



Faculty of Computer Science and Information Technology

**ESCAPEDB: GAME-BASED LEARNING WEB APPLICATION FOR
DATABASE COURSE**

Vun Jun Ye

Bachelor of Computer Science with Honours

(Multimedia Computing)

2025

**ESCAPEDB: GAME-BASED LEARNING WEB APPLICATION FOR DATABASE
COURSE**

VUN JUN YE

This project is submitted in partial fulfilment of the

requirements for the degree of

Bachelor of Computer Science with Honours

(Multimedia Computing)

Faculty of Computer Science and Information Technology

UNIVERSITI MALAYSIA SARAWAK

2025

DECLARATION

I hereby declare that this project, together with all the content, is my original work where I have not copied from others' work except due to the research-based information and related materials that were adjusted and taken out from different resources, which have clearly been cited or stated respectively.

I confirm that the work presented in this thesis is original and has been prepared by me. Any assistance or guidance received in the preparation of this thesis has been properly acknowledged.

Signed,



.....

Vun Jun Ye (81466)

Bachelor of Computer Science with Honours (Multimedia Computing)

Faculty of Computer Science and Information Technology

Universiti Malaysia Sarawak (UNIMAS)

23 July 2025

ACKNOWLEDGEMENT

I would like to express my appreciation to many people for helping me to complete this Final Year Project (FYP) report. A lot of new things I learned throughout the process of completing this study were made.

First and foremost, I want to deliver my heartiest gratitude to my supervisor, Dr. Chiu Po Chan, for her assistance, guidance, suggestions, support and supervision throughout my Final Year Project. Thank you for your patience and advice to make sure this report is completed very well. Secondly, I would like to extend my appreciation to my examiner, Dr. Suriati Khartini Binti Jali, who provided constructive feedback and comments on my Final Year Project. Lastly, I am very thankful to all FCSIT undergraduates for their cooperation in answering the questionnaires.

Besides, I would also like to express my sincere thanks to my friends who are willing to share their knowledge and always help me when I faced problems. Finally, I would like to express my gratitude to my parents and family for their endless love, support and encouragement throughout this course.

TABLE OF CONTENTS

DECLARATION	i
ACKNOWLEDGEMENT	ii
ABBREVIATIONS.....	ix
ABSTRACT	x
ABSTRAK	xi
CHAPTER 1 : INTRODUCTION	12
1.1 Introduction.....	12
1.2 Problem Statement	13
1.3 Aim and Objectives.....	14
1.4 Scope	14
1.5 Methodology	15
1.6 Significance of the Project.....	15
1.7 Project Schedule	16
1.8 Expected Outcomes.....	16
1.9 Project Outline.....	17
1.10 Chapter 1: Introduction	17
1.10.1 Chapter 2: Literature Review	17
1.10.2 Chapter 3: Requirement Analysis and Design	17
1.10.3 Chapter 4: Implementation.....	17
1.10.4 Chapter 5: Testing.....	17
1.10.5 Chapter 6: Conclusion and Future Work.....	18
CHAPTER 2 LITERATURE REVIEW.....	19
2.1 Introduction.....	19
2.2 Game-Based Learning: Escape Rooms	19
2.3 Reviews on Existing Escape Room Games.....	20
2.3.1 Escape from Witch Cottage! Magic Escape.....	20
2.3.2 Escape the Mage Tower	22
2.3.3 Christmas Escape	23
2.3.4 The Hoax Factory.....	25
2.4 Reviews on Platforms Incorporating the Escape Room Concept for Learning	26
2.4.1 Google Forms and Google Sites.....	26
2.4.2 Escapp	28

2.4.3 Genially	30
2.4.4 Breakout EDU	31
2.5 Comparison between Existing and Proposed Application	33
2.5.1 Comparison of Features between Existing Games and Proposed Game	33
2.5.2 Analysis on Reviewed Technologies for Creating DER	34
2.6 Analysis on Proposed Application	35
2.7 Summary	36
CHAPTER 3 REQUIREMENT ANALYSIS AND DESIGN	37
3.1 Introduction	37
3.2 Methodology	37
3.3 Requirements Planning	38
3.3.1 Requirement Gathering through Questionnaires	38
3.3.2 Game Features	45
3.3.3 System Requirements	46
3.4 User Design	47
3.4.1 Game Flow	47
3.4.2 Activity Diagrams	48
3.4.3 Use Case Diagram	50
3.4.4 Application Sequence Diagrams	57
3.4.5 User Interface Design	61
3.5 Construction	66
3.6 Cutover	66
3.7 Summary	67
CHAPTER 4 IMPLEMENTATION	68
4.1 Introduction	68
4.2 Implementation Overview	68
4.3 User Interfaces of “EscapeDB” game	70
4.4 User Interfaces of “EscapeDB” admin dashboard	80
4.5 Summary	87
CHAPTER 5 TESTING	88
5.1 Introduction	88
5.2 Unit Testing	88
5.2.1 Student Module Test Cases	89
5.2.2 Lecturer Module Test Cases	94

5.3 Usability Testing	102
5.3.1 System Usability Scale (SUS).....	105
5.3.2 NASA-TLX Questionnaire	107
5.3.3 General Opinion on Game-based Learning.....	111
5.4 Summary	114
CHAPTER 6 CONCLUSION AND FUTURE WORK	115
6.1 Introduction.....	115
6.2 Project Achievements.....	115
6.3 Project Limitation.....	116
6.4 Future Work	117
6.5 Conclusion.....	118
REFERENCES.....	119
APPENDICES.....	122
APPENDIX A: Gantt Chart	122
APPENDIX B: User Requirements Questionnaire	123
APPENDIX C: Usability Testing Questionnaire	132

LIST OF FIGURES

Figure 1.1 The phases in Rapid Application Development Methodology (Airapetian, 2022).	15
Figure 2.1 Navigating and interacting with elements in the environment (Escape From Witch Cottage! By Xephrys, n.d.).	21
Figure 2.2 Screenshots of Magic Escape gameplay	22
Figure 2.3 Screenshots of gameplay (Escape the Mage Tower by Moyaaaaaa, n.d.)	23
Figure 2.4 Players add notes in the clues inventory as a means of communication.	23
Figure 2.5 Screenshots of gameplay of Christmas Escape (Christmas Escape, n.d.)	24
Figure 2.6 Examples of visual feedback to guide the player	25
Figure 2.7 The Hoax Factory (Maldita.es & Universidad Politécnica de Madrid, n.d.)	26
Figure 2.8 Game interfaces of The Hoax Factory	26
Figure 2.9 A digital escape room interface hosted on Google Sites, featuring an embedded Google Slides. (Google, n.d.)	28
Figure 2.10 Google Forms is used to validate user input.	28
Figure 2.11 Screenshot of the interface for creating new puzzles and hints in teacher form (Lopez Pernas, 2024).	29
Figure 2.12 Joining the game screen for a multiplayer session on a game built using Escapp	29
Figure 2.13 An escape room template on the Genially website (Genially, n.d.)	30
Figure 2.14 Gameplay Screens on the Genially platform	31
Figure 2.15 Customizing the game on the BreakOut EDU platform (Breakout EDU - Educational Games for the Classroom, n.d.)	32
Figure 2.16 Tracking Student Progress in Breakout EDU	32
Figure 3.1 Analysis of respondents' program of study	38
Figure 3.2 Self-Assessment of Understanding in Database Concept and Design	39
Figure 3.3 Experience with Physical Escape Rooms and Virtual Escape Rooms.	39
Figure 3.4 Most Effective Learning Methods.	40
Figure 3.5 Learning Preferences: Individual vs. Group-Based Activities.	40
Figure 3.6 Topic Difficulty: Rating the Challenges in the Database Course.	41
Figure 3.7 Learning Challenges: Assessing the Struggles in the Database Course.	41
Figure 3.8 Preferred Concepts for a Digital Escape Room	42
Figure 3.9 Preferred Game Challenges	42
Figure 3.10 Leaderboard Importance.	43
Figure 3.11 Preferred Mode of Gameplay.	43
Figure 3.12 Hint System.	44
Figure 3.13 Impact of Chat or Shared Notes on Gameplay Enjoyment.	44
Figure 3.14 Flowchart of the gameplay of EscapeDB	47
Figure 3.15 Activity Diagram for EscapeDB game.	48
Figure 3.16 Activity Diagram for EscapeDB admin dashboard	49
Figure 3.17 Use case diagram of EscapeDB.	50
Figure 3.18 Application sequence diagram for the player	57
Figure 3.19 Application Sequence Diagram for Lecturer	58
Figure 3.20 Class Diagram for EscapeDB	60
Figure 3.21 Welcome menu for the game	61
Figure 3.22 User Registration Interface	62
Figure 3.23 Game Login Screen	62
Figure 3.24 Main menu of the game.	63
Figure 3.25 The user inputs an incorrect answer to the question.	63
Figure 3.26 A summary of the gameplay will be displayed after the player completes the game.	64
Figure 3.27 Admin interface for viewing player analytics	64
Figure 3.28 Admin interface for managing questions	65
Figure 3.29 Admin interface for managing users.	65
Figure 4.1 Unity (Unity Technologies, 2025).	68

Figure 4.2 Visual Studio Code (Microsoft, 2025).....	68
Figure 4.3 C# sample code for communicating with Firebase	69
Figure 4.4 Game start screen	70
Figure 4.5 Login page of “EscapeDB”	70
Figure 4.6 Main menu of “EscapeDB”	71
Figure 4.7 Settings menu.....	71
Figure 4.8 Leaderboard panel	72
Figure 4.9 Achievement panel	72
Figure 4.10 Pop-up instruction panel.....	73
Figure 4.11 Room info pop-up.....	73
Figure 4.12 Story screen.....	74
Figure 4.13 How to play instructions.....	74
Figure 4.14 Escape room view.....	75
Figure 4.15 Exit confirmation dialog.....	75
Figure 4.16 The question panel pops up.....	76
Figure 4.17 Feedback on submitting the wrong answer.....	76
Figure 4.18 Clues display.....	77
Figure 4.19 Final code panel.....	77
Figure 4.20 Summary Panel	78
Figure 4.21 True False question.....	78
Figure 4.22 Short answer question	79
Figure 4.23 The interface of the final escape room	79
Figure 4.24 Admin dashboard login screen.....	80
Figure 4.25 User management in the admin dashboard	80
Figure 4.26 Delete user data	81
Figure 4.27 Player analytics dashboard	81
Figure 4.28 Analytics for a specific user in detail.....	82
Figure 4.29 Playing record of an escape room.....	83
Figure 4.30 Question bank interface.....	83
Figure 4.31 Question types available for adding.....	84
Figure 4.32 Example of editing the question panel.....	85
Figure 4.33 Warning when deleting a question in use.....	85
Figure 4.34 Manage the escape rooms screen.....	86
Figure 4.35 Edit the escape room panel.	86
Figure 4.36 Toggles in the menu for editing the escape room.....	87
Figure 4.37 Options to choose the final escape room in use	87
Figure 5.1 Respondent’s profile	102
Figure 5.2 Respondent’s distribution.....	103
Figure 5.3 Distribution of respondents’ gender	103
Figure 5.4 Grades of the students for the database course	104
Figure 5.5 Analysis of the mental demand of the game.....	107
Figure 5.6 Analysis of the physical demands of the game	108
Figure 5.7 Analysis of the temporal demand of the game.....	109
Figure 5.8 Analysis of the performance of students in the game	109
Figure 5.9 Analysis of the effort score of players in the game	110
Figure 5.10 Analysis of the frustration score of players in the game	111
Figure 5.11 Experiences with educational escape rooms.....	111
Figure 5.12 Learning experiences with the escape room approach.....	112
Figure 5.13 Satisfaction of players with the escape room learning experience	112

LIST OF TABLES

Table 2.1 Comparison between the reviewed games and the proposed game	33
Table 2.2 Comparison between the reviewed technologies for creating DER	34
Table 3.1 Respondents' additional suggestions for game features.....	44
Table 3.2 List of game features of "EscapeDB"	45
Table 3.3 List of system specifications for development.....	46
Table 3.4 List of software used for development.....	46
Table 3.5 Use Case for Game Login.....	51
Table 3.6 Use Case for Join Game	51
Table 3.7 Use Case for Find Clues.....	52
Table 3.8 Use Case for Solving Questions.....	52
Table 3.9 Use case for View Achievement.	53
Table 3.10 Use case for View Leaderboard.....	54
Table 3.11 Use Case for Managing Users.....	54
Table 3.12 Use Case for View Player Analytics.....	55
Table 3.13 Use Case for Managing Escape Room's Questions	55
Table 5.1 Modules in EscapeDB.....	88
Table 5.2 Test cases for the game login module	89
Table 5.3 Test cases for the escape game module.....	90
Table 5.4 Test cases on the achievement module.....	92
Table 5.5 Test cases for the leaderboard module	92
Table 5.6 Test cases for the game logout module	93
Table 5.7 Test cases for the admin login module.....	94
Table 5.8 Test cases for the manage users module.....	94
Table 5.9 Test cases for the view analytic module.....	96
Table 5.10 Test cases for the manage questions module	97
Table 5.11 Test cases for the manage rooms module	100
Table 5.12 Test cases for the admin logout module	101
Table 5.13 Question items for SUS in the questionnaire	105
Table 5.14 System Usability Scale (SUS) score interpretation table.....	105
Table 5.15 Data from questionnaire for the usability of the EscapeDB game.....	106
Table 5.16 Analysis table for NASA Task Load Index	107
Table 5.17 Player feedback for the game	113

ABBREVIATIONS

GBL	Game-based Learning
RAD	Rapid application development
FCSIT	Faculty of Computer Science and Information Technology
UNIMAS	Universiti Malaysia Sarawak
PC	Personal Computer
ER	Escape Room
DEER	Digital Educational Escape Rooms
EER	Educational Escape Rooms
BGM	Background Music
UDL	Universal Design for Learning
UML	Unified Modeling Language
UI	User Interface

ABSTRACT

Database systems are fundamental in undergraduate computer science programs, yet students often struggle with database concepts and design, which are crucial for developing modern information systems. Traditional teaching methods frequently fail to engage students, leading to low participation and motivation. To address this challenge, this project explores the use of gamification through a Game-Based Learning Web Application to enhance engagement and improve learning outcomes in a database course.

The proposed web application transforms database learning into an interactive experience, incorporating game mechanics such as challenges, real-time leaderboards, and collaborative problem-solving. By integrating an escape room concept, students navigate interactive narratives and solve progressively complex problems, fostering group work and reinforcing theoretical knowledge in an active environment. A questionnaire was distributed to assess student behavior, revealing that the complexity of database concepts presents notable challenges to students. These findings highlight the importance of targeted support and gamified assessments in enhancing engagement and learning outcomes in database courses.

Findings indicate that gamification effectively enhances student motivation, engagement, and proficiency in database concepts, offering a compelling alternative to traditional instructional methods. This research offers valuable insights and presents significant implications for educators seeking to enhance their teaching strategies in database education while also improving students' learning experiences.

ABSTRAK

Sistem pangkalan data adalah asas dalam program sains komputer peringkat sarjana muda, namun pelajar sering menghadapi kesukaran dengan konsep dan reka bentuk pangkalan data, yang sangat penting dalam pembangunan sistem maklumat moden. Kaedah pengajaran tradisional sering gagal untuk menarik minat pelajar, yang membawa kepada penyertaan dan motivasi yang rendah. Untuk mengatasi cabaran ini, projek ini meneroka penggunaan gamifikasi melalui Aplikasi Web Pembelajaran Berasaskan Permainan untuk meningkatkan penglibatan dan memperbaiki hasil pembelajaran dalam kursus pangkalan data.

Sistem yang dicadangkan mengubah pembelajaran pangkalan data kepada pengalaman interaktif, dengan memasukkan mekanik permainan seperti cabaran, papan kedudukan masa nyata, dan penyelesaian masalah secara kolaboratif. Dengan mengintegrasikan konsep bilik melarikan diri, pelajar mengemudi naratif interaktif dan menyelesaikan masalah yang semakin kompleks, sambil memupuk kerja kumpulan dan memperkukuhkan pengetahuan teori dalam persekitaran yang aktif. Satu soal selidik telah diedarkan untuk menilai tingkah laku pelajar, yang mendedahkan bahawa kompleksiti konsep pangkalan data menimbulkan cabaran yang ketara kepada pelajar. Penemuan ini menekankan pentingnya sokongan yang disasarkan dan penilaian berasaskan gamifikasi dalam meningkatkan penglibatan dan hasil pembelajaran dalam kursus pangkalan data.

Penemuan menunjukkan bahawa gamifikasi secara efektif meningkatkan motivasi, penglibatan, dan kemahiran pelajar dalam konsep pangkalan data, menawarkan alternatif yang menarik berbanding kaedah pengajaran tradisional. Kajian ini memberikan pandangan yang berharga dan membawa implikasi yang signifikan bagi pendidik yang ingin meningkatkan strategi pengajaran mereka dalam pendidikan pangkalan data sambil juga memperbaiki pengalaman pembelajaran pelajar.

CHAPTER 1 : INTRODUCTION

1.1 Introduction

In an era where digital games have become a dominant form of engagement for younger generations, educators are increasingly challenged to adapt traditional teaching methods to meet students' evolving needs. According to Anastasiadis et al. (2018), students today prefer experiential learning in this digital age, seek out direct relationships, demand quick responses and social interaction, and develop their personalities in the context of flexible communities.

Database courses, foundational for all computer science undergraduates, cover essential topics such as data modeling, database design, and SQL querying. However, the complex topics and concepts covered in a database course are frequently seen as difficult by students, which may result in a decline in their interest and enthusiasm for the class. As noted by Nelson and Fatimazahra (2010), a solid understanding and foundational knowledge of database concepts are crucial for students, both within the computing field and across other disciplines. This underscores the urgent need for more engaging and enjoyable educational experiences in the database course.

Game-based learning (GBL) is one such strategy that successfully combines learning goals with captivating gameplay to maximize its interactive potential and support students in achieving academic success. GBL is described as a teaching approach that incorporates games to improve the learning experience. Nadeem et al. (2023) suggested that incorporating game elements such as challenges, rewards, and competition, educators can create environments that stimulate curiosity and encourage active participation. In contrast to traditional methods, in which students frequently face tasks that they do not fully comprehend and feel stuck, game-based activities present challenges that actively motivate them to persevere. This process fosters a greater sense of accomplishment and boosts self-esteem as students overcome these hurdles.

Furthermore, numerous studies indicate that game-based learning (GBL) can significantly enhance learning outcomes and improve information retention by fostering cognitive connections

through multimodal content delivery. However, Jääskä and Aaltonen (2022) identified several challenges to implementing GBL, including limited resources for preparing GBL courses, student resistance to the method, and insufficient understanding of its suitability for teaching certain subjects. To address these barriers, the Game-Based Learning Web Application for Database Courses provides an innovative solution, enabling students to master database concepts through an engaging virtual escape room experience that promotes active learning and collaboration.

1.2 Problem Statement

In traditional classroom settings, students are often exposed to a wide range of theories and concepts. However, despite gaining this theoretical knowledge, they frequently struggle to apply it effectively, primarily due to the lack of a platform where they can experiment with and test their understanding. It is well-established that active practice is one of the most effective methods for students to retain knowledge and develop a deeper understanding of the concepts taught. However, the success of active learning is heavily dependent on students' motivation and active participation (Deslauriers et al., 2019). Without these key elements, even well-designed learning activities may fall short of reaching their full potential.

Currently, instructors still rely heavily on traditional lecturing methods, especially in college courses with large enrollments (Stains et al., 2018). The large class size limits in-depth discussions and hampers the delivery of complex database concepts, where immediate feedback is crucial for effective learning. Consequently, students often struggle to grasp foundational database concepts. Zeng et al. (2020) argue that extended lecture sessions can make it challenging for students to maintain focus and engagement, leading to difficulties in retaining the information presented. Research by Freeman et al. (2014) further indicates that passive learning environments, where students primarily take on the role of listeners, often result in disengagement and a lack of deeper understanding.

Game-based learning platforms offer a unique opportunity to improve student engagement and comprehension. Sousa and Rocha (2018) emphasized that games provide us with the opportunity to fail without significant personal or social repercussions. Games, by their very design, provide opportunities for experimentation and trial-and-error dynamically and engagingly. Students can explore different solutions and learn from the consequences of their actions without fear of making a mistake. There is a need to propose a game-based web application for learning database concepts and design in higher education.

1.3 Aim and Objectives

This project aims to propose a web-based application incorporating gamification elements tailored to the syllabus of UNIMAS's Database Concept and Design course. The specific objectives include:

- To analyze existing digital platforms that incorporate the escape room concept for learning.
- To develop a game-based web application that facilitates students learning database through gamification concepts.
- To evaluate the usability of the proposed game-based learning.

1.4 Scope

- i. This project will be a game-based learning application built on a web platform for the Database Concepts and Design course.
- ii. This project will be hosted online to facilitate an interactive environment.
- iii. This project mainly targets undergraduate UNIMAS FCSIT students who are taking the database course.

1.5 Methodology

Rapid application development (RAD) is the methodology that will be used for the development of the project. It provides a quick development process. RAD can help streamline the design process and quickly produce a working prototype. This approach is preferred as it allows iterative changes based on feedback, leading to a more polished, user-focused game. Besides, the constant user involvement ensures the puzzles, storyline, and game mechanics are engaging and intuitive. By having the functional prototypes built early, developers can focus on refining gameplay rather than building from scratch, which shortens development time. This methodology comprises four key phases, providing a structured approach to developing the web application.

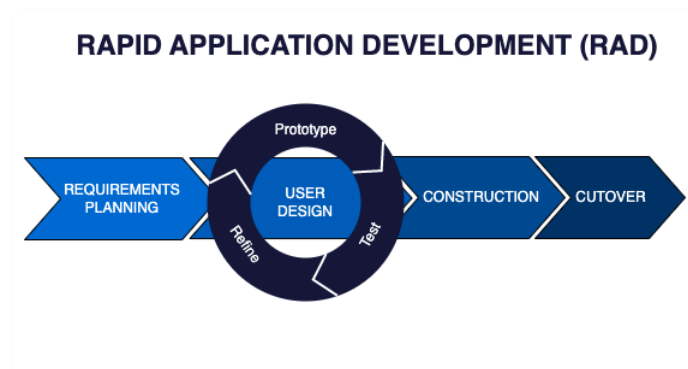


Figure 1.1 The phases in Rapid Application Development Methodology (Airapetian, 2022).

1.6 Significance of the Project

The project brings substantial benefits to UNIMAS FCSIT students enrolled in the database course, serving as an engaging and effective supplemental learning tool. By integrating gamified elements that align with the curriculum, the platform transforms learning into a dynamic and interactive experience. Immersing students in a game-like environment that simulates real-world database tasks captures their attention, encourages active participation, and bridges the gap between theoretical concepts and practical application. This approach allows students to reinforce and deepen their understanding through repeated application of key concepts, making learning both enjoyable and impactful.

Additionally, the platform addresses the learning anxiety students often face when grappling with challenging database concepts. By offering a game-based environment, it allows students to experiment freely, make mistakes, and learn from them without the fear of failure. This approach not only reduces anxiety but also promotes a more positive, growth-oriented mindset. By presenting instructional content engagingly and memorably, the platform enhances learning outcomes while empowering students to build confidence in their abilities. When students feel safe to explore and learn from their mistakes, they are more likely to succeed and retain knowledge effectively.

Furthermore, the platform allows for a personalized learning experience, enabling students to progress at their own pace. The platform adapts to individual needs, offering additional challenges for quick learners and extra support for those who need it.

1.7 Project Schedule

The project schedule has been formulated as a structured framework to ensure the timely completion of the project. It covers the period from 10th October 2018 to 28th July 2025, as outlined in the Gantt chart presented in Appendix A. This schedule serves as a pivotal tool for monitoring project progress, allocating resources efficiently, and ensuring adherence to key milestones, thereby facilitating the achievement of project objectives within the established timeframe.

1.8 Expected Outcomes

This project will provide a web-based game application specifically designed to enhance the learning experience in database courses for undergraduate students at the Faculty of Computer Science and Information Technology (FCSIT), UNIMAS. It will be optimized for PC compatibility and accessible via its website, requiring only an internet connection for participation.

The expected outcomes of this project are as follows:

- Promotes collaborative teamwork by allowing students to communicate in-game to solve database-related problems.

- Provides immediate feedback during problem-solving, helping students improve abilities and comprehension.
- Motivates students to learn from their mistakes in real-time.
- Encourages independent study to prepare for game challenges, fostering self-study habits.

1.9 Project Outline

In this project document, there will be a total of five (5) chapters to be discussed.

1.10 Chapter 1: Introduction

This chapter introduces the project, including an overview, problem statement, project scope and objectives, significance, expected outcomes, and the project schedule.

1.10.1 Chapter 2: Literature Review

This chapter provides a comprehensive overview of the key concepts, theories, and previous research relevant to the project. This chapter also discusses the strengths and limitations of existing literature and how it can be improved by the proposed application.

1.10.2 Chapter 3: Requirement Analysis and Design

Chapter 3 outlines the approach used to address the project's objectives. It analyzes problems and opportunities, analyzing the game design of the proposed online gamified platform. Additionally, the chapter presents key design elements, such as user interfaces, to represent the application's structure and functionality.

1.10.3 Chapter 4: Implementation

This chapter detailed how the project was executed, translating the research design and methodology into practical steps. It describes the development process of the proposed web application and the implementation of ideas into the game.

1.10.4 Chapter 5: Testing

In this chapter, the web-based learning platform will be available live and released to target users to test the platform. It also checks whether it meets all the requirements that have been discussed in

Chapter 3. It also includes a discussion of the testing outcomes, evaluating the comments and feedback to further improve the current platform.

1.10.5 Chapter 6: Conclusion and Future Work

Chapter 6 will discuss the future work that can be done to expand the project quality and will conclude the overall project. Any limitations of the project are discussed in this chapter.

CHAPTER 2 LITERATURE REVIEW

2.1 Introduction

This literature review focuses on the existing escape room games and platforms available for implementing Digital Escape Room (DER). It highlights what works well in existing systems and points out areas for improvement. The proposed project, an online game-based web application for a database course, will be compared with other applications on the web. By examining these applications, the insights gained will help in creating a more effective and engaging educational game.

2.2 Game-Based Learning: Escape Rooms

Escape room games, a genre of physical adventure games that require participants to solve puzzles and complete tasks to "escape" within a set period, have emerged as an innovative method for engaging students in higher education. While escape rooms originated in entertainment and recreational settings, their educational potential has led to increasing adoption in classrooms as a dynamic tool for active learning, team-building, and problem-solving. When these games are used to enhance learning in virtual or online environments, they are commonly known as digital educational escape rooms (DEERs).

Common themes for these games include scenarios such as prisons, espionage missions, and alien spaceships, each offering unique contexts that add excitement and intrigue to the experience. Participants work together to solve a series of puzzles, each of which typically reveals a code or combination needed to unlock a box, compartment, or door. As players progress through the game, they uncover more clues or puzzles that lead them closer to the goal: escaping the room. They are inspired to learn the lesson content to "win." This final objective is typically achieved by solving one last puzzle or unlocking a door, completing the sequence of challenges, and escaping or setting themselves free from such environments.

The study "Empowering Database Learning Through Remote Educational Escape Rooms," conducted by Enrique Barra and Lopez-Pernas, explored the impact of remote educational escape

rooms (EER) on database instruction. Involving 299 students, the research utilized the Escapp platform to facilitate remote participation. The study aimed to assess how EER could enhance learning outcomes in database courses. The findings suggest that remote EER presents a valuable opportunity for integration into the curriculum, offering an engaging and innovative approach to teaching complex subjects like databases (Barra et al., 2023).

According to Flynn (2024), digital escape rooms provide an engaging and inclusive learning approach that aligns with Universal Design for Learning (UDL) principles. The positive feedback and observed improvements in skill development indicate their potential to promote a collaborative classroom environment. Although the escape rooms in the study were centered on anatomy and physiology, this approach can be applied to a wide range of subjects.

2.3 Reviews on Existing Escape Room Games

There are a lot of recreational escape room games available online, this section will highlight and analyze a selection of these games to explore the uses of technology in creating interactive escape room games.

2.3.1 Escape from Witch Cottage! Magic Escape

This engaging point-and-click game, developed by Xephrys using Unity and WebGL, is available on itch.io in English. The game is primarily designed for entertainment and is available for free to play. It emphasizes fun and engagement rather than educational content. In this game, players navigate across a series of rooms within a witch's cottage, by clicking on the arrows on the side of the screen.

This game used mechanic of combining found items to progress. Players must think critically and use their inventory creatively to interact with various elements in the environment. For example, a player needs to collect firewood near the Witch's Cauldron, then light it by interacting with a fireplace in the room where the witch sleeps.

The intuitive item inventory, displayed at the bottom of the screen, allows players to easily drag and drop items onto interactive objects in the environment, ensuring smooth gameplay and immersion. As players explore the various rooms and unravel the mystery of the witch's cottage, they will when the player realize they must turn the witch into a frog to retrieve the key hanging around her neck, which is the only way to escape the cottage.

However, this game does not save the user's progress and does not provide hints to help the player.

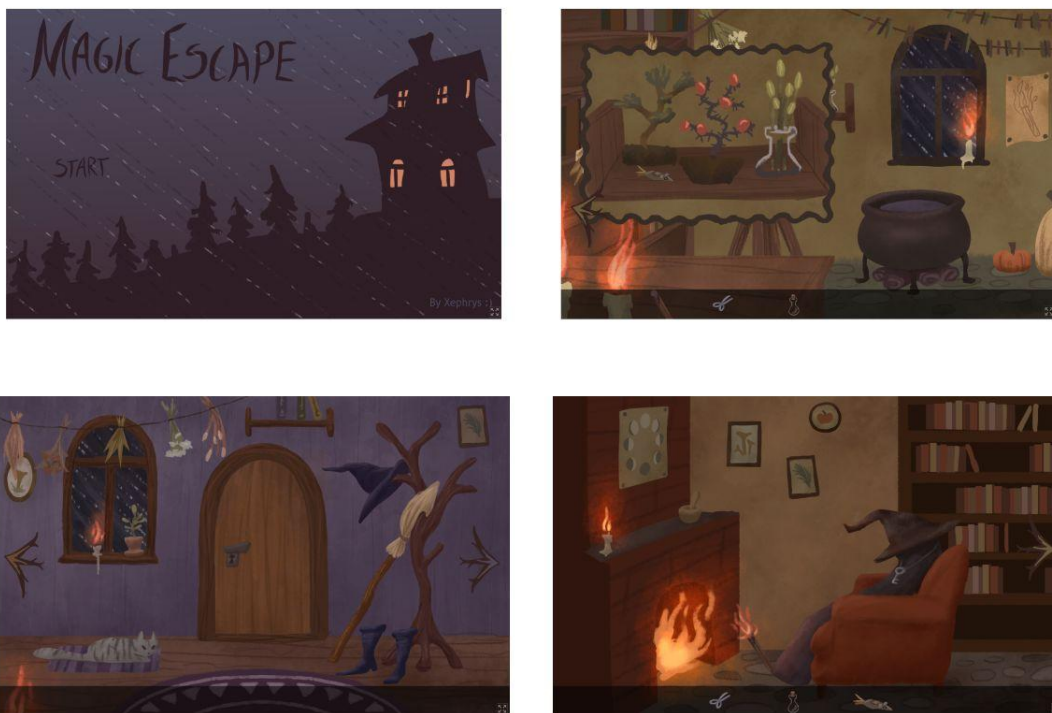


Figure 2.1 Navigating and interacting with elements in the environment (Escape From Witch Cottage! By Xephrys, n.d.)

