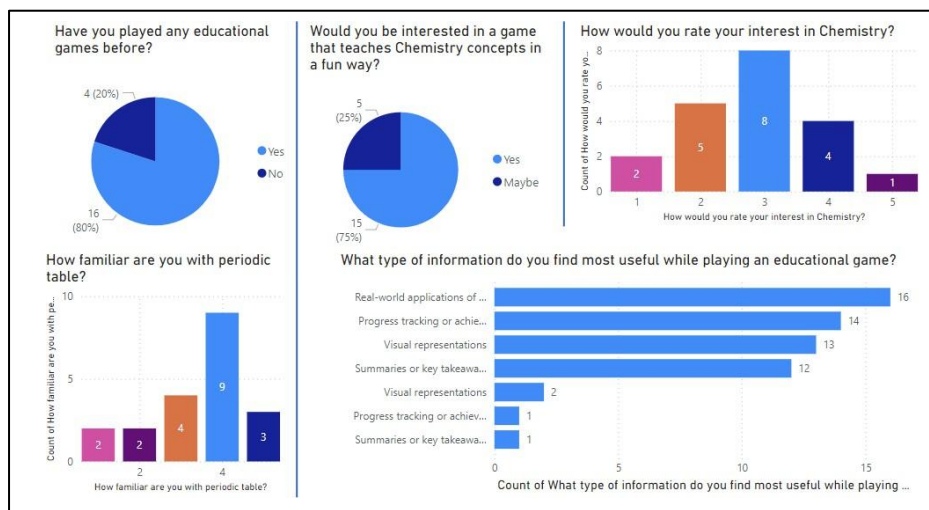


Figure 5 Knowledge and Interest in Periodic Table

In the second section, knowledge and interest in the periodic table, 80% of respondents have played educational game before, showing that gamified learning is a familiar concept for most participants. Interest in a chemical-based game was strong, with 75% expressing interest and only 25% being unsure. This indicates an openness to integrating learning and gaming. Interest in chemistry itself was rated normal distributed, with 40% giving it a score of 3 out of 5, the balance of voting on the interest reflects students or casual player have a moderately interest in chemistry. Familiarity with the periodic table showed 45% rated themselves as moderately familiar (4 out of 5), while 15% felt very familiar (5 out of 5). This aligns with the demographic data, as secondary school students may still in the early stages of learning. Besides, respondents highlight the type of information that most useful while playing an educational game are real-world applications of concepts (80%), visual representation (75%), summaries or key takeaways at the end of levels (65%), and progress tracking or achievements (75%).

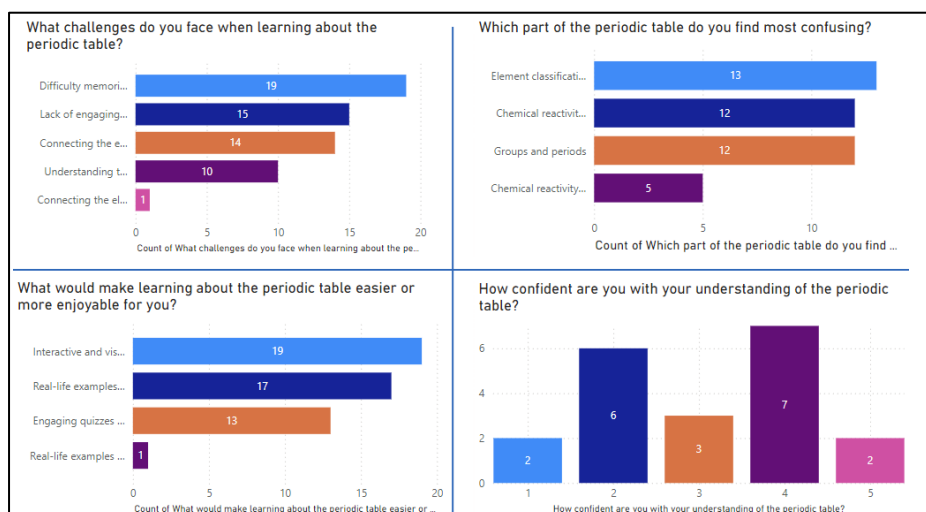


Figure 6 Concern in Understanding Periodic Table

For section C, the most prevalent issue faced by respondents was the difficulty in memorizing element names and symbols, which contains 95% of the respondents chose it. Similarly, 75% of the respondents struggled to connect elements to real-world applications or found existing learning materials unengaging, indicating a gap in traditional teaching methods. Understanding the organisation and structure of the periodic table (50%) was another hurdle, which may be due to its abstract representation. The most confusing part of the periodic table is chemical reactivity of elements showed 85% higher than element classification (65%), and groups and periods (60%). These finding highlights why an engaging and interest game is needed. Besides, respondent suggested solutions like interactive and visual learning materials (95%), real-life examples (90%), and engaging quizzes and puzzles (65%) is needed for letting them to learned well in periodic table. Last questionnaire question for this section is asking respondent stating their confident level of understanding of the periodic table and only 35% of them stated they are moderately confident and 30% stated they are moderately unconfident. This indicates that the respondent are only have knowledge but not confident in understanding on periodic table.

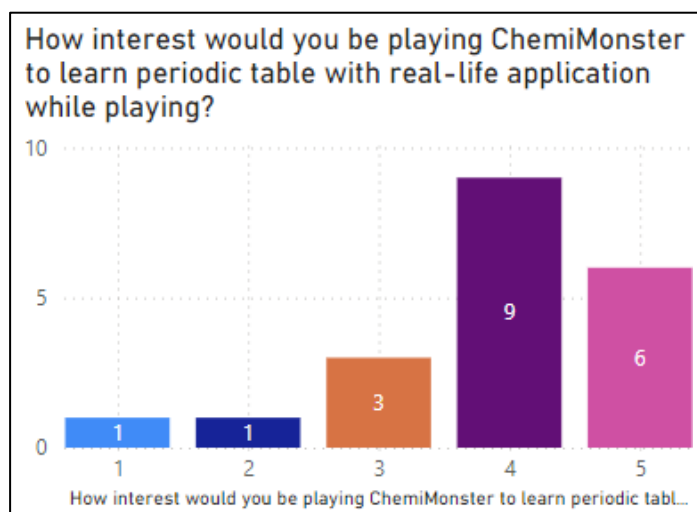


Figure 7 ChemiMonster Interest

Finally, in section D, nearly half (45%) of the respondent rated their interest at level 4 and 30% at level 5, indicating that most respondents found the concept appealing. This strong interest may stem from the game's focus on integrating real-life applications with gamified learning, which aligns with their features respondents prioritized.

3.3 System Design

The system design serves as a blueprint for the development of the game, ensuring that all components work together seamlessly to achieve the project's objectives. It translates the requirements gathered from users into a structured plan that includes system architecture, workflows, content organization, and data management. This design phase focuses on creating a cohesive framework that integrates gameplay mechanics, educational content, and user interaction to provide an engaging experience.

3.3.1 System Architecture Diagram

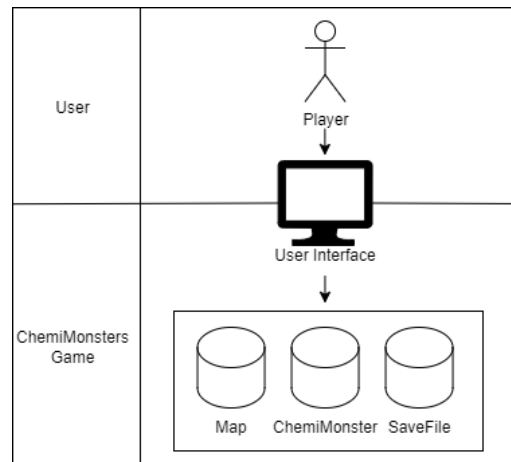


Figure 8 System Architecture Diagram

Figure 8 shows the system architecture diagram for the ChemiMonsters game. It consists of two primary sections, User and ChemiMonsters Game.

In the User section, the central actor is the Player, who interacts with the game through the User Interface. The player performs essential gameplay actions such as exploring maps, capturing ChemiMonsters, and managing their progress. The User Interface serves as the medium connecting the player to the game's internal functionality, ensuring a smooth and intuitive experience.

The ChemiMonsters Game section is where the core functionality resides. It includes three primary databases, Map, ChemiMonster, and SaveFile. The Map database stores details about the game's locations. The ChemiMonster database maintains information about the monsters. Besides, the SaveFile database manages player progress.

The architecture emphasizes the interaction between the User Interface and the backend databases. The user interface retrieves data from the databases to display information about maps, ChemiMonsters, and save files to the player. Simultaneously, it updates the databases to store the player's progress and interactions. This structured design ensures efficient gameplay management and a seamless user experience.

3.3.2 Workflow of ChemiMonsters

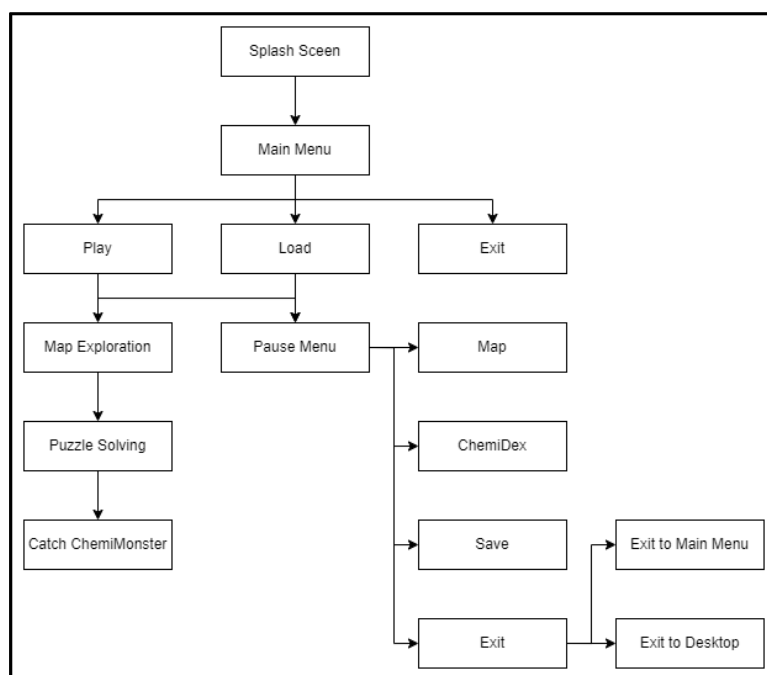


Figure 9 Workflow of ChemiMonster

Figure 9 above illustrates the workflow of the game. Initially, players encounter the splash screen, where they must press any key to proceed to the main menu. The main menu features three options (Play, Load, and Exit). For new players, only the Play and Exit buttons are active, while the Load button is disabled and visually distinct to indicate its inaccessibility.

Upon selecting either Play or Load button, players are taken into the game. During the gameplay, players can pause the game, revealing a submenu with options for Map, ChemiDex, Save, and Exit. The Map option provides an overview of the entire game world and indicates the player's current location. The ChemiDex option displays information about Chemi Monsters captured and details about the properties of elements from the periodic table. However, only the monsters that have already been captured will appear. The Save button allows players to save their current progress.

The Exit button in the main menu enables players to close the game entirely, while the Exit button in the submenu gives players the choice to either return to the main menu or exit the game directly.

While playing the game, there are three primary workflows to enhance player engagement and interaction. After the “Play” and “Load” button from the main menu, players are immersed in an exploratory phase where they can navigate through the map. Along the way, players are presented with puzzle-solving challenges. After successfully solving these puzzles, the player may catch the ChemiMonster.

3.3.3 Context Diagram

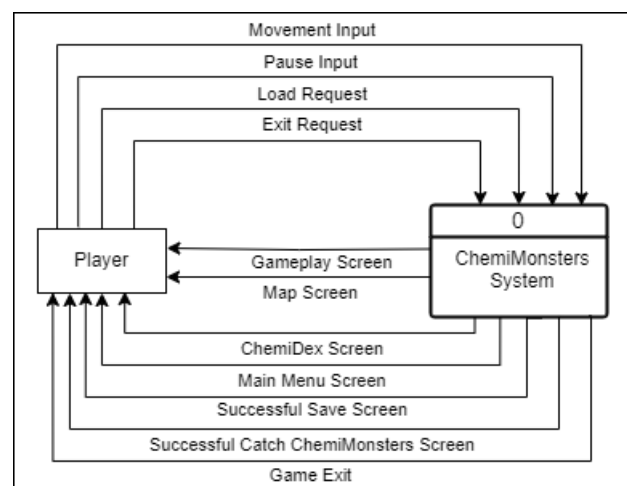


Figure 10 Context Diagram

Figure 10 illustrates the interaction between the Player and the ChemiMonsters System. It highlights the key inputs, outputs, and system responses that occur during gameplay.

The Player interacts with the system primarily through movement inputs such as pressing keys for movement ("W," "A," "S," "D") or performing pause input like "Space" or "P" to pause the game. The player can also send requests to load a game, save progress, or exit the game entirely.

The ChemiMonsters System processes these inputs and responds with various outputs to enhance the player's gaming experience. For instance, the system displays the gameplay environment, including the map for exploration, the ChemiDex for viewing details about captured ChemiMonsters, and confirmation messages for successful saves or catches of ChemiMonsters. When the player opts to exit the game or return to the main menu, the system processes these requests and performs the necessary transitions.

