The University of Hong Kong

Department of Computer Science

Final Year Project

Final Report

Strengthening Youths' Competencies for Mental Health Self-care

Yau Herman (3035570054)

Supervisor: Dr. Schnieders Dirk

Publish Date: 26th April 2024

Abstract

The high prevalence of mental health problems (such as depression and anxiety) has caused personal and societal consequences, including poor quality of life, increased suicide rate, expensive healthcare costs and reduced labor productivity. However, current measures to mitigate the issue are inadequate due to their limited reach to the target audience, expensive costs, and low accessibility. Therefore, there is a demand for a low-cost, engaging, and accessible solution to improve public health well-being and reduce suffering. In this project, a mobile game will be developed as an early intervention measure for youths to decrease the risk of mental health diseases. The game will be developed using Unity game engine with C# as the programming language. In the game, users will be able to perform a variety of self-care activities, such as doing physical exercise, building connections with people around, and writing self-reflections. The game aims to help youths to build a routine of performing self-care, thus relieving the current stress of the healthcare system. The product has been published to a major mobile application distribution platform. The current sample size of data collected is too small to determine the effectiveness of the game. However, the product has demonstrated an alternative method of data collection that can potentially be used in psychological research.

Acknowledgement

This report was written with the guidance of my supervisor Dr. Schnieders Dirk. I would like to express my profound gratitude as his helpful advice and suggestions had made this project possible.

I would like to also acknowledge the use of OpenAI's ChatGPT in the preparation of this report. This advanced language model provided invaluable assistance in refining complex ideas and ensuring clarity and coherence in the narratives. Its capabilities enabled the project to efficiently process large volumes of information and extract pertinent data, significantly enhancing the analytical processes. The role of ChatGPT as a supportive tool is appreciated in contributing to the overall quality of the project.

Table Of Contents

List of Figures and Tables

1 Introduction

Mental health affects the way humans make decisions, feel emotions, and take actions. It has an important role in our well-being, as it helps us to cope with stress, connect with others, and make society contributions. The World Health Organization defines mental health as "an integral component of health and well-being and is more than the absence of mental disorder." [1] In section 1.1, the high prevalence of mental health problems will be explained, followed up by the negative consequences of poor mental health in section 1.2. Section 1.3 will then discuss the challenges of current existing solutions. In section 1.4, an early intervention method for mental health will be introduced, where section 1.5 will introduce video games as the medium for improving mental health. Section 1.6 will discuss mental health issues associated with video games. Finally in section 1.7, the project aims will be shown.

1.1 Prevalence of Mental Health Problems

Mental health problems are prevalent across the globe. In 2019, it is estimated that 1 in every 8 people, or 970 million people, are living with a common mental health condition around the world [2], with anxiety disorders and depressive disorders being the most common, accounting for around 60% of the mental disorder cases (see Figure 1) [3]. Moreover, despite the steady
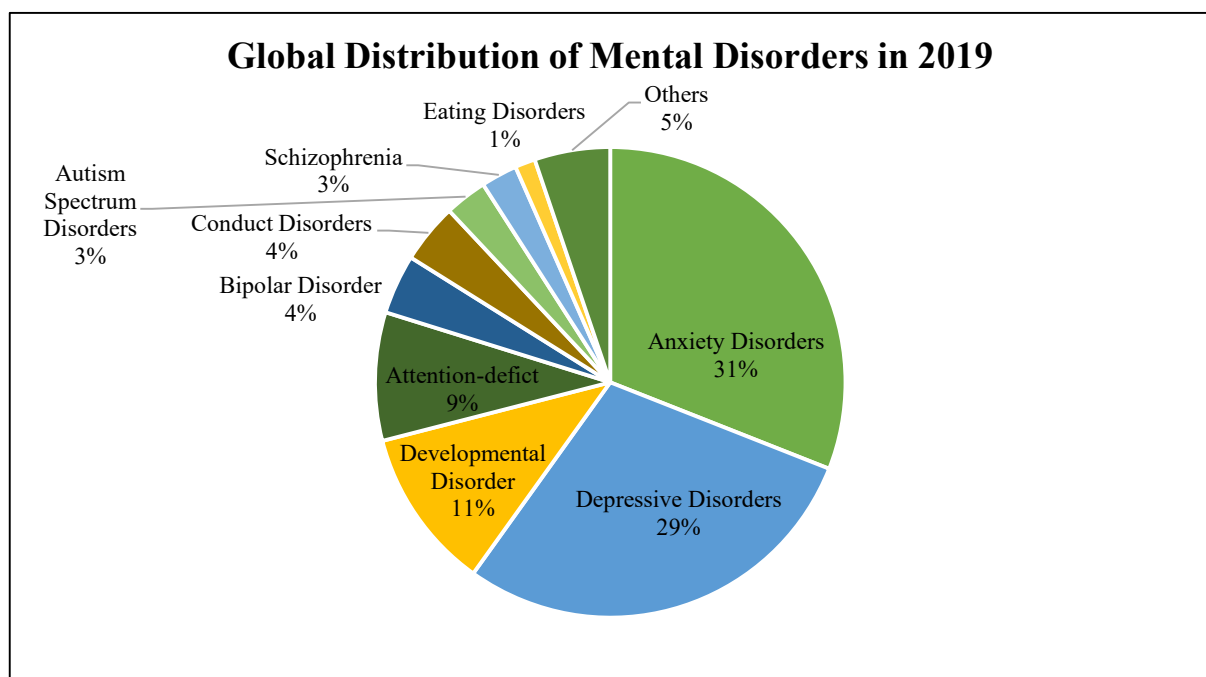
Figure 1: A graph showing the global distribution of mental disorders in 2019 [3]. Anxiety disorders and depressive disorders being the most common mental disorders.

prevalence rate of mental disorders in the recent years, the number of people living with mental disorders is still on the rise due to the global population growth, with an estimated increase of 25% between 2000 and 2019 [3]. This data is even higher for the youths in Hong Kong, where an increasing trend in mental health problems can also be observed. It is found that there is a 50% increase in the number of children and adolescents diagnosed with mental health problems from 18900 in 2011 to 28800 in 2016 [4].