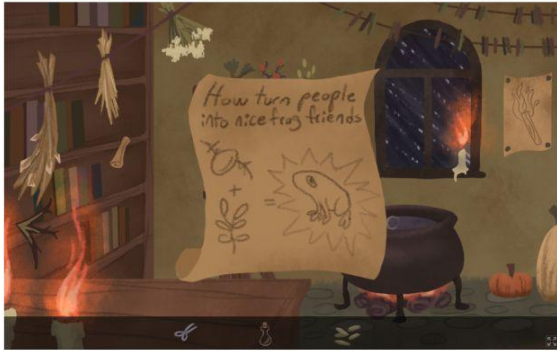


Figure 2.2 Screenshots of Magic Escape gameplay

2.3.2 Escape the Mage Tower

This is also a web-based escape game, accessible on both www.escapegamemaker.com and itch.io, offering both solo and multiplayer modes. The game was created by moyaaaaaa, and it is available in both Portuguese and English. The game is primarily for entertainment and does not focus on educational content. To play in multiplayer mode, the first player needs to initiate a new game, generating a unique room code. Other players can then join using this code, making it easy for friends or teammates to collaborate in solving the mysteries within the game.

As both players explore the environment and uncover clues, these items are added to a shared clue inventory, visible to all participants. This system allows players to communicate effectively by adding notes, allowing multiple players to contribute to the gameplay. It also has a time counter that tracks the total duration it takes to complete the game, adding an extra challenge for players who wish to race against the clock or improve their performance upon replaying.

The game also includes an option for players to exit if they wish to quit playing. However, the game's scarcity of hints can lead to frustration, as players often find themselves relying on trial and

error to progress.

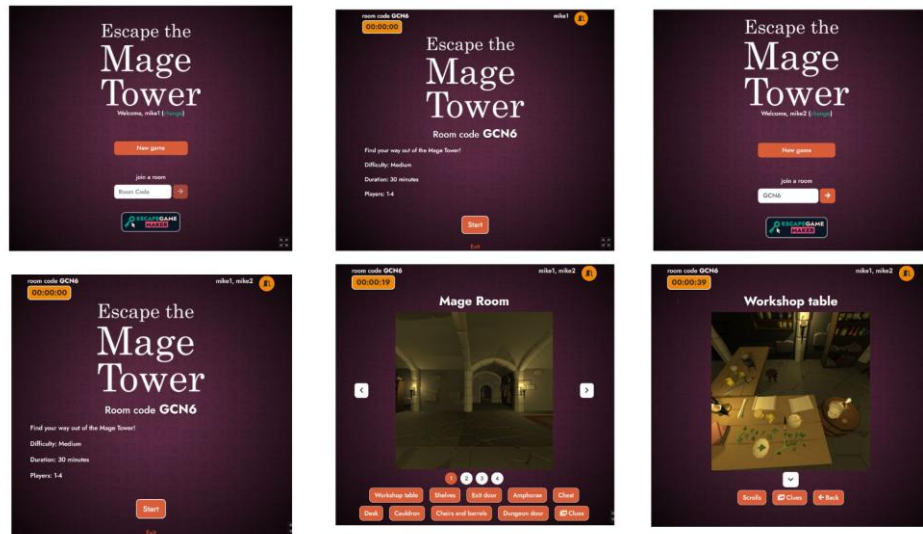


Figure 2.3 Screenshots of gameplay (Escape the Mage Tower by Moyaaaaaa, n.d.)

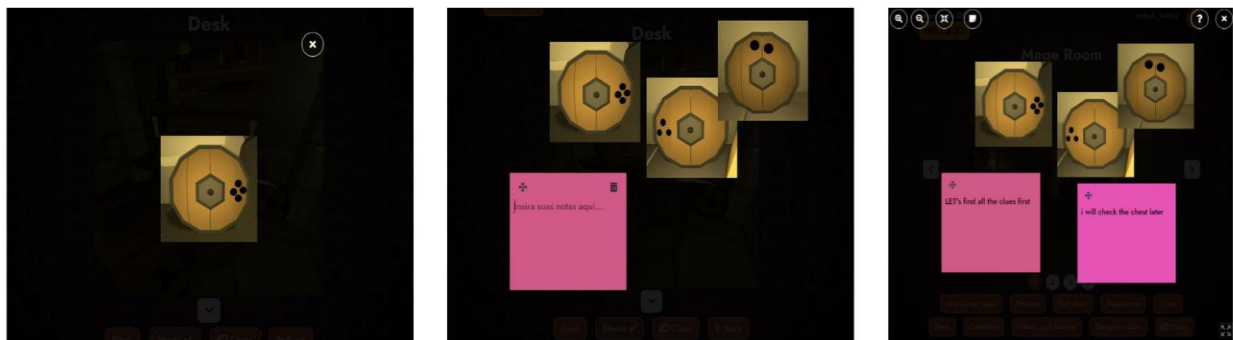


Figure 2.4 Players add notes in the clues inventory as a means of communication.

2.3.3 Christmas Escape

Christmas Escape is one of the standout titles on the popular RoomEscapeMaker platform made by André, a French escape room enthusiast. The entertainment game follows a point-and-click interface, where players can easily explore different rooms and areas using the navigation bar at the bottom of the screen. This simple control system ensures that players can focus on the puzzles without being distracted by complex mechanics or interface issues.

This game has an intuitive visual hint system. Most of the objects within the room trigger a visual tip when clicked, guiding players to their next step. These visual cues not only serve as helpful reminders but also contribute significantly to the game's narrative and atmosphere. By providing clear

indications of what to do next, the game helps players stay immersed in the story while preventing frustration.

The game also features a dynamic item inventory system that plays a key role in puzzle-solving. This creates a satisfying chain of discovery, as each item contributes to the resolution of multiple puzzles. What sets this game apart is its unique approach to item management: once an item has been used and serves its purpose, it disappears from the inventory. This design choice not only reduces clutter but also helps players stay focused on the essential tasks at hand.

Christmas Escape has a 30-minute time limit, urging players to think quickly and efficiently through the puzzles. This adds a sense of urgency and excitement, pushing players to prioritize their actions. However, the game allows players to pause whenever they wish.

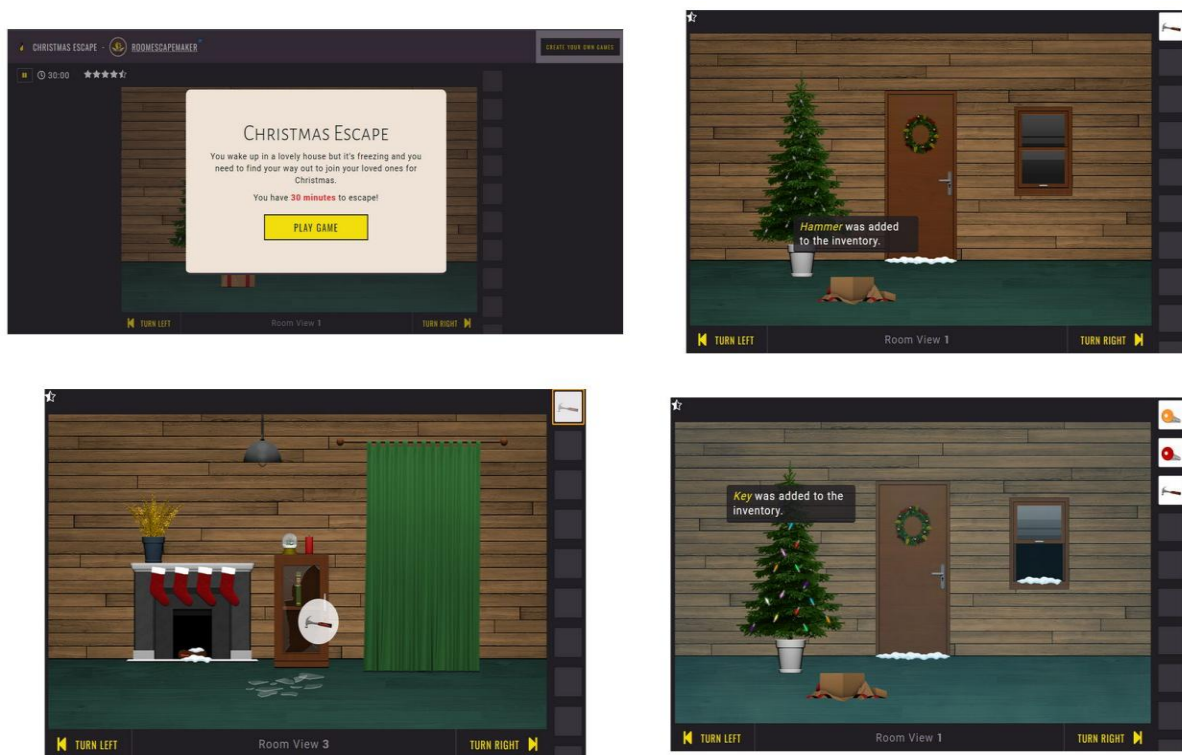


Figure 2.5 Screenshots of gameplay of Christmas Escape (Christmas Escape, n.d.)

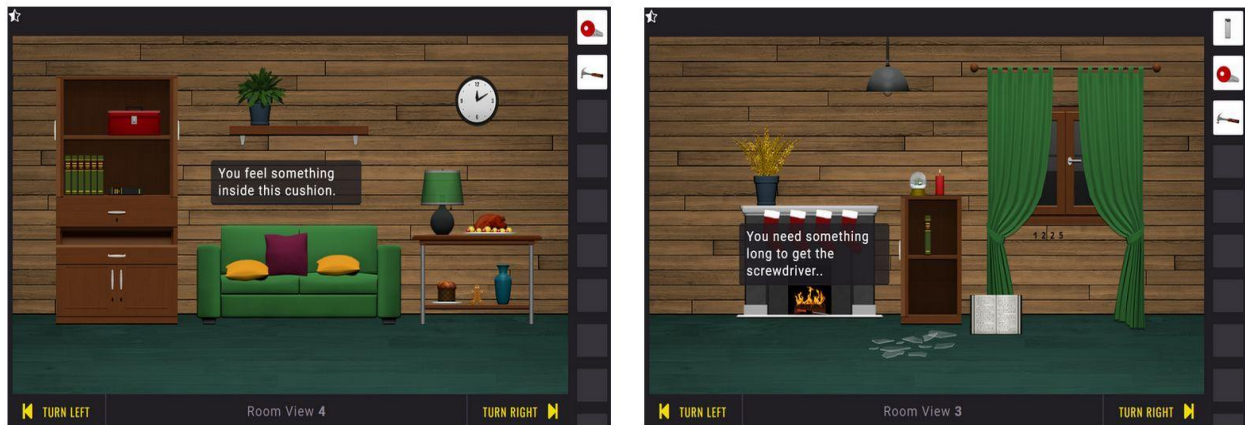


Figure 2.6 Examples of visual feedback to guide the player

2.3.4 The Hoax Factory

The Hoax Factory (Maldita.es & Universidad Politécnica de Madrid, n.d.) is an educational escape room game about migration misinformation, developed by the Maldita.es Foundation and Universidad Politécnica de Madrid, a Spanish non-profit organization dedicated to combating misinformation and fostering public trust. The game is free to play and available in Spanish, English, and Italian.

It includes an interactive map, where it shows the location of all the available rooms in the building, each containing clues and puzzles. A limited hint system prevents over-reliance by restricting the number of hints players can request within specific time intervals. This ensures a balanced challenge while maintaining engagement.

The game features a compelling storyline, where players uncover how the factory produces and spreads misinformation. As they explore the environment, they must piece together clues to expose the deception. The puzzle structure is sequential, meaning each puzzle must be solved to unlock the next set of clues, keeping players engaged and encouraging logical progression.

A 45-minute time limit adds urgency, but if time runs out, the countdown continues into negative values, allowing players to finish the game without being forced to stop. Upon completion, a leaderboard displays the player's ranking and total time taken.

However, the game lacks sound effects and background music, which could enhance immersion and engagement. Despite this drawback, The Hoax Factory effectively integrates

educational concepts with gamification elements, making it an engaging tool for learning about misinformation.

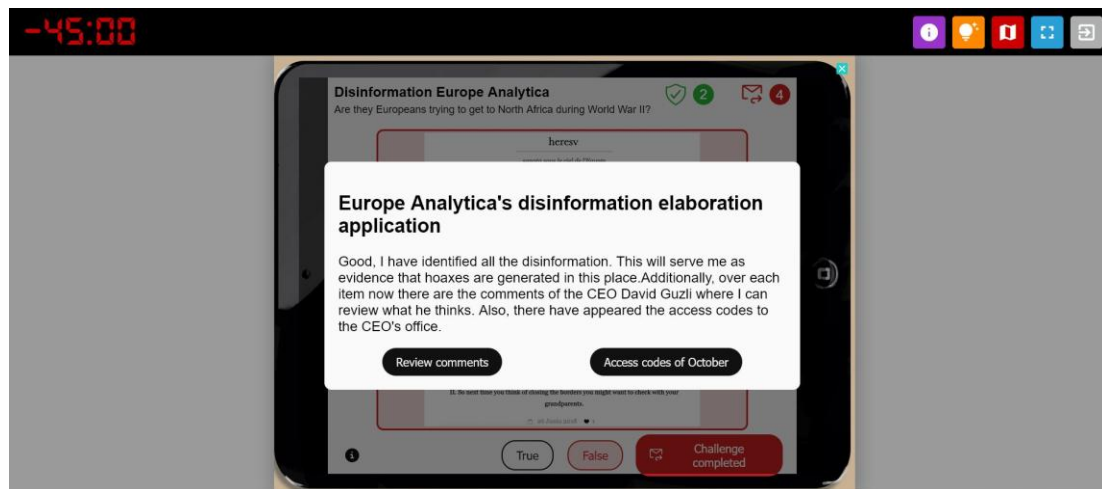


Figure 2.7 The Hoax Factory (Maldita.es & Universidad Politécnica de Madrid, n.d.)

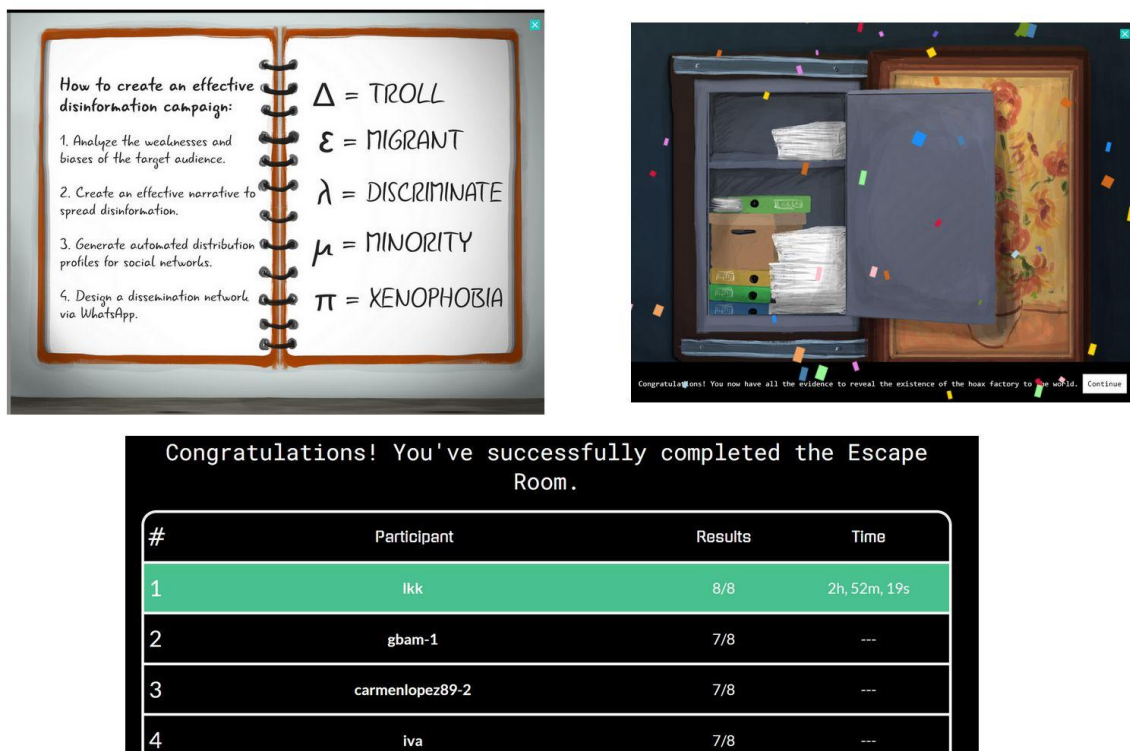


Figure 2.8 Game interfaces of The Hoax Factory

2.4 Reviews on Platforms Incorporating the Escape Room Concept for Learning

2.4.1 Google Forms and Google Sites

Google Forms and Google Sites (Google, n.d.) are popular tools among educators for designing accessible and cost-effective digital escape rooms. Google Forms can be used to design puzzles where

students answer questions to progress through the game, while Google Sites serves as a host for the full escape room experience, embedding puzzles, clues, and challenges in a sequential format. This approach enables creative customization while minimizing costs.

An escape room designed with Google Sites, Google Slides, and Google Forms creates an interactive environment where players solve puzzles or answer questions to advance through different stages. Google Sites delivers the storyline and clues, while Google Slides incorporates interactive hotspots with hidden links to external websites. Meanwhile, Google Forms captures player inputs, validates responses, and unlocks subsequent stages. For example, decorations in the virtual room may include hyperlinks to Google Forms or serve as distractors. The forms contain topic-related questions, requiring correct answers to reveal the escape code. The game integrates hyperlinks and form logic to replicate the thrilling experience of an escape room, all within the confines of a browser.

In the context of an escape room game, Google Forms can be used to track players' progress and manage the flow of the game. Many researchers, including Cash et al. (2023), Flynn (2024), and Vergne et al. (2020), have employed Google Forms as a key tool in their investigations into escape room games. Another approach taken by educators is utilizing video conferencing platforms like Zoom or Microsoft Teams to provide real-time guidance and offer instant feedback while students solve puzzles using Google tools.

Despite its benefits, this setup has limitations. Complex interactions require significant educator effort, and the games often lack real-time interaction and dynamic content, limiting immersion and challenge.

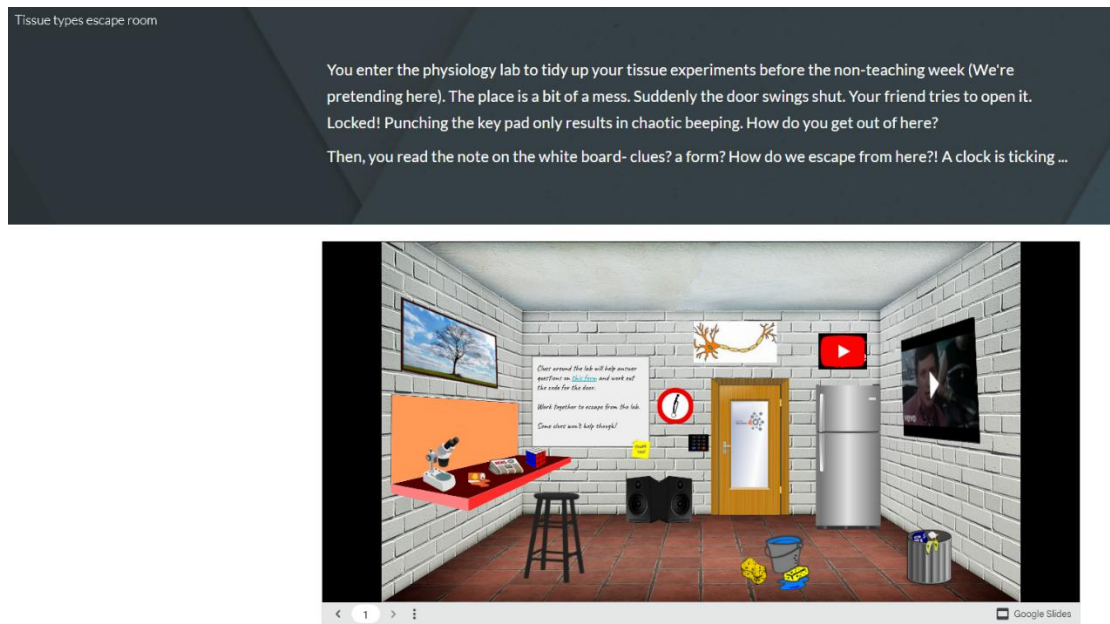


Figure 2.9 A digital escape room interface hosted on Google Sites, featuring an embedded Google Slides.
(Google, n.d.)

Keypad form

evacuate92@gmail.com [Switch account](#)

Not shared

* Indicates required question



Type in the code to open the door *

Your answer

[Next](#) [Clear form](#)

Figure 2.10 Google Forms is used to validate user input.

2.4.2 Escapp

Escapp is an open-sourced web platform developed by educational practitioner Lopez Pernas (Lopez Pernas, 2024), aimed at assisting teachers in the conduct of educational escape rooms, both face-to-face and remote. It allows setting up different shifts for an escape room, customizing and automating the content that students view, managing team formation, monitoring the progress of

students in the different challenges, inserting gamification elements (countdown, leaderboard), viewing learning analytics in real time, and exporting the results. It also provides a REST API and a WebSocket interface for the development of challenges external to the platform.

Educators can easily register on the platform to design and customize their own escape room game directly on the website. They can then invite students by setting up the shift and sharing the game link. Educators can also choose to deploy their instance of the escape room using Escapp. However, this requires a certain level of technical knowledge. Educators must be familiar with web servers, databases, and how to install and configure dependencies. For educators without technical experience, this could be a barrier to entry.

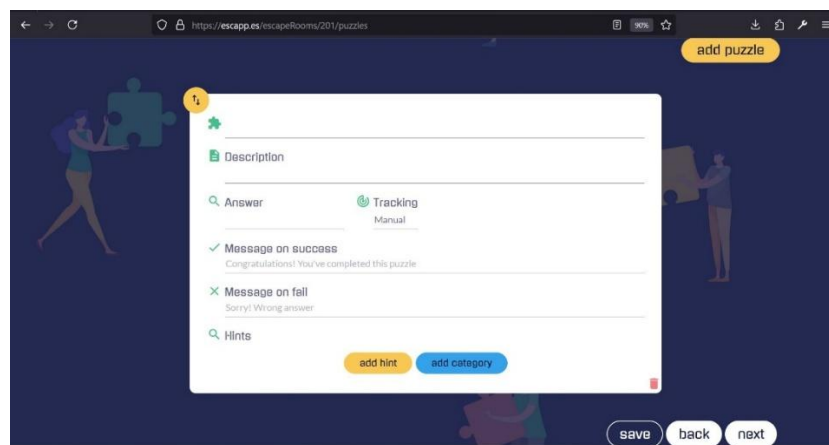


Figure 2.11 Screenshot of the interface for creating new puzzles and hints in teacher form (Lopez Pernas, 2024)

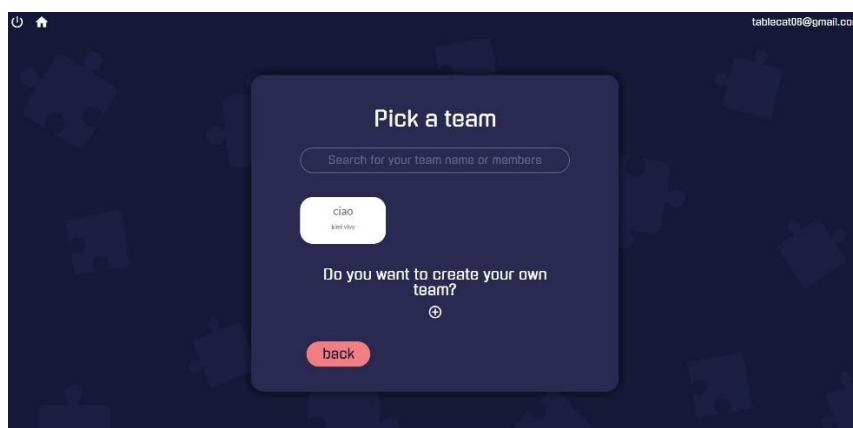


Figure 2.12 Joining the game screen for a multiplayer session on a game built using Escapp

2.4.3 Genially

Genially is an online platform that allows users to create interactive learning resources (Genially, n.d.). It has become an increasingly popular tool for developing digital escape rooms. It offers functionalities such as clickable elements, drag-and-drop interactions, and timed challenges. One of its standout features is the ready-made templates for escape room games, which lowers the barrier to entry for educators, allowing them to focus on crafting content rather than designing the technical aspects of the escape room from scratch.

Although Genially is user-friendly, there can still be a learning curve for new users, especially those unfamiliar with interactive design tools. Creating complex escape room puzzles may require time and patience, particularly for educators without prior experience in digital design. One notable advantage of Genially is its ability to allow instructors to make online changes at any time, with updates automatically reflected in the escape room in real-time. This ensures that any detected errors or improvements can be promptly addressed, making the escape room a highly effective and continuously up-to-date educational tool.

While Genially can present a game in a much more visually attractive environment, access to some of the more advanced features, such as premium templates, requires a paid license. This could be a limitation for educators working within tight budgets or having limited access to funding for educational tools.

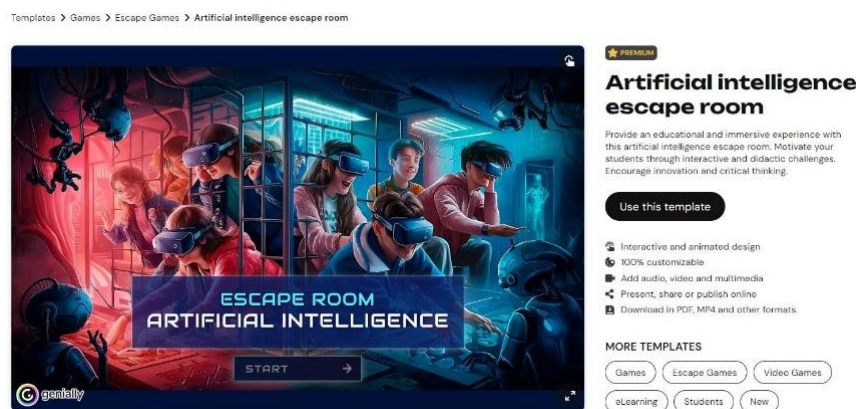


Figure 2.13 An escape room template on the Genially website (Genially, n.d.)

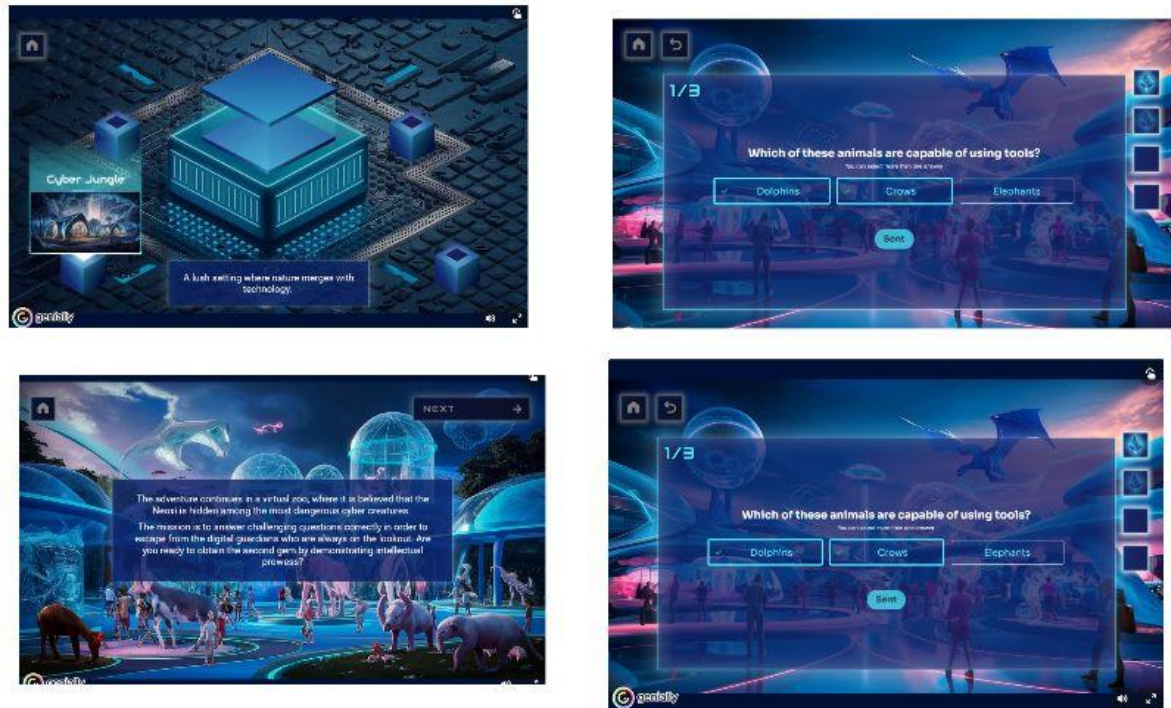


Figure 2.14 Gameplay Screens on the Genially platform

2.4.4 Breakout EDU

Breakout EDU (Breakout EDU - Educational Games for the Classroom, n.d.) is a digital platform designed to allow teachers to create escape room-style games for a classroom. The platform includes pre-made games across various subjects, allowing educators to save time while aligning with curriculum objectives. However, creating custom digital escape rooms can be time-consuming and challenging for those unfamiliar with design processes.

The user-friendly interface enables educators to select or design games, fostering student collaboration in real-time. Although it lacks built-in communication tools, educators can supplement the platform with external tools like Zoom for remote participation. Additionally, Breakout EDU features tracking mechanisms for monitoring student progress and identifying areas for support.

Educators must pay a subscription fee to access the platform's game creation feature, which, despite its limitations, offers a cost-effective and versatile tool for enhancing engagement and promoting active learning.

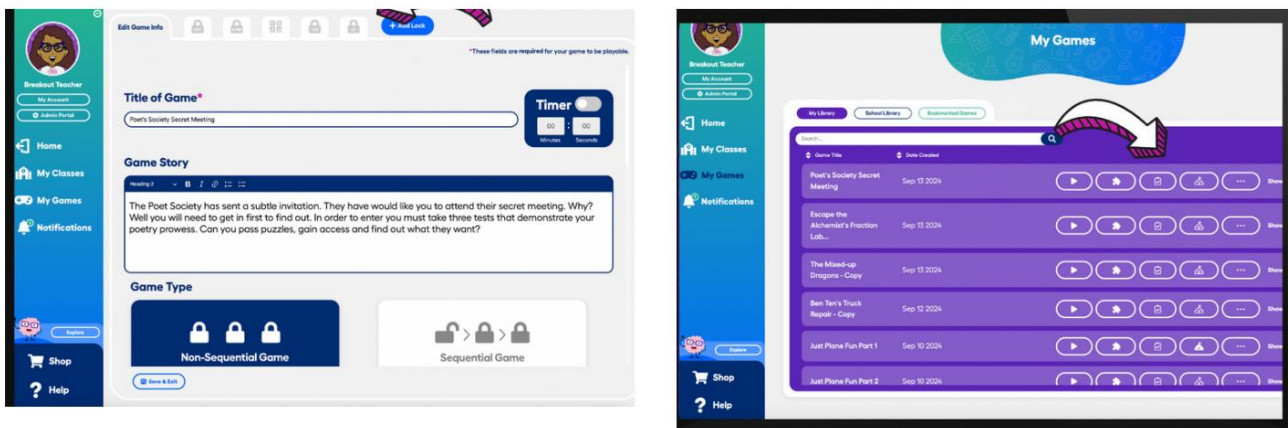


Figure 2.15 Customizing the game on the BreakOut EDU platform (Breakout EDU - Educational Games for the Classroom, n.d.)