3.3.4 Level 0 Data Flow Diagram

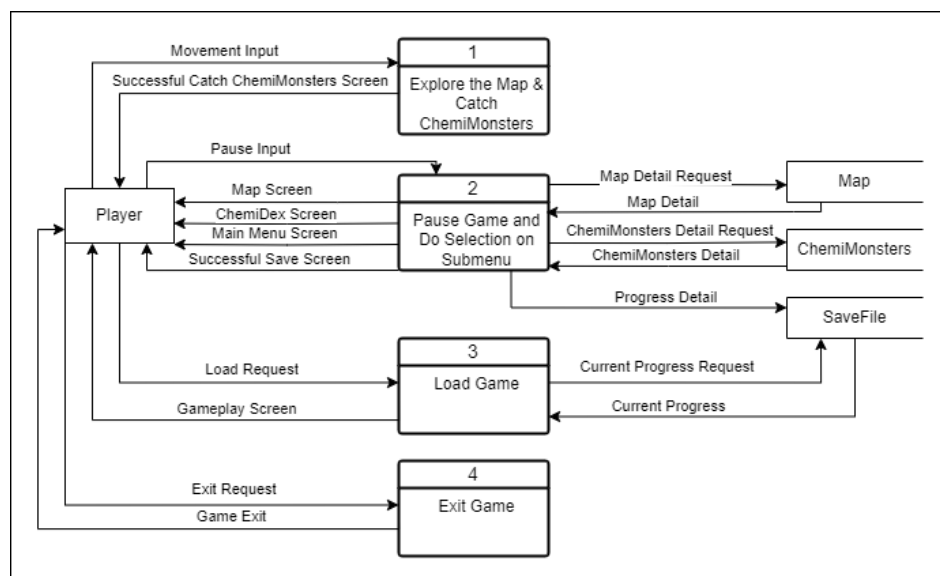


Figure 11 Level 0 Data Flow Diagram

Figure 11 above illustrates the Level 0 Data Flow Diagram of the ChemiMonsters system, highlighting the primary processes and their interactions with the player and databases.

The first process, Explore Map and Catch ChemiMonsters, allows the player to use movement inputs (“W,” “A,” “S,” and “D”) to navigate the map and interact with ChemiMonsters. Upon successfully catching a ChemiMonster, the system displays a successful catch ChemiMonsters screen, providing feedback to the player.

The second process, Pause Game and Do Selection on Submenu, is triggered when the player presses pause input, “Space” or “P”, to pause the game. The system can access the Map

Database to retrieve map details and display the map screen to the player. Similarly, the system can query the ChemiMonsters Database for details about captured ChemiMonsters and display this information in the ChemiDex. If the player chooses to save their progress, the system writes progress details to the Savefile Database and displays a "successfully saved game" message. Alternatively, if the player selects "exit to main menu," the system navigates back to the main menu.

The third process, Load Game, allows the player to request a previously saved game. The system retrieves the current progress from the SaveFile Database and displays the gameplay corresponding to the saved state.

The final process, Exit Game, is initiated when the player requests to exit the game. The system processes the request and terminates the game session.

3.3.5 Level 1 Data Flow Diagram for Explore The Map and Catch ChemiMonsters

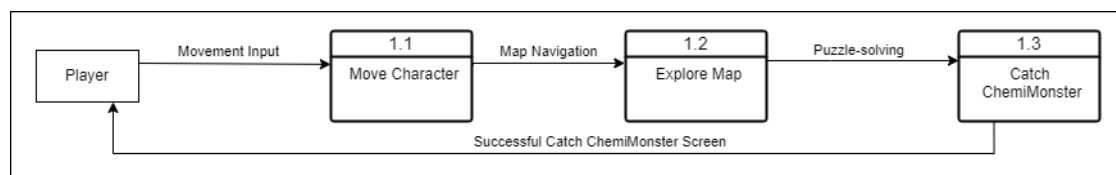


Figure 12 Level 1 Data Flow Diagram for Explore the Map and Catch ChemiMonsters

Figure 12 illustrates the Level 1 Data Flow Diagram, detailing the subprocesses of the Explore Map and Catch ChemiMonsters process.

The first subprocess, 1.1 Move Character, requires input from the player using the movement input ("W," "A," "S," and "D"). These inputs allow the character to navigate the game environment, producing an output that moves the player around the map and transitions into the 1.2 Explore Map process.

In the 1.2 Explore Map process, the system identifies areas where the player encounters puzzles. Upon reaching these puzzle zones, the player can engage in puzzle solving. Successful

completion leads to the 1.3 Catch ChemiMonster process, where the system facilitates the capture of a ChemiMonster. The process concludes by displaying a successful catch ChemiMonster screen to the player, providing feedback and reinforcing progress in the game.

3.3.6 Level 1 Data Flow Diagram for Pause Game and Submenu Selection

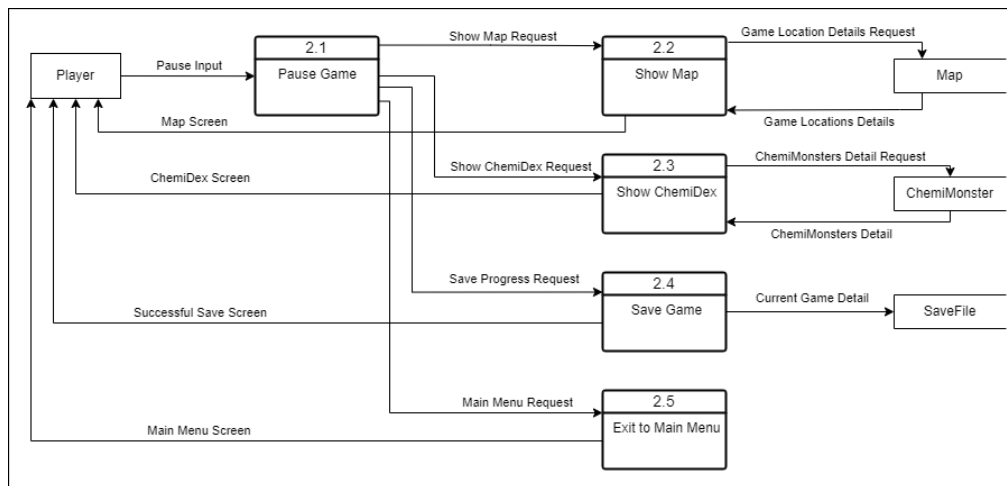


Figure 13 Level 1 Data Flow Diagram for Pause Game and Submenu Selection

Figure 13 illustrates the Level 1 Data Flow Diagram for the Pause Game and Do Selection on Submenu process. The 2.1 Pause Game process is initiated when the player presses pause input, "Space" or "P", leading to four possible outputs: 2.2 Show Map, 2.3 Show ChemiDex, 2.4 Save Game, and 2.5 Exit to Main Menu.

The 2.2 Show Map process receives a request from the player to display the map. It queries the GameMap Database for the player's current location and map details, retrieves this information, and processes it to display the map to the player. The 2.3 Show ChemiDex process handles a request to show the ChemiDex, retrieving ChemiMonsters details from the ChemiMonsters Database and displaying them, enabling the player to view information about captured ChemiMonsters.

The 2.4 Save Game process is triggered when the player chooses to save their progress. The system sends the current game details to the SaveFile Database and confirms the successful

save with a message displayed to the player. Lastly, the 2.5 Exit to Main Menu process processes a request to exit to the main menu, transitioning the game to display the main menu interface.

3.3.7 Entity Relationship Diagram

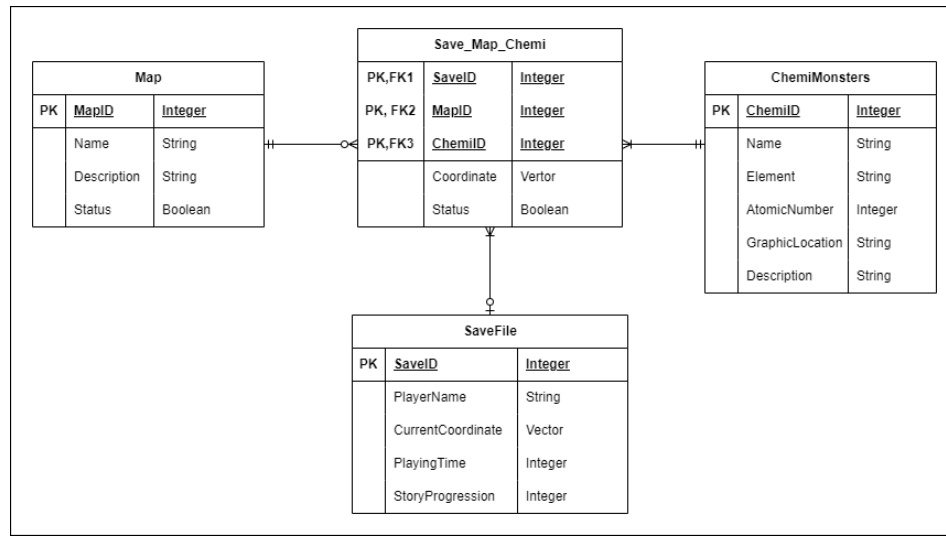


Figure 14 Entity Relationship Diagram

The Entity-Relationship Diagram (ERD) for the ChemiMonsters system defines the relationships between its core entities: Map, Save_Map_Chemi, ChemiMonsters, and SaveFile. These entities, along with their relationships, are designed to structure the game's data efficiently, facilitating gameplay and progress tracking.

The Map entity represents the various locations in the game world, serving as the foundation for exploration and encounters with ChemiMonsters. It includes the primary key, MapID, which uniquely identifies each map. The Name attribute stores the name of the location, while Description provides contextual details about the area. Additionally, the Status attribute, a Boolean value, indicates whether the location is unlocked, enabling the game to manage player progression effectively.

The ChemiMonsters entity stores details about monsters representing elements from the periodic table, highlighting the game's educational focus. It includes ChemiID as the primary key to uniquely identify each monster. The Name attribute holds the monster's name, while Element stores the corresponding chemical symbol, such as "O" for Oxygen. The AtomicNumber attribute records the atomic number of the element, for example, 8 for Oxygen. The GraphicLocation specifies the file path to the monster's graphical representation, and the Description provides information about the monster and its associated element, enriching the player's learning experience.

The SaveFile entity manages the player's progress and game state. Identified by the primary key, SaveID, it includes PlayerName, which records the player's identifier, and CurrentCoordinate, which stores the player's position in the game world. The PlayingTime attribute tracks the total playtime in seconds, while StoryProgression records the player's current level or stage in the storyline. These attributes ensure that progress is saved and can be restored seamlessly for uninterrupted gameplay.

The Save_Map_Chemi entity serves as an associative table linking the Map, ChemiMonsters, and SaveFile entities. It is identified by a composite primary key consisting of SaveID, MapID, and ChemiID, allowing a specific ChemiMonster to be tracked within a particular map and save file. Additional attributes include Coordinate, which specifies the ChemiMonster's location within the map, and Status, a Boolean value indicating whether the monster has been caught. These attributes provide detailed insights into the player's interactions with maps and ChemiMonsters.

The relationships between the entities emphasize their interdependence. A Map can have multiple associations in Save_Map_Chemi, linking it to ChemiMonsters and SaveFile. Each ChemiMonster is associated with a single map through Save_Map_Chemi, and this entity

also links to SaveFile to ensure accurate tracking of player progress across maps and monsters. This design supports the game’s core mechanics, enabling exploration, monster capture, and efficient progress management.

3.3.8 Data Dictionary

Below shows four tables on data dictionary of the four database that will be created, Map, ChemiMonsters, SaveFile, and the interconnected database Save_Map_Chemi.

Table 3 Map Database Data Dictionary

Field Name	Data Type	Data Format	Field Size	Description	Example
MapID	Integer	NN	2	Unique number ID for map location	12
Name	String		20	Location Name	Oxologon City
Description	String		50	Description of the location	The place where born of the Oxy Monster
Status	Boolean		1	Status on the location is locked or unlocked (true – unlocked, false - locked)	true

Table 4 ChemiMonsters Database Data Dictionary

Field Name	Data Type	Data Format	Field Size	Description	Example
ChemiID	Integer	NN	2	Unique number ID for ChemiMonsters	12
Name	String		20	ChemiMonsters Name	Maca
Element	String		20	Element Symbol of the ChemiMonster	Mg
AtomicNumber	Integer	NN	2	Atomic Number for the element	12
GraphicLocation	String		50	File location of the ChemiMonster Picture	/image/monster /maca.png
Description	String		50	The description of the ChemiMonster	It light bright when it reach to the fire

Table 5 SaveFile Database Data Dictionary

Field Name	Data Type	Data Format	Field Size	Description	Example

SaveID	Integer	NN	2	Unique number ID for save file	12
PlayerName	String		20	Player Name	Lokers
CurrentCoordinate	Vector	(X, Y)	2	Current position coordinate of player	{“x”: 1.0, “y”: 2.0}
PlayingTime	Integer	NNNNNNN	20	The play time that played by player in second	43200
StoryProgression	Integer	NN	2	The progress of player in stories, 1 indicates still in the first story line and so on	12

Table 6 Save Map Chemi Database Data Dictionary

Field Name	Data Type	Data Format	Field Size	Description	Example
SaveID	Integer	NN	2	Unique number ID for save file	12
MapID	Integer	NN	2	Unique number ID for map location	12

ChemiID	Integer	NN	2	Unique number ID for ChemiMonsters	12
Coordinate	Vector	(X, Y)	2	The coordinate of the ChemiMonsters allocate	{"x": 1.0, "y":2.0}
Status	Boolean		1	Status on the ChemiMonster is been captured or not (true – captured, false – not captured)	true

3.3.9 Wireframe

In this section, the wireframe of the game and its details is stated and it is represents by skeletal structure of the application's user interface and outlining the process, layout, design elements, and navigation flow of the game.

3.3.9.1 Splash Screen and Main Menu Wireframe

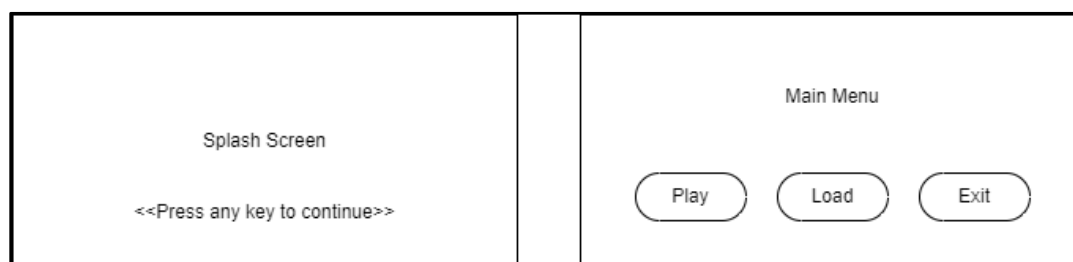


Figure 15 Splash Screen and Main Menu Wireframe

Figure 15 shows the wireframe of splash screen and main menu. The splash screen and main menu background will display the ChemiMonster drawing to engage player to play the game. On splash screen, it contains “<<Press any key to continue>>” instruct player to press any key to continue to main menu. For main menu screen, there are three button to allow player to choose to play a new game, load previous game or exit the game. After clicking the play button and the load button, player will be prompt to the game play screen.