1.2   Consequences of Poor Mental Health

Poor mental health will lead to premature mortality. It is found that individuals with severe mental health conditions have a higher chance of getting preventable diseases, therefore they have a decreased lifespan of 10 to 20 years [5]. Poor mental health may also lead to suicides, which accounts for more than 1% of the global deaths [6], and 8% of the deaths among the 15-29-year-olds [7]. In Hong Kong, the suicide rate between 2013 and 2021 for people aged between 15 and 24 has increased by 2.6, up to 10 per 100,000 people [8]. This is higher than the latest global suicide rate in 2019, which has reduced by 36% since 2000, to 9.39 per 100,000 people [9]. The increase of the suicide rate of youths is also higher than other age groups in Hong Kong, this is indicated by the converging difference in the suicide rate between these two groups (see Figure 2). A recent survey conducted by the Hong Kong government also shows
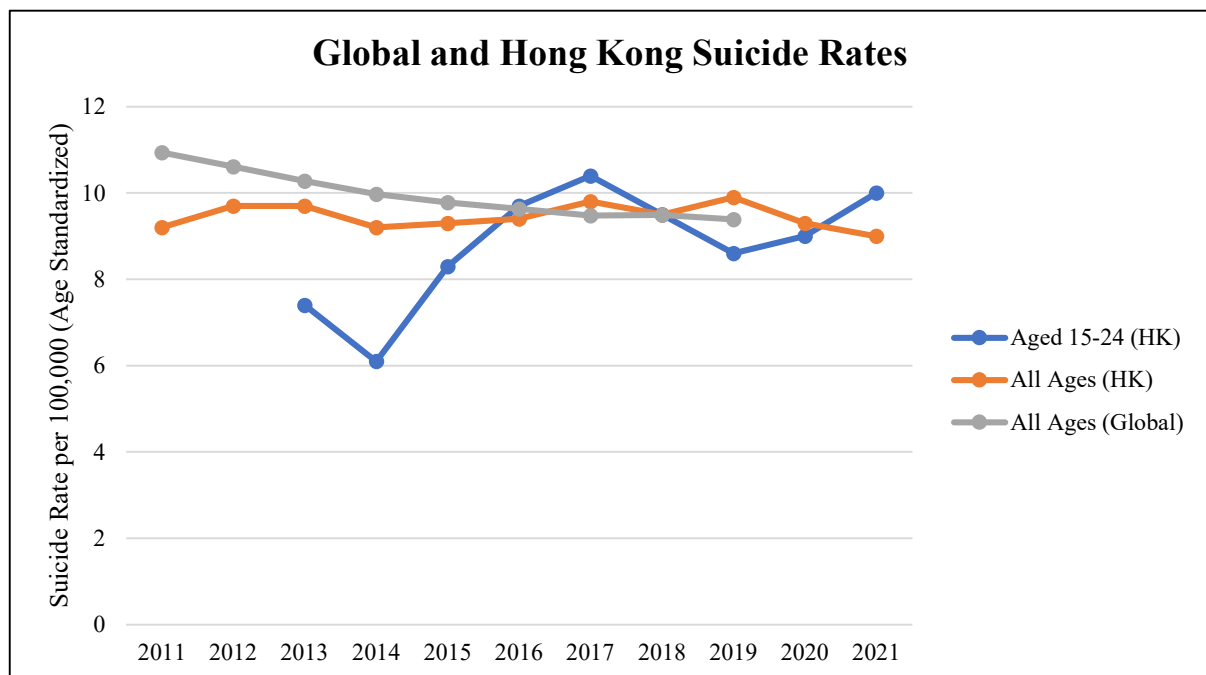
Figure 2: A graph showing the Hong Kong and global suicide rates by age groups [8]. The increase of the suicide rate of 15-24 age group is higher than other age groups, as indicated by the converging difference in the suicide rate between these two groups.

that 2.8% of the children reported thinking about committing suicide in 2023, with 1.3% or around 4300 students proceeded to attempt to suicide [10].

Youths with mental health conditions may impact their studies negatively as they struggle to concentrate or focus due to stress or sleep difficulties. It is shown by research that depression is associated with poor academic performance and attendance in school [11], this will impose challenges in their future employment and overall health [12].

Mental health conditions will also have impacts to the society. For instance, economic productivity is decreased due to premature deaths or disability. It is estimated that the societal cost of each treated individual, including the costs of treatment and forgone production value, is between US$1180 to US$18313 [8]. It is also projected that the global total cost of mental health conditions will rise from US$ 2.5 trillion in 2010 to $ 6 trillion in 2030 [9], which is higher than the costs of other severe diseases combined such as cancer and diabetes, indicating the significance of the cost of mental health problems.

1.3   Challenges of Existing Solutions

Existing counselling services can improve mental health. However, stigma is preventing individuals from seeking professional support due to the risk of being discriminated in the society. Mental health is often misunderstood, individuals with mental health conditions are stereotyped to be irresponsible, irrational, or dangerous [13]. An example would be the term "Schizophrenia", which has been labelled as "dangerous" as the name translates to "splitting of mind". To counter this, governments in Japan, South Korea, Taiwan have either introduced a new name such as "dysregulation of thought and perception", or straight up renamed the disorder in an attempt to reduce stigma [14]. People can experience stigma anyone in the society, from friends, families, professionals or even themselves, which pushes those people to choose to suffer from mental health illness instead of getting help. For instance, only 26% of the Hong Kong citizens diagnosed with mental disorders have consulted professional help in the past year [15].

Another hurdle of mental health care is the service gap. In Hong Kong, there are only 4.39 psychiatrists per 100,000 people [16], which is half the number recommended by the World Health Organisation. The shortage of mental health workers results in long waiting time to see a psychiatrist in the public sector, which can reach up to 95 weeks for some stable mental health

cases [17]. This shortage also results in unaffordable prices of private sector psychiatric counselling session for some low-income families, with costs that can range from HK$1200 to HK$1500 [18], which is 10 times more expensive than the public sectors [19]. As the wealth gap in Hong Kong continues to widen, more and more people will be unable to seek mental health support from professionals.

Youths could also look for self-care materials individually by researching online. However, some of the web pages might contain inaccurate or misleading information. On top of that, information on the Internet is very scattered, and it could be very time-consuming for the youths to obtain the materials they need. Also, since self-care includes a huge variety of activities, the youths might only focus on the ones that do not suit their needs, and this will hinder the growth of their self-care skills.

There are physical products for self-care activities available from different organizations. For instance, consumers can buy gratitude journals specifically designed as a guide to help them write down their thoughts and feelings. However, physical products are not immediately accessible and are only available in some parts of the globe. Those products also come with price tags and individuals might be willing to invest money to purchase such products.

Self-care mobile applications are also available, but some of these applications require money investments. While alternative free version of those applications may be provided, they are very limited in terms on functionality when compared to the paid version. On top of that, another major downside of those applications is the lack of incentives for users to use them on a regular basis.

1.4   Self-care as Early Intervention for Mental Health

Early intervention of mental health illness refers to the actions done to identify early warning signs and help prevent symptoms from developing. Patients who have received early intervention had reported improvements in their lifestyle and quality of life [20]. It is estimated that half of all the diagnosed mental disorders start before 14 years old, and three-quarters start before 24 years old [21]. Early intervention during youth years will prevent more severe symbols from developing in the later years. However, due to the huge demographic size, it would be unrealistic to provide professional care for early intervention of mental health to every individual.