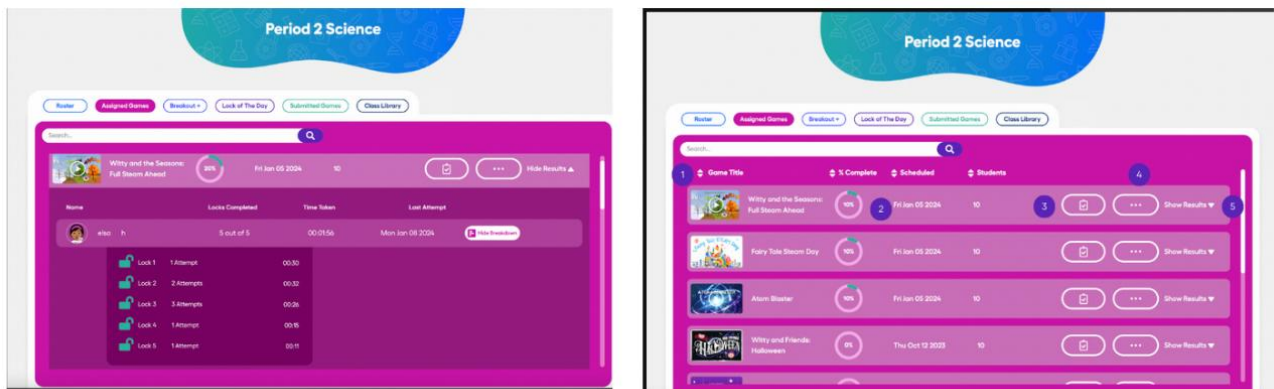


Figure 2.16 Tracking Student Progress in Breakout EDU

2.5 Comparison between Existing and Proposed Application

2.5.1 Comparison of Features between Existing Games and Proposed Game

Table 2.1 Comparison between the reviewed games and the proposed game

Features	Magic Escape	Escape the Mage Tower	Christmas Escape	The Hoax Factory	EscapeDB
Dimension	2D	2D	2D	2D	2D
Game Design (Audio & Visual)	Ambient background music, vibrant visuals	No audio, simple, interactive elements	No background music, but audio cues are provided to signal interactions. Interesting visual that changes based on interactions	No BGM, contains image- and video-based content.	Use audio cues and BGM, and use interactable visual elements.
Navigation	Point-and-click, drag and drop	Point-and-click	Point-and-click	Point-and click	Point-and-click, drag and drop
Game Feedback	No	Minimum	Very details	Available	Clear feedback
Time Pressure	No	Record the time taken to complete	Yes	Yes, but players can continue even after the time runs out.	Yes
Story Narration	Yes	Yes	Yes	Yes	Yes
Progress Saving	No	Browser cache (expires in 3 hours)	No	No	Yes
Multiplayer Mode	No	Available	No	No	No
Tutorial	No	Yes	No	No	Yes
Login	No	No	No	No	Yes
Cost	Free	Free	Free	Free	Free

While there is a lack of escape room games focused on teaching database concepts, there are many recreational escape room games can be found online. They provide a more focused approach to escape

rooms, though it is primarily geared toward entertainment rather than education. These examples will be analyzed to better assist in creating a DER for the proposed application.

2.5.2 Analysis on Reviewed Technologies for Creating DER

Table 2.2 Comparison between the reviewed technologies for creating DER

Features	Google Sites, Slides, Forms	Escapp	Genially	Breakout EDU
Leaderboard	No	Yes	No	Yes
Analytics	Yes, but limited	Yes	No	Yes
Cost	Free	Free	Free / Paid	Paid
Time Pressure	No	Yes	Yes	Yes
Interface	Redirect from one form to another	Customizable	Customizable but limited	Customizable
Auto saves	Automatically saves responses using Google Forms	Yes	No	Yes
Multiplayer	No	Yes	No	Yes
Login required	No	Yes	No	Yes

Based on the comparison, platforms like Breakout EDU, Genially and Escapp are more suited to help educators to integrate DER in their teaching compared to the conventional Google tools and Genially. While Google tools are accessible and easy to use, they lack advanced game mechanics and performance tracking. Genially offers interactivity but requires external tools for collaboration and lacks robust real-time features.

While the platforms mentioned above offer accessibility, interactivity, and scalability for implementing escape rooms in higher education, they also exhibit notable limitations:

- **Technical skills and support:**

Many of the digital platforms require educators to have a certain level of technical proficiency. While some platforms are user-friendly, others may require a higher learning curve, especially for more complex tasks like multimedia integration or puzzle design.

- **Cost and resources:**

While some tools are free, others, like BreakOut EDU and Genially, require a subscription or purchase of more advanced templates and functions. Budget constraints can limit access to certain platforms, especially for smaller or underfunded institutions.

- **Scalability:**

Digital platforms may offer more scalability than physical ones, but issues like student collaboration can present challenges. Some platforms can be difficult to scale to large groups of students.

- **Adaptability to learning objectives:**

Escape rooms offer a high degree of adaptability; however, designing them to align with specific learning outcomes can be time-intensive and complex. Educators must ensure that puzzles and activities are not only engaging but also pedagogically relevant, reinforcing course content and fostering critical thinking.

In response to these limitations, the proposed web application will adopt a similar approach to Escapp, incorporating a dynamic question pool that allows educators to seamlessly add and modify questions within the game. This design aims to enhance flexibility, adaptability, and analytical capabilities, ensuring that the escape room remains aligned with evolving pedagogical objectives while providing valuable insights into student engagement and performance.

2.6 Analysis on Proposed Application

Numerous platforms enable educators to design and implement digital escape room (DER) experiences tailored to classroom needs. However, many of these platforms are hindered by high costs, steep learning curves, or a lack of alignment with specific educational objectives.

The proposed web-based application, EscapeDB, attempts to address these limitations by integrating the strengths of existing platforms and educational games. By leveraging these foundations, EscapeDB enables educators to create interactive escape room experiences aligned with their teaching goals. Educators can design quiz-style questions through an intuitive administrative interface, allowing for the dynamic creation and modification of questions. This flexibility ensures that educators can

update and tailor puzzles to diverse learning objectives without requiring technical expertise. A backend database system supports real-time storage, retrieval, and updating of game content, ensuring seamless customization.

To enhance student learning and engagement, the system will offer real-time feedback and hints. Immediate feedback helps students overcome challenges and refine their problem-solving skills, minimizing frustration during complex tasks. Additionally, EscapeDB provides progression tracking and a leaderboard system, which gamifies the experience by allowing students to monitor their performance, compare scores, and engage in friendly competition, fostering a sense of achievement.

The game mechanics are designed to be both fun and engaging, using escape room elements to captivate students. Each puzzle or challenge incorporates multimedia elements like interactive visuals, audio cues, and storytelling to maintain student interest and support concept mastery. This design helps students build competence and confidence in database skills within a dynamic, immersive learning environment.

Additionally, EscapeDB features a login system that allows students to log in with their credentials. This functionality enables educators to track individual performance while ensuring secure access to the game and preserving player data for post-game analysis.

2.7 Summary

To summarize, a well-designed escape room game can significantly enhance the classroom experience by fostering teamwork, critical thinking, and active participation. However, without dedicated systems to support these activities, educators who implement educational escape rooms may struggle to fully leverage their potential, despite investing considerable time and effort in their design and execution. From the analysis, many of the platforms chosen have shown that they have implemented different features designed to encourage and motivate users. Although existing platforms are not specifically tailored for database courses, the approaches taken can be examined to help create the proposed application.

CHAPTER 3 REQUIREMENT ANALYSIS AND DESIGN

3.1 Introduction

For the game development methodology of this project, rapid application development (RAD) is chosen and used. Hence, this chapter will dive into RAD methodology in detail while describing its relevance to this platform development. The detailed steps for first and second phase in the methodology used by the development of this project will be discussed in this section. This chapter will present a proposed application design to provide a clear vision of how the web application will appear upon the completion of its development phase.

3.2 Methodology

The Rapid Application Development (RAD) methodology is an agile software development approach focused on quick and iterative delivery. It emphasizes user involvement and rapid prototyping, which allows for continuous feedback and refinement. It can also help the development team respond quickly to changes or new ideas during the development process.

The first phase is Requirements Planning which includes gathering user requirements by examining current curriculum needs and identifying key concepts to be integrated into the game. Then, the features to be included in the proposed application will be defined. Additionally, this phase involves determining the technical requirements, including the selection of the appropriate technology stack to implement the desired functions effectively.

In the User Design phase, the UML diagrams of the application will be designed to meet the requirements. Wireframes for the user interface are also designed to show how players interact with the web application.

During the Construction phase, full game features are built, including finalized puzzle mechanics, sound effects, and graphics. Frequent internal testing is conducted to ensure the game logic works as expected. It will be discussed elaborately in Chapter 4: Implementation.

Finally, the Cutover phase includes final testing and bug fixes to ensure the game is bug-free

and has smooth gameplay. The game is then deployed, hosted on the cloud platform, and published online. Post-launch, user feedback is monitored for any final adjustments or updates, and any issues that arise are addressed quickly. It will be discussed more in Chapter 5: Testing.

3.3 Requirements Planning

The first stage of the RAD methodology involves gathering requirements, which allows the developer to understand what is needed from their targeted groups.

3.3.1 Requirement Gathering through Questionnaires

The goal of this research is to assess students' confidence in studying the database course and gather feedback on the in-game features. To achieve this, a questionnaire was developed using Google Forms and distributed among the students enrolled in the database course for the current semester. The sample of the questionnaire is shown in Appendix B for reference. A total of 32 respondents participated in this survey. This section will present the responses gathered from the survey participants and the analysis of the findings.

Program of Study
32 responses

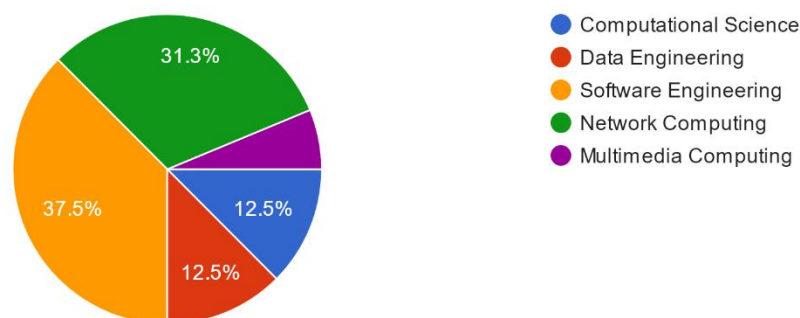


Figure 3.1 Analysis of respondents' program of study

The questionnaire was distributed among various programs for students enrolled in database courses. A higher number of participants came from software engineering and network computing programs, contributing significantly to this research.

What do you think of your current understanding level of the theories and concepts in Database Concept And Design course?
32 responses

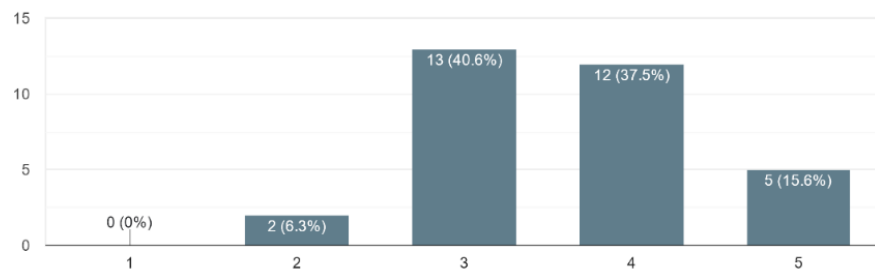
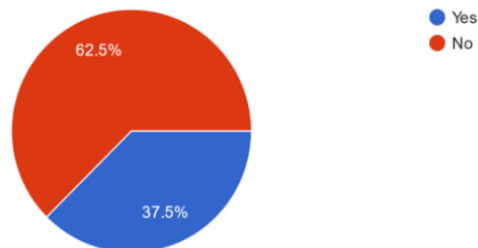


Figure 3.2 Self-Assessment of Understanding in Database Concept and Design

A notable 40.6% of the participants expressed a neutral stance (rating 3), suggesting a degree of uncertainty in their understanding. In contrast, 37.5% of the respondents indicated moderate confidence (rating 4). These findings highlight the potential need for clearer explanations and additional practice to reinforce students' comprehension and confidence levels.

Do you have an escape room experience (physical)?
32 responses



Have you ever played escape room game virtually on your device?
32 responses

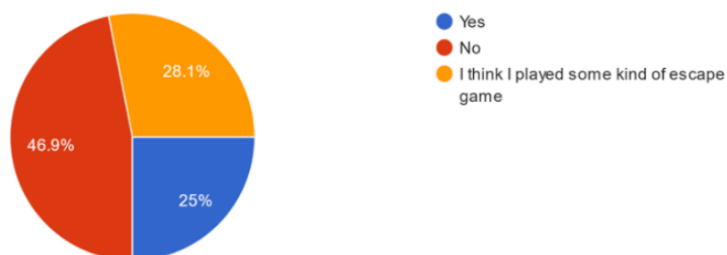


Figure 3.3 Experience with Physical Escape Rooms and Virtual Escape Rooms

A significant 62.5% of students have not experienced a physical escape room, and 46.9% have never played an escape game genre before. Given that most students are novices in playing escape

rooms, it is crucial to include a comprehensive tutorial and clear instructions before the commencement of the game. This approach will ensure that participants are adequately prepared and can fully engage with the experience.

What learning methods do you find most effective?

32 responses

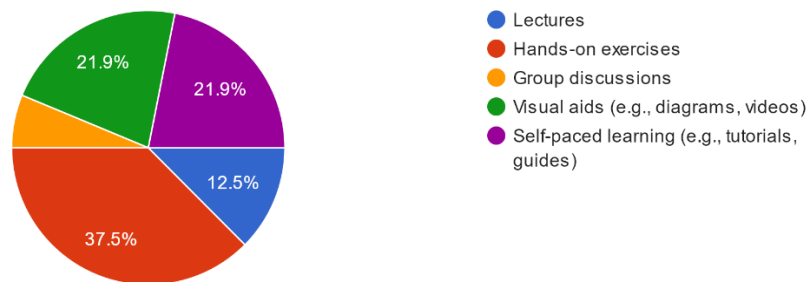


Figure 3.4 Most Effective Learning Methods

Hands-on exercises emerged as the most effective learning method among the respondents, with 37.5% indicating it as their top choice. Both self-paced learning and visual aids were selected by 21.9% of the respondents, while only 6.3% opted for group discussions. These findings suggest that while hands-on exercises are highly valued, a significant portion of students also appreciate self-paced learning and visual aids. Therefore, integrating hands-on activities, such as puzzles and interactive challenges, along with self-paced tutorials and visual aids, will likely enhance the engagement and effectiveness of the game.

Do you prefer individual learning or group-based activities when learning new concepts?

32 responses

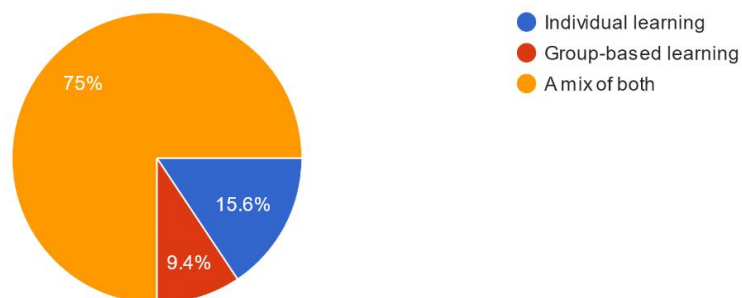


Figure 3.5 Learning Preferences: Individual vs. Group-Based Activities

75% of the students prefer a mix of individual and group-based activities when learning new concepts. Integrating both types of activities during learning would create a dynamic experience that caters to diverse learning preferences.

How challenging do you find each of the following topics in the database course? Please rate each one on a scale from 1 to 5.

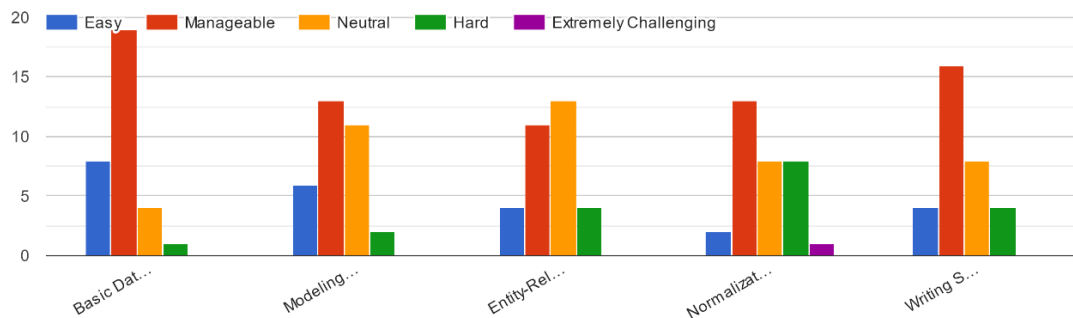


Figure 3.6 Topic Difficulty: Rating the Challenges in the Database Course

There are a variety of responses from the respondents, but most of them find that “Normalization (1NF, 2NF, 3NF)” is harder compared to other concepts. The results are mostly distributed over manageable and neutral for “Writing SQL Queries (e.g., SELECT, INSERT, UPDATE, DELETE, JOINS, subqueries)”, “Entity-Relationship (ER) Model (e.g., constructing and interpreting ER diagrams)” and “Modeling Relationships: One-to-Many, Many-to-Many (M:M)”. Most students find Basic Database Concepts and Terminology (e.g., tables, attributes, primary keys, foreign keys, etc.) easier than others.

What challenges did you face when learning the database course? Please rate each one on a scale from 1 to 5.

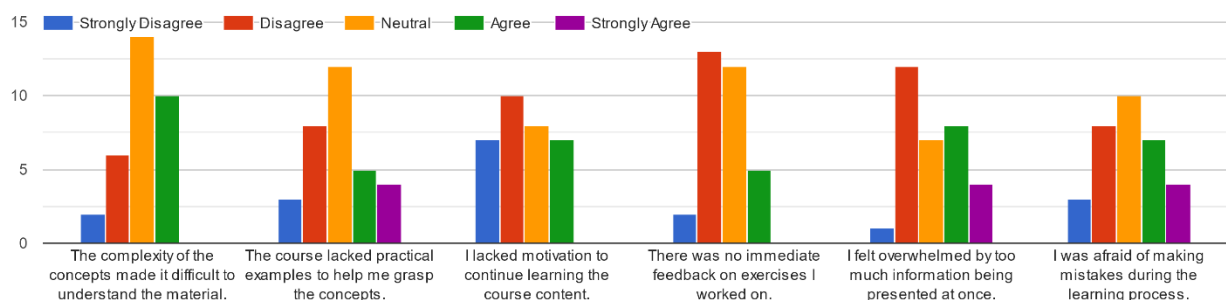


Figure 3.7 Learning Challenges: Assessing the Struggles in the Database Course

The data presented in the figure indicates that a significant number of students believe the complexity of the concept hinders their understanding of the material. Conversely, a substantial proportion of students disagree with the statements regarding the challenges they face, specifically, the lack of immediate feedback on exercises and the feeling of being overwhelmed by too much information presented at once.

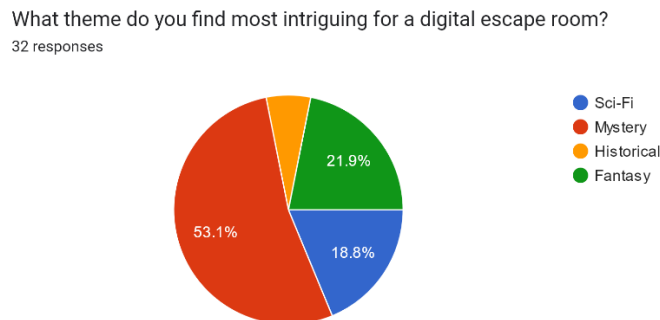


Figure 3.8 Preferred Concepts for a Digital Escape Room

Based on the visualization, more than half of the students (53.1%) state that they prefer to have a mystery-themed escape room.

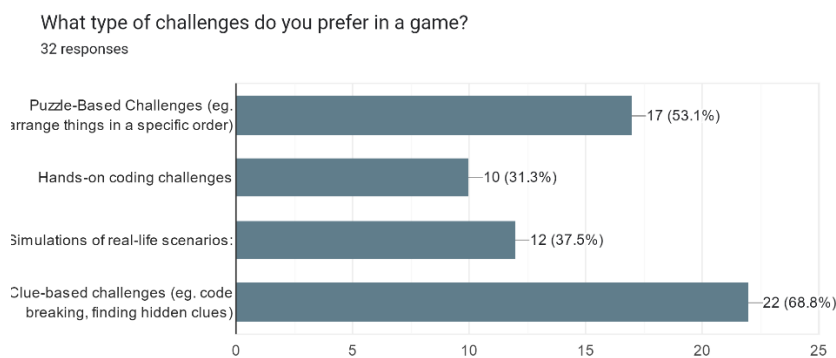


Figure 3.9 Preferred Game Challenges

The survey reveals that 68.8% of students express a preference for clue-based challenges in the games they play. Incorporating these types of challenges into the game design is essential, as they are a popular strategy to maintain student engagement. Additionally, 53.1% of students find puzzle-based challenges enjoyable. This indicates that including a mix of clue-based and puzzle-based challenges

will likely enhance the overall engagement and enjoyment for the students, making the game both entertaining and educational.

How important do you think a leaderboard is for showcasing players' achievements in an educational escape room game?

32 responses

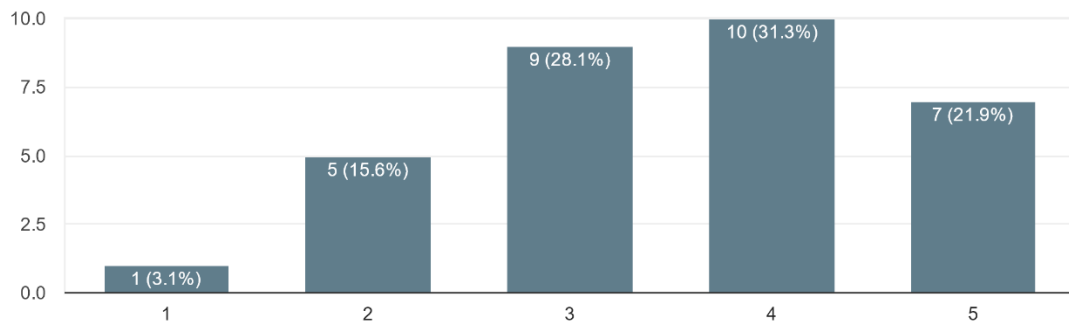


Figure 3.10 Leaderboard Importance

The data indicates that most students believe the leaderboard is an important feature. This finding highlights the value of incorporating a leaderboard into the game design. A leaderboard can foster a sense of competition and achievement, motivating students to engage more actively and strive for higher performance. By tracking and displaying student progress, the leaderboard can enhance the overall educational experience and promote a dynamic, interactive learning environment.

Do you prefer to play the game alone or play together with another friend?

32 responses

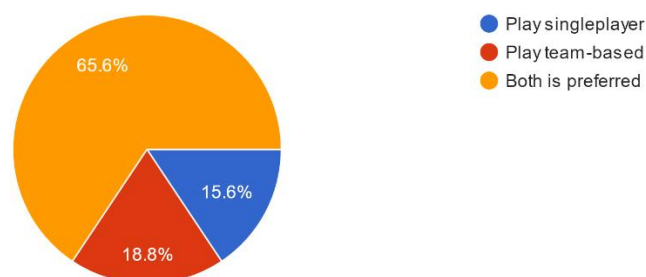


Figure 3.11 Preferred Mode of Gameplay

It was observed that 65.6% of students expressed a preference for both team-based and single-player modes of gameplay. In response to this preference, the proposed game will incorporate both gameplay modes to better engage students.

Should the game include a hint system for players who get stuck?
32 responses

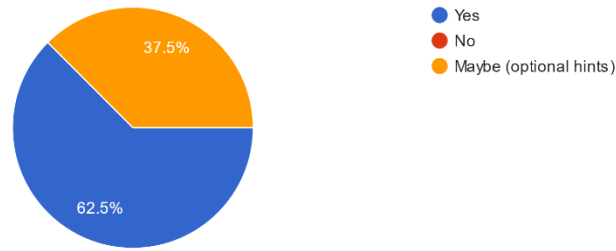


Figure 3.12 Hint System

The hint system is important for players to prevent them from getting stuck, so it will be used sparingly in the game to enhance the gameplay experience.

How do you feel about the addition of in-game chat or a shared notes feature? Would it help you enjoy the gameplay better?
32 responses

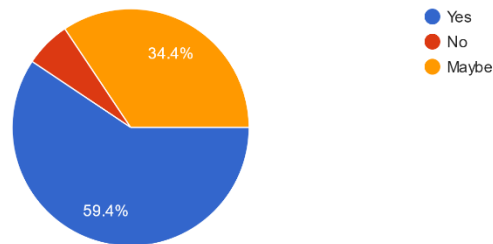


Figure 3.13 Impact of Chat or Shared Notes on Gameplay Enjoyment

19 students (59.4%) agree that the addition of in-game chat will make them enjoy the game more. An in-game chat can foster collaboration, idea sharing, and peer support, thereby enriching the overall gaming experience and promoting a more engaging and interactive learning environment.

Some respondents provided valuable suggestions for additional game features. These suggestions are documented in the table below.

Table 3.1 Respondents' additional suggestions for game features

Respondent	Suggestions
1	I think you should make the room space wider with a map given to each player.
2	Maybe can add a guidebook for the gameplay.
3	Recognizable universal icons, organized content layout, quick access menu on the left, and simple color tone.

4	My suggestion is when we want to get tutorial/secret note OR to get additional time for each puzzle/entire escape room, you can add very simple mini games (simple sudoku, arranging simple pictures, simple word puzzle and etc) so that it will make the games more interesting and at the same time it can release students' stress after answering database questions.
5	How about adding a secret note to show the place of the puzzle at the begin, cause sometime the point of puzzle is difficult to find out.
6	More challenging puzzle would be nice and provides with a hint to help those who got stuck along the way.

3.3.2 Game Features

Table 3.2 List of game features of “EscapeDB”

Game Features	Description
2D first person	The game is a web-based 2D game with drag and drop elements which players find hidden clues in the rooms and solve puzzles related to database concepts.
“Point and click” for the action	This game features a "point and click" mechanic for its core gameplay. Players can move between rooms by clicking the side arrows on either side of the screen. By clicking on certain objects within each room, players can discover hidden clues or puzzles.
Story narration	The game uses simple narration for introduction. As players solve a series of sequential puzzles, they unlock visual changes in the environment, such as new pathways or doors opening.
Dynamic Visual Feedback	The game will provide players with instant feedback when they make decisions. For example, if the student chooses the wrong option, feedback will be given so that it can be solved again and thus learn the correct terminology/procedures even in the case of a mistake.
Progress Tracking	Keeps track of each player's completion time for the game and calculates the score based on the attempts made.
Leaderboard System	Shows the ranking of all players based on the completion time and the score obtained.
Hints	Optional hints will be provided when wrong attempts are made to guide players and prevent them from being stuck too long on a single puzzle.

3.3.3 System Requirements

3.3.3.1 Hardware Requirements

Table 3.3 List of system specifications for development

Hardware		Requirement & Description
Laptop	Operating System (OS)	- Windows 10 is the minimum requirement to develop the project. The latest Windows 11 is also acceptable. - To better support the running of Unity.
	Processor (CPU)	- CPU: Intel Core i5 and above - Ensure faster code compilation and enhance debugging.
	Memory (RAM)	- Minimum 8GB - To ensure smooth operation when processing data.
	Graphics Card (GPU)	4GB and above, supports DirectX 12 - Improve performance when processing graphics in Unity.

3.3.3.2 Software Requirements

Table 3.4 List of software used for development

Software	Description
Figma	Figma is a free, online UI tool to create, collaborate, and prototype. This toolkit will be used for prototype development.
Visual Studio Code	The main development Integrated Development Environment (IDE) used to code C# scripts in Unity and develop the backend logic for the project.
Unity 2022.3.11f1	The game engine used to develop the graphical user interface and the game mechanics of the proposed application will be used to build the WebGL version of the game.
Firebase	It is a Backend as a Service (BaaS) platform that offers real-time database service and cloud storage. It will be used for real-time communications in game and act as the database server for the project.

3.4 User Design

This section will present Unified Modeling Language (UML) diagrams and user interface designs to offer a comprehensive overview of the web application to be developed. It will include various UML diagrams such as use case diagrams, use case descriptions, application sequence diagrams, activity diagrams, and class diagrams.

3.4.1 Game Flow

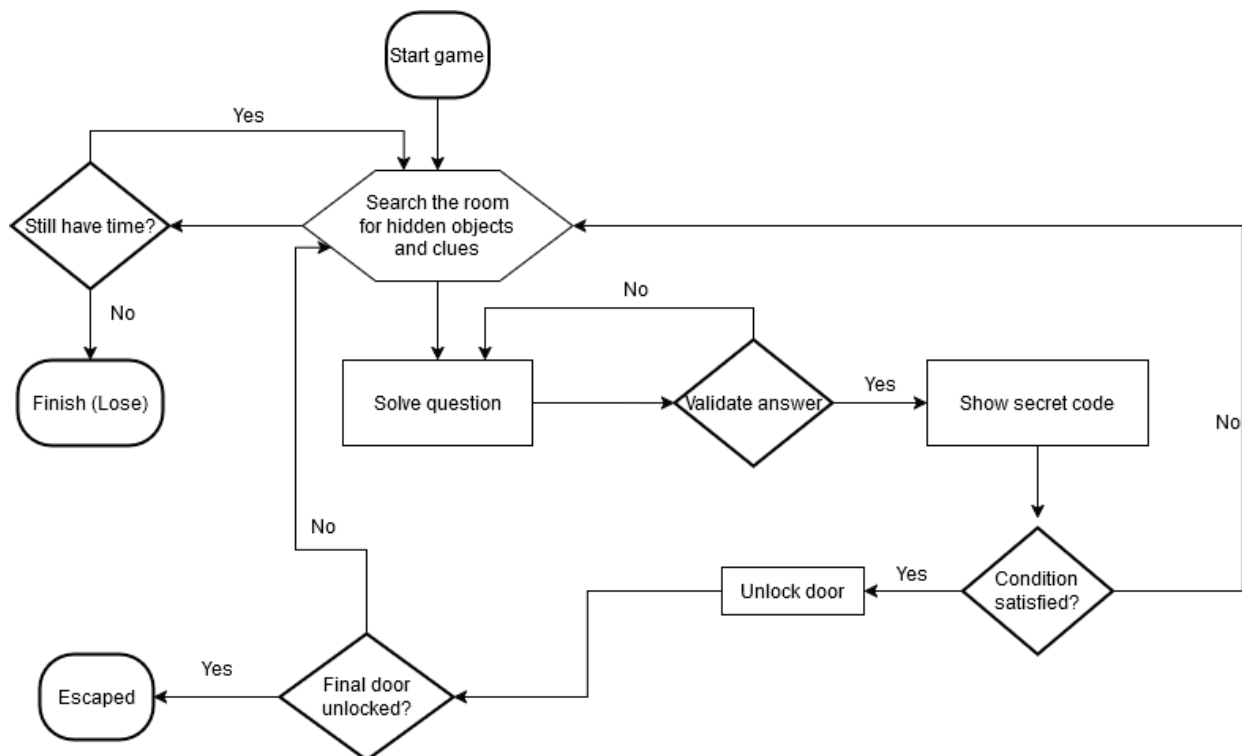


Figure 3.14 Flowchart of the gameplay of EscapeDB

The game begins with an introduction screen providing a brief overview of the escape room scenario and the final objective: escaping before time runs out. Players start in the first room of the escape room environment.