3.3.9.2 Game Wireframe

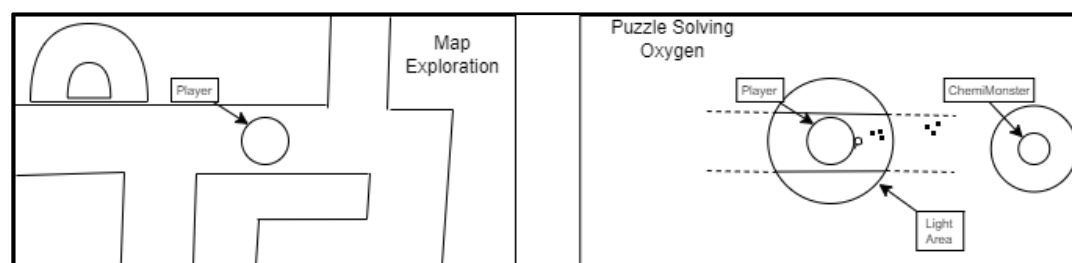


Figure 16 Game Wireframe

Figure 16 shows wireframe of the game where player can explore the map. In the map exploration screen, the navigates through a structured map filled with pathways and obstacles. The puzzle screen highlights the interaction with ChemiMonster, in this case, the Oxygen monster. The puzzle involves positioning the player character within a specific “light area” or zone that activates the capturing mechanism. Together with the map exploration and puzzle

solving wireframe, its demonstrate how the game combines exploration and problem-solving to create an engaging and interactive experience for players.

3.3.9.3 Submenu Wireframe

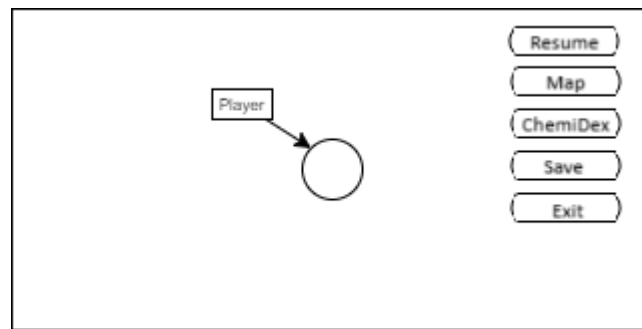


Figure 17 Submenu Wireframe

Figure 17 shows the submenu wireframe after the player clicked “space” button or “P” button. There will be 4 button on the right such as “Map”, “ChemiDex”, “Save”, and “Exit” buttons. The wireframe after the buttons is clicked is shown below.

3.3.9.4 Map Wireframe

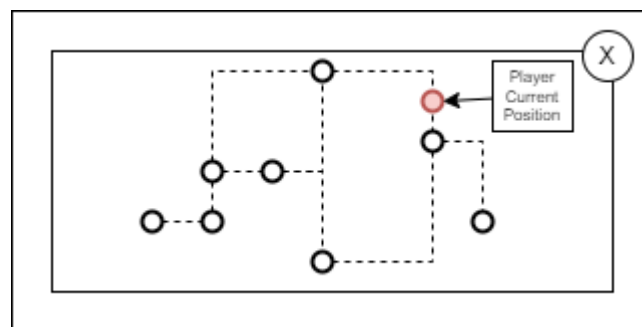


Figure 18 Map Wireframe

After the “Map” button is clicked in Figure 17, Figure 18 will prompt to player. The map screen visually represents the player’s current position and the whole game world map. The highlighted circle in the wireframe indicates the player current position and the non-highlighted circle in wireframe indicates the towns available in the whole map.

3.3.9.5 ChemiDex Wireframe

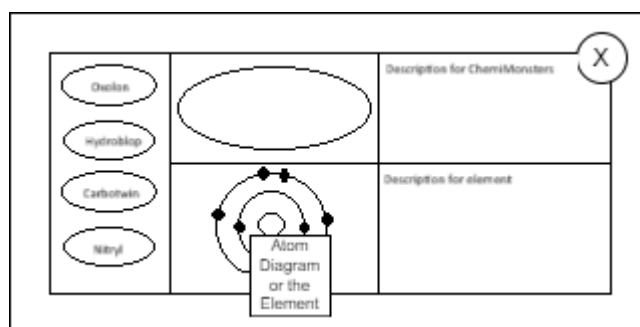


Figure 19 ChemiDex Wireframe

Figure 19 above shows the wireframe of ChemiDex where it shows after the “ChemiDex” button in submenu is clicked and the player successfully catch the ChemiMonster. In the ChemiDex screen, there will be a dropdown list of unlocked chemistry element. After the element is clicked, it will shows the details of the ChemiMonster providing with an image of the ChemiMonster, the atom diagram of the element, in-game details of the monster and the real-world properties of the element.

3.3.9.6 Successfully Save Wireframe

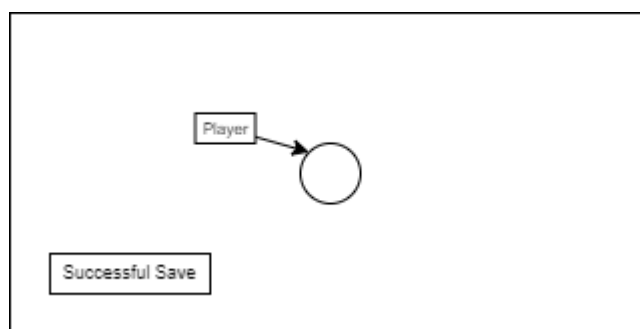


Figure 20 Successfully Save Wireframe

Figure 20 shows a little message “Successful save” pop out on the left bottom after the player choose the save option in Figure 17 (Submenu). This screen confirms that the player’s progress has been successfully saved.

3.3.9.7 Exit Page Wireframe

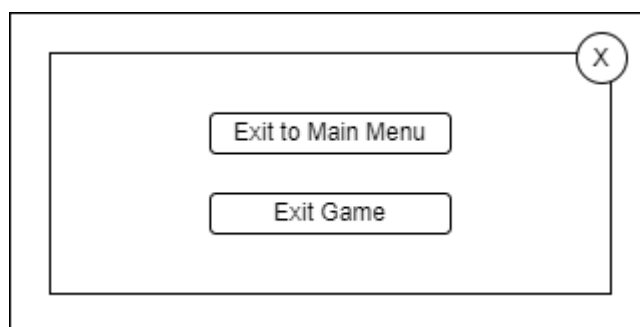


Figure 21 Exit Page Wireframe

Figure 21 above shows a screen with 2 options after the option “Exit” in submenu is clicked. There are two options provides to the player, “Exit to Main Menu”, and “Exit Game”. The “Exit to Main Menu” options allow the player to exit the current progress and exit to the main menu, while the “Exit Game” options allow the player to close the game immediately.

3.4 Conclusion

In conclusion, this chapter outlined the systematic approach to gathering and analysing the requirements for the development of ChemiMonsters, ensuring the game addresses the needs of its target users effectively. By employing a well-structured questionnaire, valuable insights were obtained regarding user demographics, challenges in learning the periodic table, and preferences for gamified learning. The findings highlighted the necessity of integrating interactive gameplay, visual learning tools, and real-world applications to enhance engagement and knowledge retention. Additionally, the system design, including workflows, context diagrams, and data flow diagrams, provided a comprehensive blueprint to guide the game’s development. These efforts ensure that ChemiMonsters will deliver an engaging and educational experience, meeting both the functional and aesthetic expectations of its players.

CHAPTER 4: Implementation

4.1 Introduction

This chapter presents the practical development and implementation of the ChemiMonsters game by detailing how the concept was transformed into a working prototype. This part demonstrates how the data, research findings, and user needs described in Chapter 2 were turned into actual game features. Besides, this chapter will also give an overview of the main game aspects that have been developed, including the splash screen, menus, gameplay mechanics, user interface, and instructional components, follows the introduction of the tools and technologies utilized during the development process. Every aspect of the game is described, paying particular attention to how it affects learning objectives and user engagement. To bring the ChemiMonsters experience to life, this chapter also considers the development choices taken, the difficulties faced, and how they were solved.

4.2 Implementation Tools

To bring ChemiMonsters to life, a variety of tools and platforms were utilized, each playing a unique role in the game development pipeline. These tools supported different aspects of development such as coding, artwork, sound design, and gameplay integration.

4.2.1 Unity

Unity served as the primary game development engine for ChemiMonsters. With Unity Hub and Unity Engine (2022.3.47f1 Version), the game's 2D environment was built, including scene creation, character and ChemiMonsters animations, gameplay mechanics, and user interactions. The engine also enables seamless integration of visual assets, audio elements, and custom scripts, forming the core of the gameplay experience.

4.2.2 Pro Motion NG

Pro Motion NG was used to design and edit the pixel art assets for the game. This tool allowed precise control over sprite creation, animation frames, and environmental textures. Characters like the ChemiMonsters and NPCs, and various UI components were crafted using this software to match the game's retro pixel art aesthetic.

4.2.3 Visual Studio Code

Visual Studio Code was the main programming environment used to write and edit C# scripts and JSON configuration files. The editor's lightweight interface, code intelligence features, and Unity integration made it effective for scripting game behaviour, managing data files, and debugging.

4.2.4 BandLab and Freesound

BandLab was employed to compose the game's background music and generate custom audio tracks, while Freesound.org provided free sound effects such as explosion, fire extinguish, and freeze wate. These audio tools enhanced the atmosphere of the game, making gameplay more immersive and dynamic.

4.2.5 Unity Free Assets

Several free assets from the Unity Asset Store were integrated into the game to accelerate development and improve visual presentation. These included:

- City Pack – Top Down – Pixel Art
- Footsteps – Essentials

- House Interior Tile set 32x32 LITE
- Pixel Art Menu Package (5 sets).

These assets were instrumental in crafting detailed environments and interactive elements efficiently.

4.3 Application Implementation

This section details the practical implementation of various features in ChemiMonsters, showcasing how each screen and system contributes to a complete gameplay experience. The development focused on user engagement, intuition navigation, and consistent theme design throughout the application.

4.3.1 Splash Screen



Figure 22 Splash Screen

Figure 22 shows the splash screen of ChemiMonsters. It serving as the first vision introduction to the game. The screen prominently features the game's title, set against a background of three key ChemiMonsters, Oxolon, Hydroblop, and Nitry, ChemiMonsters that represents the elements Oxygen, Hydrogen and Nitrogen. This vibrant trio was chosen to spark curiosity and excitement from the moment the game launches. At the bottom of the title, a

simple prompt, “Press any key to continue”, guiding player to click any key to continue to the main menu screen.

4.3.2 Main Menu



Figure 23 Main Menu

Figure 23 presents the main menu of ChemiMonsters, which appears after the player presses any key on the splash screen. In a smooth animation, three buttons fly in from the bottom to their designed positions, adding a dynamic touch to the interface. This main menu act as the game’s central hub, offering three core options such as starting a new adventure with the “Play” button, opening the Load Panel to continuing the previous game with the “Load” button, or exiting the game with the “Exit” button. The background design carries forward the ChemiMonsters splash screen design to ensure a cohesive and immersive visual experience.

4.3.3 Pause Submenu

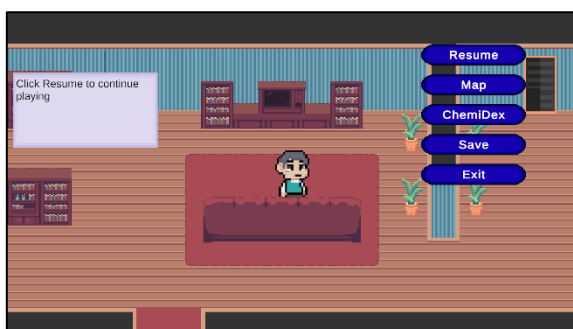


Figure 24 Pause Submenu

Figure 24 illustrates the in-game pause submenu, which appears on the right side of the screen when player presses the “P” key during gameplay. This overlay provides quick and intuitive access to several essential options such as “Resume”, “Map”, “ChemiDex”, “Save”, and “Exit”. The “Resume” button allows player to return to the game seamlessly. The “Map” button opens the game’s map panel, helping players understand their current location. The “ChemiDex” button leads to the ChemiDex panel, where players can view collected ChemiMonsters. The “Save” option lets players save their current progress, while “Exit” directs them to the exit panel. This design ensures that players can pause and manage various aspects of the game without interrupting the overall flow of gameplay.

4.3.4 Maps Panel



Figure 25 Maps Panel

Figure 25 displays the map panel, which appears when the player clicks the “Map” button in the pause submenu. This panel provides a visual overview of the ChemiMonsters game world, helping players understand the layout and navigate between different locations. The map illustrates key routes, such as paths from the city to the forest and from the forest to the cave. Each location is represented by a square icon. The player’s current position is clearly highlighted in red, while other available locations are marked in white. Besides showing the current and available locations, each icon on the map is interactive and can be clicked to reveal

a description of the selected place. These descriptions appear in a designated text area below the map and provide narrative or contextual information about the environment. This enriches the player's understanding of the game world and adds a layer of storytelling to the exploration experience.