The role of self-care is important when it comes to satisfying the society's demand for mental health. Self-care refers to activities that help individuals to live well and improve both mental and physical health even without the presence of a healthcare provider. A recent survey showed that the most-endorsed ways for improving symptoms of anxiety and depression are self-care activities including spending time outdoors and talking to people close to them [22]. Self-care can also be used clinically guided by specialists, this has been used in interventions for anxiety and depression and has shown to be as effective as face-to-face consultations [23].

However, self-care is underutilized. Research has shown that the prevalence of self-care use is only around 46.7% [24]. This means that the majority of the general population has missed out on a potential effective counter measure of common mental health problems.

1.5   Video Game as a medium for Improving Mental Health

Video games can be beneficial when it comes to mental health. Different studies have shown that there are cognitive, motivational, social, and emotional benefits of playing commercial video games, including better spatial, problem-solving, and social skills, enhanced creativity and motivational style, elicited positive emotions, and much more [25]. This could be because that video games are becoming more complex. Nowadays video games do more than just provide entertainment, but they also create immersive experiences and become a medium to tell stories and convey ideas. For instance, the story of the game "Omori" revolves around a depressive young boy and explores his inner thoughts [26], while the game "Ring-Fit Adventure" encourages the users to do physical exercises at home on a routine basis [27]. There are also educational games like "Kahoot!" to increase students' engagement in learning [28].

The benefits of gaming can be very impactful to the society as the video game industry is becoming one of the most important sectors of technology nowadays. Report shows that there were 2.6 billion mobile game players in the world [29]. Video games are especially popular among youths, data shows that 99% of the male teens and 94% of the female teens play video games [30]. The convenience of mobile game applications, which can be installed on devices like smartphones and tablets, also contributes to the ever-growing size of the market demographic.

Professionals have harnessed those positive effects of video games through gamification and created tailor-made games. For instance, a video game has been designed in the medical field

for child cancer patients so that they would learn to adhere to their treatments [25]. Video games also make their appearance in the field of education as well, with teachers attempting to create educational games to aid students' learning process [25]. However, the outcomes of playing those games have yet to be scientifically evaluated, therefore the efficiency of gamification is still unknown. However, the potential and feasibility of such means have been highlighted in different studies.

In fact, video games hold significant advantages when it comes to mental health interventions. For one, video games tend to be more engaging especially among adolescents when compared to traditional lesson-based approaches of conveying mental health information, this is because it is a primary goal for the game designers to keep the players interested using gameplay mechanics. For instance, a role-playing game SPARX developed for countering depression has shown to be as effective as traditional therapy programs [25]. Video games are also almost immediately accessible to most of the people no matter where they live, the only entry barrier would be the cost and accessibility of hardware and software to run the game. Therapy sessions on the other hand are usually more expensive, with accessibility being dependent on the region that people reside in.

1.6   Mental Health Problems associated with Video Games

Video game addiction, also known as gaming disorder, is commonly associated with video games. Video game addiction is defined as the impaired control over gaming for an individual, who would prioritize gaming over other daily activities in life [31]. The prevalence rate of video game addiction ranges from 0.21% to 57.60% among the general population depending on the screening method that the study used [31]. Even though the diagnosis process for this disorder has yet to be standardized, this data has shown the potential risks associated with video games.

Excessive gaming will lead to a series of negative psychosocial consequences. These often include lack of sleep, lack of social or real-life relationship, loneliness, poor academic performance, increased hostility and so on [32]. Studies have also shown that there may be physical consequences in addition to the mental ones such as hallucinations, seizures, wrist or neck pain and much more [32]. Therefore, it can be seen that video games can cause harm to individuals who have impaired control over the time spent on gaming as the negative

consequences outweigh the short-term entertainment those individuals receive from each gaming session.

1.7   Project Aims

This project aims to contribute to solving mental health problems by helping youths to incorporate mental self-care routine into their daily lives and providing useful information on mental health wellbeing. To achieve that, this project proposes a mobile game application that will use video game industry's appeal to youths as an advantage for early prevention of mental health disorders like depression and anxiety. The deliverables of the project shall include an application that is installable on recent mobile devices running Android operating systems.

The project does not aim to be a replacement for professional help. While self-care can improve individuals' physical and psychological health and is effective in early intervention of mental health problems, self-care itself cannot act as cure for individuals who have already developed severe symptoms of mental health disorders. Recovery of mental health illness requires support from profession health workers and medical substances. Therefore, the application will not give mental health diagnoses to individuals or give medical advice.

This project does not give mental health diagnoses to the users either. This is due to the intricate nature of mental health issues. The expertise, ethical considerations, and integrated approach that professional health workers provide are indispensable when it comes to an accurate diagnosis.

The project will not enforce or monitor users to perform self-care. Due to hardware limitations, it is unrealistic to track users' actions to check whether they are performing some specific activities. On the contrary, the application expects the user to be willing to perform these self-care activities on a voluntary basis, and provide the guidance and information that they may need to carry them out.

Users of the game can expect to improvements in health by practicing self-care on a regular basics using the game, which can lower the risk of getting mental health diseases like anxiety and depression through early intervention and prevention. Thus, the stress of the current healthcare system can be relieved as the number of patients with mental health problems is reduced. In the long term, this project may contribute to an increase in the labour productivity

of the society due to decreased premature mortality rate and reduced number of individuals with disability.

The project will counter with problems associated with video game addiction by giving off life skills to users that will be useful even in the long term. Instead of the one-off entertainment that is rewarded form the traditional video games, this project will teach users the importance of self-care and the different ways of performing them. This way, users will be constantly rewarded something that is beneficial for them in the long time.

When compared to other solutions, the proposed game provides a better incentive for users to build a regular self-care routine. First, the game is more convenient on-the-go. Users can use the application whenever and wherever without the need of making appointments required in some other solutions. Second, the game uses the advantage of its anonymity to allow users to play the game with an ease of mind without the feeling of shame or fear of discrimination. Finally, the game has a low-entry bar for users as it is free of charge and is easily accessible on their mobile devices.

In the remaining parts of this report, the methodology of the project will then be offered in chapter 2, followed with the results given by the product in chapter 3. Finally, the report will close with a discussion on the results and findings in chapter 4.

2 Methodology

To achieve the goals mentioned in section 1, this project will go through 3 stages. Section 2.1 will explain the design stage, which will be the first stage of the project. Then, in section 2.2, information on the development stage will be given. Finally, section 2.3 will go through the content of the evaluation stage.

2.1 Design Stage

In the design stage, three major components are created: The concept design, the UI/UX design, and the prototype.

2.1.1 Concept Design

The concept design was first established to outline the four major functions of the application. First, users can conduct a self-evaluation on their mental health by giving a score on how they currently feeling. Then, they can perform some self-care activities in real life and defeat in-game enemies by answering simple questions, taking photos, or watching videos. After that, they can review the results as well as the achievements of activities done in the past to see how they have progressed. Finally, users will be encouraged to repeat those actions in the next day as they unlock new self-care activities that they can perform when they defeat an enemy.