As players interact with the environment, they come across various clues. However, to obtain a clue, players must solve questions related to database courses. The game will validate the player's answer and only display the escape code, a single-digit number, if the input is correct.

Once the player collects enough digits and figures out the correct sequence, they can attempt to unlock the door. If the code is correct, the door will unlock, completing the escape from the room.

During this process, the time taken by the player is recorded and contributes to the final score.

If time runs out, the player loses the game.

The goal is to solve all puzzles and unlock the final door, enabling the player to escape. The final time taken is recorded and updated on the leaderboard.

3.4.2 Activity Diagrams

3.4.2.1 Activity Diagram for EscapeDB Game

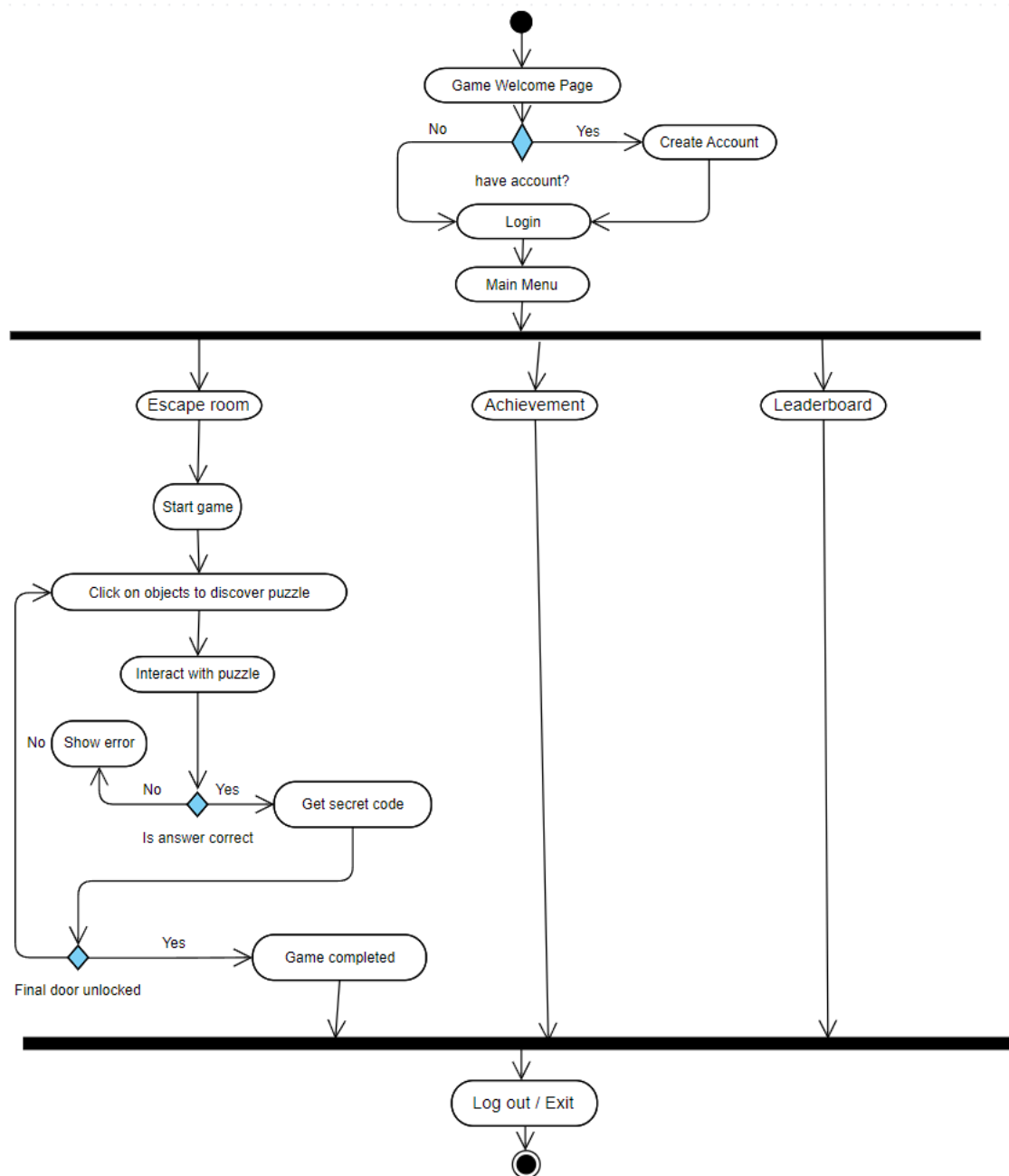


Figure 3.15 Activity Diagram for EscapeDB game

To access the game, students must create an account and log in, ensuring their progress is saved and tracked. First-time users must register, while returning players log in with validated credentials before reaching the main menu. The user can also get their account from the lecturer, as the lecturer can create an account for the users.

Once in the game environment, students explore by clicking objects to uncover clues and hidden puzzles. Progression relies on solving these puzzles correctly, as each correct answer unlocks an escape code needed to advance. The game continues through a series of challenges, ultimately leading to the final puzzle. Solving this last challenge unlocks the final door, allowing the student to escape and win the game.

The students can also access the leaderboard from the main menu, displaying the rankings of all players. The leaderboard includes key metrics such as completion time and accumulated scores, allowing students to compare their performance with others.

3.4.2.2 Activity Diagram for EscapeDB Admin Dashboard

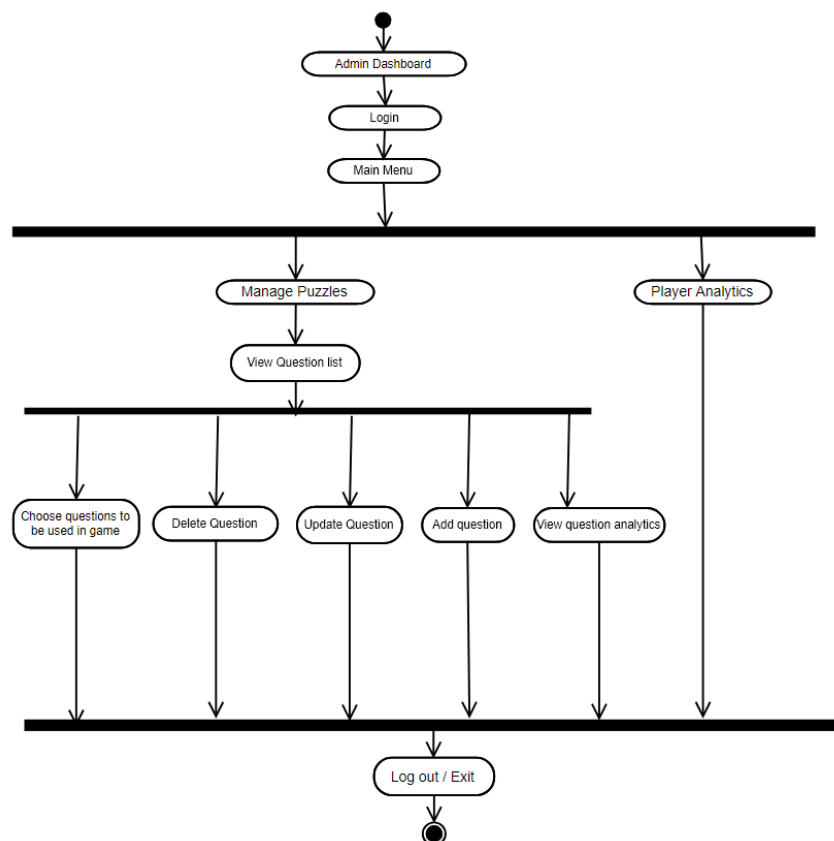


Figure 3.16 Activity Diagram for EscapeDB admin dashboard

The lecturer can perform various administrative tasks through the Admin Dashboard for the EscapeDB game. One key feature is the ability to view player analytics, which provides insights into each student's performance, including their progress and scores.

In the Manage Puzzles section, the lecturer can access detailed analytics for individual questions. This includes metrics such as question accuracy and the number of attempts made by students. Additionally, the lecturer can activate or deactivate specific questions in the game. Once changes are saved, the in-game question pool updates immediately, ensuring dynamic and varied gameplay.

Additionally, the lecturer has full control over the question bank. The lecturer can modify the question bank by adding new questions, editing existing ones, or deleting outdated questions. These modifications help maintain the game's educational value and adaptability.

3.4.3 Use Case Diagram

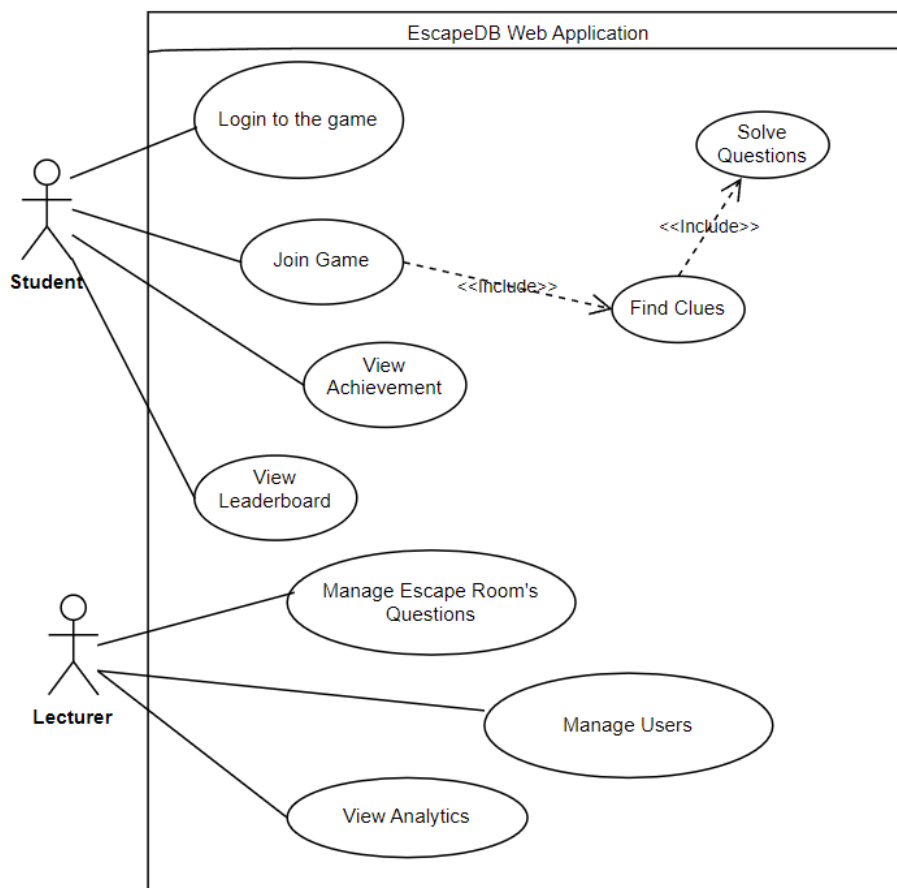


Figure 3.17 Use case diagram of EscapeDB.

The use case diagram above shows the interaction between users with the application. For this application, the user is categorized into two types: normal users (students) who use the application to play the escape room game; and the admin (lecturer) who manages the whole database of the game.

3.4.3.1 Use Case Descriptions

Table 3.5 Use Case for Game Login

Use Case ID	1
Use Case	Log in to the game
Brief Description	Users are required to enter their credentials to log in to the application.
Actor(s)	Student
Pre-condition	The lecturer must create an account for the student first.
Post-condition	The user will be able to access the escape room game.
Normal flow	1. User clicks on the “Sign In” button on the game welcome screen. 2. User enters username and password. 3. User clicks on login. 4. User enters the game's main menu.
Alternative Flow	N/A

Table 3.6 Use Case for Join Game

Use Case ID	2
Use Case	Join Game
Brief Description	The user chooses an escape room on the game map to start playing.
Actor(s)	Student
Pre-condition	The user needs to log in to the application to access the escape room game.
Post-condition	The user will be able to start the gameplay.

Normal flow	1. The user clicks on the “House” icon on the game map. 2. The user enters the game by clicking on the “Play” button.
Alternative Flow	N/A

Table 3.7 Use Case for Find Clues

Use Case ID	3
Use Case	Find Clues
Brief Description	Users navigate around the rooms in the game and search for clues.
Actor(s)	Student
Pre-condition	The user is currently in a game session.
Post-condition	The user will be able to access the in-game question and obtain clues.
Normal flow	1. The user clicks on an interactive element within the game environment. 2. The clicked element triggers a pop-up question window. 3. The user can choose to start answering the question or close the question window and continue exploring.
Alternative Flow	N/A

Table 3.8 Use Case for Solving Questions

Use Case ID	4
Use Case	Solve Questions
Brief Description	The user attempts to solve a question in the room by entering the correct answer.
Actor(s)	User
Pre-condition	The user clicks on a certain object to trigger the question panel.

Post-condition	Successful Completion: The single-digit escape code will be displayed and updated on the code status panel. Failure Condition: An error message will be displayed indicating a wrong attempt by the user.
Normal flow	1. The user clicks on an object in the room. 2. A question panel with a question will be displayed to the user. 3. The user enters the correct answer or chooses the correct option. 4. The escape code will be displayed to the user. 5. User clicks on the “Close” button to close the puzzle interface.
Alternative Flow	1. The user clicks on an object in the room. 2. The user accesses the puzzle interface and reveals the enclosed question. 3. The user enters the wrong answer or chooses the incorrect option. 4. The system displays an error message. 5. The user can then retry or click on the “Close” button to close the puzzle interface.

Table 3.9 Use case for View Achievement.

Use Case ID	5
Use Case	View Achievement
Brief Description	User can view the achievement to check their current progress and performance.
Actor(s)	Student
Pre-condition	The user is logged in to the system, and an escape room is completed.
Post-condition	User can view their completed room’s best score and performance.
Normal flow	1. The user clicks on the “Achievement” button. 2. A panel will show all the rooms the user has completed and the best score for the room. 3. After viewing, the user then clicks the home icon to return to the main menu.
Alternative Flow	N/A

Table 3.10 Use case for View Leaderboard.

Use Case ID	6
Use Case	View Leaderboard
Brief Description	User can view the leaderboard to compare their performance with others.
Actor(s)	Student
Pre-condition	The user is logged in to the system, and an escape room is completed.
Post-condition	User can view their position in the leaderboard.
Normal flow	4. User clicks on the “Leaderboard” button to view the leaderboard on the menu page. 5. Leaderboard displays the total score earned and average completion time for the game. 6. After viewing, the user then clicks the home icon to return to the main menu.
Alternative Flow	N/A

Table 3.11 Use Case for Managing Users

Use Case ID	7
Use Case	Manage Users
Brief Description	A lecturer can import new users to the game and also delete the playing statistics of a certain player.
Actor(s)	Lecturer
Pre-condition	The lecturer is logged in.
Post-condition	New user’s account created in the database.
Normal flow	1. The user clicks on the import users button. 2. The user chooses an Excel file format that contains the user’s data from the local file folder. 3. User clicks on the “Import” button. 4. The system will parse the file and add the new users to the database.

Alternative Flow	N/A
-------------------------	-----

Table 3.12 Use Case for View Player Analytics

Use Case ID	8
Use Case	View Player Analytics
Brief Description	Users can view analytics on student performance in-game, such as completion times and scores.
Actor(s)	Lecturer
Pre-condition	The user is logged in to the system, and the game has been completed by the students.
Post-condition	The analytics are displayed to the lecturer.
Normal flow	1. The user navigates to the menu page and clicks on the "Player Analytics" button. 2. Player analytics display. 3. Once the user finishes reviewing the player analytics, they can exit the analytics screen.
Alternative Flow	N/A

Table 3.13 Use Case for Managing Escape Room's Questions

Use Case ID	9
Use Case	Manage Escape Room's Question
Brief Description	The user can change the questions for the game.
Actor(s)	Lecturer
Pre-condition	The user is logged in to the system.
Post-condition	The game dynamically loads the new data updated by the lecturer.

Normal flow	1. User navigates to the “Manage Puzzles” and clicks on the “Add” button. 2. The user chooses the question type to be added from the dropdown menu. 3. The user keys in the relevant details regarding the question in the template provided. 4. User clicks the “Save” button. 5. The application shows a toast message to inform the user that a new question has successfully been added.
Alternative Flow	1. The user navigates to the question management dashboard. 2. The user clicks on the “inactive” button to set the question to be active. 3. The status button of the question turns green and shows “active,” indicating that the question is now in use.
Exception Flow	1. The user attempts to delete the questions in use.

3.4.4 Application Sequence Diagrams

3.4.4.1 Application Sequence Diagram for Player

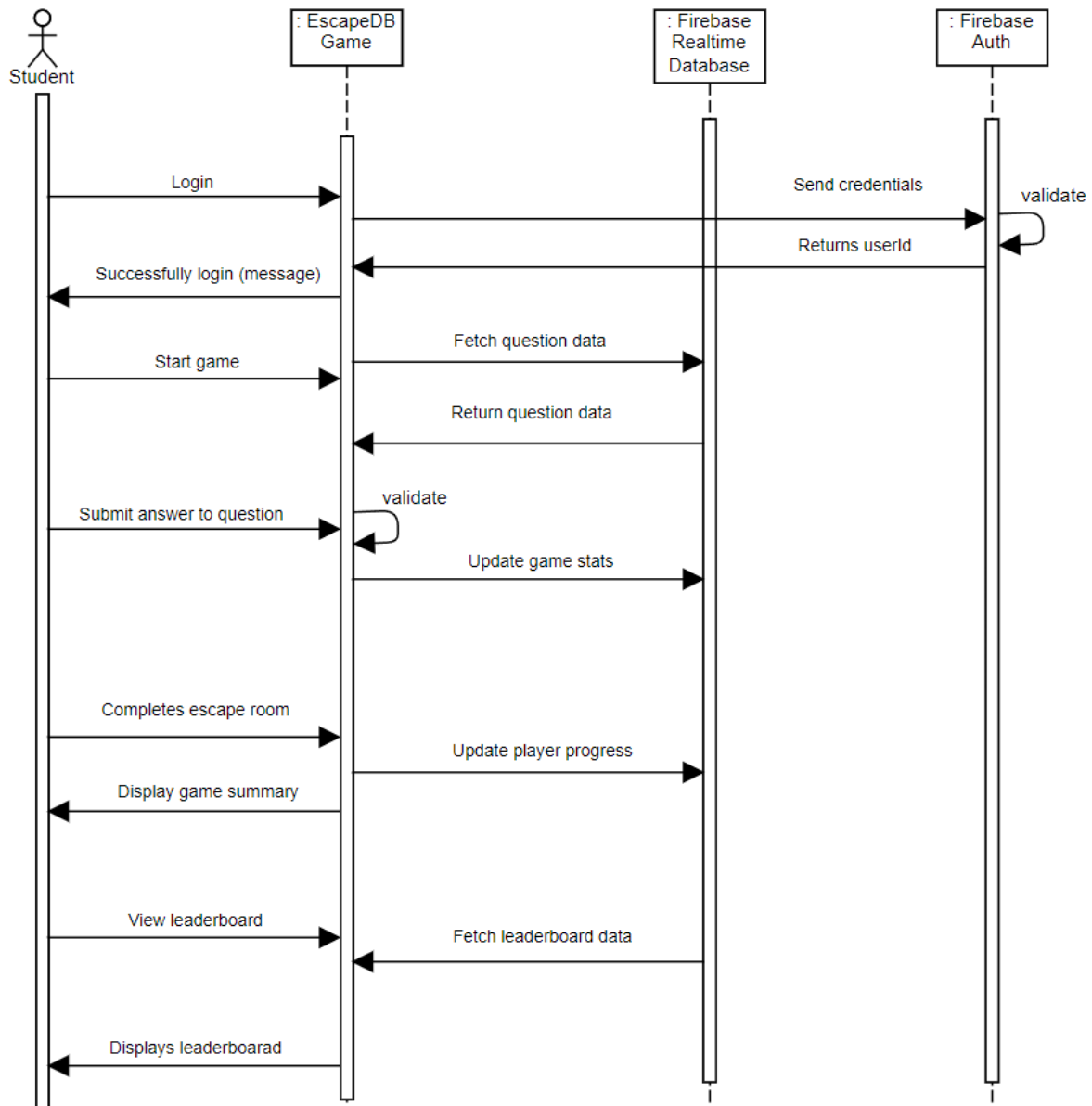


Figure 3.18 Application sequence diagram for the player

The EscapeDB Game processes player interactions using client-side game logic. It communicates with Firebase Realtime Database and Firebase Authentication through JavaScript interop services, enabling real-time state synchronization, secure authentication, and dynamic leaderboard tracking.

To begin, the student enters login credentials, which they send to Firebase Auth for authentication. Firebase Auth then validates the credentials and returns a valid userId upon success.

Upon successful login, the game establishes a session.

During gameplay, when the student submit an answer for the question, the game client will compare the user's answer with the fetched correct answer to that question. It then updates the game state accordingly and provides feedback.

If the student requests to view the leaderboard, the database will query the leaderboard ordered by the total score descending and highlights the current player on the leaderboard.

3.4.4.2 Application Sequence Diagram for Lecturer

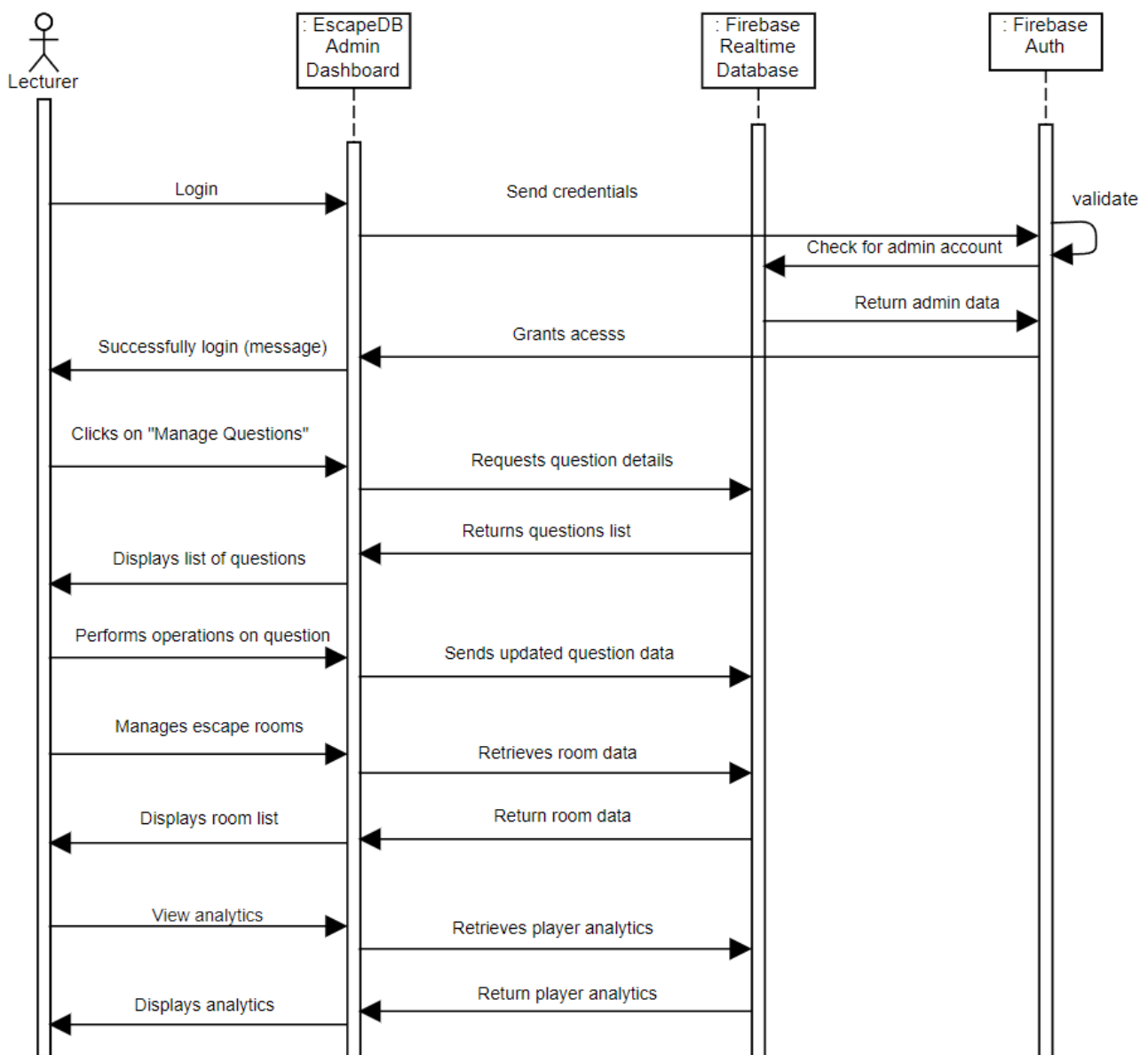


Figure 3.19 Application Sequence Diagram for Lecturer

The lecturer navigates to the Admin Dashboard and enters their login credentials. The Admin Dashboard sends the authentication request to Firebase Authentication. Firebase checks if the account belongs to an admin by querying the database. If the credentials are valid and the account is an admin, Firebase returns a success response, and the lecturer will be logged in.

Using the Admin Dashboard, the lecturer can manage a list of questions to be used in the game, including creation, updates, and deletions. The dashboard communicates with the database, which processes the request and updates the database accordingly.

When the lecturer clicks on Manage Rooms, the admin dashboard will request a list of all the rooms currently set up in the game. Then the lecturer can choose the questions to be used in each escape room and set up the number of rooms playable in the game.

For analytics, the lecturer requests game insights through the Admin Dashboard. The dashboard queries the database to retrieve player performance data—such as scores and completion times—from the database. Some more analytic data like accuracy of each player will then be calculated based on the data stored in the realtime database.

3.4.4.3 Class diagram

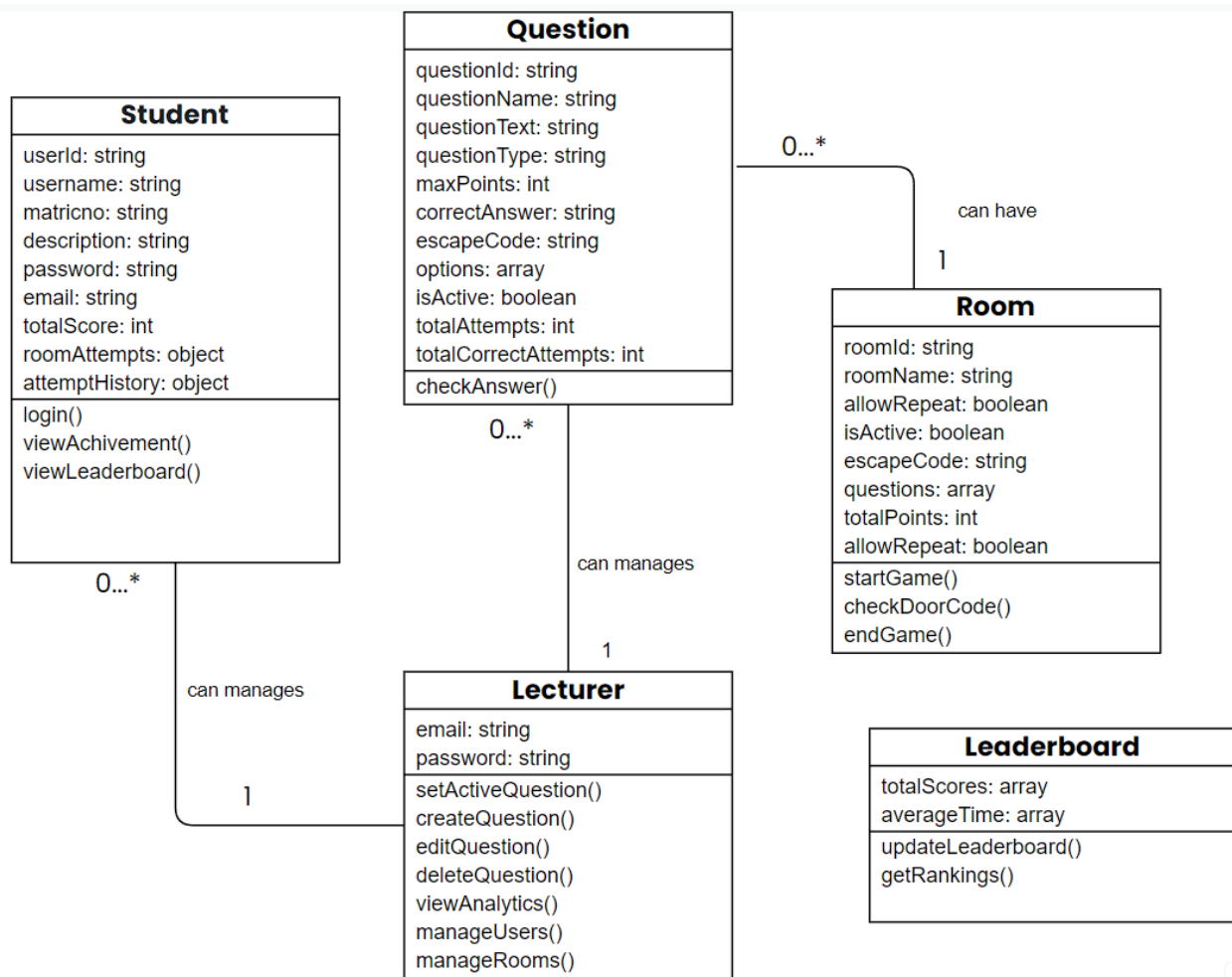


Figure 3.20 Class Diagram for EscapeDB

The figure above illustrates the relationships between key classes in EscapeDB and their interactions with students and lecturers. The Lecturer class manages multiple Student instances, allowing lecturers to oversee game analytics using `viewAnalytics()` and configure in-game questions via the admin dashboard. Through the dashboard, the lecturer can perform CRUD (Create, Read, Update, Delete) operations by using methods like `createQuestion()`, `editQuestion()`, or `deleteQuestion()` on the question pool. Lecturer can define different question types—True/False, Multiple-Choice, or Short Answer—and customize each question by adding answer choices, specifying correct responses, and setting a maximum point value. When the players play the game, their attempts at the questions will be recorded to analyze the success rate of each question.