4.3.5 ChemiDex Panel



Figure 26 ChemiDex Panel Displaying Caught ChemiMonsters



Figure 27 ChemiDex Panel Displaying Uncaught ChemiMonsters

Figure 26 and Figure 27 show the ChemiDex Panel, which is accessed by clicking the “ChemiDex” button in the pause submenu. The ChemiDex serves as an in-game encyclopedia, allowing players to review both captured and uncaptured ChemiMonsters along with their corresponding real-world chemical elements. On the left side of the panel, it shows a scrollable list displays available elements buttons and detailed information about the selected ChemiMonster can be reveal after clicking one of the buttons.

The right side of the panel is divided into four sections. The top-left shows the image of the ChemiMonster, while the top-right contains a description of its appearance and traits. The bottom-left displays an atom structure diagram, with coloured squares representing the number of ChemiMonsters the player has caught and black squares indicating those yet to be caught. The bottom-right provides detailed information about the associated chemical element including its group and period in the periodic table, organization (metal, nonmetal, or metalloid),

atomic mass, melting and boiling points, and real-life examples of its uses (e.g., oxygen tanks, combustion, and respiration for Oxygen). All elemental descriptions and properties displayed within the ChemiDex panel are sourced from the KSSM Chemistry Form 4 textbook (Isqyaacob, 2020), ensuring direct alignment with the national educational curriculum.

Figure 26 illustrates a ChemiDex entry for a caught ChemiMonster, whereas Figure 27 displays an uncaught entry. In the latter, the ChemiMonster image is replaced with a “?”, the atom structure shows a default placeholder, the description is replaced with a “Catch ChemiMonster to unlock!” message, and the element info appears as “???”. This setup is made to encourages players to continue exploring the game world and capturing ChemiMonsters to unlock more content and knowledge.

4.3.6 Save and Load Panel

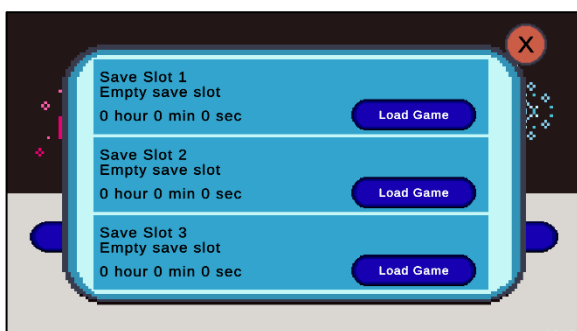


Figure 28 Load Panel



Figure 29 Save Panel

Figure 28 shows the Load Panel, which appears after “Load” button is clicked in main menu, while Figure 29 shows the Save Panel, which accessed through “Save” button in the pause submenu. These panels form the core of the game’s save system, enabling players to store their progress at any point and return to it later.

Both panels display three boxes representing only three save slots available. The three boxes contain the player’s name and the total time played by the player. Besides, the primary difference lies in their function and interface. In the load panel, each slot includes a “Load

Game” button that allows players to resume a previously saved game. In the save panel, each slot features a “Save” button that stores the current game progress into the selected slot. Additionally, in the save panel, a “Successful Save” message appears at the bottom-left of the screen after the game is successful saved, providing visual feedback to the player.

4.3.7 Exit Panel



Figure 30 Exit Panel



Figure 31 Save Before Exit Panel

Figure 30 shows the Exit Panel, which appear after the player clicks “Exit” button in the pause submenu. This panel presents two options which is “Exit to Main Menu” and “Exit Game”. Upon selecting either option, a confirmation panel appears, as shown in Figure 31.

Figure 31 illustrates the Save Before Exit Panel, which prompts the player with message “Doo You Want to Save the Game Before Exit?”. This additional step ensures players don’t accidentally lose progress. If the player selects “Yes”, player will be redirected to the save panel while if player selects “No”, the game will proceed with the original exit option.

4.3.8 Opening Story Telling Scene

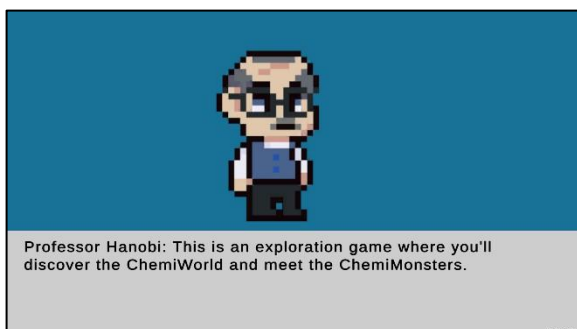


Figure 32 Opening Story Telling Scene

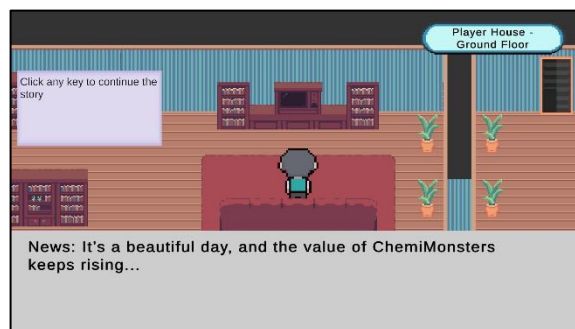


Figure 33 In Game Opening Story Telling Scene

Figure 32 shows opening story telling scene appears when a new game is started. In this scene, players are introduced to the game world by Professor Hanobi, an in-game character. In this scene, he explains the purpose and concept of ChemiMonsters. This serves as a narrative hook to immerse players right from the beginning. This scene layout features the storytelling text at the bottom of the screen, similar to NPC dialogue in other games.

Figure 33 presents the next part of the storytelling sequence, which appears after the player enters their name. A tutorial-style text box is displayed on the right side of the screen, providing novice guidance on how the game progresses. This helps players understand the basic flow and mechanics, ensuring a smooth onboarding experience for first-time players.

4.3.9 Change Scene



Figure 34 Scene after player exits the house

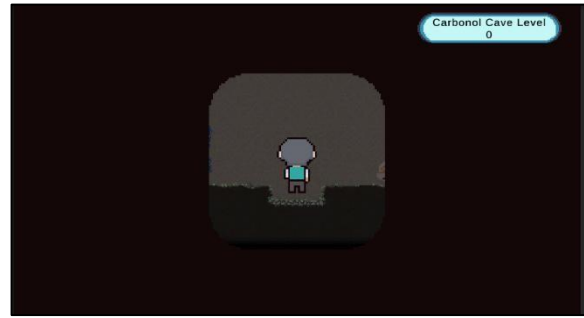


Figure 35 Scene after player enters the cave

Figure 34 and Figure 35 illustrates the dynamic scene transitions that occur as the player moves from one location to another within the game environment. These transitions are triggered by interacting with designed scene teleporters, such as doorways, cave entrance, tower entrance, and staircase. When a scene change occurs, a location notification appears on the top-right corner of the screen, displaying the name of the new area. This feature helps orient the player by indicating their current location in the game world, enhancing spatial awareness and gameplay continuity.

4.3.10 Interaction Scene

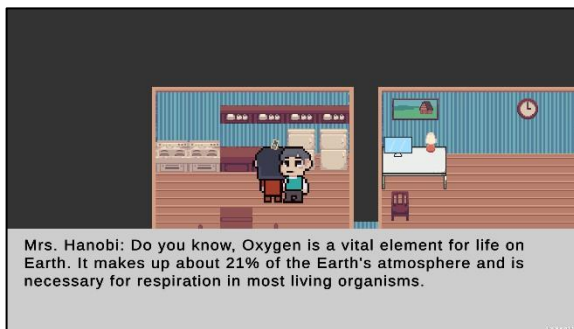


Figure 36 Interaction Scene with NPC

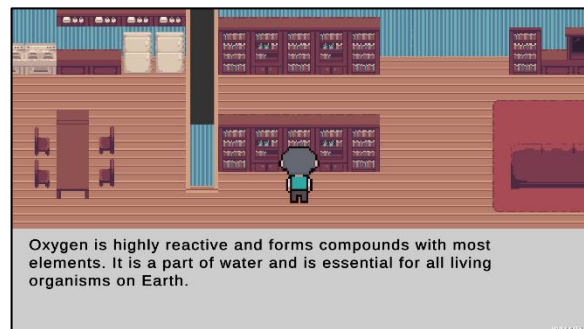


Figure 37 Interaction Scene with Item

Figure 36 and Figure 37 shows Interaction Scene, which is triggered when the player interacts with either NPCs or interactive items within the game world. When engaging with an NPC, a dialogue box appears at the bottom of the screen, displaying the character's conversation with the player, adding narrative depth and personality to the game environment. On the other

hand, when players interact with items such as shelves, a text dialogue appears containing information details about chemical elements or other relevant scientific facts. This feature enriches the gameplay by blending exploration with educational value, encouraging players to learn through interaction.

4.3.11 Game Animation



Figure 38 Player Sprites

Figure 38 showcases the character animation sprites used in ChemiMonsters. The top section of the figure displays the idle sprites of the player character facing four directions (up, down, left, right). These frames are used when the character is stationary, helping convey presence and orientation in the game world.

The bottom section presents the walking animation, consisting of eight frames showing the player moving to the right. Similar frame sequences are created for walking in the remaining three directions to ensure smooth and responsive motion in all directions. Besides, NPC characters are also animated with their own directional and idle sprites, making the game world feel more dynamic and alive. These animations enhance immersion and visual feedback, allowing players to feel more engaged during interactions and movement throughout the environment.

4.3.12 Game Logic



Figure 39 Before Catch ChemiMonsters



Figure 40 After Catch ChemiMonsters

Figure 39 and Figure 40 illustrate the core catching mechanic of ChemiMonsters. When player encounters a ChemiMonster in the game world, they can walk towards it to initiate an interaction. As shown in Figure 39, the ChemiMonster remains idle in the field until player interact by walk near to it. Once the player walks near the ChemiMonster, an interaction screen will appear, as shown in Figure 40, indicating that the player has successfully caught the ChemiMonster. This screen provides instant feedback, reinforcing the achievement and encouraging further exploration.

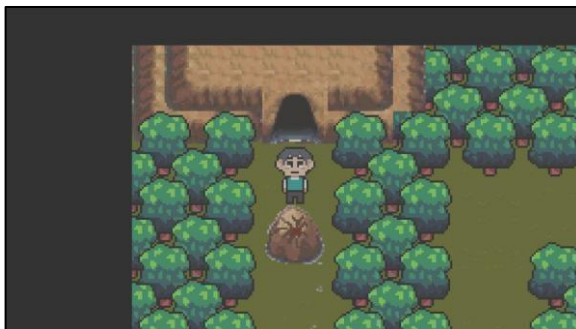


Figure 41 Rock Obstacle Blocking

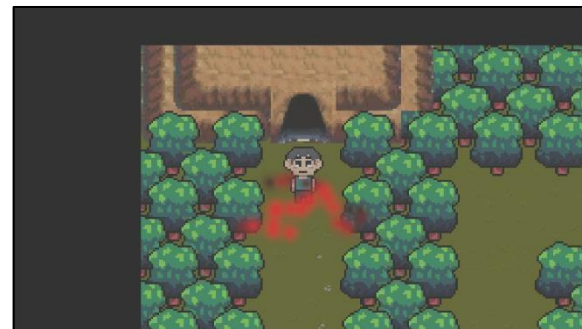


Figure 42 Rock Obstacle Disappear

Additionally, game logic is applied to environment progression. For example, Figure 41 shows a scenario where a rock obstacle blocks the player's path. This rock cannot be passed until player has acquired certain ChemiMonsters or items. Once the required condition is met, the rock will explode or disappear, as shown in Figure 42, allowing the player to walk through

previously inaccessible areas. This mechanic adds a puzzle-solving layer to the gameplay and gives purpose to collecting specific elements.

4.3.13 ChemiMonsters Designed and Created

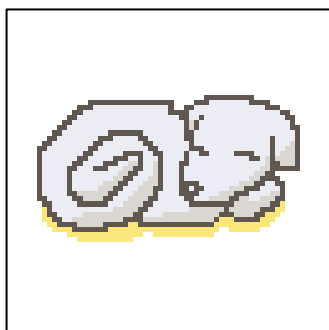


Figure 43 Oxolon



Figure 44 Hydroblop

Figure 43 shows Oxolon, the ChemiMonster representing oxygen. It is designed as a dog and cloud because oxygen is vital for human survival, and it's often said that pets, particularly dogs, are essential companions in life. The cloud aspect further emphasizes oxygen's omnipresent nature in the atmosphere.

Figure 44 shows Hydroblop, the ChemiMonster that represents hydrogen. It is designed as a fish because when a lighted splint is placed in hydrogen gas, it produces a distinctive "pop" sound. This sound is reminiscent of bubbles popping, and fish are commonly associated with bubbles, making the design visually and audibly evocative of hydrogen's properties.

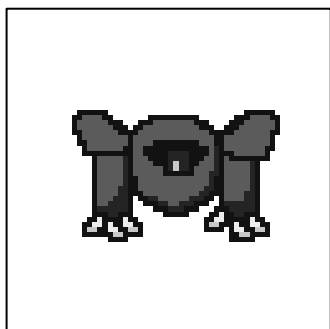


Figure 45 Carbotwin

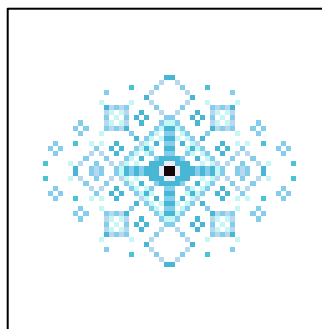


Figure 46 Nitry

Figure 45 shows Carbotwin, the ChemiMonsters representing carbon. Its design features elements of coal, which is a common form of carbon and one of the most recognizable carbon-made objects linked to human civilization and industry. The “twin” aspect could allude to carbon’s ability to form multiple bonds and diverse structures.

Figure 46 shows Nitry, the ChemiMonster representing nitrogen. It is designed as an icy snowflake due to nitrogen’s widespread use in its liquid form for freezing applications, owing to its extremely low boiling point. The snowflake motif effectively conveys its chilling properties.