For this project, "one cycle" will be defined as the completion of self-evaluation, and defeating the enemy after some self-care activities are completed (see Figure 3).
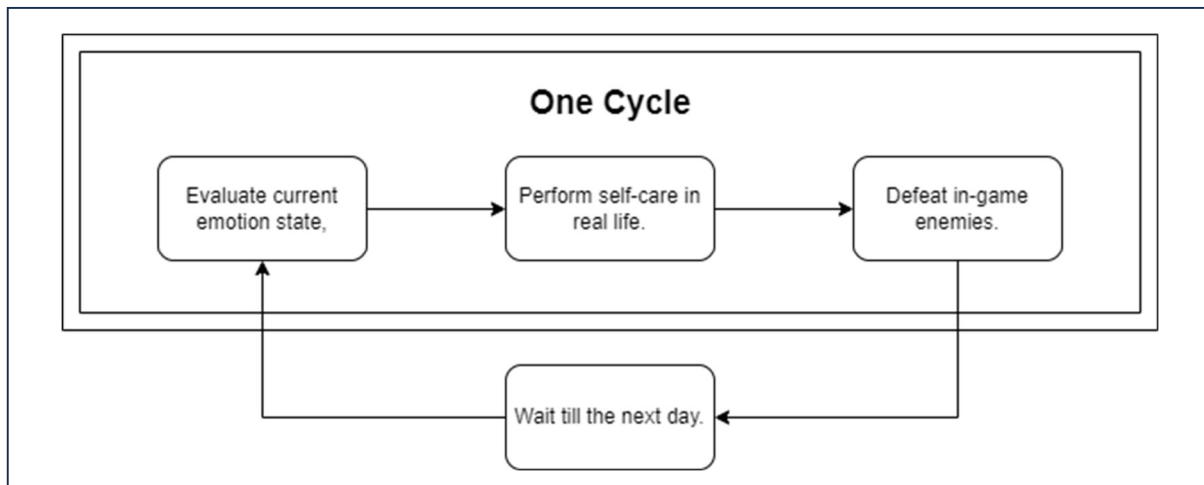
Figure 3: A flowchart demonstrating the core concept design of the application and the definition of "one cycle" of usage in this project.

2.1.2 User Experience Design

The user experience design was then created to finalize the components of the application, it illustrates the process of how the users are going to use the application. In the current design, the application will feature three major components (see Figure 4).
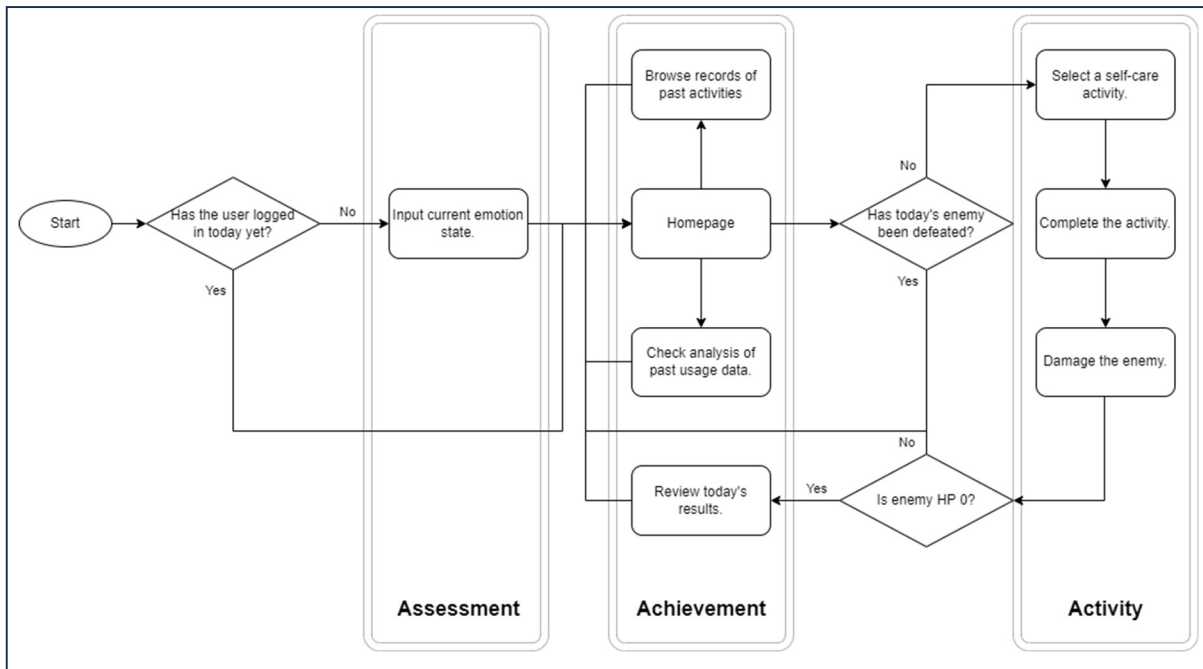
Figure 4: A flowchart demonstrating the user experience (UX) flow of the application. The three major components are shown, including the ability to exercise self-care, review achievements and conduct emotion assessment.

First, users will be able to input their current emotion state, which includes giving a score on how happy or unhappy they are, and selecting the emotions that best describe what they are feeling today.

Then, user will see an enemy on the screen, and they will be asked to participate in a variety of self-care activities categorized into 6 categories (see Table 1) to defeat the enemy. A colour is assigned to each category for easier identification. The colour is shown as the background colour of the activity's button in the menu.

Category	Goal	Colour
Emotional	Learn emotion coping mechanisms.	Red
Mental	Simulate people's mind and energizes their mental strength.	Orange
Physical	Improve their physical well-being.	Yellow
Spiritual	Give comfort to people's mind.	Purple
Practical	Fulfil certain goals in life.	Green
Social	Reach out and connect with the people they love.	Blue

Table 1: A table illustrating six categories of self-care activities and their respective colour representations that are included in the game.

When an activity is initiated, the application will first display a brief description of the activity as well as the benefits of it. Then, instructions of how to perform the activity will be shown. After that, users will be able to interact with the application by inputting text, uploading photos, or watching videos. Those interactive elements will help users to engage in the activities. There are a total of 20 self-care activities included in the application (see Table 2). After the activity is completed, the health point of the enemy will be reduced by an amount defined by that activity. When the health point of the enemy reaches 0, the enemy will be considered defeated.