The Leaderboard class updates and stores player's total scores and average completion time in

the database, the game then ranks students based on these two metrics accumulated over multiple games.

Each room in the game requires a final secret code to be unlocked. This code is the concatenation of all the questions' escape codes. Players must correctly answer all associated questions to collect the digits for the code and enter the digits in the correct sequence to unlock the door.

3.4.5 User Interface Design

A user interface (UI) shows a graphical representation of the proposed application in which it will show expectation the completed project. The main selected page designs are shown in the figures below.

3.4.5.1 Game Interfaces



Figure 3.21 Welcome menu for the game

The welcome menu of EscapeDB will prompt first time players to sign up first so that they can log in and access the main menu. This step is essential for tracking their performance and saving their progress.

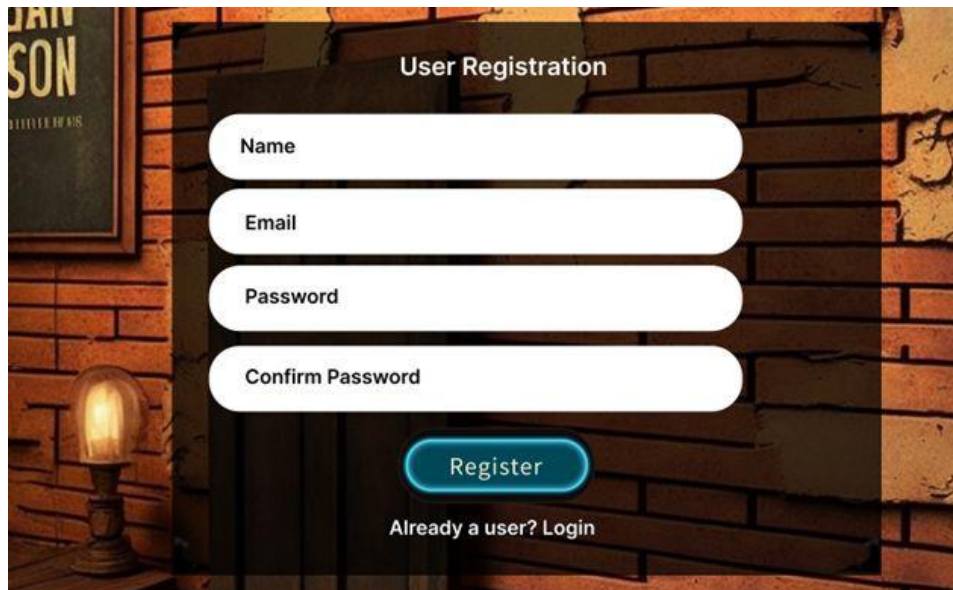


Figure 3.22 User Registration Interface

The figure above illustrates the required fields for student registration within the game. Upon successful registration, the system will automatically redirect the student to the login screen.

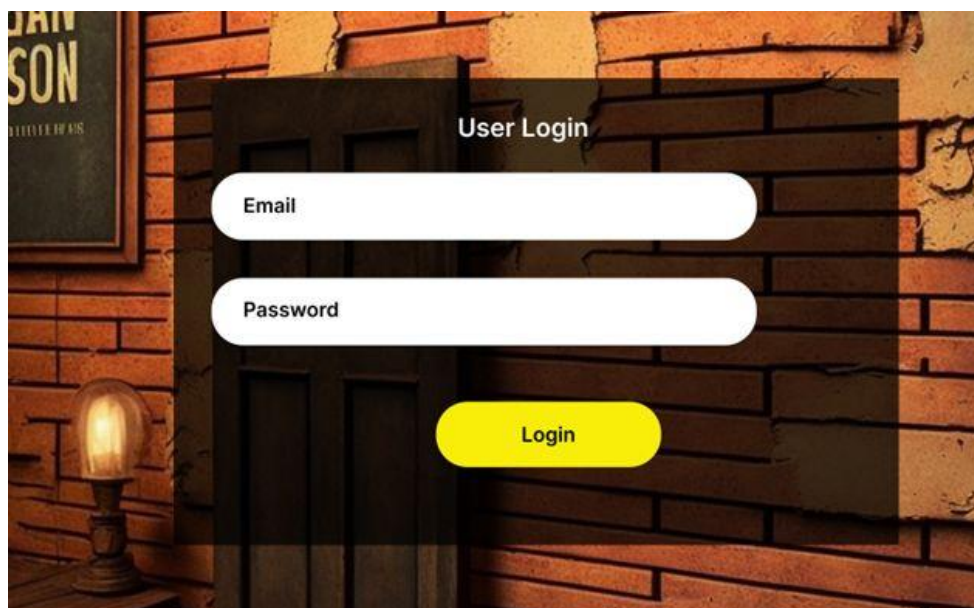


Figure 3.23 Game Login Screen

The figure above displays the login screen, where students are required to enter their credentials to access the game.



Figure 3.24 Main menu of the game

The main menu displays various game modes for players to choose from. Players can opt to play in single-player mode or join a team of two in multiplayer mode. Additionally, they can view the leaderboard to compare their scores with others. The settings button allows players to access gameplay settings.

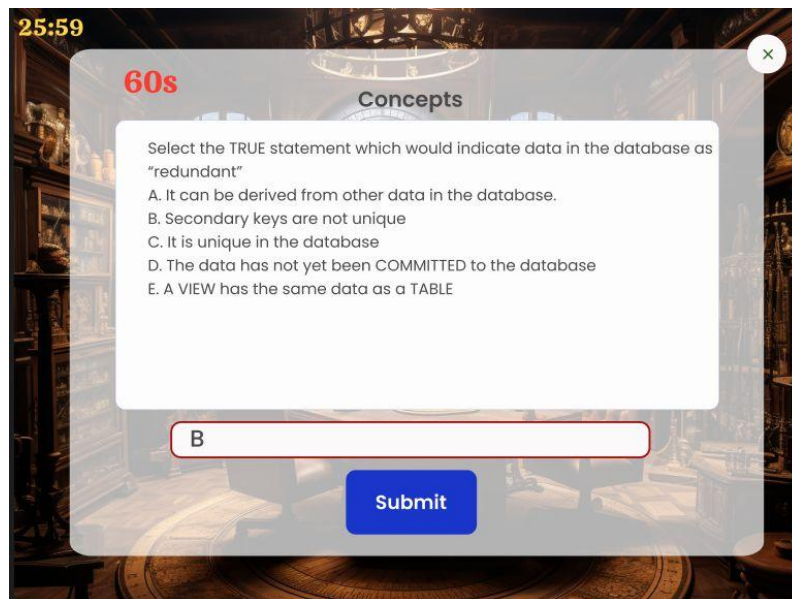


Figure 3.25 The user inputs an incorrect answer to the question.

This interface incorporates game mechanics such as a countdown timer for the current game to create a sense of urgency. Players must solve the question correctly to obtain the secret code needed to advance in the game. The UI also provides feedback by highlighting the input box in red when a player enters an incorrect answer. A close button is also available for the player to exit the view.



Figure 3.26 A summary of the gameplay will be displayed after the player completes the game. The designed interface for showing a short review after a player completes an escape room game is crucial. It informs the player of their progress, updates their total score, and motivates them to continue playing to improve their performance or accumulate scores for leaderboard competition. This interface design employs the principle of contiguity, aligning gameplay metrics relevantly within the context they provide.

3.4.5.2 Admin Dashboard Interfaces

 Manage Users Player Analytics Manage Puzzles						
Total Users: 17						
ID	Name	Total Score	Avg Completion Time	Team Score	Avg Team Completion Time	Actions
1	Amirul	90	20:00	160	14:00	
2	Johannes	130	21:50	160	15:00	
3	Azlee	150	20:23	160	15:40	
4	Azmi	75	23:00	160	14:40	
5	Jazz	85	19:50	160	16:50	
6	Mike	90	22:00	160	22:00	
7	Mirza	90	19:00	160	18:00	
8	Nelson	80	19:20	160	16:00	

Figure 3.27 Admin interface for viewing player analytics

This interface presents a preliminary design for player analytics. The table-like structure enables the administrator to sort metrics and compare student performance more efficiently. Key metrics include total scores earned, average completion time for single-player mode, and team scores, along with

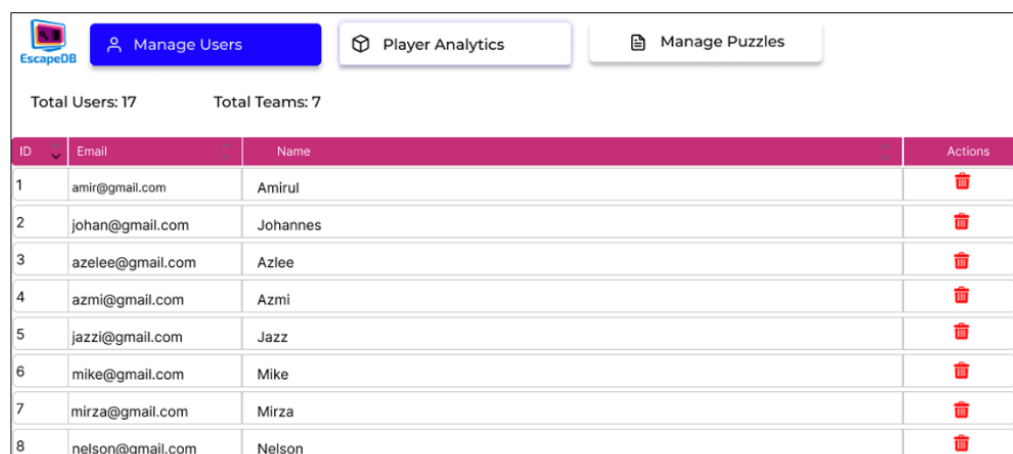
average completion time for multiplayer mode. Additionally, the administrator can delete any player's progress if necessary.



ID	Question Name	Question Type	Total Attempts	Correct Attempts	Success Rate	Status	Actions
1	Entity diagram	MCQ	9	9	100%	Inactive	
2	Modelling	MCQ	9	9	100%	Active	
3	Normalization	TrueFalse	10	9	90%	Active	
4	SQL	ShortAnswer	10	9	90%	Active	
5	Advanced SQL	ShortAnswer	15	9	60%	Active	
6	Query Optimization	MCQ	9	9	100%	Active	
7	Transaction mgmt	MCQ	9	9	100%	Inactive	
8	Entity relationship	ShortAnswer	9	9	100%	Active	

Figure 3.28 Admin interface for managing questions

This interface demonstrates the admin's ability to dynamically modify the questions used in the game, enhancing its replayability. To simplify question management and analytics, the question-specific analytics are displayed alongside each question, allowing the admin to identify questions that students find challenging. Additionally, the admin can perform operations such as adding, editing, or deleting questions from the question list.



ID	Email	Name	Actions
1	amir@gmail.com	Amirul	
2	johan@gmail.com	Johannes	
3	azelee@gmail.com	Azlee	
4	azmi@gmail.com	Azmi	
5	jazzi@gmail.com	Jazz	
6	mike@gmail.com	Mike	
7	mirza@gmail.com	Mirza	
8	nelson@gmail.com	Nelson	

Figure 3.29 Admin interface for managing users

This interface features a design similar to the previous admin interface, but is dedicated to user management. The admin can monitor the number of registered players and has the ability to delete players if necessary.

3.5 Construction

In the construction phase, the development of the full game features takes place, encompassing the finalization of puzzle mechanics, sound effects, and graphics. This stage focuses on ensuring that all components of the game, including interactive objects, room design, and game logic, are meticulously designed and seamlessly integrated. The game's puzzle structure will be developed, ensuring that each sequential puzzle is connected through a coherent and logical progression. It also includes the integration of sound effects, background music, and high-quality graphics.

The admin dashboard for integrating the administrative tasks of the game will be developed. The game will also be integrated with Firebase for real-time data updates, ensuring that player progress, interactions, and game states are consistently synchronized and recorded throughout gameplay.

Frequent internal testing, logical validation of puzzle design, usability evaluation of the interface, and performance analysis are conducted to ensure the game logic works as expected.

3.6 Cutover

The Cutover phase includes several important tasks to get the web application and game ready for release. First, the game undergoes thorough testing to ensure all parts work together smoothly. This includes a final round of testing to identify and fix any remaining bugs that could affect gameplay or performance. A bug-fixing process will address these issues to ensure a seamless user experience.

Once the game passes all tests, it will be deployed and hosted on a cloud platform, making it accessible online. This will allow users to play the game from any location with an internet connection, and the cloud hosting ensures that the game can handle different numbers of users without issues.

After launch, the developer will continue to monitor user feedback to spot any new problems or areas for improvement. This feedback will guide final adjustments or updates to improve the game's performance, enhance the user experience, and ensure it stays aligned with educational goals. Post-launch support and monitoring will be ongoing to maintain smooth gameplay and resolve any emerging

challenges.

3.7 Summary

This chapter discusses the initial two phases of the Rapid Application Development (RAD) methodology: Requirements Planning and User Design. By focusing on these phases, this chapter aims to provide a thorough early planning and overview of the web application's development. Key elements include gathering and analyzing requirements and creating an initial UI design to ensure that the application will meet user needs. By providing a comprehensive overview of these foundational phases, this chapter aims to lay the groundwork for a successful development process.

CHAPTER 4 IMPLEMENTATION

4.1 Introduction

In this chapter, the design of the web application is implemented by the idea of design in Chapter 3. The final design of the user interface of this prototype will be different compared to the previously proposed design with some modification. Some applications like Unity and Visual Studio Code need to be set up before starting the development. The outcome of the application development is shown with screenshots and is attached with a detailed description.

4.2 Implementation Overview

The development tool/software used to develop the game is Unity. The database used for this prototype is Firebase. Several software programs are used to develop and implement the game. The software is listed below:

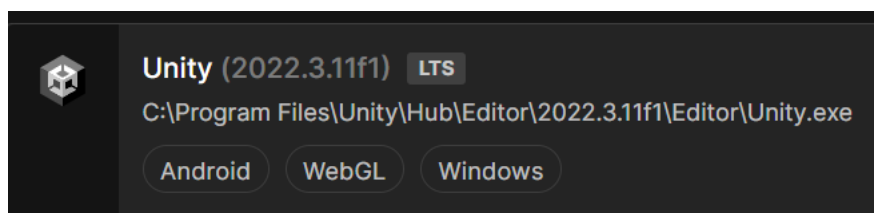


Figure 4.1 Unity (Unity Technologies, 2025)

Unity Editor serves as the primary development environment for my WebGL game, allowing me to write and compile C# scripts into WebGL-compatible builds. It provides a powerful visual interface for managing game scenes, assets, and user interactions, while also streamlining the implementation of game logic through an intuitive workflow. This combination of code and GUI-based tools significantly accelerates development and debugging.

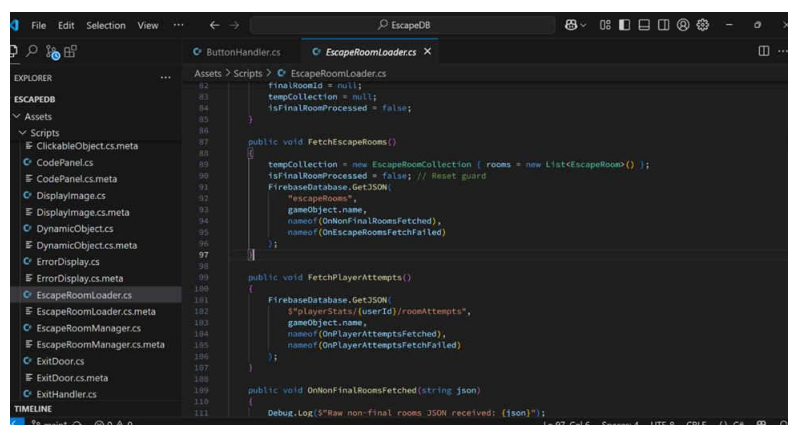


Figure 4.2 Visual Studio Code (Microsoft, 2025)

This WebGL game and its corresponding administrative dashboard are developed using Visual Studio Code, mainly because of its lightweight design and extensive set of useful add-ons. Notably, the Live Preview extension makes it easier to host a local server inside the development environment so that webpages can be previewed instantly. This feature is especially helpful when testing the game's database connectivity with Firebase Realtime Database and when the administrative dashboard is being developed iteratively.

```
Assets > FirebaseWebGL > Scripts > FirebaseBridge > FirebaseAuth.cs
1  using System.Runtime.InteropServices;
2
3  namespace FirebaseWebGL.Scripts.FirebaseBridge
4  {
5      public static class FirebaseAuth
6      {
7          [DllImport("__Internal")]
8          public static extern void InitializeFirebase();
9
10         [DllImport("__Internal")]
11         public static extern void SignOut(string objectName, string onSuccess, string onError);
12
13         [DllImport("__Internal")]
14         public static extern void SignInWithEmailAndPassword(
15             string email,
16             string password,
17             string objectName,
18             string callback,
19             string fallback
20         );
21     }
22 }
```

Figure 4.3 C# sample code for communicating with Firebase

Some C# code for interacting with Firebase services and JavaScript environments is shown in the figure above. This C# solution serves as an essential link since there isn't currently a direct, official Firebase SDK for Unity's WebGL build target. Through the use of an interop approach, Unity developers could create WebGL games that wanted to add dynamic, server-connected features by utilizing Firebase's robust backend features, like real-time databases, user authentication, or cloud functions.

4.3 User Interfaces of “EscapeDB” game



Figure 4.4 Game start screen

To ensure that the players are prepared to begin playing the game, this starting screen is meant to wait for their input. Since the admin can now create user accounts beforehand through the admin dashboard, the sign-up option has been removed.



Figure 4.5 Login page of “EscapeDB”

Players must first authenticate themselves for their in-game progress to be stored in the database. Firebase Authentication, which thoroughly verifies user-provided credentials against the registered user accounts kept in the Firebase system, serves as the foundation for this functionality. The lecturer securely issues pre-provisioned accounts and matching passwords to enable access to the game.



Figure 4.6 Main menu of “EscapeDB”

There are three options available, which are Escape Room, Achievement, and Leaderboard. The main menu is navigated by using a mouse click. On the top right, there are a sign-out button and a settings button. The settings button will open a settings panel for the user to change the volume of the sound in the game. The log out button will show a log out prompt upon clicking to confirm whether the user wants to sign out. Upon signing out, the user will return to the login page.



Figure 4.7 Settings menu

The Settings menu allows the player to customize the game's audio settings, including the master volume, music volume, and SFX volume, to suit their preferences.



RANK			
	halo	40 pts	108 s
	Aimer	34 pts	200 s
	student	30 pts	79 s
4	dodo	20 pts	115 s
5	Bob	12 pts	122 s
6	star	5 pts	87 s

Figure 4.8 Leaderboard panel

Leaderboards serve as an important mechanism for elevating player engagement within a game. It encourages players to improve their performance, aim for higher rankings, and move up the leaderboard's hierarchy by creating a competitive atmosphere. As students actively seek status and recognition among their peers, this dynamic encourages ongoing play and skill development.



Figure 4.9 Achievement panel

This screen displays a player's progress and unlocks for various in-game accomplishments. It typically shows a list of achievements, their icons, descriptions, and whether they have been unlocked or not. Achievements can encourage players to explore different aspects of the game and try new challenges. Besides, unlocking achievements provides a sense of progression and completion.



Figure 4.10 Pop-up instruction panel.

The instruction panel pop-up illustrates the core progression mechanics of the game. Players must successfully finish some typical escape rooms to advance to the game's final escape room challenge, which has a linear progression system. The administrator-designated single-play rooms on the map will be visually marked as greyed out when they are finished. In contrast, rooms that allow for multiple attempts by the administrator will continue to be visible and accessible on the game map, enabling players to revisit them. This design distinguishes between one-time challenges and replayable content while encouraging a clear progression path.



Figure 4.11 Room info pop-up

A pop-up panel containing the room name and score that can be obtained upon completion will appear when the user clicks on a "house" icon on the map. After that, the user can click the play button to start

the game. A final, unlocked room at the far right of the map is also depicted in the above figure, signifying that the player has successfully finished every earlier escape room.

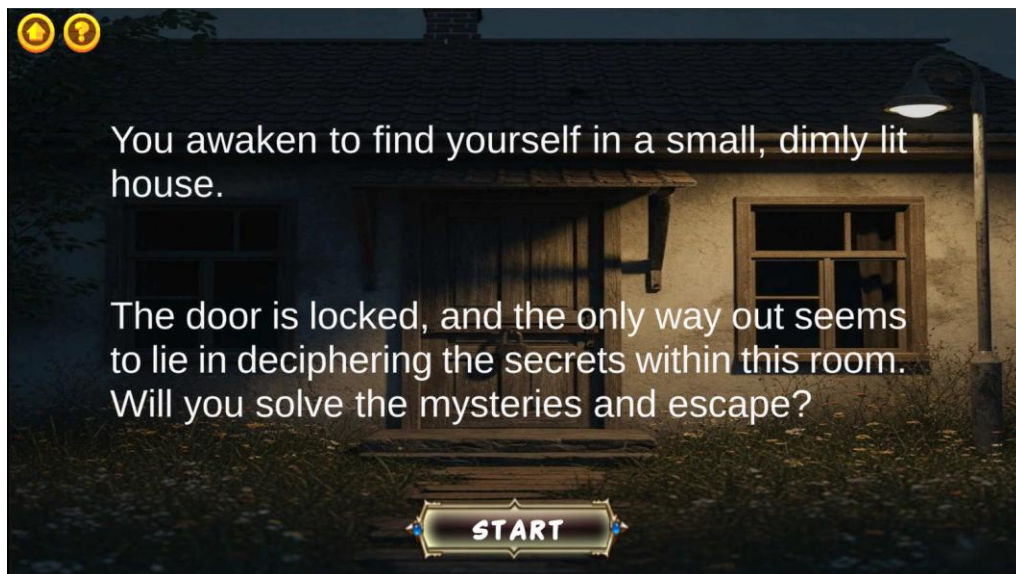


Figure 4.12 Story screen

A background image with a narrative will be shown to the player at the beginning of the game to help immerse them in the atmosphere of the escape room. The start button will remain inactive for a while before becoming interactive once the room data has been successfully loaded from the database.

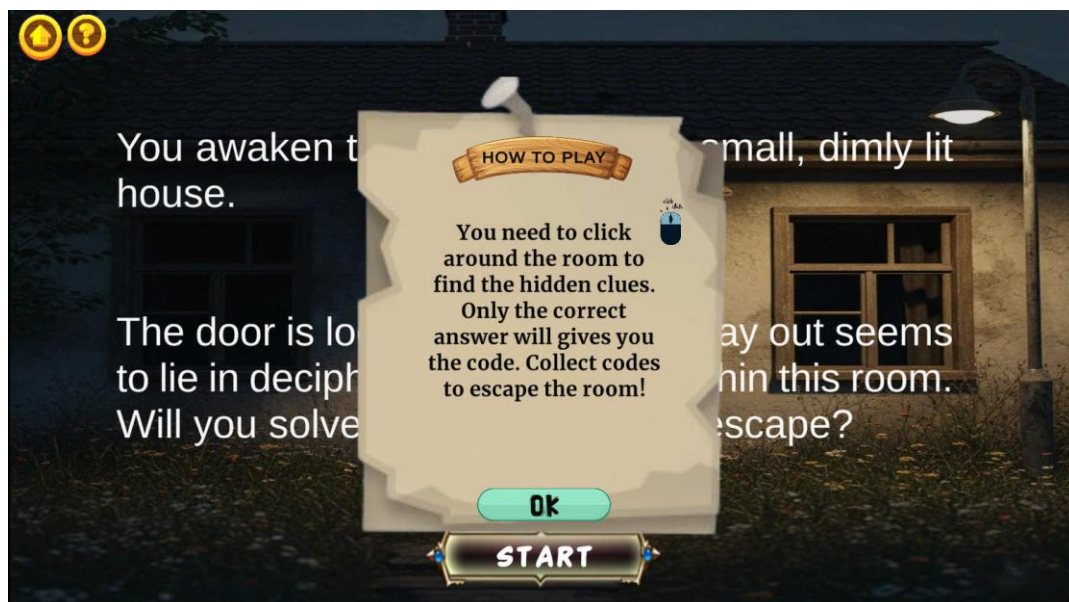


Figure 4.13 How to play instructions

The figure above shows a pop-up panel which describes the gameplay, where the player has to click around the scene to find the hidden clues. Then, they have to answer the database-related questions correctly in order to get the codes to escape the room. This tutorial panel is essential to guarantee that

players have a thorough grasp of the game's goals and mechanics right away.



Figure 4.14 Escape room view

Upon starting the game, a countdown timer begins, creating a sense of urgency as players work to solve the puzzles within the limited time. Additionally, at the top of the game view, a code status panel is displayed, showing the progress of five questions that need to be answered. Each question corresponds to a code that must be gathered to unlock the door, emphasizing the player's task of collecting all five codes to complete the challenge.



Figure 4.15 Exit confirmation dialog

During gameplay, a confirmation dialog will appear when the user clicks on the home icon to see if they truly want to quit the game. The player's current attempts will be deleted from the database when they exit.

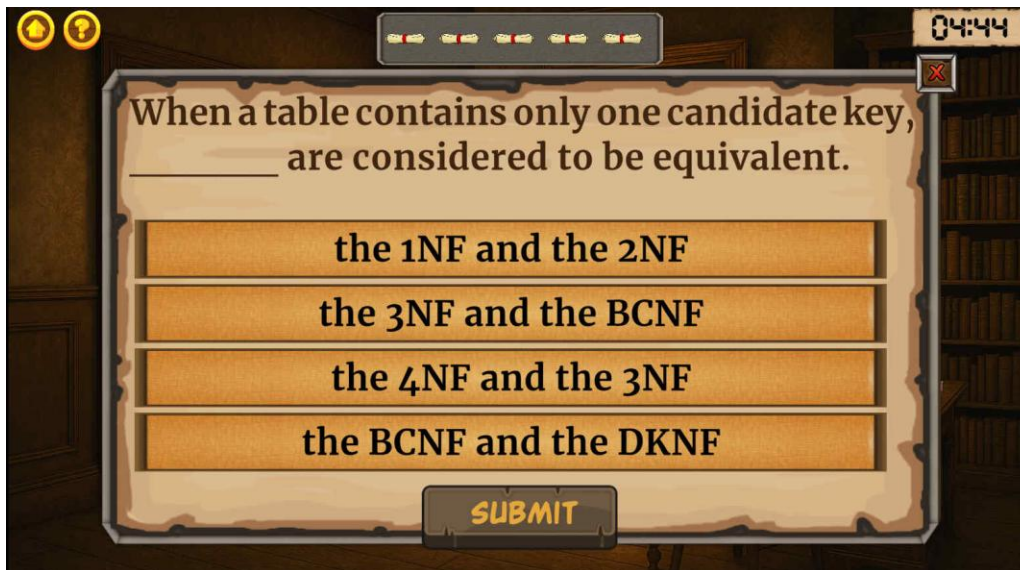


Figure 4.16 The question panel pops up.

When the player interacts with an object containing hidden clues, a question is presented for them to solve. The questions assigned to each object are randomly shuffled from a pool of five questions selected by the lecturer, ensuring that the positions of these questions differ between players. This randomization prevents cheating and encourages students to solve the questions independently, fostering a fair and personalized learning experience.

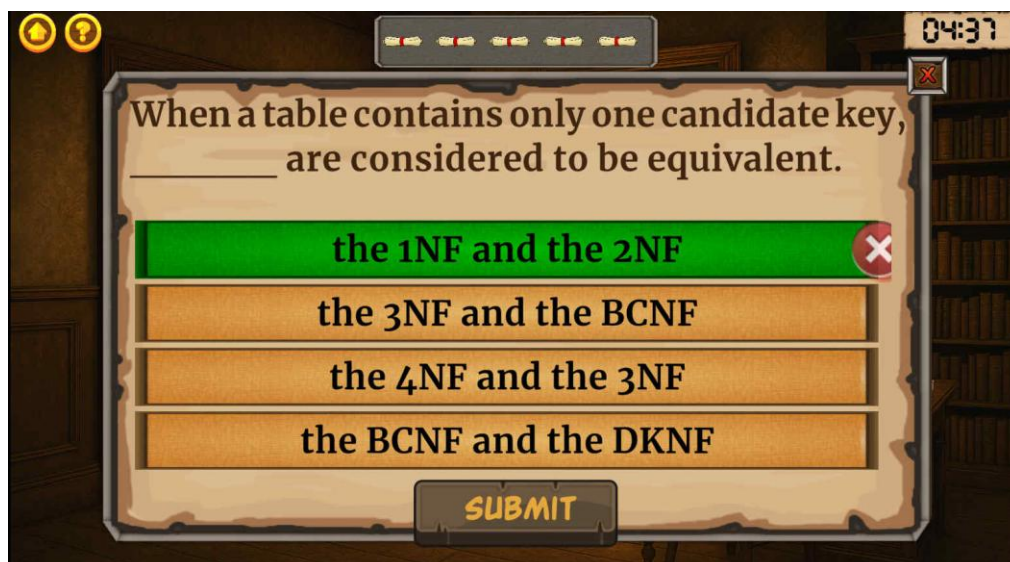


Figure 4.17 Feedback on submitting the wrong answer

The system allows players to retry a question even after submitting an incorrect answer. A red close icon provides immediate visual feedback, signaling that the answer is wrong. This urgent feedback helps players quickly recognize and correct their mistakes. While no penalties are applied for incorrect

answers, the number of attempts for each question is recorded in the database. This data is used for analyzing question success rates and the player's accuracy, with results accessible through the admin dashboard. Upon wrong attempt, the question choices will be shuffled to prevent players from memorizing the order of the answers. This shuffling encourages critical thinking and ensures a fair challenge each time the question is attempted.



Figure 4.18 Clues display

Upon successfully solving a question, the corresponding escape code is revealed to the player. Additionally, this code is displayed in the correct sequence on the code status panel at the top of the game screen, allowing players to easily track their progress. This system eliminates the need for players to repeatedly navigate back to the object to check the sequence, reducing frustration and providing a clear overview of the remaining codes to be discovered.



Figure 4.19 Final code panel

Once all the escape codes have been collected, clicking on the door will display a final code panel. The player must then enter the code shown on the code status panel into the input field. Upon submitting the correct final code, the player will complete the game.



Figure 4.20 Summary Panel

The summary panel appears once the player completes the game, under two possible conditions. If the time runs out, the panel will display 'Time Up' instead of 'Room Completed.' It will show the player's earned score and the time taken to complete the game, providing a clear summary of their performance.



Figure 4.21 True False question

The question panel displays a True/False question, with two buttons—'True' and 'False'—for the player to select their answer. The player simply clicks on the appropriate button to submit their response, making it an interactive and straightforward way to answer the question.