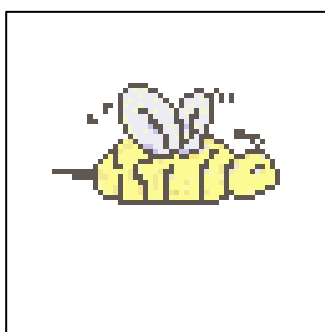


Figure 47 Helium

Figure 47 shows Helium, the ChemiMonster representing helium. After people inhale helium, their voice becomes high-pitched, similar to the buzzing sound of bees. This distinctive auditory effect led to helium being designed as a bee, visually capturing this well-known property.

4.3.14 Maze Implementation

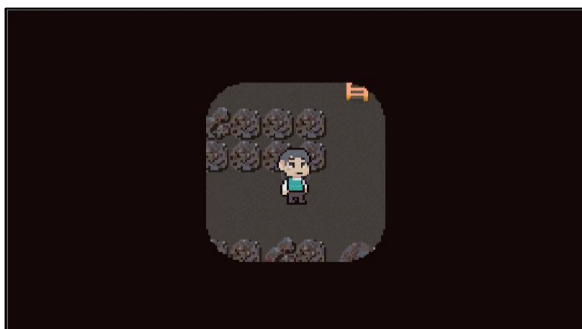


Figure 48 In-Game Cave Scene



Figure 49 Zoom Out Cave Scene

Figure 48 and Figure 49 showcase the maze feature implemented in ChemiMonsters, adding a layer of challenge and exploration to the gameplay experience. Mazes are primarily found in cave areas and serve as obstacles that player must navigate through to reach hidden ChemiMonsters.

Figure 48 demonstrates how the maze appears during normal gameplay where the camera is limited to the player's immediate surroundings, creating a sense of mystery and encouraging memory and navigation skills. Figure 49 provides a zoomed-out view of the same cave maze. This figure serves as an example of the intricate design behind the scenes. While players never see the full maze during gameplay, this design ensures a balance between difficulty and fun, rewarding those who pay close attention to their environment. These maze challenges enrich the gameplay by encouraging exploration, spatial awareness, and perseverance.

4.4 Implementation Strength of “ChemiMonsters” Game

There are three main strengths of the ChemiMonsters game, which are its educational content, user-friendly design, and engaging gameplay mechanics.

The first strength is its integration of real-world elements into a fun gaming experience. By catching ChemiMonsters that represent actual elements from the periodic table and

interaction with game objects, players can learn atomic properties, scientific facts, and real-world examples of element usage in an interactive way.

The second strength is the well-structured interface and menu navigation. Important functions such as saving, loading, and accessing the ChemiDex are clearly organized, making it easy for players of all ages to explore the game without confusion.

The final strength lies in the storytelling and visual design. With animated characters, interactive NPCs, and a consistent art style, the game successfully builds an immersive world that keeps players engaged while learning new knowledge along this way.

4.5 Conclusion

In this chapter, the implementation details of ChemiMonsters were presented, showcasing how the game's core features, design elements, and educational objectives were brought to life using a range of development tools and thoughtful design strategies. Each feature was created and crafted to enrich both the gameplay experience and the learning journey.

CHAPTER 5: Testing and Evaluation

5.1 Introduction

This chapter discusses the testing and evaluation phases carried out to ensure the functionality, usability, and overall quality of the ChemiMonsters game. The focus of this chapter includes internal testing to verify that the system works as intended, and user evaluation to collect feedback from real users such as students and gamers. The insights gathered help identify strengths and areas for improvement.

5.2 Testing

To evaluate the ChemiMonsters game, two kinds of testing were carried out which is functionality testing and user evaluation. Functionality testing makes sure that every aspect of the game works as it should. Contrarily, user evaluation aims to evaluate the game's general usability, degree of engagement, and user experience from the viewpoints of players and students. These tests' results are used to confirm the game's functionality and are covered in more detail in the sections that follow.

5.2.1 Functionality Testing

The functionality testing of the ChemiMonsters game was divided into 4 key sections to ensure a smooth and bug-free gameplay experience. The 4 section of functionality testing includes testing on interacted buttons, movement of player and NPC, interacted game objects, and soundtrack and music.

Section 1: Interacted button

There are several buttons in ChemiMonsters game across different interfaces. Each button was tested to ensure it functions as intended. The detailed results of the button functionality tests are presented in **Error! Reference source not found.**, covering buttons from the splash screen, main menu, and pause submenu.

Table 7 Interacted Button Testing Result

Test Case ID	Test Scenario	Test Case	Pre-condition	Test Steps	Test Data	Expected Result	Post-condition	Actual Result	Status (Pass / Fail)
TC-Button-001	Splash Screen	Test “Any Key”	Splash Screen is displayed	Press any key (mouse)	Any mouse input	“Press any key” words disappear, and main menu button flies up	Main menu is displayed	“Press any key” words disappear, and main menu button flies up	Pass
TC-Button-001	Splash Screen	Test “Any Key”	Splash Screen is displayed	Press any key (keyboard)	Any keyboard input	“Press any key” words disappear, and main menu button flies up	Main menu is displayed	“Press any key” words disappear, and main menu button flies up	Pass
TC-Button-002	Main Menu	Test “Play” Button	Main menu’s button appears	Press “Play” button		The game proceeds with a new game	A scene on a professor talking appear	The game proceeds with a new game	Pass
TC-Button-002	Main Menu	Test “Load” Button	Main menu’s button appears	Press “Load” button		A load game submenu appears	Load Panel displayed	The load game submenu appears	Pass
TC-Button-002	Main Menu	Test “Exit” Button	Load Panel displayed	Press “Exit” button		The game close	The game close	The game close	Pass

TC-Button-003	Load Panel	Load a game	Load Panel displayed	Press a save slot's "Load Game" button		Game loads pervious saved files and proceed to the saved game	Game Resume	Game loads and scene shows previous saved position	Pass
TC-Button-003	Load Panel	Close Load Panel	Load Panel displayed	Press the "X" button on the top right		The load panel closed and showed main menu buttons	Main menu is displayed	The load panel closed and showed main menu buttons	Pass
TC-Button-004	Name Player	Key in Player name	After professor scene is done	Insert Player Name and press "Enter" button	Player Name insert	The username will be saved and proceed to the new game	Game scene displayed	Game scene is displayed	Pass
TC-Button-004	Name Player	Doesn't key in Player name	After professor scene is done	Press "Enter" button		Nothing changes	Nothing changes	Nothing changes	Pass
TC-Button-005	Pause Submenu	Open Pause Submenu	Any game scene	Enter "P" in any gameplay section		Submenu will show and player can't move	Submenu displayed	Submenu shown and player can't move	Pass
TC-Button-005	Pause Submenu	Test "Resume" button	Submenu displayed	Press the "Resume" button		The submenu will close, and player can continue to play the game	Game scene	The submenu closed and player can move	Pass
TC-Button-005	Pause Submenu	Test "Map" button	Submenu displayed	Press the "Map" button		The submenu will close, and Map Panel is displayed	Map panel displayed	The map panel shown	Pass

TC-Button-005	Pause Submenu	Test “ChemiDex” button	Submenu displayed	Press the “ChemiDex” button		The submenu will close, and ChemiDex Panel is displayed	ChemiDex panel displayed	The ChemiDex panel shown	Pass
TC-Button-005	Pause Submenu	Test “Save” button	Submenu displayed	Press the “Save” button		The submenu will close, and Save Panel is displayed	Save Panel displayed	The Save panel shown	Pass
TC-Button-005	Pause Submenu	Test “Exit” button	Submenu displayed	Press the “Exit” button		The submenu will close, and Exit Panel is displayed	Exit Panel displayed	The Exit panel shown	Pass
TC-Button-006	Map Panel	Map Icon Testing	Map Panel displayed	Press the square map icon in Map Panel		Map description is shown at the bottom of map	Description shown	Map description is shown at the bottom of map	Pass
TC-Button-006	Map Panel	Close Map Panel	Map Panel displayed	Press the “X” button on the top right of Map Panel		Map Panel is closed, and Submenu is displayed	Submenu Displayed	Map Panel is closed, and Submenu is displayed	Pass
TC-Button-007	ChemiDex Panel	Before the ChemiMonsters is caught	ChemiDex Panel displayed	Press the ChemiMonsters Name that haven’t being caught		ChemiDex shows “?” on picture of ChemiMonsters and a sentence of “Catch ChemiMonster to unlock” shows	ChemiDex Panel with default ChemiMonsters information	ChemiDex shows “?” on picture of ChemiMonsters and a sentence of “Catch ChemiMonster to unlock” shows	Pass
TC-Button-007	ChemiDex Panel	After the ChemiMonsters is caught	ChemiDex Panel displayed	Press the ChemiMonsters Name		ChemiDex shows ChemiMonsters Description with correct number of	ChemiDex Panel with ChemiMonsters	“Oxolon” is pressed after 1 Oxolon is caught, the ChemiDex shows	Pass

				already been caught		light electrons on the atomic diagram	information	Oxolon's descriptions and 1 light up electron in atomic diagram	
TC-Button-007	ChemiDex Panel	Close ChemiDex Panel	ChemiDex Panel displayed	Press the "X" button on the top right of ChemiDex Panel		ChemiDex Panel is closed, and Submenu is displayed	Submenu Displayed	ChemiDex Panel is closed, and Submenu is displayed	Pass
TC-Button-008	Save Panel	Save Game Progress	Save Panel displayed	Press on "Save" button on one of the three save slot's		A successful save panel shows and the save progress changed from the previous save details to the new game process details	Successful Save Panel shown and information changed	A successful save panel shows and the save progress changed from the previous save details to the new game process details	Pass
TC-Button-008	Save Panel	Close Save Panel	Save Panel displayed	Press the "X" button on the top right of Save Panel		Save Panel is closed, and Submenu is displayed	Submenu Displayed	Save Panel is closed, and Submenu is displayed	Pass
TC-Button-009	Exit Panel	Exit to Main Menu	Exit Panel displayed	Press the "Exit to Main Menu" button		A Save Before Exit Panel shown asked is player willing to save before exit	Save Before Exit Panel displayed	The save panel shown	Pass
TC-Button-009	Exit Panel	Exit Game	Exit Panel displayed	Press the "Exit		A Save Before Exit Panel shown asked	Save Before	The save panel shown	Pass

				Game” button		is player willing to save before exit	Exit Panel displayed		
TC-Button-009	Exit Panel	Close Exit Panel	Exit Panel displayed	Press the “X” button on the top right of Exit Panel		Exit Panel is closed, and Submenu is displayed	Submenu Displayed	Exit Panel is closed, and Submenu is displayed	Pass
TC-Button-010	Save Before Exit Panel	Save Before Exit to Main Menu	Save Before Exit Panel displayed after “Exit to Main Menu” is clicked	Press the “Yes” button		Save Panel displayed and allow player to save and exit to main menu	Main Menu	Save Panel displayed and allow player to save and exit to main menu	Pass
TC-Button-010	Save Before Exit Panel	Save Before Exit Game	Save Before Exit Panel displayed after “Exit to Game” is clicked	Press the “Yes” button		Save Panel displayed and allow player to save and exit game	The game close	Save Panel displayed and allow player to save and exit game	Pass
TC-Button-010	Save Before Exit Panel	Don’t Save Before Exit to Main Menu	Save Before Exit Panel displayed after “Exit to Main Menu” is clicked	Press the “No” button		Exit to Main Menu	Main Menu	Main Menu shown	Pass

TC-Button-010	Save Before Exit Panel	Don't Save Before Exit Game	Save Before Exit Panel displayed after "Exit to Game" is clicked	Press the "No" button		Game is closed	The game close	Game is closed	Pass
TC-Button-010	Save Before Exit Panel	Close Save Before Exit Panel	Save Before Exit Panel displayed	Press the "X" button on the top right of Save Before Exit Panel		Exit Panel and Save Before Exit Panel is closed, and Submenu is displayed	Submenu Displayed	Exit Panel and Save Before Exit Panel is closed, and Submenu is displayed	Pass

Section 2: Movement of Player and NPC

The movement animations of both the player and NPCs were examined for fluidity and correctness. This includes idle states and walking animations in all directions. The detailed results of the movement animation are presented in **Error! Reference source not found..**

Table 8 Movement of Player and NPC Testing Result

Test Case ID	Test Scenario	Test Case	Pre-condition	Test Steps	Test Data	Expected Result	Post-condition	Actual Result	Status (Pass / Fail)
TC-Move-001	Player	Idle Left	Gameplay Section	Click "A" or "Left Arrow" key and stop	"A" or "Left Arrow" input	The Player will be facing to the left but no movement	Player facing left	The Player facing left and no movement	Pass

TC-Move-001	Player	Idle Right	Gameplay Section	Click “D” or “Right Arrow” key and stop	“D” or “Right Arrow” input	The Player will be facing to the right but no movement	Player facing right	The Player facing right and no movement	Pass
TC-Move-001	Player	Idle Up	Gameplay Section	Click “W” or “Up Arrow” key and stop	“W” or “Up Arrow” input	The Player will be facing up but no movement	Player facing up	The Player facing up and no movement	Pass
TC-Move-001	Player	Idle Down	Gameplay Section	Click “S” or “Down Arrow” key and stop	“S” or “Down Arrow” input	The Player will be facing down but no movement	Player facing down	The Player facing down and no movement	Pass
TC-Move-001	Player	Walk Left	Gameplay Section	Click “A” or “Left Arrow” key	“A” or “Left Arrow” input	The Player will be moving to the left	Player moves to the left	Player moves to the left	Pass
TC-Move-001	Player	Walk Right	Gameplay Section	Click “D” or “Right Arrow” key	“D” or “Right Arrow” input	The Player will be moving to the right	Player moves to the right	Player moves to the right	Pass
TC-Move-001	Player	Walk Up	Gameplay Section	Click “W” or “Up Arrow” key	“W” or “Up Arrow” input	The Player will be moving upwards	Player moves upwards	Player moves upwards	Pass
TC-Move-001	Player	Walk Down	Gameplay Section	Click “S” or “Down Arrow” key	“S” or “Down Arrow” input	The Player will be moving downwards	Player moves downwards	Player moves downwards	Pass