Name	Type	Description	Cycle #	Damage (%)
Compliment	Social	Give compliments to others, then write down to whom and what compliments the user gave.	1	50
Deep Breathes	Emotional	Take a few deep breathes by following a guide video.	1	34
Gratitude Journal	Emotional	Write down a few things that the user felt grateful for that day.	1	80
Get in Touch	Social	Contact someone by giving them a call or messaging them, then write down who the user contacted, and their thoughts about it.	1	50
Stay Hydrated	Physical	Drink some water.	1	34
Hobby Time	Mental	Spend some time to do what the user likes to do, then write down what the user did and their thoughts about it.	2	100
Fruity Reminder	Physical	Buy and place the fruits in a place that is commonly seen day to day.	2	34
Strolling	Physical	Spend some time to go for a short walk somewhere, then write down the place the user went and their thoughts about it.	3	80
Coffee or Tea	Emotional	Spend some time to relax and drink a cup of coffee or tea.	3	50

Sleep Well	Physical	Remind the user to at least sleep for 8 hours the next day.	3	50
Curtains Up	Emotional	Remind the user to open the curtains when they wake up and make it their first thing to do in the morning.	4	34
Declutter	Practical	Select a personal place that the user thinks need to clean up. Take a photo first, then tidy it up. Finally, take another photo for a before-and-after comparison.	4	80
Charity	Emotional	Do something for charity, then write down what the user did and their thoughts about it.	5	50
Nature	Spiritual	Spend some time in the nature, then write down where the user went and their thoughts about it.	5	100
Keep Fit	Physical	Spend some time to do some physical exercises and write down what the user did.	5	100
Meditation	Spiritual	Spend some time to meditate by following the instructions.	6	80
Snack Time	Emotional	Eat some snacks as a treat for the user.	6	50
Get Crafty	Emotional	Spend some time to make anything, such as cooking, knitting, painting, or writing. Then, write down what the user created and their thoughts about it.	7	100
Goals and Plans	Practical	Spend some time to write down the goals and plans for the coming week.	7	50
Learning	Mental	Spend some time to learn something new, and then write down what the user learnt.	7	80

Table 2: A table illustrating the 20 of self-care activities that are included in the game. The "Cycle #" column represents the cycle that the respective self-care activity will become available on. The "Damage %" represents the amount of points that the enemy will reduce when the activity is completed. The enemy has a total health point of 100.

The third major component is the achievement overview. Users will also be able to review the past self-care activities that they have participated and see a summary of different metrics like the frequency of self-care activities participation, and the change in mood of the user.

2.1.3 User Interface Design

Two designs were created for the interface of the application (see Figure 5). Design B was selected as the final design because of the warmer colour temperature, which could be more comfortable to the users. This is important for the game due to the nature of it being about mental health.
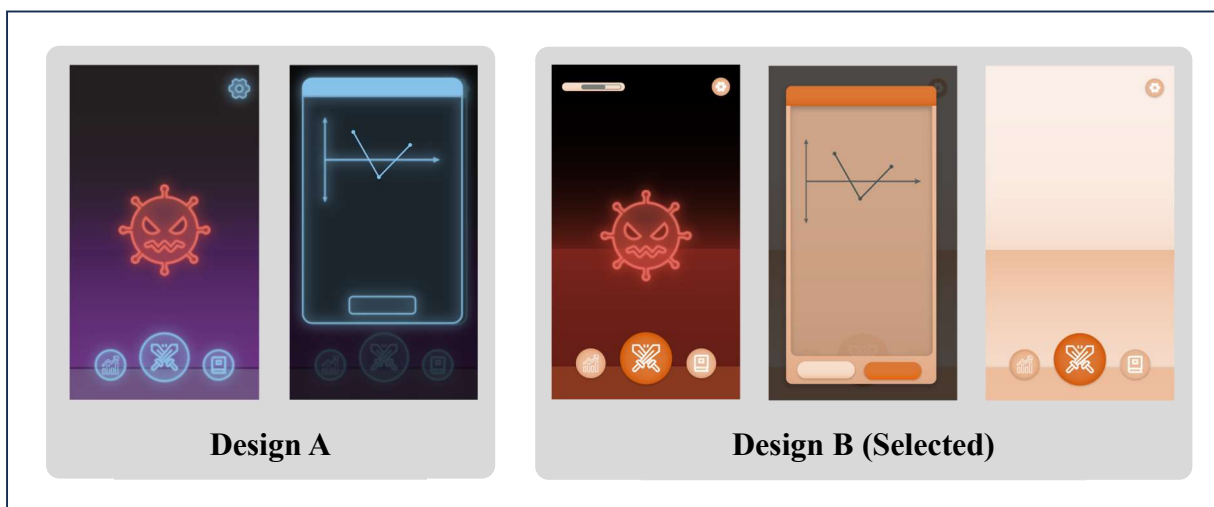

Figure 5: A comparison between the two designs created in the process. Design B was selected as the final design style of the application.

2.1.4 Prototyping

The prototype is created to demonstrate the concept of the game (see Figure 6), the process of the user flow as well as to validate the feasibility of the data collection process. The prototype is equipped with the basic functionality of inputting emotion state and performing self-care activities. It also has an achievement UI display that does not use actual real data for concept demonstration purposes. It was built and run on the Android operating system successfully and it was able to send custom data to the Unity Analytics service.
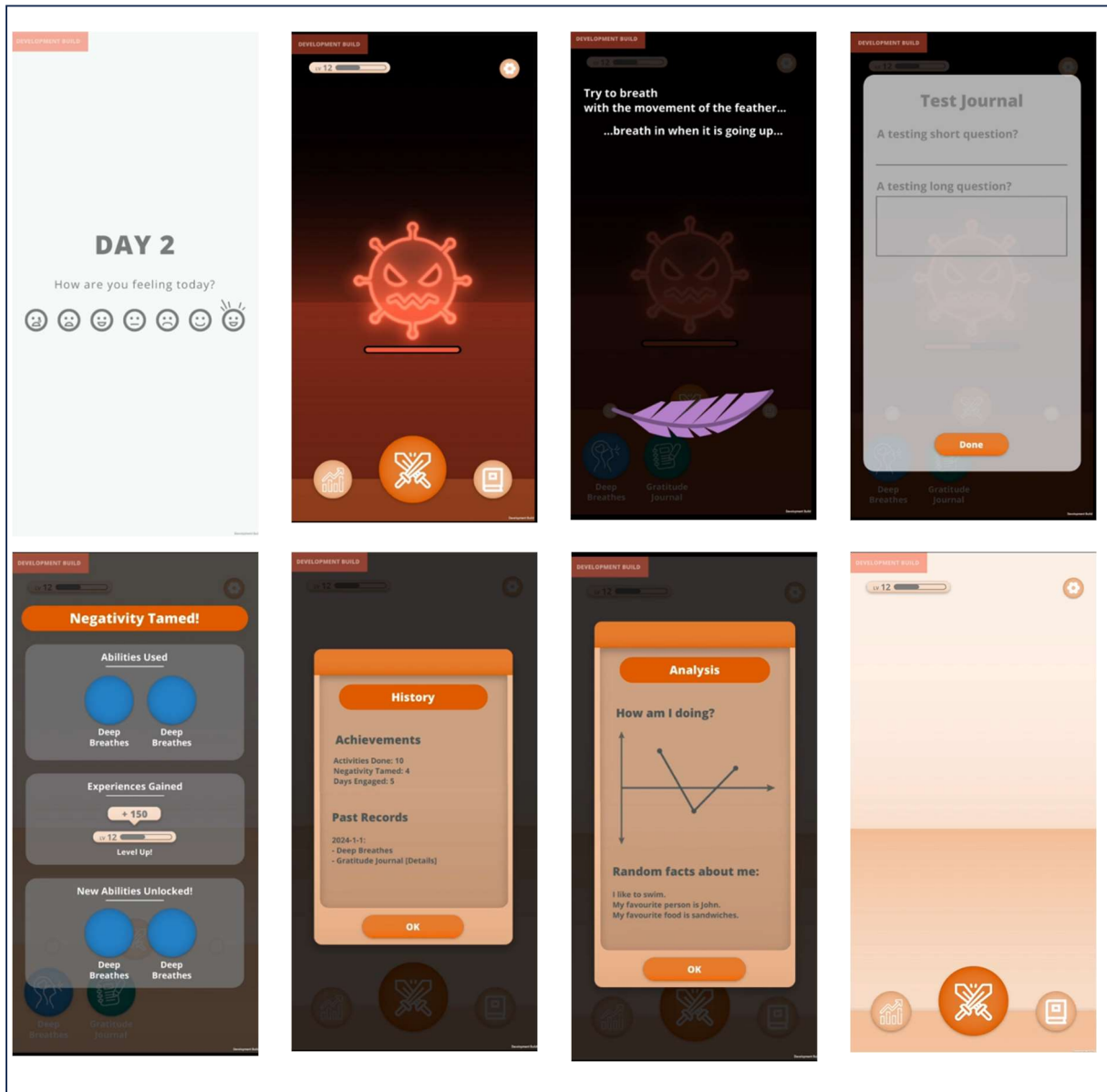
Figure 6: Several screenshots from the prototype. From left to right, then top to bottom are the emotion assessment screen, homepage with an enemy being displayed, guidance-based self-care activity, interaction-based self-care activity, result screen, history screen, emotion analysis screen, and homepage after the enemy has been defeated.