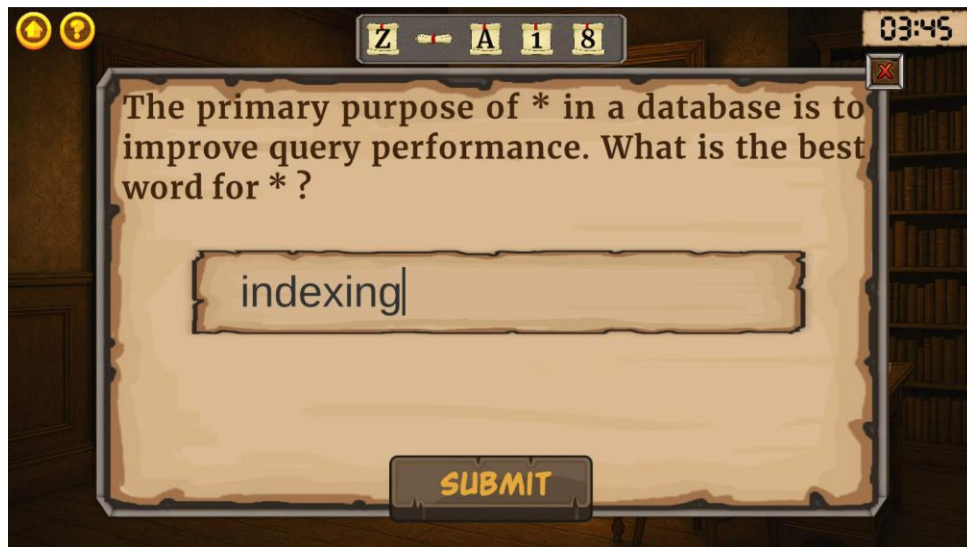


Figure 4.22 Short answer question

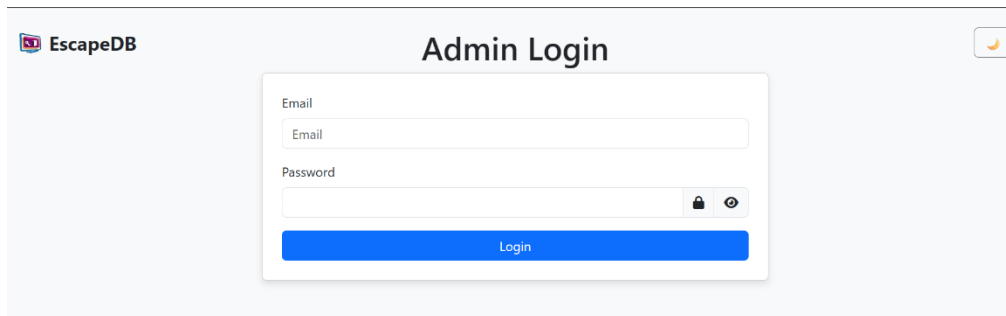
The question panel presents a short answer question, where the player is required to input their response in the provided field and click the submit button. The system will then compare the player's input with the correct answer to determine if it's correct. If it is wrong it will clear the input and display an error message pop up.



Figure 4.23 The interface of the final escape room

The final escape room does not feature a timer or database-related questions. It serves as a relaxing and enjoyable experience after the challenges of the main game. Players can navigate the scene using two arrows on the sides of the screen. In this mode, clickable objects will display clues, like the regular escape room game, focusing on providing a fun and stress-free player's adventure. It will add a one-time reward of a certain score to the player's leaderboard upon completion.

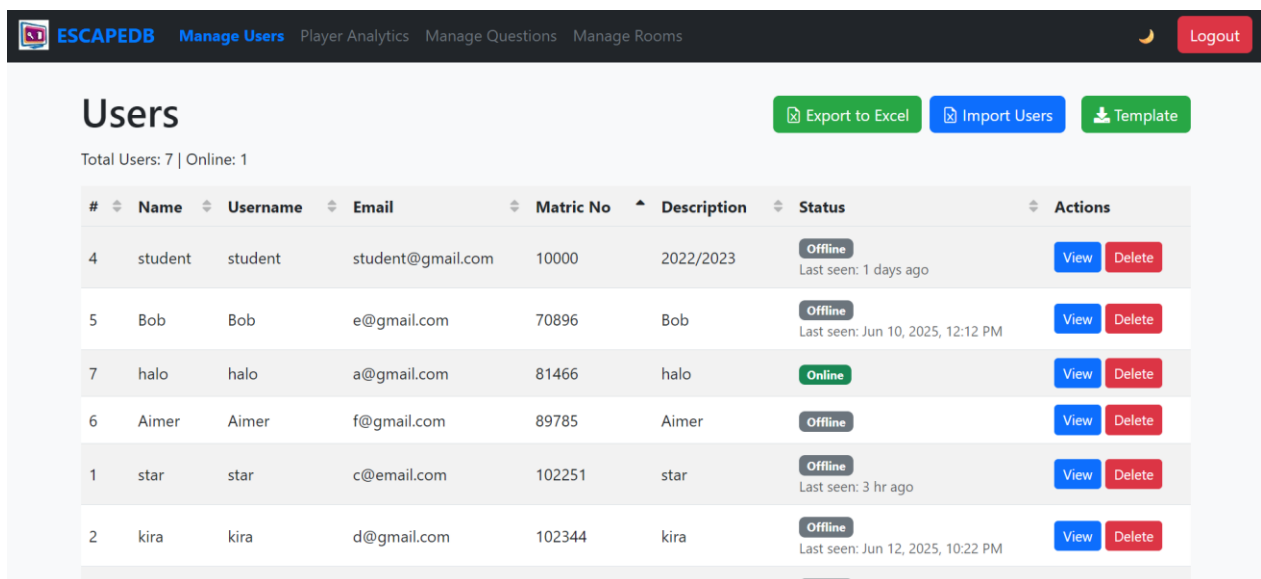
4.4 User Interfaces of “EscapeDB” admin dashboard



The image shows the Admin Login screen of the EscapeDB dashboard. It features a central login form with fields for Email and Password, a Login button, and a small profile icon in the top right corner.

Figure 4.24 Admin dashboard login screen

This admin dashboard requires an existing admin account to log in. If multiple admins are needed, additional accounts can be configured in the database and the Firebase dashboard. Access is secured through an email and password login process, ensuring that only authorized users can manage the system.



The image shows the User management dashboard of the EscapeDB system. It includes a header with navigation links, a title 'Users', and a table listing user details. The table has columns for #, Name, Username, Email, Matric No, Description, Status, and Actions. The status column shows 'Offline' or 'Online' with 'Last seen' timestamps. The Actions column has 'View' and 'Delete' buttons.

#	Name	Username	Email	Matric No	Description	Status	Actions
4	student	student	student@gmail.com	10000	2022/2023	Offline Last seen: 1 days ago	View Delete
5	Bob	Bob	e@gmail.com	70896	Bob	Offline Last seen: Jun 10, 2025, 12:12 PM	View Delete
7	halo	halo	a@gmail.com	81466	halo	Online	View Delete
6	Aimer	Aimer	f@gmail.com	89785	Aimer	Offline	View Delete
1	star	star	c@email.com	102251	star	Offline Last seen: 3 hr ago	View Delete
2	kira	kira	d@gmail.com	102344	kira	Offline Last seen: Jun 12, 2025, 10:22 PM	View Delete

Figure 4.25 User management in the admin dashboard

This user management dashboard allows the lecturer to monitor the current number of users and their statuses. It displays details such as the student's recent online activity, along with specific fields like matriculation number and a description for better identification. Additionally, the system includes a user import function, enabling the lecturer to download a template and import users in the specified format, streamlining the process of adding new users.

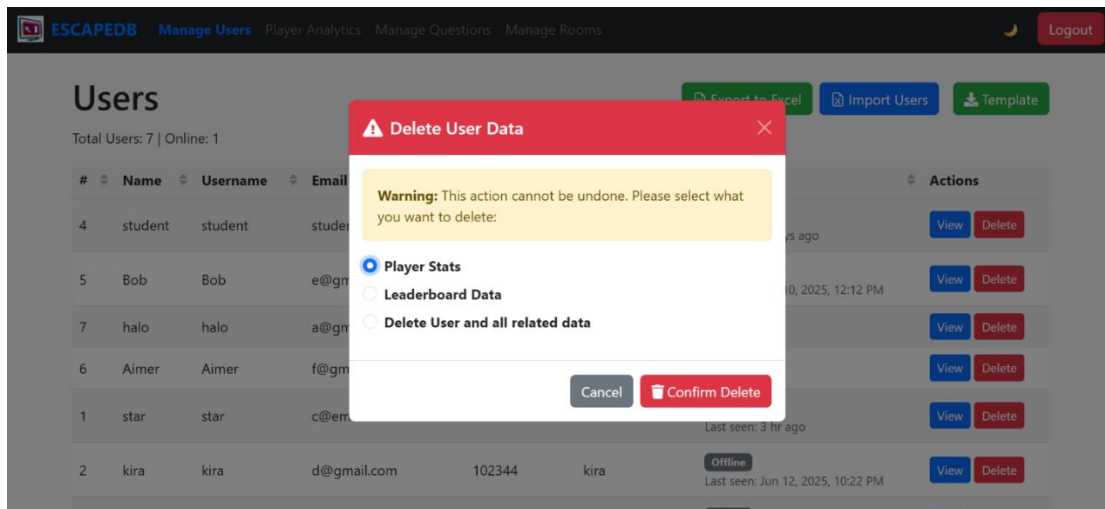


Figure 4.26 Delete user data

The system also includes a user data deletion function, allowing the lecturer to selectively remove different types of user data. The lecturer can choose to delete a player's stats, which resets their game progress, remove their leaderboard data to eliminate them from the rankings, or delete the user from the database. The ability to delete a user account is currently unavailable, though, as this is a premium feature provided by Firebase. For example, full user account deletion within Firebase Authentication is typically offered as part of Firebase's premium or paid-tier features, requiring a specific plan or integration beyond the scope of basic or free-tier usage. However, it is possible to do it manually in the Firebase dashboard.

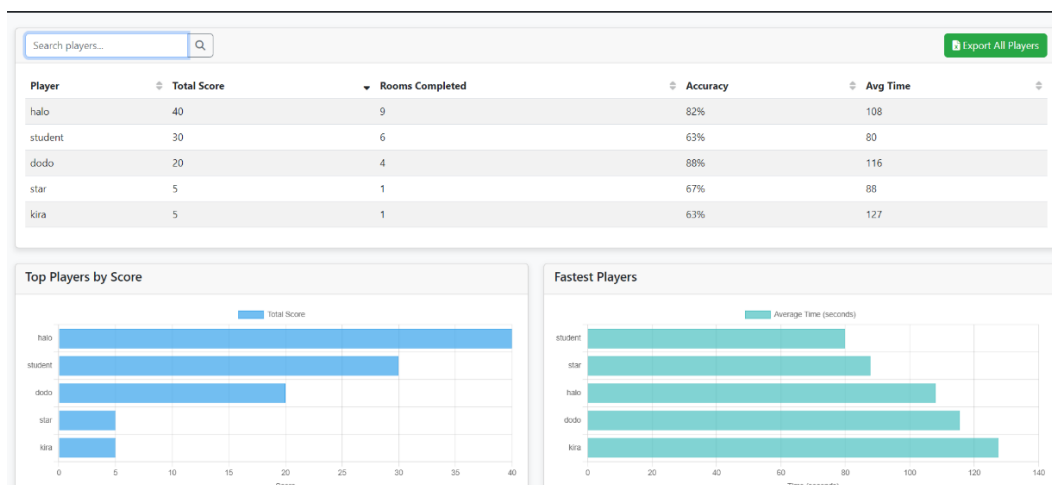


Figure 4.27 Player analytics dashboard

On this screen, the lecturer has access to a comprehensive set of play analytics for all users. To present the data in a clear and engaging way, key game metrics such as the highest score and the fastest player

(determined by the lowest average completion time) are visualized in two separate graphs. The lecturer can easily search for specific players using the table list, providing quick access to individual performance records.

The interface also includes sorting features, allowing the lecturer to organize the table based on criteria such as the number of rooms completed or answer accuracy. This enables the identification of players who have completed the most games or demonstrated the highest level of skill in answering questions. Furthermore, the system allows exporting all player data, facilitating detailed record-keeping or further analysis.

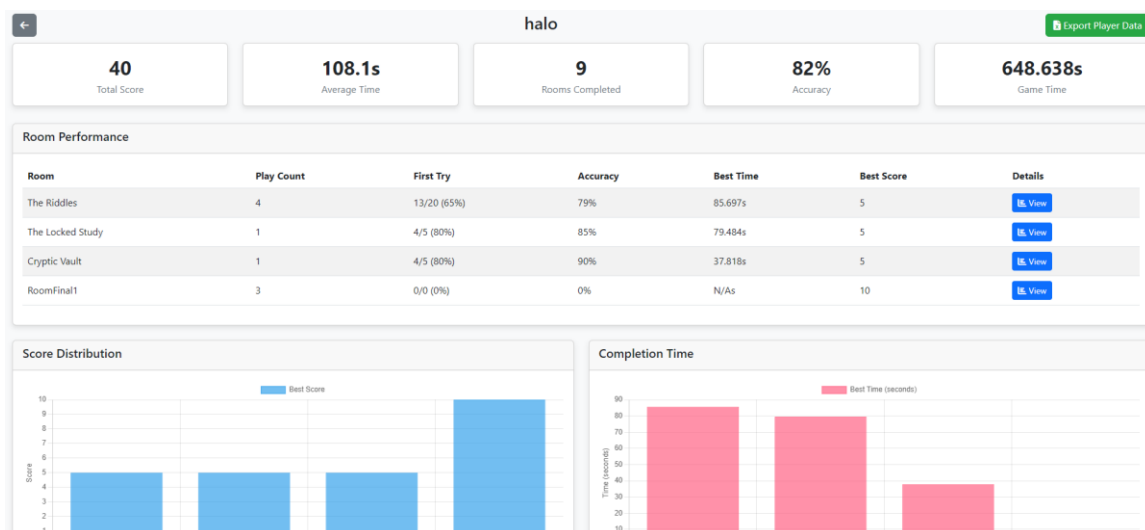


Figure 4.28 Analytics for a specific user in detail

The lecturer can also view detailed analytics for a specific user by clicking on their profile, which will redirect to a comprehensive overview of their performance across all escape rooms in the game. This detailed view displays all relevant metrics, providing insights into the player's strengths and areas for improvement. Additionally, the lecturer has the option to export the player's data, allowing for easy record-keeping or further analysis.

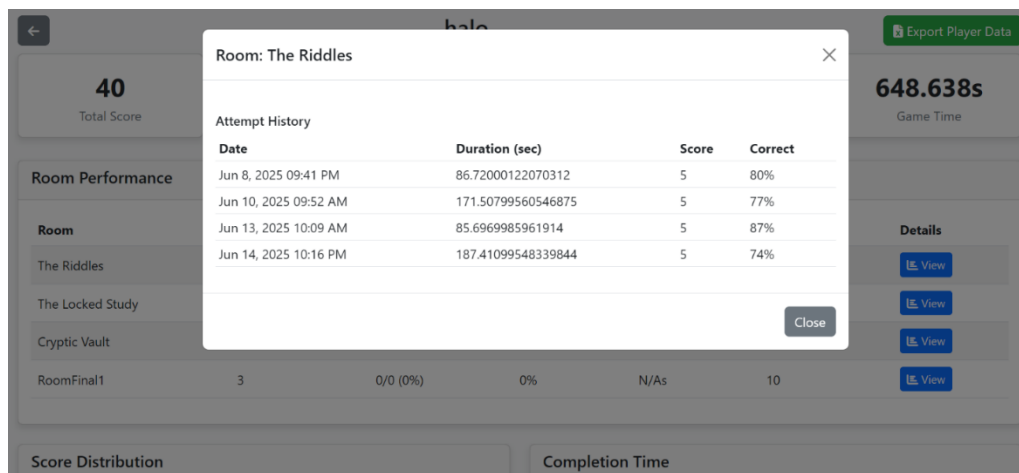


Figure 4.29 Playing record of an escape room

By clicking on the 'View' button, the lecturer can access detailed information about when the player played the game, along with the metrics for that specific session. The system also automatically calculates the player's accuracy for each attempt, offering a more insightful overview of their performance. This helps the lecturer track the player's progress and assess their consistency in answering correctly.

#	Question Name	Question Type	Total Attempts	Correct Attempts	Success Rate	Status	Actions
1	LU 1 Q1	multiple-choice	33	13	39%	Active	Edit Delete
2	LU 1 Q2	multiple-choice	0	0	0%	Inactive	Edit Delete
3	LU 1 Q3	multiple-choice	45	22	49%	Active	Edit Delete
4	LU 1 Q4	multiple-choice	34	20	59%	Active	Edit Delete
5	LU 1 Q5	multiple-choice	8	6	75%	Active	Edit Delete
6	LU 1 Q6	multiple-choice	17	6	35%	Active	Edit Delete
7	LU 1 Q7	multiple-choice	13	7	54%	Active	Edit Delete

Figure 4.30 Question bank interface

This screen provides the lecturer with the ability to manage the game's question bank. The lecturer can add questions manually using the 'Add Question' button or import questions directly from an Excel template. A reference template outlining the required format is available for download by clicking the 'Download Template' button.

Additionally, the system allows the lecturer to export the question bank for backup or local editing. In the sortable table, the metrics for each question are displayed, showing the total number of student attempts and the success rate for each question. This enables the lecturer to identify which questions students find challenging and offer additional support on those topics. The lecturer can also edit, delete, or toggle the status of each question to mark it as active or inactive, ensuring efficient management of the question pool.

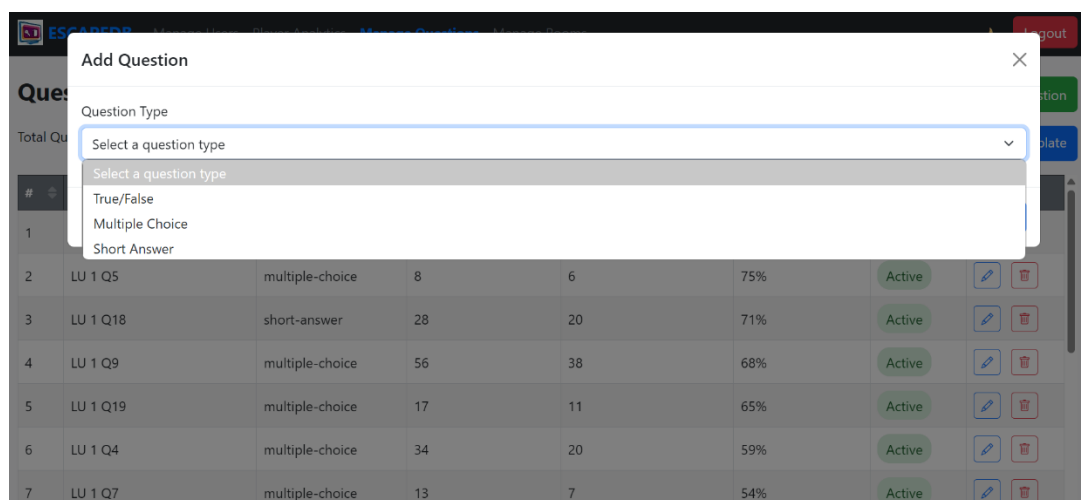


Figure 4.31 Question types available for adding

The current system supports three types of questions: True/False, Multiple Choice, and Short Answer. Before entering the editing panel, the lecturer must first select the type of question they wish to add. This ensures that the lecturer is guided to the correct format and tools for each question type, allowing for efficient and accurate question creation.

Question Text

SELECT FALSE

Max Points

1

Correct Answer

False

Hints

false is the answer

Escape Code

A

Close Save

Figure 4.32 Example of editing the question panel

The screenshot above illustrates the process of editing an existing question. Each question must have an escape code, which the lecturer is required to add. However, it's important to note that the question type cannot be changed directly from the 'Edit Question' panel. This restriction ensures that the integrity of the question's structure remains intact during editing.

escapedb-admin.web.app says
Cannot delete question. It is used in the following escape rooms: The Locked Study.

OK

Question Bank

Total Questions: 23 | In-Use: 22

#	Question Name	Question Type	Total Attempts	Correct Attempts	Success Rate	Status	Actions
1	LU 1 Q20	true-false	23	18	78%	Active	Edit Delete
2	LU 1 Q5	multiple-choice	8	6	75%	Active	Edit Delete
3	LU 1 Q18	short-answer	28	20	71%	Active	Edit Delete
4	LU 1 Q9	multiple-choice	56	38	68%	Active	Edit Delete
5	LU 1 Q19	multiple-choice	17	11	65%	Active	Edit Delete
6	LU 1 Q4	multiple-choice	34	20	59%	Active	Edit Delete
7	LU 1 Q7	multiple-choice	13	7	54%	Active	Edit Delete

Figure 4.33 Warning when deleting a question in use

When the lecturer attempts to delete a question that is currently being used in any escape room within the game, a warning will be displayed to prevent the deletion. This is a safety feature designed to protect the game's functionality. Deleting a question that is in use could cause abnormalities when the game loads, leading to potential issues or errors. The warning ensures that such deletions are avoided.

#	Escape Room Name	Questions	Escape Code	Total Points	Allow Repeat	Status	Actions
1	The Riddles	5/5	Z7A18	5	Yes	Active	>
2	The Locked Study	5/5	BCDEF	5	Yes	Active	>
3	Cryptic Vault	5/5	GHIZP	5	Yes	Active	>
4	Detective's Dilemma	5/5	12PZ3	5	No	Inactive	>
5	Secret Library	5/5	917IH	5	No	Inactive	>
6	Hidden Archive	5/5	IZP91	5	No	Inactive	>
7	Mystic Server Room	5/5	td198	5	Yes	Inactive	>
8	Codebreaker's Lair	5/5	DCHI3	5	Yes	Inactive	>

Figure 4.34 Manage the escape rooms screen.

On this screen, the lecturer can manage the questions used in the game. By clicking the arrow icon, they can view and control the details for each of the 10 supported escape rooms. The escape code for each room is generated by concatenating the escape codes of the questions used within that room. Additionally, the lecturer can control which rooms are available in the game by toggling the active or inactive status for each room via the actions menu accessible through the arrow click.

Edit Escape Room

Escape Room Name:

Selected Questions: LU 1 Q9 LU 1 Q18 LU 1 Q20 LU 1 Q13 LU 1 Q19

Clear

Name	Text	Points	Code	Success Rate
LU 1 Q9	When a table contains only one candidate key, ____.	1	Z	67.86%
LU 1 Q10	A table is in 4NF if it is in 3NF, and ____.	1	P	53.85%
LU 1 Q11	Some very specialized applications may require nor...	1	5	0%
LU 1 Q12	What type of dependency does 4NF specifically remo...	1	9	0%
LU 1 Q13	When mapping an ER diagram into relations where tw	1	1	30.95%

Figure 4.35 Edit the escape room panel.

The lecturer can search for a specific question using the search box. The list displayed only includes questions that are marked as active in the question bank. Additionally, the system enforces a limit of 5 questions per room. If there are more or fewer than 5 questions selected, the lecturer will receive a warning when attempting to save the room setup. To manage the questions, the lecturer can simply click on a question in the table list to select or deselect it for use in the room.

Escape Code

GHIZP

Total Points

5

☒ Allow Repeat (Players can replay this room)

☒ Is Active?

Cancel Save Changes

Figure 4.36 Toggles in the menu for editing the escape room

The lecturer has the option to configure whether a room allows repeat play, meaning players can either play the same room multiple times or only once. Additionally, the lecturer can toggle the room's active status, determining whether the room will be available for use in the game. If the room's status is toggled off, it will not appear on the game map, effectively removing it from the game until it is activated again.

8	Codebreaker's Lair	5/5	DCHI3	5	Yes	Inactive	>
9	Data Dungeon	5/5	9ICE1	5	Yes	Inactive	>
10	Query Quell	5/5	41932	5	Yes	Inactive	>

Final Escape Room

Final 1

Room ID: RoomFinal

Escape Code: kkkkk

Points: 10

Set as Active Final Room

Cave Odyssey

Room ID: RoomFinal1

Escape Code: ISET

Points: 10

Currently Active

Final 2

Room ID: RoomFinal2

Escape Code: 12345

Points: 10

Set as Active Final Room

Figure 4.37 Options to choose the final escape room in use

The lecturer can select which final escape room to include in the game. Currently, there are three different escape rooms available for selection, allowing the lecturer to choose which one to be used.

4.5 Summary

This chapter discussed the last four stages of this project, which are coding, testing, delivery of game prototype and player feedback stages. In the coding stages, the game “EscapeDB” is developed along with the dashboard to manage the game.

CHAPTER 5 TESTING

5.1 Introduction

This chapter outlines the various testing methods used to verify the functionality of the prototype and ensure its components operate correctly and in the intended sequence. The primary focus is on functional testing, which involves executing test cases to validate the proposed web application. During this process, specific inputs are provided to the system, and the resulting outputs are evaluated to confirm that all functions perform as expected. Unit testing is a key component of this stage, used to systematically test and validate individual components of the web application. Besides, user testing is carried out to evaluate the usability of the game-based web application.

5.2 Unit Testing

Unit testing was conducted to verify that each module of the proposed web application performs as designed. Every critical function within the EscapeDB game and the admin dashboard was tested, with results documented in a test case table. Key components, such as input fields, functional buttons, and validation mechanisms, were thoroughly evaluated.

Test cases were developed for each module in the EscapeDB web application to facilitate unit testing. The modules are categorized based on their user roles: students (EscapeDB game) and lecturers (admin dashboard).

Table 5.1 Modules in EscapeDB

Modules for Students (EscapeDB Game)	Modules for Lecturer (Admin Dashboard)
Game Login Module	Admin Login Module
Escape Game Module	Manage Users Module
Achievement Module	View Analytics Module
Leaderboard Module	Manage Questions Module
Game Logout Module	Manage Rooms Module
	Admin Logout Module

5.2.1 Student Module Test Cases

Table 5.2 Test cases for the game login module

Project Name:		EscapeDB	Designed by:	Vun Jun Ye
Module:		Game Login Module	Designed Date:	17/6/2025
Test Title:		Login	Pre-requisite:	-
No.	Test Case	Test Procedure	Expected Result	Pass/Fail
1	Login	- Enter a valid Email and a valid Password. - Click the <i>Login</i> button.	- User logged in successfully. - Redirect to game menu.	Pass
		- Enter an incorrect Email. - Click the <i>Login</i> button.	Display an error message of wrong credentials to notify the user.	Pass
		- Enter incorrect Password. - Click the <i>Login</i> button.	Display an error message of wrong credentials to notify the user.	Pass
		- Input fields are left empty. - Click the <i>Login</i> button.	Display error message of “Please enter email and password”.	Pass

Table 5.3 Test cases for the escape game module

Project Name:		<i>EscapeDB</i>	Designed by:	Vun Jun Ye
Module:		Escape Game Module	Designed Date:	17/6/2025
Test Title:		Play the escape game	Pre-requisite:	User is logged in.
No.	Test Case	Test Procedure	Expected Result	Pass/Fail
2	Start game	Click on the <i>Escape Room</i> button on the main menu.	The game menu map showed up.	Pass
		Click on the <i>Ok</i> button on the pop-up instruction panel.	The instruction panel closes.	Pass
		Click on the <i>house</i> icon on the game map.	A pop-up panel appears at the bottom of the screen.	Pass
		Click on the <i>close</i> button on the pop-up panel.	The pop-up panel closes.	Pass
		Click on the <i>play</i> button on the pop-up panel.	The story panel for that room level will show.	Pass
		Click on the greyed-out <i>play</i> button on the story panel.	The button is not interactable.	Pass
		Click on the <i>play</i> button after it changes back to normal color.	The story panel closes, and the user will enter the game. The timer starts the countdown.	Pass
3	Interact with the game environment	Hovering over the clickable objects in the room.	Mouse icon changes.	Pass
		Click on the “door” or keypad without answering 5 questions correctly.	Display an error message indicating 5 questions to be solved before	Pass
		Click on a clickable object in the room.	A question panel with questions is displayed.	Pass
		Click on the <i>question mark</i> button.	An instruction panel shows.	Pass
		Click on the <i>ok</i> button on the instruction panel	The instruction panel closes.	Pass

4	Interacting with the question panel	Click on the true/ false button for true-false type questions.	The correct answer will show the escape code panel; a wrong answer will show fading red crosses as feedback.	Pass
		Click on two or more choices on the MCQ questions that have multiple correct answers.	Two or more selected choices background turn green, indicating selection.	Pass
		Click on the input field for short-answer questions.	The input field is activated and can receive user input.	Pass
		- Enter a wrong answer in the input field. - Click the <i>submit</i> button.	A fading error message shows, and the input field is cleared.	Pass
		- Click on the wrong answer choice for multiple-choice questions. - Click the <i>submit</i> button.	The red cross icon is shown on the right side of the wrong choices, indicating a wrong answer.	Pass
		- Click on the correct answer option. - Click the <i>submit</i> button.	- The escape code of the current question replaces the question panel. - The code status panel updates with the current escape code.	Pass
		Click the <i>close</i> button.	The question panel closes.	Pass
4	Entering the final code	Click on the door/keypad after gathering 5 escape codes.	The final code panel shows.	Pass
		Enter the wrong final code.	A fading error message shows, and the input field is cleared.	Pass
		Enter the correct final code.	The game summary is displayed; the timer stops.	Pass
5	Exit the game	Click on the home button.	A pop-up exit confirmation showed.	Pass
		Click on “No” on the exit confirmation dialog.	Confirmation dialog closed.	Pass
		Click “Yes on the exit confirmation dialog.	- Redirected to the game map menu. - Current attempt removed from the database.	Pass

Table 5.4 Test cases on the achievement module

Project Name:		<i>EscapeDB</i>	Designed by:	Vun Jun Ye	
Module:		Achievement Module	Designed Date:	17/6/2025	
Test Title:		Shows the achievement panel	Pre-requisite:	User is logged in	
No.	Test Case	Test Procedure	Expected Result		Pass/Fail
6	View achievement	Click on the <i>Achievement</i> button on the game menu.	Achievement panel shows.		Pass
		- Play at least one game. - Click on the <i>Achievement</i> button on the game menu.	- Display unlocked achievement with a different icon and shows a green ‘unlocked’ status. - Locked achievement remains unchanged.		Pass
		Click the <i>close</i> button.	Achievement panel closes.		Pass

Table 5.5 Test cases for the leaderboard module

Project Name:		EscapeDB	Designed by:	Vun Jun Ye	
Module:		Leaderboard module	Designed Date:	17/6/2025	
Test Title:		Shows the leaderboard panel	Pre-requisite:	-	
No.	Test Case	Test Procedure	Expected Result	Pass/Fail	
7	View the leaderboard panel.	Click on the <i>Leaderboard</i> button on the game menu.	Leaderboard ranking shows, but no current player entry is found.	Pass	
		- Click on the <i>sort leaderboard panel with the score</i> button. - Click on the <i>sort leaderboard with the average completion time</i> button.	- No changes in display as it is the default view unless you click after sorting with the average time button. - The leaderboard ranking sorts the players with the shortest average completion time.	Pass	
		- Complete at least one game. - Click on the <i>Leaderboard</i> button on the game menu.	Display the current user’s entry background as yellow with updated scores and average completion time.	Pass	