TC-Move-002	Professor	All Movement	In Professor Lab	Investigate Animation of Professor		The animation needs to be smooth and in looped	Movement in Loop	The animation is smooth and in looped	Pass
TC-Move-003	Lab Assistant	All Movement	All assistant lab	Investigate Animation of Assistant		The animation needs to be smooth and in looped	Movement in Loop	The animation is smooth and in looped	Pass
TC-Move-004	Woman	All Movement	All room that has Woman	Investigate Animation of Woman		The animation needs to be smooth and in looped	Movement in Loop	The animation is smooth and in looped	Pass
TC-Move-005	Man	All Movement	All room that has Man	Investigate Animation of Man		The animation needs to be smooth and in looped	Movement in Loop	The animation is smooth and in looped	Pass
TC-Move-006	Little Boy	All Movement	All room that has Little Boy	Investigate Animation of Little Boy		The animation needs to be smooth and in looped	Movement in Loop	The animation is smooth and in looped	Pass
TC-Move-007	Little Girl	All Movement	All room that has Little Girl	Investigate Animation of Little Girl		The animation needs to be smooth and in looped	Movement in Loop	The animation is smooth and in looped	Pass

Section 3: Interacted Game Objects

All interactive elements in the game were tested for functionality. This includes interacting with NPCs, triggering object-specific events like rock explosions, fire extinguishing, freezing water, interacting with shelves, catching ChemiMonsters, and showing the tower's puzzle. The detailed results of the interacted elements are presented in **Error! Reference source not found..**

Table 9 Interacted Game Object Testing Result

Test Case ID	Test Scenario	Test Case	Pre-condition	Test Steps	Test Data	Expected Result	Post-condition	Actual Result	Status (Pass / Fail)
TC-Object-001	NPC	Talk with NPC	Scene that has NPCs	Player moves towards NPC and click left click	Left Click input	A story telling scene appears	Story Telling scene displayed	A story telling scene appears	Pass
TC-Object-002	Scene Teleporter	Move towards Scene teleporter	Any Game Scene	Player moves to door, stairs, and other scene teleport places		The scene is smoothly change and player can go back to the previous scene	Changed Scene	The scene is smoothly change and player can go back to the previous scene	Pass
TC-Object-003	ChemiMonsters	Catch ChemiMonsters	All scene that contains ChemiMonsters	Move towards ChemiMonsters		ChemiMonster disappear and successfully catch ChemiMonster message appear	ChemiMonsters Disappear	ChemiMonster disappear and successfully catch ChemiMonster message appear	Pass

TC-Object-003	ChemiMonsters	Display ChemiMonsters	Professor Lab and all assistant's Lab	Investigate the lab after caught the ChemiMonsters		ChemiMonsters shown in Lab indicates that the ChemiMonsters are being caught	ChemiMonsters Displayed	ChemiMonsters displayed	Pass
TC-Object-004	Road Blocking	Click Rock before getting Hydro Bomb	Any scene that contains Rock	Stay close to the Rock and click left click		A message "I think I need a bomb to blast it." pop out	Story scene	A message "I think I need a bomb to blast it." pop out	Pass
TC-Object-004	Road Blocking	Click Rock after getting Hydro Bomb	Any scene that contains Rock	Stay close to the Rock and click left click		The rock disappears with an effect	Effect and Sound	The rock disappears	Pass
TC-Object-004	Road Blocking	Click Rock with Vein before getting Fire Extinguisher	Any scene that contains Rock with Vein	Stay close to the Rock and click left click		A message "This isn't a normal cracked rock... I think I need fire to blast it." pop out	Story scene	A message "This isn't a normal cracked rock... I think I need fire to blast it." pop out	Pass
TC-Object-004	Road Blocking	Click Rock with Vein	Any scene that contains	Stay close to the Rock with Vein and		The rock with vein disappears with an effect	Effect and Sound	The rock with vein disappears	Pass

		after getting Fire Extinguisher	Rock with Vein	click left click					
TC-Object-004	Road Blocking	Click Water before getting Freezer	Any scene that contains Water	Stay close to the Water and click left click		A message “I think I need a freezer to freeze the water.” pop out	Story scene	A message “I think I need a freezer to freeze the water.” pop out	Pass
TC-Object-004	Road Blocking	Click Water after getting Freezer	Any scene that contains Water	Stay close to the Water and click left click		The water being freeze and player can walk through it	Effect and Sound	The water being freeze and player can walk through it	Pass
TC-Object-004	Bookshelves	Click Bookshelves	Any scene that contains Bookshelves	Stay close to Bookshelves and click left click		A story telling scene appears and having descriptions on atoms	Story scene	A story telling scene appears and having descriptions on atoms	Pass
TC-Object-005	Tower Puzzle	Tower Puzzle button	Inside Helum Tower	Walk through Tower Puzzle button		Some of the rock disappear and some of the rock appears (work as puzzles for puzzle solving)		Some of the rock disappear and some of the rock appears	Pass

Section 4: Soundtrack and Music

All the background music and sound transition were reviewed to ensure they align with the intended game scenes. The detailed results of the interacted elements are presented in Table 10.

Table 10 Soundtrack and Music Testing Results

Test Case ID	Test Scenario	Test Case	Pre-condition	Test Steps	Test Data	Expected Result	Post-condition	Actual Result	Status (Pass / Fail)
TC-Sound-001	Background Music	Splash Screen and Main Menu	Splash Screen displayed	Press any key	Any mouse and keyboard input	The background music does not change	Main Menu displayed	The background music does not change	Pass
TC-Sound-001	Background Music	Play a game	Main Menu displayed	Press "Play" or load a game		The background music change to the gameplay music	Game scene displayed	The background music change	Pass
TC-Sound-001	Background Music	Scene Change (Beside Change to Cave)	Any Game Play scene besides Cave	Walk to any places that will indicate change scene		The background music does not change and will continue playing	Game scene displayed	The background music does not change and continue playing	Pass
TC-Sound-001	Background Music	Scene Change to Cave	Any Game Play scene beside Cave	Walk into a Cave		The background music change to the cave music	Game scene displayed (Cave)	The background music change	Pass

TC-Sound-001	Background Music	Scene Change Cave to Cave	Any Cave scene	Walk to any places that will indicate change scene to a cave		The background music does not change and will continue playing	Game scene displayed (Cave)	The background music does not change and continue playing	Pass
TC-Sound-001	Background Music	Scene Change Cave to Any other scene	Any Cave scene	Walk to any places that will indicate change scene to any other non-cave scene		The background music change to the gameplay music	Game scene displayed (Not Cave)	The background music change	Pass
TC-Sound-001	Background Music	Scene Change to Main Menu	Any Game Scene and Save Before Exit Panel displayed	Click "No"		The background music will change to splash screen and main menu music	Main Menu	The background music change	Pass
TC-Sound-002	Screen	Click Scene	Any Scene	Click left click		There will be a small soundtrack appears		There are a small soundtrack appears	Pass
TC-Sound-003	Button	Hover Button	Any Panel	Hover the mouse icon to a button		There will be a small soundtrack appears		There are a small soundtrack appears	Pass

TC-Sound-003	Button	Click Button	Any Panel	Click a button		There will be a small soundtrack appears		There are a small soundtrack appears	Pass
TC-Sound-004	Player	Player Moving	Any Scene	Let Player move around		Moving soundtrack appears	Player move	Moving soundtrack appears	Pass
TC-Sound-005	Road Blocking	Rock Explosion	Any Scene that contains Rock and Player already get "Hydro Bomb"	Move close towards Rock and click left click		The Rock disappear with an effect and a bomb soundtrack appears	Rock disappears	The Rock disappear with an effect and a bomb soundtrack appears	Pass
TC-Sound-005	Road Blocking	Rock with Vein Fire	Any Scene that contains Rock with Vein and Player already get "Fire Extinguisher"	Move close towards Rock with Vein and click left click		The Rock with Vein disappear with an effect and a fire soundtrack appears	Rock with Vein disappears	The Rock with Vein disappear with an effect and a fire soundtrack appears	Pass
TC-Sound-005	Road Blocking	Water Freeze	Any Scene that contains Water and Player already get "Freezer"	Move close towards Water and click left click		The Water being freeze with an effect and a freeze soundtrack appears	Water freeze	The Water being freeze with an effect and a freeze soundtrack appears	Pass

TC-Sound-006	Story Telling	NPCs talking	Any scene contains NPCs	Move close to NPC and click left click		Storytelling scenes pop out and a bleep soundtrack appears	Story Telling Scene displayed	Storytelling scenes pop out and a bleep soundtrack appears	Pass
TC-Sound-006	Story Telling	Bookshelves	Any scene contains Bookshelves	Move close to Bookshelves and click left click		Storytelling scenes pop out and a bleep soundtrack appears	Story Telling Scene displayed	Storytelling scenes pop out and a bleep soundtrack appears	Pass
TC-Sound-007	Successful Change ChemiMonsters	Successful Change ChemiMonsters	Any scene contains ChemiMonsters (have not caught)	Move close to the ChemiMonsters		Storytelling scenes pop out with a bleep soundtrack and successful catch soundtrack appears	Story Telling Scene displayed	Storytelling scenes pop out with a bleep soundtrack and successful catch soundtrack appears	Pass
TC-Sound-008	Tower Puzzle	Rock Disappears and appears	Any Helum Tower Scene	Walk through Tower Puzzle button		The rocks disappear and appear with a rock soundtrack appears	Rocks disappear and appear	The rocks disappear and appear with a rock soundtrack appears	Pass

Each test case in this section was tested repeatedly to ensure smooth performance and error-free operations. Any identified bugs or unexpected behaviours were resolved during iterative development cycles.

5.2.2 User Evaluation

User evaluation was conducted to assess the effectiveness, usability, and overall player experience of the ChemiMonsters game. Two main target groups were involved in this user evaluation test case. The first target groups are secondary school students, while the second target groups are gamers. The evaluation was divided into four key sections such as Understanding and Knowledge Gain, User Interface, Graphic and Design, and Game Function. Besides the evaluation form, some feedback is record while the game is played. Respondents rated their agreement using a 5-point Linkert scale where 1 is Strongly Disagree and 5 is Strongly Agree. The evaluation questions are detailed in APPENDIX C.

For both student and gamer groups, 10 participants were involved, and each gameplay session lasted for 30 minutes. During this time, students on average caught 3 ChemiMonsters, while gamers average caught approximately 4 ChemiMonsters. Since not all the ChemiMonsters are been caught and not all elemental information is fully explored within the 30 minutes gameplay period, the user evaluation primarily focuses on assessing the initial gameplay experience.

5.2.2.1 User Evaluation Result (Students)

This section presents the findings from the user evaluation conducted with 10 secondary school students.

5.2.2.1.1 Understanding and Knowledge Gain

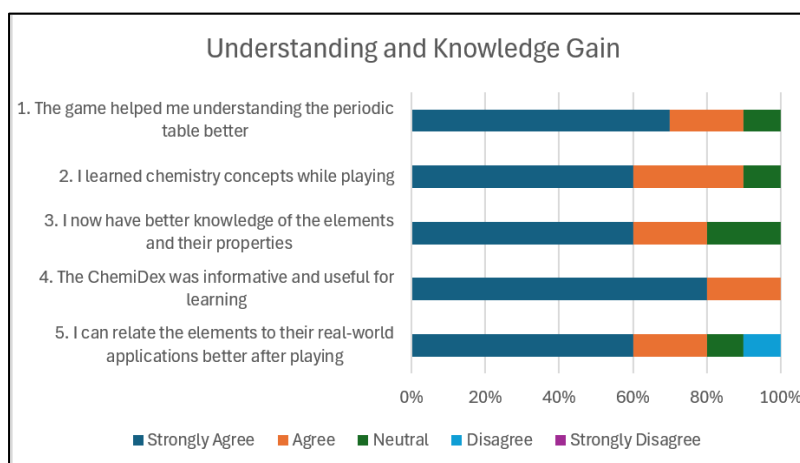


Figure 50 Evaluation Feedback from Student (Section A)

Figure 50 above shows student feedback on Understanding and Knowledge Gain section. Student feedback overwhelmingly indicated that ChemiMonsters is an effective tool for learning chemistry. As an illustration, 70% of students strongly agreed and 20% of students agreed that the game improved their understanding of the periodic table. This showcases the game's core educational impact. Besides, 60% of students strongly agreed and 30% agreed that they learned chemistry concepts while playing the game, indicating that instructional information had been successfully included.

Additionally, 60% of students strongly agreed and 20% agreed that they now have better knowledge of the elements and their properties, further affirming the game's success in imparting specific chemical information. The ChemiDex feature received particularly strong endorsement with 80% of students strongly agreeing and 20% agreeing that it was informative and useful for learning, highlighting its exceptional value as a direct knowledge resource. Finally, 60% of students strongly agreed and 20% agreed that they could relate the elements to their real-world applications better after playing. This demonstrates the game's ability to connect abstract concepts to practical relevance. Overall, these results strongly affirm

ChemiMonsters' potential as an engaging and effective supplementary tool for chemistry education.