2.2 Development Stage

During the development stage, the application is developed using third-party toolsets by following a system architecture design.

2.2.1 System Architecture Design

In the current design, the application codebase can be categorized into three major sectors (see Figure 7). First, "view" scripts are responsible for converting raw data into UI display components. Then, they will be controlled by some "logic" scripts, which are responsible for filtering data and controlling the flow of the application. Finally, those "logic" scripts can access "data" scripts, which represent the user data that has been generated during usage as well as the game data that stores the fixed data for the game mechanics. Then, those "logic" and "data" scripts are managed by their respective singleton classes. On the lowest level is the application control singleton class, which is responsible for managing all the system components.
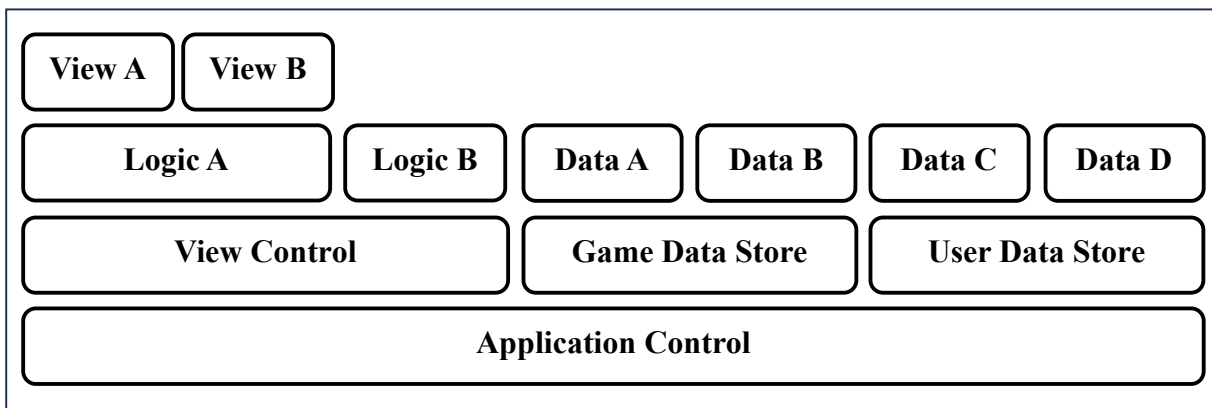

Figure 7: A diagram illustrating the system architecture of the application, the components on the lowest level are the parents to the components on the higher levels.

2.2.2 Development Tools

The implementation of the project is done using Unity game engine (see Figure 8). Unity is a software that is specifically designed for game development, it is equipped with libraries and programs that facilitate the efficiency and reliability of the development process. Unity is chosen over other game engines due to its feature-rich capabilities and robust support for simple 2D games.
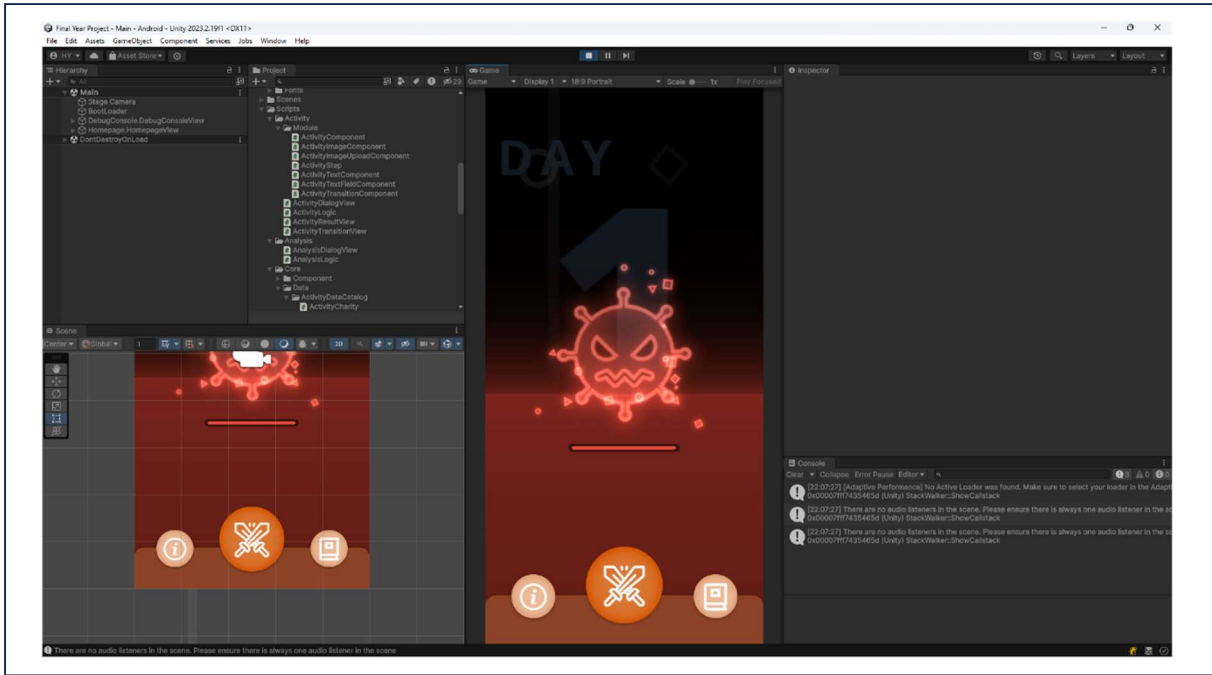
Figure 8: Screenshot of the Unity development environment. The software is currently running the game in preview mode.