		- Click on the <i>Leaderboard</i> button on the game menu. - Use another account on a different browser session to complete a game to earn scores.	The Leaderboard panel updates the score of that account in real-time.	Pass
--	--	---	---	------

Table 5.6 Test cases for the game logout module

Project Name:	<i>EscapeDB</i>		Designed by:	Vun Jun Ye	
Module:	Game Logout Module		Designed Date:	17/6/2025	
Test Title:	Logout		Pre-requisite:	User is logged in	
No.	Test Case	Test Procedure	Expected Result		Pass/Fail
8	Logout	Click the <i>Logout button</i> on the main menu.	Redirect to “login” page		Pass

5.2.2 Lecturer Module Test Cases

Table 5.7 Test cases for the admin login module

Project Name:	<i>EscapeDB</i>		Designed by:	Vun Jun Ye	
Module:	Admin Login Module		Designed Date:	17/6/2025	
Test Title:	Log in to the admin dashboard		Pre-requisite:	-	
No.	Test Case	Test Procedure	Expected Result		Pass/Fail
9	Login	- Enter a valid <u>Email</u> and a valid <u>Password</u>. - Click the <i>Login</i> button.	- User logged in successfully. - Redirect to the manage users screen in the admin dashboard.		Pass
		- Enter an incorrect <u>Email</u>. - Click the <i>Login</i> button.	Display an error message of Invalid email or password.to notify the user.		Pass
		- Enter incorrect <u>Password</u>. - Click the <i>Login</i> button.	Display an error message of Invalid email or password.to notify the user.		Pass
		- Input fields are left empty. - Click the <i>Login</i> button.	Display error message of “Please input this field”.		Pass

Table 5.8 Test cases for the manage users module

Project Name:	<i>EscapeDB</i>		Designed by:	Vun Jun Ye	
Module:	Manage Users Module		Designed Date:	17/6/2025	
Test Title:	Manage users in the game		Pre-requisite:	User is logged in	
No.	Test Case	Test Procedure	Expected Result		Pass/Fail
10	Download template	Click on the <i>download template</i> button.	Initiates a download of a user import template Excel file to the local device.		Pass
11	Export users	Click on the <i>export to Excel</i> button.	Initiates a download of an Excel file containing all the users to the local device.		Pass
12	Import users	- Click on the <i>import from Excel</i> button. - Choose a user import template with some invalid	An open file dialog will show, and user can choose the supporting file		Pass

		fields.	- type. - A warning notification indicating data format error will show up.	
		- Click on the import from excel button. - Choose a user import template with complete and valid fields.	- An open file dialog will show, and user can choose the supporting file type. - A success notification 'User created successfully' will show. - The user table is updated with new users.	Pass
13	View user details	Click on the <i>view</i> button in the action column.	A pop-up modal showing the user details will show.	Pass
14	Delete user data	- Click on the <i>delete</i> button in the action column. - Choose Player Stats from the options list. - Click <i>confirm delete</i> button.	The game data of the current user is deleted from the database.	Pass
		- Click on the <i>delete</i> button in the action column. - Choose Leaderboard Data from the options list. - Click <i>confirm delete</i> button.	The leaderboard data of the current user is deleted.	Pass
		- Click on the <i>delete</i> button in the action column. - Choose Leaderboard Data from the options list. - Click <i>confirm delete</i> button.	- The game data, leaderboard data, and the current user will be deleted from the database. - The table updates to reflect the changes.	Pass
15	Sort table by column	Click on the <i>table header</i> which has a sort icon to sort.	- The table sorts the data in the table in ascending or descending. - The sort icon updates its current state.	Pass

Table 5.9 Test cases for the view analytic module

Project Name:	<i>EscapeDB</i>		Designed by:	Vun Jun Ye
Module:	View Analytics Module		Designed Date:	17/6/2025
Test Title:	View user analytics		Pre-requisite:	User is logged in
No.	Test Case	Test Procedure	Expected Result	Pass/Fail
16	Search users	- Click on the search user input. - Enter a user's name for searching.	The table filters the view based on the user's input.	Pass
17	Export player analytics	Click on the <i>export all players</i> button.	Initiates a download of an Excel file containing all the user analytics to the local device.	Pass
18	Sort the table by column	Click on the table header column that has a sort icon to sort.	- The table sorts the data in the table in ascending or descending order. - The sort icon updates its current state.	Pass
19	View detailed user analytics	- Click on any user in the table. - Click on the <i>view</i> button in the details column for any room. - Click the <i>back</i> button.	- A modal containing the room performance of that user will show. - The details modal pop-up shows all the play records of that room. - Change the view to show all player analytics.	Pass
20	Export a specific user's analytics	- Click on any user in the table. - Click on the <i>export user data</i> button.	Initiates a download of an Excel file containing the user analytics to the local device.	Pass

Table 5.10 Test cases for the manage questions module

Project Name:	<i>EscapeDB</i>		Designed by:	Vun Jun Ye
Module:	Manage Questions Module		Designed Date:	17/6/2025
Test Title:	Manage the question pool		Pre-requisite:	User is logged in
No.	Test Case	Test Procedure	Expected Result	Pass/Fail
21	Download template	Click on the <i>download template</i> button.	Initiates a download of a question import template Excel file to the local device.	Pass
22	Export questions	Click on the <i>export questions</i> button.	Initiates a download of an Excel file containing all the questions to the local device.	Pass
23	Import questions	- Click on the <i>choose file</i> button. - Choose a question import template with some invalid fields or invalid headers. - Click on the <i>import from Excel</i> button.	- An open file dialog will show, and the user can choose the supporting file type. - A warning notification indicating a data format error will show up.	Pass
		- Click on the <i>choose file</i> button. - Choose a user import template with complete and valid fields. - Click on the import from Excel button.	- An open file dialog will show, and the user can choose the supporting file type. - A success notification, 'Question imported successfully' will show. - The question table is updated will new questions.	Pass
24	Adding questions	- Click on the <i>add question</i> button. - Choose True/False from the options list. - Check the box for isActive. - Enter question name, question text, and max points. - Choose either true or false from the dropdown. - Enter the escape code. - Click the <i>save</i> button.	- A dropdown list containing three question types is shown. - A question modal for adding true false questions is shown. - The questions are added to the database. - The table is reloaded with the newly added question with active status.	Pass

	- Click on the <i>add question</i> button. - Choose True/False from the options list. - The isActive checkbox is unchecked. - Enter question name, question text, and max points. - Choose either true or false from the dropdown. - Enter the escape code. - Click the <i>save</i> button.	- A dropdown list containing three question types is shown. - A question modal for adding true false questions is shown. - The questions are added to the database. - The table is reloaded with the newly added question with inactive status.	Pass
	- Click on the <i>add question</i> button. - Choose Multiple Choice from the options list. - Enter question name, question text, and max points. - Enter choice 1, choice 2, choice 3, and choice 4. - Check 'is Multiple Answers Allowed?' box. - Check any two answers from the dropdown. - Enter the escape code. - Click the <i>save</i> button.	- A dropdown list containing three question types is shown. - A question modal for adding multiple-choice questions is shown. - The question is saved to the database. - The table is reloaded to reflect the changes made.	Pass
	- Click on the <i>add question</i> button. - Choose Multiple Choice from the options list. - Enter question name, question text, and max points. - Choose number of choices = 3 from the dropdown. - Enter choice 1, choice 2, and choice 3 - Enter the escape code. - Click the <i>save</i> button.	- A dropdown list containing three question types is shown. - A question modal for adding multiple-choice questions is shown. - The choice field is updated with the number of choices chosen. - The question is saved to the database. - The table is reloaded to reflect the changes made.	Pass
	- Click on the <i>add question</i> button. - Choose Short Answer from the options list. - Enter question name, question text, max points, and correct answer. - Enter the escape code. - Click the <i>save</i> button.	- A dropdown list containing three question types is shown. - A question modal for adding short answer questions is shown. - The question is saved to the database. - The table is reloaded to reflect the changes made.	Pass

25	Delete question	- Click on the <i>delete</i> button in the action column for any question. - Click ok on the pop-up dialog. - Click the <i>yes</i> button on the pop-up warning.	- A delete confirmation dialog is shown. - The question is deleted from the database, - The table is reloaded to reflect the changes made.	Pass
		- Add the current question to be used in a room using the Manage Rooms dashboard. - Click on the <i>delete</i> button in the action column for any question.	A warning shows that the current question is being used and cannot be deleted.	Pass
26	Edit question	- Click on the <i>edit question</i> icon in the action column for any question. - Check the isActive? box. - Modify the value of the question name. - Modify the escape code. - Click the <i>save</i> button.	- An edit question modal with the current question data is shown. - The question is updated in the database. - The table is reloaded to reflect the changes made.	Pass
27	Sort the table by column	Click on the <i>table header</i> that has a sort icon to sort.	- The table sorts the data in the table in ascending or descending order. - The sort icon updates its current state.	Pass

Table 5.11 Test cases for the manage rooms module

Project Name:		EscapeDB	Designed by:	Vun Jun Ye
Module:		Manage Rooms Module	Designed Date:	17/6/2025
Test Title:		Manage the escape rooms in the game,	Pre-requisite:	User is logged in
No.	Test Case	Test Procedure	Expected Result	Pass/Fail
28	Set the rooms' replayability in the game	- Click on the arrow icon in the action column for any escape room. - Toggle the Allow Repeat option on. - Ensure the Is Active toggle is on. - Click the save button. - Open the game using a player account that has completed that room before.	The house icon linked to that escape room will still be shown on the game map, and it is allowed to be replayed.	Pass
		- Click on the arrow icon in the action column for any escape room. - Toggle the Allow Repeat option off, - Ensure the Is Active toggle is on. - Click the <i>save</i> button. - Open the game using a player account that has completed that room before.	The house icon linked to that escape room will be greyed out on the game map; it is not interactable.	Pass
29	Choose questions to be used in the game	- Click on the arrow icon in the action column for any escape room. - Click on the question to select or deselect a question to be used. - Click the <i>save</i> button. - Open the game using a player account and open the game in the modified room.	- The system will warn the user if more than 5 questions have been selected upon clicking the 6th. - The system will warn the user if they attempt to save the question with fewer than 5 questions. - The final escape code of the room and total points will change dynamically based on the questions selected. - The new data will be saved to the database. - The game will display a different set	Pass

			of questions across the objects in the scene.	
30	Search questions in the list	- Click on the arrow icon in the action column for any escape room. - Type the question name to be searched in the search box.	The question list will filter the questions to be displayed based on the user's input.	Pass
31	Change the final escape room to be used in the game.	- Navigate to the final escape room section. - Click on the Set as Active Final Room button on a different room other than the currently active one. - Open the game using a player account that has completed all the active escape rooms at least once to access the final escape room.	- The active final escape room is changed in the database. - The game will now load a different final escape room.	Pass

Table 5.12 Test cases for the admin logout module

Project Name:		<i>EscapeDB</i>	Designed by:	Vun Jun Ye
Module:		Admin Logout Module	Designed Date:	17/6/2025
Test Title:		Logout	Pre-requisite:	User is logged in
No.	Test Case	Test Procedure	Expected Result	Pass/Fail
32	Logout	Click the <i>Logout button</i>.	Redirect to “login” page	Pass

5.3 Usability Testing

Usability testing is a software testing method where target end-users test the developed web application for its ease of use, handling controls, flexibility, and ability to meet the outlined objectives. Here, usability testing was done to see if the game was effective and met the goals of increasing student engagement with database concepts.

A total of 30 respondents were chosen to play the game for usability testing. After the respondents play test it, they are requested to answer a questionnaire about the usability of the proposed web application. The three parts of the usability testing questionnaire are the System Usability Scale (SUS) survey, the NASA-TLX Questionnaire, and General Opinion on Game-Based Learning. The usability testing questionnaire sample is included in Appendix C for reference.

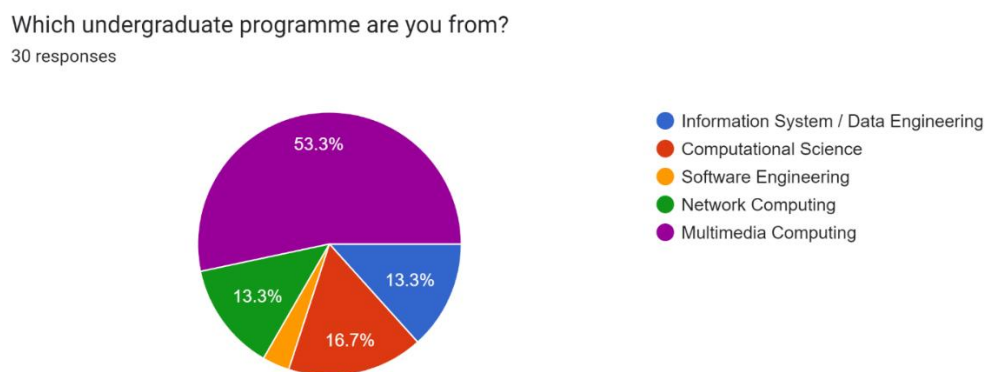


Figure 5.1 Respondent's profile

The respondents participating in this questionnaire are a diverse group of students from the Faculty of Computer Science and Information Technology at UNIMAS. Most of these respondents are students enrolled in the Multimedia Computing program.

In which semester are you taking TMF2034 Database Concept and Design?
30 responses

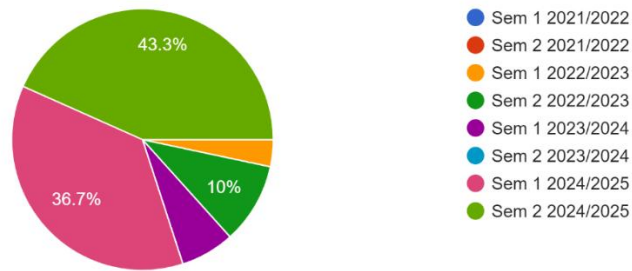


Figure 5.2 Respondent's distribution

The respondents vary from second-year to final years of study, with the majority of them being second-year students. This suggests that the participants have a strong foundational understanding of core concepts within their field, particularly as many of them are currently engaged in relevant coursework this semester. This distribution allows for a diverse range of insights from different years of students who have studied the database course.

What is your gender?
30 responses

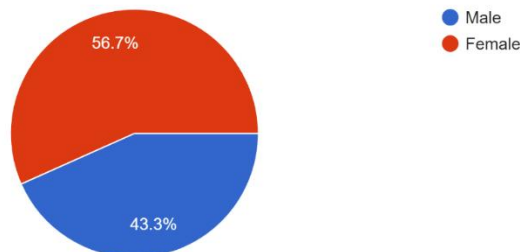


Figure 5.3 Distribution of respondents' gender

This shows that there is a slightly higher proportion of female respondents than male respondents.

What grade did you received in TMF2034?

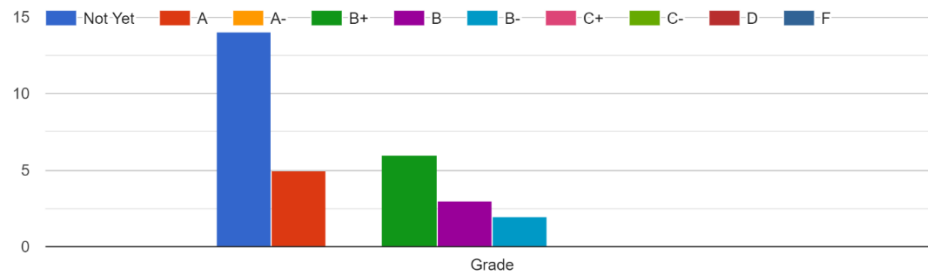


Figure 5.4 Grades of the students for the database course

The analysis of students' grades for the Database course reveals that most respondents have not yet received their final grades, as they haven't completed their final exams. However, for third- and fourth-year students who have already completed the course, there is a notable distribution of grades ranging from A to B-. This indicates that these students, who are likely to have a more advanced understanding of the subject, performed well in the course, but with some variation.

5.3.1 System Usability Scale (SUS)

A usability evaluation was conducted using the System Usability Scale (SUS) as shown in Table 5.12, which consists of 10 standardized statements answered on a 5-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). A total of 30 respondents participated in the assessment.

Table 5.13 Question items for SUS in the questionnaire

No.	SUS Statement	Type
1	I think that I would like to use this game frequently.	Positive
2	I found the game unnecessarily complex.	Negative
3	I thought the game was easy to use.	Positive
4	I think that I would need support from someone to play this game.	Negative
5	I found the various functions in this game were well integrated.	Positive
6	I thought there was too much inconsistency in this game.	Negative
7	I would imagine that most people would learn to play this game very quickly.	Positive
8	I found the game very cumbersome to play.	Negative
9	I felt very confident playing the game.	Positive
10	I needed to learn a lot of things before I could get going with this game.	Negative

Table 5.14 System Usability Scale (SUS) score interpretation table

SUS Score Range	Grade	Usability Rating	Acceptability
85 – 100	A+	Excellent	Acceptable (Best)
80 – 84.9	A	Very Good	Acceptable
70 – 79.9	B	Good	Acceptable
60 – 69.9	C	OK / Marginal	Marginally Acceptable
50 – 59.9	D	Poor	Not Acceptable
Below 50	F	Awful / Unusable	Not Acceptable

The interpretation of the System Usability Scale Score is divided into 5 Letter Grades from A, B, C, D, and F.

Each SUS response was converted into a score as follows:

- For positively worded items (questions 1, 3, 5, 7, and 9), the score contribution is:

$$\text{Score} = (\text{Response} - 1)$$

- For negatively worded items (questions 2, 4, 6, 8, and 10), the score contribution is:

$$\text{Score} = (5 - \text{Response})$$

This means each question yields a score from 0 to 4, and the total score from all 10 items ranges from 0 to 40. To convert this into a SUS score out of 100, the total is multiplied by 2.5:

- SUS Score = (Sum of adjusted item scores) $\times$ 2.5

After processing the data from the 30 respondents, the average SUS score was calculated by summing each participant's total SUS score and dividing by 30.

Table 5.15 Data from questionnaire for the usability of the EscapeDB game.

No	Respondents	Score results										Score	SUS
		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10		
1	R1	3	4	3	4	4	3	4	3	4	3	27	67.5
2	R2	3	4	4	3	3	3	4	3	3	3	26	65
3	R3	3	4	4	4	4	2	4	3	4	3	30	75
4	R4	3	3	3	3	4	4	4	3	3	3	26	65
5	R5	3	3	4	3	4	4	3	3	3	3	36	90
6	R6	4	4	4	3	3	4	3	3	4	3	35	87.5
7	R7	2	3	3	3	4	3	4	3	3	3	36	90
8	R8	4	3	4	3	4	2	4	3	4	3	40	100
9	R9	2	3	3	3	4	3	3	3	3	3	27	67.5
10	R10	4	3	4	3	3	3	3	3	3	3	26	65
11	R11	4	4	5	4	5	1	4	2	3	4	26	65
12	R12	5	5	5	3	5	2	5	2	5	5	28	70
13	R13	4	2	4	2	4	3	4	2	4	2	29	72.5
14	R14	3	2	4	3	5	3	5	3	4	4	26	65
15	R15	5	5	5	3	5	3	5	1	5	3	30	75
16	R16	5	1	5	1	5	1	5	1	5	1	40	100
17	R17	5	1	5	4	5	1	5	1	5	5	33	82.5
18	R18	5	2	4	4	4	2	5	3	5	3	29	72.5
19	R19	5	1	5	1	5	1	5	1	5	1	40	100
20	R20	5	4	5	4	5	2	5	3	4	2	29	72.5
21	R21	5	5	5	3	5	1	5	1	5	5	30	75
22	R22	5	5	4	5	4	5	4	4	5	5	18	45
23	R23	4	3	4	3	4	3	4	2	4	4	25	62.5
24	R24	5	1	5	4	4	4	5	5	5	2	28	70
25	R25	5	2	2	2	5	2	5	2	5	2	32	80
26	R26	5	3	4	3	4	3	3	3	4	3	25	62.5
27	R27	4	4	4	1	4	4	4	4	4	4	23	57.5
28	R28	5	2	5	2	5	2	5	2	5	5	32	80
29	R29	5	5	5	5	5	5	5	5	5	5	20	50
30	R30	5	2	2	3	5	2	3	3	5	5	25	62.5
Average SUS Score on EscapeDB													73.1

The average System Usability Scale (SUS) score of 73.1, accompanied by a grade of B, indicates that the game's interface is functional and generally well-received, reflecting an acceptable level of usability. A SUS score between 70 and 75 is typically considered a strong indication that users find the interface intuitive and easy to use, though some areas for refinement remain to deliver a more

seamless user experience. The score falls within the acceptable range, but small refinements could push the interface toward an even better user experience based on the user feedback.

5.3.2 NASA-TLX Questionnaire

Table 5.16 Analysis table for NASA Task Load Index

Dimension	Question	Score Range	Interpretation
Mental Demand	How mentally challenging was the game?	1 (Low) – 10 (High)	High scores indicate cognitive overload (too much thinking/problem solving).
Physical Demand	How physically demanding was the game?	1 (Low) – 10 (High)	High scores suggest excessive mouse/keyboard usage or hand fatigue.
Temporal Demand	How rushed or pressured did you feel by the time limits or pacing?	1 (Low) – 10 (High)	High scores suggest stress or time anxiety during gameplay.
Performance	How successful do you think you were in completing the tasks?	1 (Low) – 10 (High)	High scores here are positive, indicating task success and player confidence.
Effort	How hard did you have to work to complete the tasks?	1 (Low) – 10 (High)	High scores indicate the game requires a lot of effort (could be mental or physical).
Frustration	How irritated, insecure, or stressed did you feel while playing?	1 (Low) – 10 (High)	High scores suggest poor user experience, confusion, or bad interface/game design.

How mentally challenging was the game? Did it require a lot of thinking, problem solving, or concentration?
30 responses

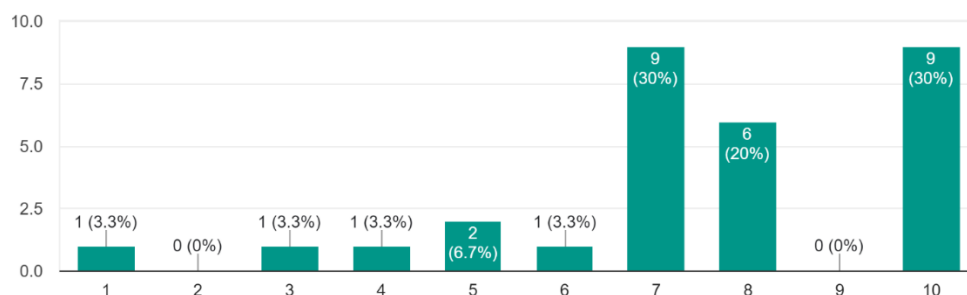


Figure 5.5 Analysis of the mental demand of the game

The average mental demand score was 7.5 out of 10, indicating a high level of cognitive workload experienced by players during gameplay. This suggests that the game requires substantial concentration, thinking, and mental effort. The game tasks involve solving database-related questions,

requiring both domain-specific knowledge and critical thinking skills. The added time pressure increases cognitive load, making the gameplay more urgent and intense. While a high mental demand score suggests engaging and intellectually stimulating gameplay, it may also lead to overwhelm or fatigue for some players.

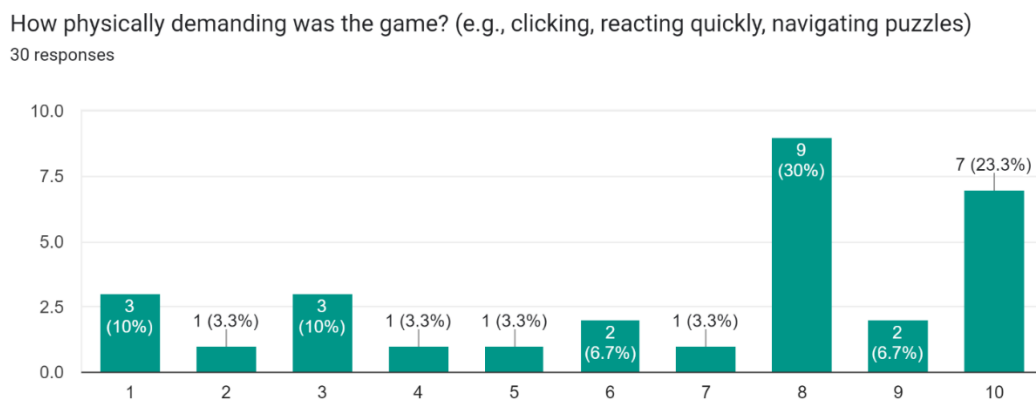


Figure 5.6 Analysis of the physical demands of the game

The average physical demand score for the game was 6.7 out of 10, indicating a moderately high level of physical effort required from players during gameplay. This suggests that players perceived the game to involve frequent or repetitive physical interactions, particularly mouse movements and clicks. This result aligns with the core interaction design of the game, which is a point-and-click escape room. To progress, players need to click on objects to interact with them, navigate between different scenes and search for hidden hints and input answers. Although this control scheme is typical and expected for the genre, the frequent clicking and scene-switching may have contributed to an increased sense of physical workload, especially during a time-limited session. Some users might have experienced mild fatigue or frustration, particularly if clickable objects were not easily distinguishable.

How rushed or pressured did you feel by the time limits or pacing in the game?

30 responses

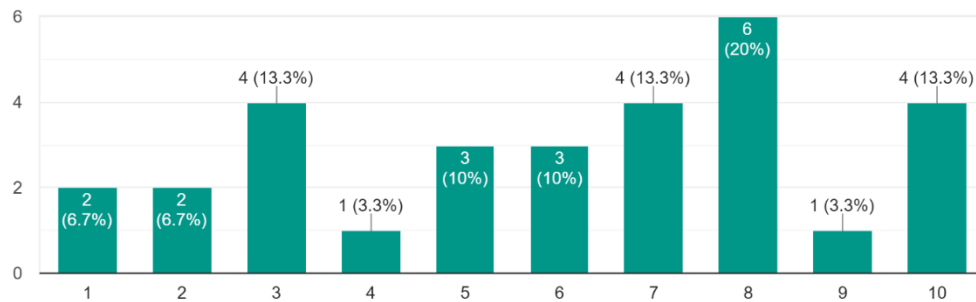


Figure 5.7 Analysis of the temporal demand of the game

The average temporal demand score was 6 out of 10, indicating a moderately high level of time pressure perceived by the players during gameplay. This suggests that many participants felt they had to work quickly and manage their time carefully to complete the tasks within the provided time limits. In the game design, each escape room includes a 5-minute countdown, which likely contributed to the heightened temporal demand. While the limited time helps simulate a realistic escape room challenge and adds excitement, it also imposes a sense of urgency that may affect user performance and comfort, especially for those who are not confident with database-related questions. However, a positive aspect is that players can freely choose which escape room to attempt first. This flexibility may help reduce anxiety, allowing users to start with rooms they feel most comfortable in. Additionally, unlocking the final escape room as a non-timed, leisure-based experience offers a well-balanced break from the time pressure of earlier stages.

How successful do you think you were in completing the game tasks or objectives?

30 responses

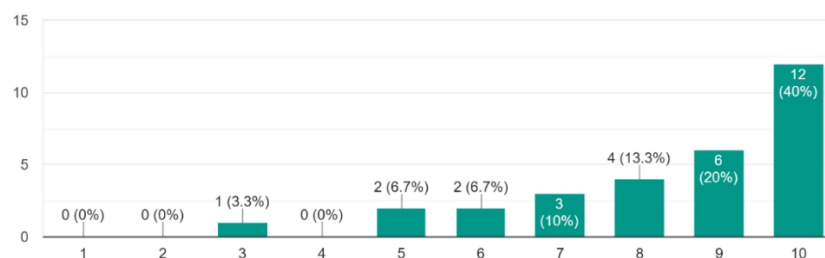


Figure 5.8 Analysis of the performance of students in the game

The average performance score was 8.4 out of 10, indicating that most respondents felt they performed well and achieved their objectives during gameplay. This reflects greater user confidence, task completion success, and overall satisfaction with their effectiveness in the game. This result suggests that despite the cognitive challenge and time constraints, players generally understood the game objectives, were able to answer the database-related questions, and successfully unlocked the required escape codes within the time limits. The relatively high-performance rating may also reflect effective game design features.

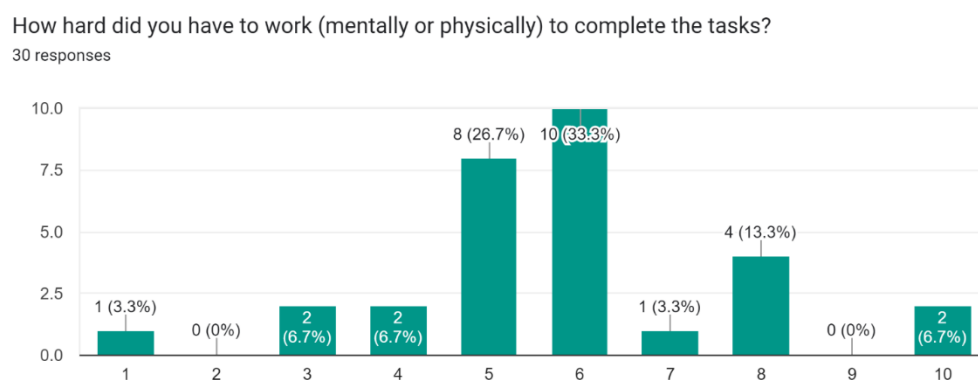


Figure 5.9 Analysis of the effort score of players in the game

The average effort score was 8.4 out of 10, indicating that respondents felt they had to put in a significant amount of physical and/or mental work to complete the tasks in the game. including cognitive strain, focus, trial-and-error, and persistence during gameplay. While the score aligns with the game's design goals, which is to be mentally engaging and challenging, it also suggests that the experience may have been intensive and possibly fatiguing for some users, particularly those less familiar with the subject matter or the escape room format.

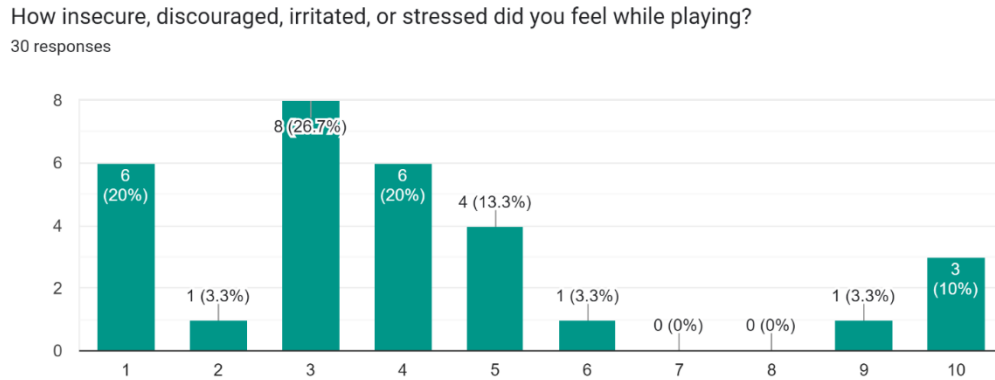


Figure 5.10 Analysis of the frustration score of players in the game

An average frustration score of 4.0 indicates that while the game presented challenges, most players were able to navigate them without feeling overwhelmed or discouraged, keeping frustration at a manageable and acceptable level. This is a positive outcome, especially considering the game's educational focus and cognitive demands. Several design features likely played a key role in preventing frustration from escalating. For instance, the changing mouse cursor helped players quickly identify clickable objects, minimizing trial-and-error interactions. Additionally, the option to choose the order of rooms gave players a sense of control, reducing pressure and fostering a more personalized experience. Finally, the leisure room unlocked after completing the basics served as a psychological reward, providing players with a relaxing break and alleviating stress accumulated from earlier challenges.