5.2.2.1.2 User Interface, Graphic and Design

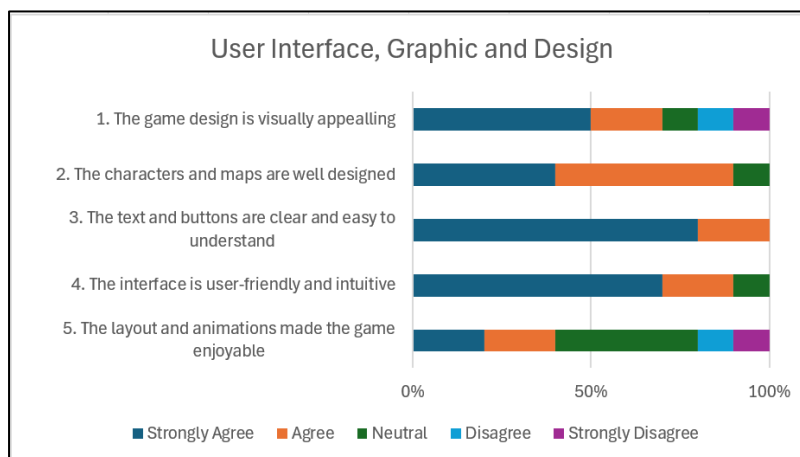


Figure 51 Evaluation Feedback from Student (Section B)

Figure 51 presents student feedback on the User Interface, Graphic and Design. Student perceptions regarding the game's visual and design elements were generally positive, through with some mixed responses for overall appeal and animations. Specifically, while 50% of students strongly agreed and 20% agreed that the game design was visually appealing, 10% of the students disagreed and 10% strongly disagreed, suggesting varying aesthetic preferences. However, the characters and maps were largely well-received, with 40% strongly agreeing and 50% agreeing on their design quality.

Furthermore, 80% strongly agreed and 20% agreed that the text and buttons were clear and easy to grasp. In a similar vein, 20% agreed and 70% strongly agreed that the interface was easy to use and intuitive, suggesting seamless navigation. However, opinions on the layout and animations made the game enjoyable received a mixed reception with 40% remaining neutral, and 10% disagreed and 10% strongly disagreed, indicating that these features might not always increase enjoyment to the same extent as other design features.

5.2.2.1.3 Game Function

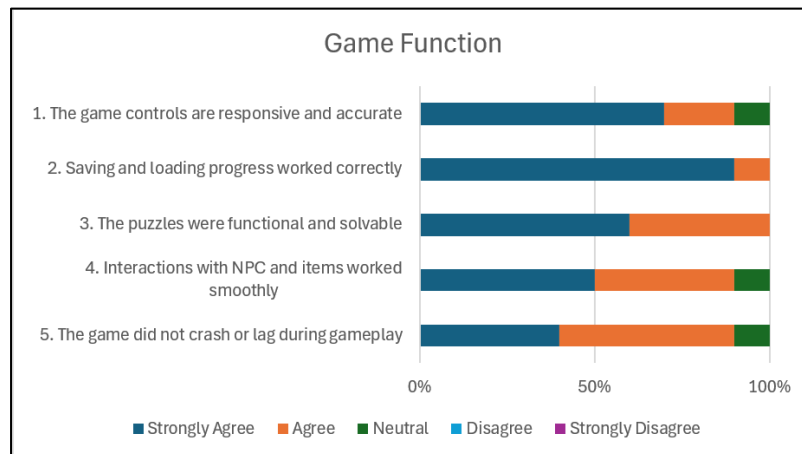


Figure 52 Evaluation Feedback from Student (Section C)

Figure 52 shows student feedback on the Game Function section. Students highly gave the game's functionalities feedback with good impressions, indicating that they gain a stable and reliable gameplay experience. For instance, 20% of students agreed and 70% strongly agreed that the game controls were accurate and responsive, which helped to create a smooth engagement. The saving and loading progress functionality demonstrated exceptional reliability, with 90% strongly agreeing and 10% agreeing that it worked correctly, which is vital for player progression.

Additionally, 40% of students agreed and 60% strongly agreed that the puzzles were workable and solvable. This demonstrating the resilience of this fundamental game feature. Besides, 50% strongly agreed and 40% agreed that interactions with NPCs and things went smoothly. Finally, there was broad agreement about game stability, with 50% agreeing and 40% strongly agreeing that the game did not lag or crash while playing.

5.2.2.2 User Evaluation Result (Gamers)

This section presents the findings from 10 gamers who evaluated ChemiMonsters. Their feedback offers a valuable perspective on the game's overall quality, mechanics, and educational integration from individuals with potentially broader gaming experience.

5.2.2.2.1 Understanding and Knowledge Gain

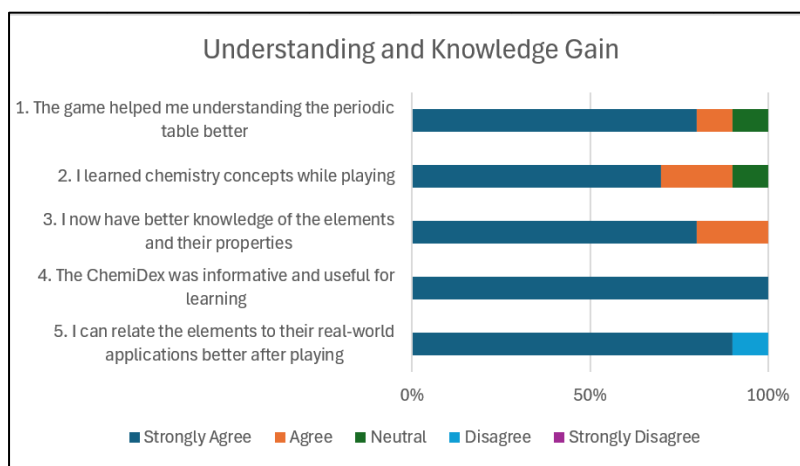


Figure 53 Evaluation Feedback from Gamers (Section A)

Figure 53 shows gamer feedback on the Understanding and Knowledge Gain. Even among gamers, who may not be primarily focused on education content, the learning aspects of ChemiMonsters were highly recognized. Specifically, 80% of gamers strongly agreed and 10% agreed that the game helped them understand the periodic table better. This indicates that the ChemiMonsters game is broad appeal as an educational tool. Besides, 70% strongly agreed and 20% agreed that they learned chemistry concepts while playing, reinforcing the game's effective blend of education and entertainment.

Additionally, 80% of the gamers strongly agreed and 20% agreed that they now had better knowledge of elements and their properties. The ChemiDex feature received an exceptional response, with 100% of gamers strongly agreeing that it was informative and useful for learning. This highlighting its superb utility for knowledge acquisition. Finally, 90% of

gamers strongly agreed that they could relate elements to their real-world applications better after playing. This further demonstrates the game’s success in making chemistry tangible, with a single gamer disagreeing.

5.2.2.2.2 User Interface, Graphic and Design

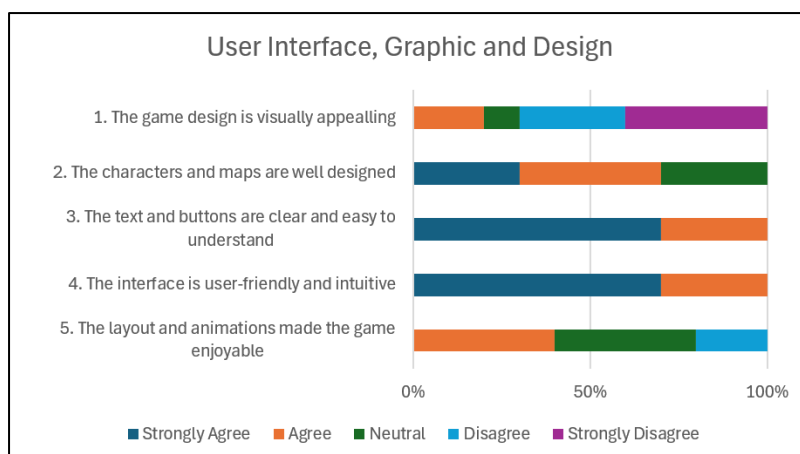


Figure 54 Evaluation Feedback from Gamers (Section B)

Figure 54 illustrates gamer feedback on the User Interface, Graphic and Design. This area revealed a notable divergence in opinion compared to students, with gamers expressing significant concerns regarding the game’s visual appeal. A substantial 30% of gamers disagreed and 40% strongly disagreed that the game design was visually appealing. This suggests the pixel art style, while accepted by students, might not meet the aesthetic expectations of a general gamer audience. However, 30% strongly agreed and 40% agreed that the characters and maps were well designed indicating specific strengths within the game’s art assets despite overall visual critiques.

Positively, the clarity of text and buttons was affirmed, with 70% strongly agreeing and 30% agreeing they were clear and easy to understand. Likewise, 70% strongly agreed and 30% agreed that the interface was user-friendly and intuitive. Similar to students, the layout and animations’ contribution to enjoyment was mixed, with 40% remaining neutral and 20%

disagreeing, reinforcing the potential need to enhance these elements for greater gamer engagement.

5.2.2.2.3 Game Function

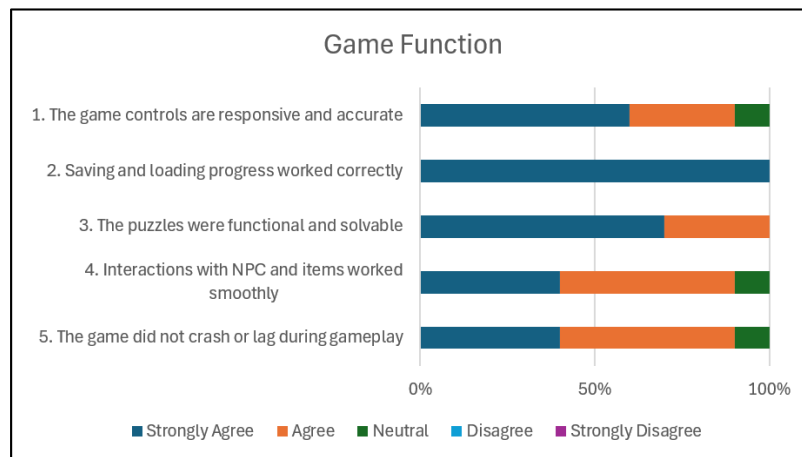


Figure 55 Evaluation Feedback from Gamers (Section C)

Figure 55 displays gamer feedback on the Game Function. Gamers largely confirmed the robust functionality of the game, mirroring the positive feedback from students. Specifically, 60% of gamers strongly agreed and 30% agreed that the game controls were responsive and accurate. The saving and loading progress functionality received a perfect 100% strongly agree, indicating flawless operation crucial for retaining player progress. Furthermore, 70% strongly agreed and 30% agreed that the puzzles were functional and solvable, confirming the strength of the core puzzle mechanics. Interactions with NPCs and items also worked smoothly, with 40% strongly agreeing and 50% agreeing. Finally, a strong consensus was observed on technical stability, as 40% strongly agreed and 50% agreed that the game did not crash or lag during gameplay, demonstrating the game's robustness.

5.3 Conclusion

This chapter confirmed the robust functionality and overall quality of the ChemiMonsters game through comprehensive internal testing, with all test cases passing successfully. User evaluation from both students and gamers provided generally positive feedback, particularly highlighting the game's effectiveness in enhancing chemistry understanding and its smooth core functionalities. While most aspects were well-received, feedback from gamers indicated areas for potential improvement in visual design and animations. In essence, ChemiMonsters is a functional and engaging educational game, with identified opportunities for further refinement to enhance broader user experience.

CHAPTER 6: Conclusion and Future Work

6.1 Introduction

In this chapter, it brings together the key findings and outcomes of the ChemiMonsters game development project. This chapter also will revisit the primary objectives, highlight the project's successes, and candidly discuss the limitations encountered during development and evaluation. Furthermore, this chapter will outline exciting avenues for future work, laying the groundwork for potential enhancements and expansions of ChemiMonsters. It concludes with summary of the project's overall contributions and its promising role in educational gaming.

6.2 Achievements

Achievement in the ChemiMonsters is analysed to meet the objectives of the project.

Table 11 below summarises each project objective and details how it was achieved.

Table 11 Objectives and Achievements

Objectives	Achievements
To develop an interactive 2D puzzle game, ChemiMonsters, that enables players to explore and learn about the elements of the periodic table through engaging problem-solving and immersive gameplay.	Achieved by successfully developed 2D puzzle game complete with interactive elements such as NPCs and integrated of ChemiDex feature. User evaluation results from both students and gamers indicated strong engagement and positive feedback on the immersive gameplay experience.
To align with educational curriculums, providing a tool for teachers to supplement their lessons on the periodic table and chemistry fundamentals.	Achieved by integrating core chemistry concepts and periodic table knowledge directly into the game's mechanics, puzzles, and the ChemiDex information system. All elemental descriptions and properties displayed within the ChemiDex panel are sourced from the KSSM Chemistry Form 4 textbook (Isqyaacob, 2020), ensuring direct alignment with the national educational curriculum. From user evaluation, particularly from secondary school students, strongly affirmed the game's educational value.

To evaluate the usability of the game in enhancing players' understanding of elemental properties and chemistry concepts.	Achieved by conducting a comprehensive user evaluation involving 10 secondary school students and 10 gamers. The results consistently showed a high positive agreement across “Understanding and Knowledge Gain” questions for both groups.
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6.3 Limitation of ChemiMonsters

ChemiMonsters features a few limitations that present chances for advancement in the future. The four main limitations of this project are visual aesthetics, the scope of content exploration for user evaluation within limited playtime, limited detail on elemental groups, and the absence of direct in-game knowledge assessments.

6.3.1 Visual Aesthetics

According to the feedback from gamers, they indicated that the current 2D pixel art style might not universally meet the visual expectations of a broader gaming audience. Similarly, mixed opinions on the layout and animations' contribution to overall enjoyment suggest these elements could be refined to enhance player immersion.

6.3.2 Scope of Content Exploration within Limited Playtime

The user evaluation revealed that participants only caught a limited number of ChemiMonsters within the standard 30-minute gameplay sessions. This implies that not all elemental information or game content could be fully explored or absorbed within a typical play session. While the evaluation successfully assessed the initial gameplay experience and immediate learning, the time constraint limits the ability to gauge the game's capacity for long-term engagement and comprehensive mastery of all chemistry concepts it aims to deliver.

Therefore, players might require extended or multiple play sessions to fully unlock and absorb the complete educational depth offered by ChemiMonsters.

6.3.3 Limited Detail on Elemental Groups

The current iteration of ChemiMonsters primarily focuses on individual elements and their basic properties. A limitation identified is the less detailed exploration or representation within the game of the characteristics and behaviours of specific periodic table groups. For example, for inert nature of Group 18 Noble Gases, or the reactivity of Group 1 Alkali Metals. Providing more in-depth information and gameplay mechanics tied to these group properties could significantly enhance the educational value and reinforce a more holistic understanding of the periodic table.