Most of the code are written in C# as it is the language used by the API of Unity. The code scripts are written using Rider IDE with the help of GitHub Copilot to generate some of the repetitive code using the power of artificial intelligence (see Figure 9).
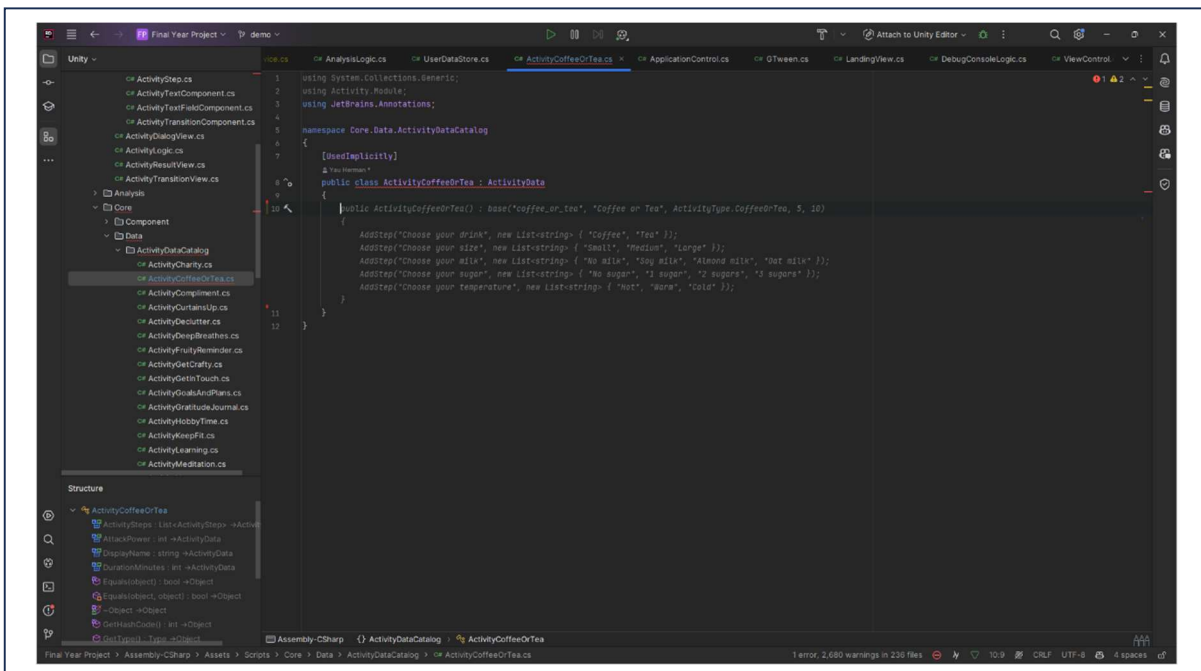

Figure 9: Screenshot of the use of GitHub Copilot inside Rider IDE. GitHub Copilot has suggested a section of code in grey based on the patterns it observed in other parts of the project.

FairyGUI, a third-party software, is used for implementing the user interface of the game (see Figure 10). This tool facilitates the creation of different user interface components as well as the animation between different interfaces.
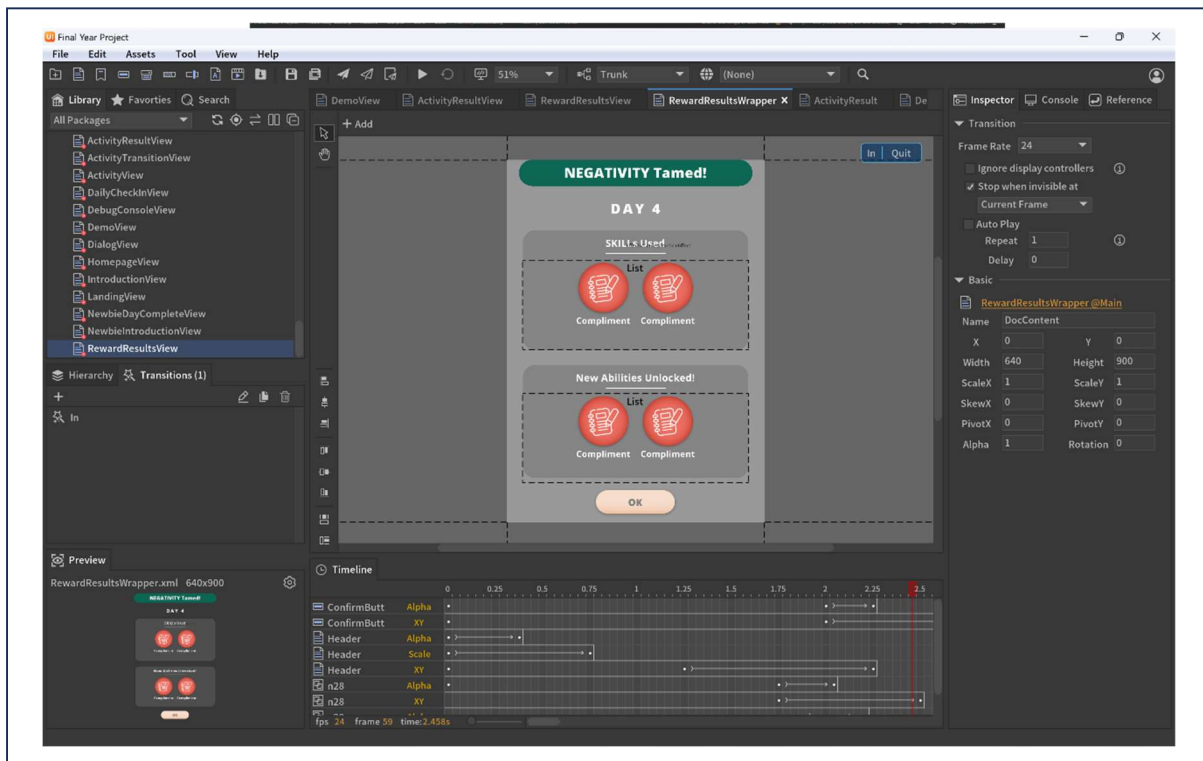

Figure 10: Screenshot of FairyGUI editor. The program is currently showing the transition control screen for the "Result" screen.