5.3.3 General Opinion on Game-based Learning

Prior to this course, do you have any educational experience using the Escape Room?
30 responses

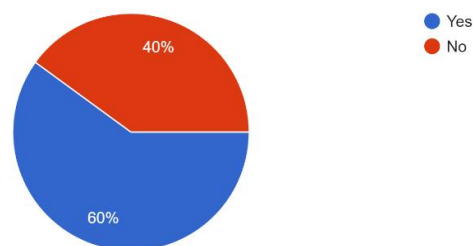


Figure 5.11 Experiences with educational escape rooms

The majority of the respondents had experienced an educational escape room before playing this game. This indicates that most of them are familiar with the concept of an escape room.

Rate the following statements based on your learning experiences with the Escape Room (ER) Approach.

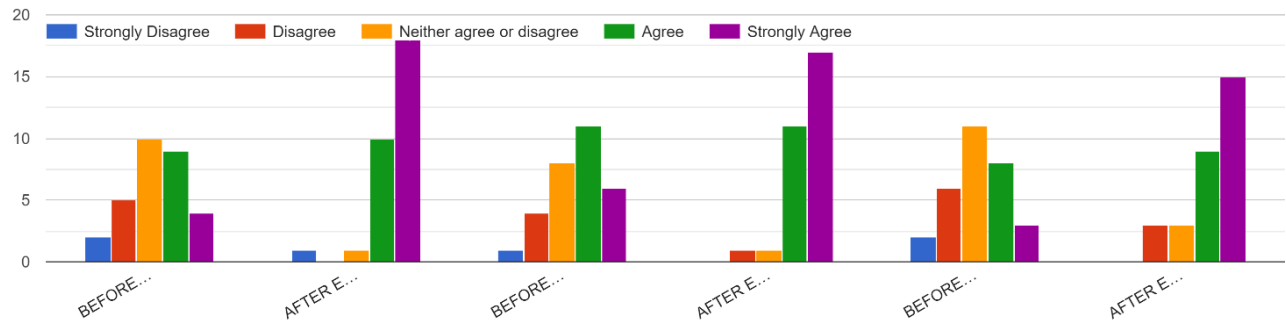


Figure 5.12 Learning experiences with the escape room approach

The chart above demonstrates that respondents feel their knowledge of the lecture topics has significantly increased after participating in the escape room approach. Additionally, they believe the activity has enhanced their problem-solving skills and improved their effectiveness in completing assignments compared to before engaging in the escape room experience.

Overall, how satisfied are you with the Escape Room learning experience?
30 responses

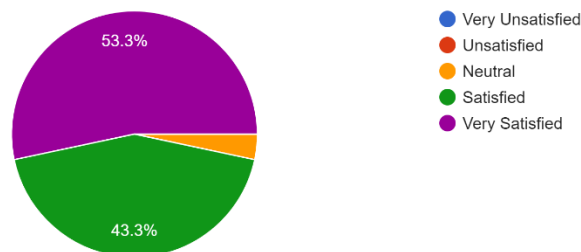


Figure 5.13 Satisfaction of players with the escape room learning experience

Respondents expressed overall satisfaction with the learning experience, highlighting the effectiveness of the escape room as a gamified element that enhanced engagement and motivation.

Table 5.17 Player feedback for the game

Respondent	Feedback
1	Consider adding a hint system for the puzzles.
2	Make the clickable object appearance more visible or bigger, and for the short answer question, it can have a hint if the user inputs the wrong answer 3 times above. Once the user has finished answering and escaped, the room can display that the room has already been answered.
3	Need more graphical improvement.
4	"The Spirit's Call" is very interesting. For suggestions, I think it can give some clues to navigate the player to find the escape code quiz entry point, such as the area that is twinkling.
5	The visual is appealing, and I think the loading in the beginning took so much time.
6	I like that it does not limit the chances from trying different answers. I think the font in the questions can be improved as some of them are too close to each other, making it difficult to read at the first glance.
7	The game was good overall, but needed improvement on hints (need more brief explanation of how the game mechanics work, for example, different riddles with different hints) for new players.
8	The concept is good, but it needs to improve the gameplay.
9	It's fun to learn things in a gamification way. The game is a little bit repetitive; maybe it is better to add more mini-game types.
10	It should be less laggy and playable on a phone.
11	hard to scroll (by using the mouse), at the leaderboard, and the achievement
12	Maybe make mini puzzles along the way that would solve bigger puzzles and finally lead to the escape. Makes it more enjoyable and require some level of critical thinking.
13	I think you can make it obvious where to click to show the question.
14	Variations in the storyline and map changing to give a sense of progression would be a huge boost to engagement.
15	I think it's great already, especially on the design of games, and it is a very attractive way for students to learn :)
16	It gives us another interesting way to learn about database.
17	I dont have any suggestions, but overall, the game was fun and good for my brain to exercise especially during free time.
18	The theme of the escape room needs to be balanced with the intro of the game.

5.4 Summary

The chapter describes the testing phase of the proposed web application to ensure the requirements and objectives are achieved without any fault. Besides, the testing phase is important to make sure the proposed web application is free from bugs before it is used by the targeted users. During its development, testing is required to be done continuously to ensure that the system features and functionalities work as intended. The unit testing and functional testing have been completed to ensure all components and functions are performed as expected. The test results from each test are recorded to determine the performance of the proposed web application. Feedback from every tester will be collected and used to improve the proposed application in the future.

CHAPTER 6 CONCLUSION AND FUTURE WORK

6.1 Introduction

The conclusion of the proposed project is discussed in this chapter. To ensure the requirements are met, the proposed objectives will be compared with the project outcomes. Additionally, recommendations for future work and project limitations will be made for better improvement.

6.2 Project Achievements

Objectives	Achievement
To analyze existing digital platforms that incorporate the escape room concept for learning.	A comprehensive analysis was conducted on existing digital platforms that integrate the escape room concept for learning. The review focused on identifying key features, exploring the current technologies available to educators for creating escape rooms, and examining how the escape room concept is applied within educational settings. Chapter 2 summarizes the results and provides insights into how educators use the existing technology to implement the escape room gamification concept in educational settings.
To develop a game-based web application that facilitates students learning database through gamification concepts.	The game-based web learning platform, EscapeDB, incorporates and has been developed and deployed. It allows students to test their knowledge through gameplay.
To evaluate the usability of the proposed game-based learning.	The effectiveness of gamification on student performance in a Database course was evaluated through usability testing. The results showed that the proposed game received an acceptable user rating, earning a B grade, which underscores its usability as an engaging tool that can enhance both student motivation and academic performance within the database course context.

6.3 Project Limitation

One of the significant project limitations is encountered in the development of the game itself, primarily due to the current absence of an official Firebase Software Development Kit (SDK) that natively supports WebGL builds. This necessitates extensive research and implementation of alternative communication methods to establish connectivity between the Unity WebGL game and Firebase services. Specifically, a "bridge" is required to facilitate data exchange, either through C# Interop services or a direct REST API. Interop services have been chosen as the preferred approach for this project, as they can be configured easily after studying the documentation provided by Unity.

Furthermore, substantial developmental delays were attributed to the intricate design of the database structure. Optimizing data models within Firebase Realtime Database to simultaneously support real-time game state synchronization, comprehensive player analytics, and administrative backend functionalities proved to be a complex undertaking, necessitating an iterative process of conceptualization, implementation, and refinement.

Besides, a notable limitation encountered pertains to input handling for WebGL builds on mobile devices. While a partial solution was achieved through the integration of a third-party plugin to enable basic mobile input recognition, the game's user interface and overall experience are not yet fully optimized for mobile-friendly interaction.

Finally, the uniformity of gameplay mechanics among the different escape rooms is acknowledged to be a drawback. This intrinsic similarity runs the risk of reducing replayability and player engagement, especially after first being introduced to the fundamental puzzle paradigms. The current design could greatly benefit from a wider variety of puzzle types and interactive elements to sustain challenge and player interest over time, as escape room experiences are usually created for unique, one-time engagements.

6.4 Future Work

For future development, it is critically important that the limitations identified in the project (as detailed in Section 6.3 are addressed and overcome.

Specific areas for future enhancement include:

i. Diversification of Game Mechanics

A primary focus should be on introducing a greater variety of puzzle types and interactive challenges across the escape rooms. This could include logic puzzles, pattern recognition, environmental manipulation, and narrative-driven objectives, moving beyond primarily clue-finding and question-answering. This expanded diversity is crucial for maintaining player interest and ensuring each room offers a unique and stimulating experience, thereby increasing engagement and replayability, which is vital for an escape room format.

ii. Implementing Multiplayer Features

This would involve designing a gameplay which allows multiple players to collaboratively tackle escape room challenges. This could significantly enhance social interaction and problem-solving dynamics.

iii. In-Game Communication System

This would enable real-time communication between players, allowing them to share observations, theories, and potential solutions, fostering teamwork and deepening the collaborative aspect of the escape room experience.

iv. Mobile Platform Compatibility

Explore extending the game's reach by developing native mobile applications (Android), potentially leveraging Firebase's native SDKs.

6.5 Conclusion

In the past ten years, gamification has gained attention in the field of higher education since it has been shown to help students in many ways and has given teachers a variety of options to improve the teaching and learning process. This study explores the potential of gamified learning to improve student engagement and learning outcomes in an undergraduate database course. It serves as a foundation for understanding the impact of gamified assessments in such courses, providing actionable insights for educators and instructional designers. The study suggests that gamification effectively promotes engagement, enhances proficiency in database concepts, and fosters an interactive learning environment. To summarize, the use of an escape room game as a learning tool proves to be both effective and engaging, even when conducted digitally. As a web-based platform, it offers easy access to students for active participation.

REFERENCES

- Airapetian, G. (2022, December 14). Rapid Application Development (RAD). Trusted Local Appliance Repair, Electrical & Plumbing Experts. <https://www.agilelonestar.com/knowledge-base/rapid-application-development>
- Anastasiadis, T., Lampropoulos, G., & Siakas, K. (2018). Digital game-based learning and serious games in education. *International Journal of Advances in Scientific Research and Engineering*, 4(12), 139–144. <https://doi.org/10.31695/ijasre.2018.33016>
- Breakout EDU - Educational Games for the classroom.* (n.d.). <http://www.breakoutedu.com/>
- Cash, A. R., Penick, J. R., Todd, C. F., & So, M. C. (2023). Escaping the Environmental Crises: Online Escape Rooms for Evaluating Student Data Analysis Skills. *Journal of Chemical Education*, 100(11), 4530–4535. <https://doi.org/10.1021/acs.jchemed.3c00339>
- Christmas Escape.* (n.d.). Room Escape Game by Roomescapemaker. <https://roomescapemaker.com/u/roomescapemaker/christmas>
- Deslauriers, L., McCarty, L. S., Miller, K., Callaghan, K., & Kestin, G. (2019). Measuring actual learning versus the feeling of learning in response to being actively engaged in the classroom. *Proceedings of the National Academy of Sciences*, 116(39), 19251–19257. <https://doi.org/10.1073/pnas.1821936116>
- Escape from witch cottage! by Xephrys.* (n.d.). itch.io. <https://xephrys.itch.io/escape-from-witch-cottage>
- Escape the Mage Tower by moyaaaaaa.* (n.d.). itch.io. <https://moyaaaaaa.itch.io/escape-the-mage-tower>
- Flynn, C. (2024). Escape to Learn: Digital Escape Rooms and Universal Design for Learning. *AISHE-J*, 16(2), 1–10. <https://doi.org/10.62707/aishej.v16i2.837>

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences*, 111(23), 8410–8415. <https://doi.org/10.1073/pnas.1319030111>

Google. (n.d.). Google Forms. Google. <https://forms.google.com>

Google. (n.d.). Google Sites. Google. <https://sites.google.com>

Jääskä, E., & Aaltonen, K. (2022). Teachers' experiences of using game-based learning methods in project management higher education. *Project Leadership and Society*, 3, 100041. <https://doi.org/10.1016/j.plas.2022.100041>

Klein, K., Calabrese, J., Aguiar, A., Mathew, S., Ajani, K., Almajid, R., & Aarons, J. (n.d.). Evaluating Active Lecture and Traditional Lecture in Higher Education. DigitalCommons@USU. <https://doi.org/10.26077/ba42-a5cc>

Barra, E., López-Pernas, S., Gordillo, A., Pozo, A., Muñoz-Arcenales, A., & Conde, J. (2023). Empowering Database Learning Through Remote Educational Escape Rooms. *IEEE Internet Computing*, 28(1), 18–25. <https://doi.org/10.1109/mic.2023.3333199>

Lopez Pernas, S. (2024). *Escapp* (Version 1.4) [Computer software]. GitHub. <https://github.com/ging/escapp>

Marques, M. M., & Pombo, L. (2021a). The Impact of Teacher Training Using Mobile Augmented Reality Games on Their Professional Development. *Education Sciences*, 11(8), 404. <https://doi.org/10.3390/educsci11080404>

Maldita.es & Universidad Politécnica de Madrid. (n.d.). *The hoax factory*. <https://escaperoom.maldita.es/>

Microsoft. (2025). Visual Studio Code. Retrieved from <https://code.visualstudio.com/>

Nadeem, M., Oroszlanyova, M., & Farag, W. (2023). Effect of Digital Game-Based Learning on Student Engagement and Motivation. *Computers*, 12(9), 177. <https://doi.org/10.3390/computers12090177>

Nelson, D., & Fatimazahra, E. (2010). Review of Contributions to the Teaching, Learning, and Assessment of Databases (TLAD) Workshops. *Innovation in Teaching and Learning in Information and Computer Sciences*, 9(1), 78–86. <https://doi.org/10.11120/ital.2010.09010078>

Sousa, M. J., & Rocha, Á. (2018). Leadership styles and skills are developed through game-based learning. *Journal of Business Research*, 94, 360–366. <https://doi.org/10.1016/j.jbusres.2018.01.057>

Stains, M., Harshman, J., Barker, M. K., Chasteen, S. V., Cole, R., DeChenne-Peters, S. E., Eagan, M. K., Esson, J. M., Knight, J. K., Laski, F. A., Levis-Fitzgerald, M., Lee, C. J., Lo, S. M., McDonnell, L. M., McKay, T. A., Michelotti, N., Musgrove, A., Palmer, M. S., Plank, K. M., . . . Young, A. M. (2018). Anatomy of STEM teaching in North American universities. *Science*, 359(6383), 1468–1470. <https://doi.org/10.1126/science.aap8892>

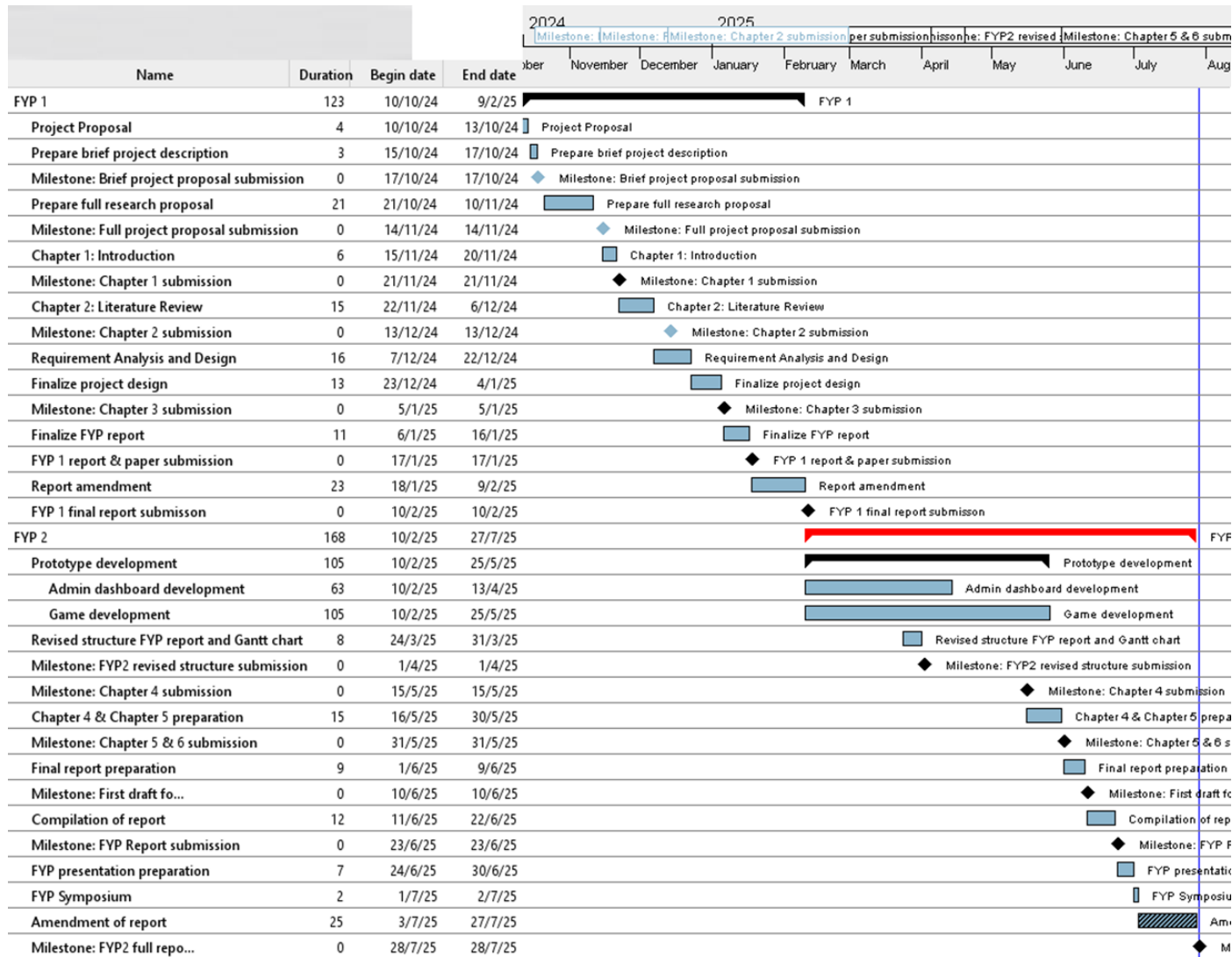
Unity Technologies. (2025). *Unity*. Retrieved from <https://unity.com/>

Vergne, M. J., Smith, J. D., & Bowen, R. S. (2020). Escape the (Remote) Classroom: An Online Escape Room for Remote Learning. *Journal of Chemical Education*, 97(9), 2845–2848. <https://doi.org/10.1021/acs.jchemed.0c00449>

Zeng, H. L., Chen, D. X., Li, Q., & Wang, X. Y. (2020). Effects of seminar teaching method versus lecture-based learning in medical education: A meta-analysis of randomized controlled trials. *Medical Teacher*, 42(12), 1343–1349. <https://doi.org/10.1080/0142159X.2020.18051>

APPENDICES

APPENDIX A: Gantt Chart



APPENDIX B: User Requirements Questionnaire

Learn Database Concept and Design with an Escape Game - EscapeDB

👋 Hello and thank you for participating in this survey! 📄

My name is Vun Jun Ye, and I am currently in my final year pursuing a degree in Multimedia Computing at the Faculty of Computer Science and Information Technology (FCSIT), Universiti Malaysia Sarawak (UNIMAS).

This survey is a part of a final-year project, and the project aims to develop a game-based learning system for teaching database course. The insights collected through this survey will help to better understand the current requirement of the subject by Year 2 Semester 1 students of FCSIT, as well as the preferences for in game features.

The survey consists of 3 sections and will take approximately 5-10 minutes to complete.

- Section 1: Demographic Information
- Section 2: Requirement analysis
- Section 3: Preferences for In-Game Features

The response results will be put in writing and presented as a part of this project. Please note that the CONFIDENTIALLY of your response is assured. All your information will not be shared and only be used for academic purposes.

Your kind response and time are valuable and most appreciated. For further explanation or any inquiry, please contact me through 81466@siswa.unimas.my

Thank you in advance.

* Indicates required question

1. I understand that my participation in this study is entirely voluntary and that I may choose to withdraw from the study at any time without penalty. I have read and understood the information provided. By clicking "I agree" below, I consent to participate in this study. *

Mark only one oval.

☐ I agree

Demographic Information

2. Gender *

Mark only one oval.

- ☐ Male
☐ Female

3. Program of Study *

Mark only one oval.

- ☐ Computational Science
☐ Data Engineering
☐ Software Engineering
☐ Network Computing
☐ Multimedia Computing

Requirement Analysis

4. What do you think of your current understanding level of the theories and concepts in Database Concept And Design course? *

Mark only one oval.

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

5. Do you have an escape room experience (physical)?

Mark only one oval.

☐ Yes

☐ No

6. Have you ever played escape room game **virtually** on your device? *

Mark only one oval.

☐ Yes

☐ No

☐ I think I played some kind of escape game

7. If you believe you have played this kind of game or a similar-themed game before, please share the name(s) or link to the game(s) you've experienced. (eg. The Room, Cube Escape...)

8. What learning methods do you find most effective? *

Mark only one oval.

- ☐ Lectures
- ☐ Hands-on exercises
- ☐ Group discussions
- ☐ Visual aids (e.g., diagrams, videos)
- ☐ Self-paced learning (e.g., tutorials, guides)

9. Do you prefer individual learning or group-based activities when learning new concepts? *

Mark only one oval.

- ☐ Individual learning
- ☐ Group-based learning
- ☐ A mix of both

10. How challenging do you find each of the following topics in the database course? *
Please rate each one on a scale from 1 to 5.

Mark only one oval per row.

	Easy	Manageable	Neutral	Hard	Extremely Challenging
Basic Database Concepts and Terminology (e.g., tables, attributes, primary keys, foreign keys, etc.)	☐	☐	☐	☐	☐
Modeling Relationships: One-to-Many, Many-to- Many (M:M)	☐	☐	☐	☐	☐
Entity- Relationship (ER) Model (e.g., constructing and interpreting ER diagrams)	☐	☐	☐	☐	☐
Normalization (1NF, 2NF, 3NF)	☐	☐	☐	☐	☐
Writing SQL Queries (e.g., SELECT, INSERT, UPDATE, DELETE, JOINS, subqueries)	☐	☐	☐	☐	☐

11. What challenges did you face when learning the database course? Please rate each one ^{*} on a scale from 1 to 5.

Mark only one oval per row.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
The complexity of the concepts made it difficult to understand the material.	☐	☐	☐	☐	☐
The course lacked practical examples to help me grasp the concepts.	☐	☐	☐	☐	☐
I lacked motivation to continue learning the course content.	☐	☐	☐	☐	☐
There was no immediate feedback on exercises I worked on.	☐	☐	☐	☐	☐
I felt overwhelmed by too much information being presented at	☐	☐	☐	☐	☐

once.

I was **afraid**
of **making**
mistakes
during the
learning
process.

☐☐☐☐☐

12. What other problems you have faced when you are learning Database Concept and Design course?

Preferences for In-Game Features

13. What theme do you find most intriguing for a digital escape room? *

Mark only one oval.

- ☐ Sci-Fi
☐ Mystery
☐ Historical
☐ Fantasy

14. What type of challenges do you prefer in a game? *

Tick all that apply.

- ☐ Puzzle-Based Challenges (eg. arrange things in a specific order)
- ☐ Hands-on coding challenges
- ☐ Simulations of real-life scenarios:
- ☐ Clue-based challenges (eg. code breaking, finding hidden clues)

15. Would you like the game to feature **some sort of tutorials or secret notes** related to database concepts as part of the gameplay? *

Mark only one oval.

- ☐ Yes
- ☐ No, I would like to figure out the database mechanics on my own.

16. Do you prefer a time limits for each puzzle or a time limits for the entire escape room? *

Mark only one oval.

- ☐ Yes, time limits for each puzzle.
- ☐ Yes, time limits for the entire escape room.
- ☐ Both of them

17. How important do you think a leaderboard is for showcasing players' achievements in an educational escape room game? *

Mark only one oval.

	1	2	3	4	5	
Not :	☐	☐	☐	☐	☐	Very important

18. Do you prefer to play the game alone or play together with another friend? *

Mark only one oval.

- ☐ Play singleplayer
☐ Play team-based
☐ Both is preferred

19. Should the game include a hint system for players who get stuck? *

Mark only one oval.

- ☐ Yes
☐ No
☐ Maybe (optional hints)

20. How do you feel about the addition of in-game chat or a shared notes feature? Would it help you enjoy the gameplay better? *

Mark only one oval.

- ☐ Yes
☐ No
☐ Maybe

21. Do you have any additional suggestions for game features?

APPENDIX C: Usability Testing Questionnaire

EscapeDB: Game-Based Learning Web Application for Database Course

Hi everyone! My name is Yun Jun Ye (81466). I am a final year student from Bachelor of Computer Science (Multimedia Computing) course and I am currently working on my final year project. I'd truly appreciate it if you could take a few minutes to play the game and then fill out a Google Form to share your feedback. Your insights will help me improve the usability and overall experience.

👉 Please use a laptop or desktop browser to play the game (it's not fully optimized for mobile — though you're welcome to try it).

🔗 Game Link: [EscapeDB Game](#) (Login by creating an account) **please fill in the email you used for the game in the form below, thanks**

** Indicates required question*

1. Email *

2. By choosing "Agree" as your option, you agree to be the tester of "EscapeDB", an educational game for learning database concepts and to give honest feedback on the game based on the questions given throughout this form. *

Tick all that apply.

☐ Agree

Demographic Information

3. Which undergraduate programme are you from? *

Mark only one oval.

- ☐ Information System / Data Engineering
- ☐ Computational Science
- ☐ Software Engineering
- ☐ Network Computing
- ☐ Multimedia Computing

4. In which semester are you taking TMF2034 Database Concept and Design? *

Mark only one oval.

- ☐ Sem 1 2021/2022
- ☐ Sem 2 2021/2022
- ☐ Sem 1 2022/2023
- ☐ Sem 2 2022/2023
- ☐ Sem 2 2023/2024
- ☐ Sem 1 2023/2024
- ☐ Sem 1 2024/2025
- ☐ Sem 2 2024/2025

5. What is your gender? *

Mark only one oval.

- ☐ Male
- ☐ Female

6. What is your age? *

Mark only one oval.

- ☐ 18-20
- ☐ 21-23
- ☐ 24-26
- ☐ 27 and above

7. What grade did you received in TMF2034? *

Mark only one oval per row.

	Not Yet	A	A-	B+	B	B-	C+	C-	F
Grade	☐	☐	☐	☐	☐	☐	☐	☐	☐

System Usability Scale (SUS) Questionnaire

- 1 - Strongly disagree
- 2 - Disagree
- 3 - Neither disagree nor agree
- 4 - Agree
- 5 - Strongly agree

8. I think that I would like to use this game frequently. *

Mark only one oval.

1 2 3 4 5

Stro ☐ ☐ ☐ ☐ ☐ Strongly agree

9. I found the game unnecessarily complex. *

Mark only one oval.

1 2 3 4 5

Stro ☐ ☐ ☐ ☐ ☐ Strongly agree

10. I thought the game was easy to use. *

Mark only one oval.

1 2 3 4 5

Stro ☐ ☐ ☐ ☐ ☐ Strongly agree

11. I think that I would need support from someone to play this game. *

Mark only one oval.

1 2 3 4 5

Stro ☐ ☐ ☐ ☐ ☐ Strongly agree

12. **I found the various functions in this game were well integrated.** *

Mark only one oval.

1 2 3 4 5

Stro ☐ ☐ ☐ ☐ ☐ Strongly agree

13. **I thought there was too much inconsistency in this game.** *

Mark only one oval.

1 2 3 4 5

Stro ☐ ☐ ☐ ☐ ☐ Strongly agree

14. **I would imagine that most people would learn to play this game very quickly.**

Mark only one oval.

1 2 3 4 5

Stro ☐ ☐ ☐ ☐ ☐ Strongly agree

15. **I found the game very cumbersome to play.** *

Mark only one oval.

1 2 3 4 5

Stro ☐ ☐ ☐ ☐ ☐ Strongly agree

16. **I felt very confident playing the game.** *

Mark only one oval.

1 2 3 4 5

Strongly disagree ☒ ☐ ☐ ☐ ☐ Strongly agree

17. I needed to learn a lot of things before I could get going with this game. *

Mark only one oval.

	1	2	3	4	5	
Stro	☐	☐	☐	☐	☐	Strongly agree

NASA-TLX Questionnaire

Please rate the following aspects based on your experience **while playing the game**. Use a scale from **0 to 100**, where:

0 = Very Low

10 = Very High

18. How mentally challenging was the game? Did it require a lot of thinking, problem solving, or concentration? *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Very	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Very High

19. How physically demanding was the game? (e.g., clicking, reacting quickly, navigating puzzles) *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Very	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Very High

20. How rushed or pressured did you feel by the time limits or pacing in the game? *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Very	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Very High

21. How successful do you think you were in completing the game tasks or objectives? *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Very	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Very High

22. How hard did you have to work (mentally or physically) to complete the tasks? *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Very	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Very High

23. How insecure, discouraged, irritated, or stressed did you feel while playing? *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Very	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Very High

General Opinion on Game-Based Learning

In this section, you will be question about your opinion on GBL.

24. Prior to this course, do you have any educational experience using the Escape Room? *

Mark only one oval.

☐ Yes

☐ No

25. Rate the following statements based on your learning experiences with the Escape Room (ER) Approach. *

Mark only one oval per row.

	Strongly Disagree	Disagree	Neither agree or disagree	Agree	Strongly Agree
BEFORE ER: My knowledge on the topics covered in the lectures have increased.	☐	☐	☐	☐	☐
AFTER ER: My knowledge on the topics covered in the lectures have increased.	☐	☐	☐	☐	☐
BEFORE ER: The activity enhanced my problem solving skills.	☐	☐	☐	☐	☐
AFTER ER: The activity enhanced my problem solving skills.	☐	☐	☐	☐	☐
BEFORE ER: My effectiveness in completing assignments has improved.	☐	☐	☐	☐	☐
AFTER ER:					

My
AFTER ER:
effectiveness
My
in
effectiveness
completing
in
assignments
completing
has
assignments
improved.
has
improved.

☐☐☐☐☐

26. Overall, how satisfied are you with the Escape Room learning experience? *

Mark only one oval.

- ☐ Very Unsatisfied
- ☐ Unsatisfied
- ☐ Neutral
- ☐ Satisfied
- ☐ Very Satisfied

27. What do you think is good about the game and do you have any suggestions on what can be improved? *

This content is neither created nor endorsed by Google.

Google Forms