6.3.4 Absence of Direct In-Game Knowledge Assessment

Currently, ChemiMonsters provides elemental and periodic table information in an indirect manner through the ChemiDex and interactions with NPCs. A significant limitation is the lack of direct knowledge assessment features, such as in-game quizzes or questions, to formally check players' understanding. This indirect approach means there isn't built-in mechanism to actively verify if players are truly grasping the chemical concepts and elemental properties presented within the game's mechanics.

6.4 Future Work

To further improve the game's appeal and educational value, a number of crucial areas have been identified for future expansion, building upon the strong foundation laid by ChemiMonsters. The top priority is to enhance the game's visual appeal and animations. This

will be involve investigating modern art style, improving the character and environmental animations that are already there, and adding more dynamic visual effects to produce a more engaging and visually appealing experience. Besides, a new guiding feature will also be included to help players who get stuck in a certain area or task, guaranteeing a more seamless advancement through the game's challenges and enhancing the user experience while lowering frustration.

Additionally, future work will entail greatly increasing the roster to accommodate a wider range of ChemiMonsters and their related elements, even if the current edition of ChemiMonsters comprises five distinct ChemiMonsters representing core elements. With a longer gameplay duration, this upgrade seeks to enhance the chemistry content, promote more thorough exploration, and offer a more comprehensive learning experience. Furthermore, to more rigorously assess learning outcomes, future evaluations will incorporate pre- and post-game quizzes to quantitatively measure students' understanding of chemical concepts, moving beyond subjective feedback forms.

Moreover, future development will integrate direct in-game quizzes to actively assess player comprehension. These quizzes could be implemented to unlock new content or levels, or appear after capturing certain ChemiMonsters, ensuring players genuinely understand the elemental and periodic table information learned through gameplay. With these planned improvements, ChemiMonsters will become an even more complete and interesting educational tool, guaranteeing its continuous use and efficacy in education gaming.

6.5 Conclusion

In conclusion, the ChemiMonsters project successfully developed a functional and engaging 2D puzzle game that effectively teaches periodic table concepts. Rigorous testing

confirmed its stability, and user evaluation highlighted its educational impact and general usability, especially the ChemiDex feature. While the game achieved its core objectives, future efforts will focus on enhancing visual appeal and expanding content and refining evaluation methodologies to offer a more comprehensive and polished learning experience.

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APPENDIX A: GANTT CHART

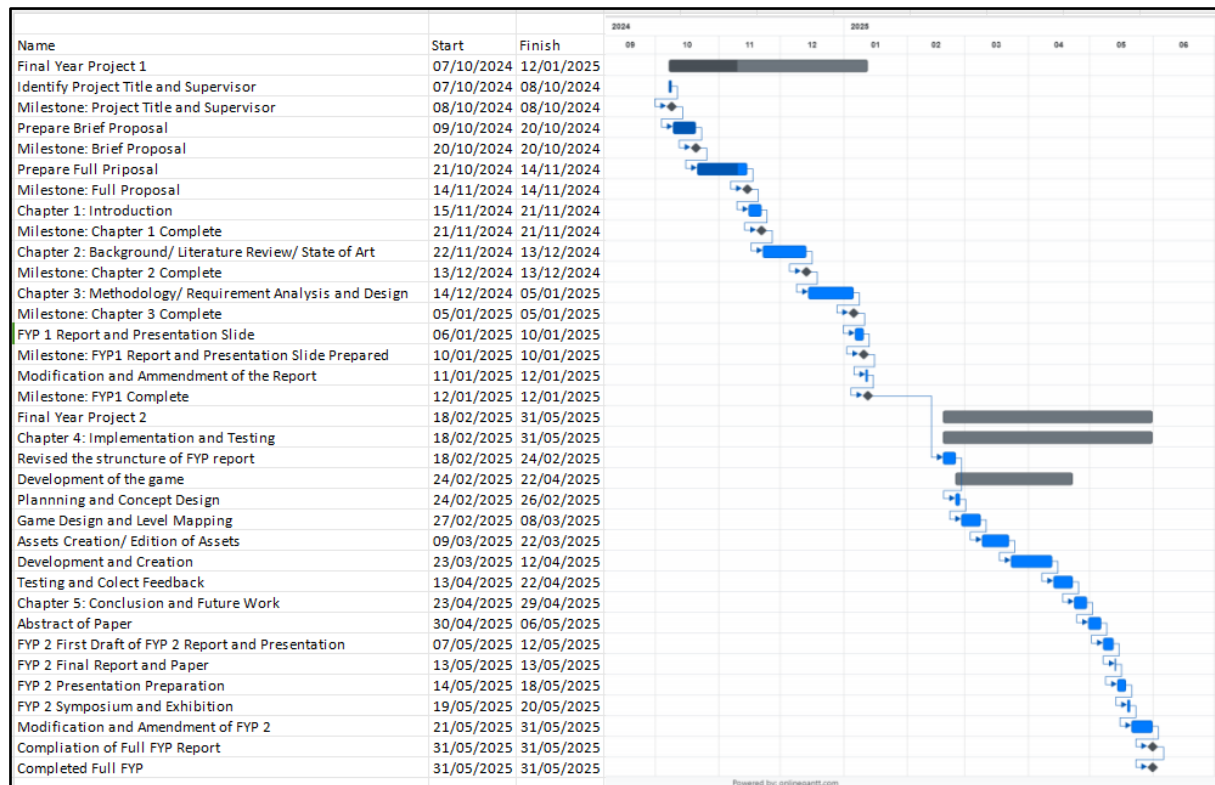


Figure 56 Project Schedule

APPENDIX B: QUESTIONNAIRE

Table 12 Questionnaire Form

Questionnaire Final Year Project (FYP): ChemiMonster - A 2D Puzzle Game for Exploring the Periodic Table

Introduction

My name is Choong Kai Sheng. I am a final-year Bachelor of Computer Science with Honours (Information Systems) student at the Faculty of Computer Science and Information Technology (FCSIT), University Malaysia Sarawak (UNIMAS). For my final year project, I am developing **ChemiMonster** : A 2D Puzzle Game for Exploring the Periodic Table.

Project Description

ChemiMonster is designed as a 2D puzzle game where players explore the periodic table in a fun and interactive way. Players will take on challenges, solve puzzles, and learn about chemistry elements, including their properties, atomic structures, and real-world applications. The game aims to make chemistry more engaging and accessible, blending educational content with entertaining gameplay.

Project Aim and Objectives

This project aims to develop an engaging and interactive 2D puzzle-based game that presents general knowledge about the periodic table, focusing on elemental properties, atomic structure, and real-world applications. The objectives of this project are as below:

1. To develop an interactive 2D puzzle game, ChemiMonsters, that enables players to explore and learn about the elements of the periodic table through engaging problem-solving and immersive gameplay.
2. To align with educational curriculums, providing a tool for teachers to supplement their lessons on the periodic table and chemistry fundamentals.
3. To evaluate the usability of the game in enhancing players' understanding of elemental properties and chemistry concepts.

Sections

The survey is divided into four sections:

- **Section A** : Demographic Information
- **Section B** : Knowledge and Interest in Periodic Table
- **Section C** : Concern in Understanding Periodic Table
- **Section D** : ChemiMonster Interest

The survey will take approximately 3-5 minutes to complete, and all responses will remain confidential.

Your feedback is greatly appreciated and will contribute significantly to the success of this project. Should you have any question or need further clarification, please feel free to contact me at 79084@siswa.unimas.my. Thank you.

Section A : Demographic Information

This section is to collect basic details about the respondents. Kindly provide information about your gender, age, study level. Participation is entirely voluntary, and all responses will be kept strictly confidential.

Gender

Male ☐

Female ☐

Age

Under 18 ☐

18 -29 ☐

29 – 40 ☐

41 and above ☐

What is your study level?

Primary School ☐

Secondary School ☐

Pre-University ☐

Undergraduate ☐

Postgraduate ☐

Working ☐

Other: _____

Section B : Knowledge and Interest in Periodic Table

This section is to explore respondents' current understanding in periodic table.

Have you played any educational games before?

Yes ☐

No ☐

How would you rate your interest in Chemistry?

1

2

3

4

5

Low

☐☐☐☐☐

High

How familiar are you with periodic table?

Not	1	2	3	4	5	Very
familiar	☐	☐	☐	☐	☐	familiar

Would you be interested in a game that teaches Chemistry concepts in a fun way?

Yes ☐ Maybe ☐ No ☐

What type of information do you find most useful while playing an educational game?
(Select all that apply)

☐ Real-world applications of concepts

☐ Visual representations

☐ Summaries or key takeaways at the end of levels

☐ Progress tracking or achievements

☐ Other: _____

Section C : Concern in Understanding Periodic Table

This section will identify the challenges faced by respondent while studying or learning knowledge on periodic table.

What challenges do you face when learning about the periodic table? (Select all that apply)

☐ Difficulty memorizing element names and symbol

☐ Understanding the organization and structure of the periodic table

☐ Connecting the elements to the real-world applications

☐ Lack of engaging or interactive learning materials

☐ Other: _____

Which part of the periodic table do you find most confusing? (Select all that apply)

☐ Groups and periods

☐ Element classifications (e.g., metals, non-metals, noble gases)

☐ Chemical reactivity of elements

☐ Other: _____

What would make learning about the periodic table easier or more enjoyable for you? (Select all that apply)

☐ Interactive and visual learning materials

☐ Real-life examples and applications of elements

☐ Engaging quizzes and puzzles

☐ Other: _____

How confident are you with your understanding of the periodic table?

Not	1	2	3	4	5	Very
confident	☐	☐	☐	☐	☐	confident

Section D: ChemiMonster Interest

This section is to check response interest in playing the game and its potential appeal to the target audience.

How interest would you be playing ChemiMonster to learn periodic table with real-life application while playing?

Not	1	2	3	4	5	Very
Interested	☐	☐	☐	☐	☐	Interested

APPENDIX C: EVALUATION FORM

Questionnaire Final Year Project (FYP): ChemiMonster - A 2D Puzzle Game for Exploring the Periodic Table

Introduction

My name is Choong Kai Sheng. I am a final-year Bachelor of Computer Science with Honours (Information Systems) student at the Faculty of Computer Science and Information

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Project Aim and Objectives

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1. To develop an interactive 2D puzzle game, ChemiMonsters, that enables players to explore and learn about the elements of the periodic table through engaging problem-solving and immersive gameplay.
2. To align with educational curriculums, providing a tool for teachers to supplement their lessons on the periodic table and chemistry fundamentals.
3. To evaluate the usability of the game in enhancing players' understanding of elemental properties and chemistry concepts.

Sections

The survey is divided into four sections:

- **Section A** : Understanding and Knowledge Gain
- **Section B** : User Interface, Graphic and Design
- **Section C** : Game Function

The survey will take approximately 3-5 minutes to complete, and all responses will remain confidential.

Your feedback is greatly appreciated and will contribute significantly to the success of this project. Should you have any question or need further clarification, please feel free to contact me at 79084@siswa.unimas.my. Thank you.

Section A : Understanding and Knowledge Gain

This section is designed to evaluate the respondent's understanding and knowledge gain after playing the ChemiMonsters game. It focuses on how effectively the game helps players learn about chemistry, particularly the periodic table and its elements.

The game helped me understand the periodic table better

Strongly	1	2	3	4	5	Strongly
Disagree	☐	☐	☐	☐	☐	Agree

I learned chemistry concepts while playing.

Strongly	1	2	3	4	5	Strongly
Disagree	☐	☐	☐	☐	☐	Agree

I now have better knowledge of the elements and their properties.

Strongly	1	2	3	4	5	Strongly
Disagree	☐	☐	☐	☐	☐	Agree

The ChemiDex was information and useful for learning.

Strongly	1	2	3	4	5	Strongly
Disagree	☐	☐	☐	☐	☐	Agree

I can relate the elements to their real-world applications better after playing.

Strongly	1	2	3	4	5	Strongly
Disagree	☐	☐	☐	☐	☐	Agree

Section B : User Interface, Graphic and Design

This section assesses the user's experience with the game's interface, graphics, and overall design. It aims to understand the visual appeal, ease of use, and clarity of navigation within the game.

The game design is visually appealing

Strongly	1	2	3	4	5	Strongly
Disagree	☐	☐	☐	☐	☐	Agree

The characters and maps are well designed

Strongly	1	2	3	4	5	Strongly
Disagree	☐	☐	☐	☐	☐	Agree

The text and buttons are clear and easy to understand

Strongly	1	2	3	4	5	Strongly
Disagree	☐	☐	☐	☐	☐	Agree

The interface is user-friendly and intuitive

Strongly	1	2	3	4	5	Strongly
Disagree	☐	☐	☐	☐	☐	Agree

The layout and animations made the game enjoyable

Strongly	1	2	3	4	5	Strongly
Disagree	☐	☐	☐	☐	☐	Agree

Section C : Game Functionality

This section focuses on the technical performance and gameplay functionality of ChemiMonsters. It evaluates how well the game responds to user actions, how smooth the gameplay is, and whether core features work as intended.

The game controls are responsive and accurate

Strongly	1	2	3	4	5	Strongly
Disagree	☐	☐	☐	☐	☐	Agree

Saving and loading progress worked correctly

Strongly	1	2	3	4	5	Strongly
Disagree	☐	☐	☐	☐	☐	Agree

The puzzles made were functional and solvable

Strongly	1	2	3	4	5	Strongly
Disagree	☐	☐	☐	☐	☐	Agree

Interactions with NPCs and items worked smoothly						
Strongly	1	2	3	4	5	Strongly
Disagree	☐	☐	☐	☐	☐	Agree
The game did not crash or lag during gameplay						
Strongly	1	2	3	4	5	Strongly
Disagree	☐	☐	☐	☐	☐	Agree