The project uses Git for version control, which is useful when there is a need to roll back the project to a certain state, or when a separate version of the project needs to be created for occasions like demonstration or presentation. GitHub is used as the repository server.

2.2.3   System Functionality Implementation

The implementation process began after the designs had been completed and the environment had been setup. The project first implemented the core system functionality of the program. The process is detailed as below.

<u>User Interface View Control</u>

Each user interface is defined as a "view", the current views being displayed are layered like a stack. The view control system is responsible for managing this stack and take control of how

views are pushed into and popped out of the stack. When a view is pushed, a game object is first instantiated for it, then the view control wait until no other views are exiting from the interface, finally the view is being initialized and the view's entrance transition will be played. When a view is being popped, it will first play the exit transition, then the game object associated with the view is destroyed.

Save and Load of User Data

Save functionality of user data is required for this project as users are expected to use the program over a few days, and it is not possible to keep the program data in memory for such a lengthy time. User data save is triggered in the following situations: The consent button is pressed in the "Introduction" screen, an emoji is pressed in the "Emotion Self-Evaluation" screen, the next or previous button is pressed in the "Activity" screen, one of the tutorials is completed in the "Tutorial" screen, or the enemy's health is being deducted in the "Homepage" screen. Saving is achieved by serializing the data stored in memory to a JSON file (see Figure 11), while loading of user data is done by deserializing the said JSON file.

```json
{
    "isDirectToHomepage": false,
    "userGameDayDataList": [
        {
            "startDate": "4/22/2024 12:00:00 AM",
            "endDate": "1/1/0001 12:00:00 AM",
            "emotionScore": 5
        }
    ],
    "userGameActivityDataList": [
        {
            "activityId": 1,
            "activityData": [],
            "completeDate": "4/22/2024 6:22:38 PM",
            "activityName": "ActivityDeclutter"
        },
        {
            "activityId": 4,
            "activityData": [
                {
                    "key": "Transition1",
                    "value": "1"
                }
            ],
            "completeDate": "4/22/2024 7:00:07 PM",
            "activityName": "ActivityDeepBreathes"
        }
    ],
    "enemyHealth": 100,
    "isNewbieIntroductionSeen": true,
    "isNewbieDayCompleteSeen": false,
    "isConsentReceived": true,
    "isConsentEventSent": true
}
```

Figure 11: A sample of the user JSON data file.

<u>Analytics Service</u>

The application will send the usage data over to Unity Cloud while the user is playing the game. To achieve this, the game will initialize and connect to the analytics service in a separate worker thread using Unity's analytics SDK when the application loads the "Landing" screen. The application will only proceed to the next screen when the initialization process has been completed successfully.

2.2.4 User Interface Implementation

To facilitate the development of the application, the workload of the user interface development is split by different features. When a feature has completed development, it is thoroughly tested before the next feature is being developed. A description of each of those features can be found below:

<u>Game Introduction</u>

The "Game Introduction" screen is the first screen that the users see when they first launch the application (see Figure 12). On the screen, the logo and a short description of the game will be
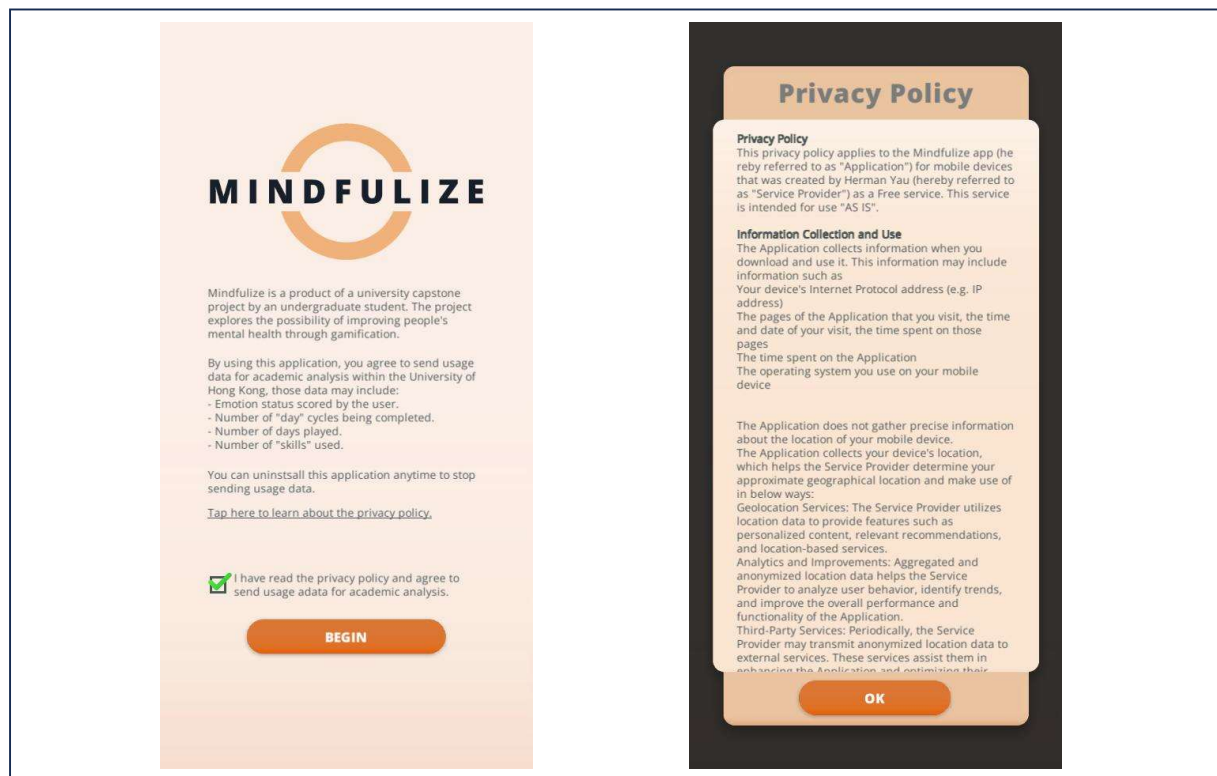

Figure 12: Screenshots of the "Game Introduction" screen (left), and the "Privacy Policy" screen (right).

shown. The game will tell the users that usage data will need to be collected when playing the game, and it will give examples of such data. Users will be informed that those data will be used for academic research. The user can also review the privacy policy through a popup dialog window from this screen (see Figure 12). To continue playing, the user must agree to the privacy policy by ticking the checkbox. Then, they will be able to advance to the next screen by pressing the "Begin" button.

Landing

The user will see the "Landing" screen under one of the two following scenarios: The user pressed the "Begin" button in the "Game Introduction" screen, or the user has consented to data collection before and has opened the application once again. In this screen, a motivational quote that is randomly selected will be shown to the user (see Figure 13). The game will also connect to analytics service in this screen.
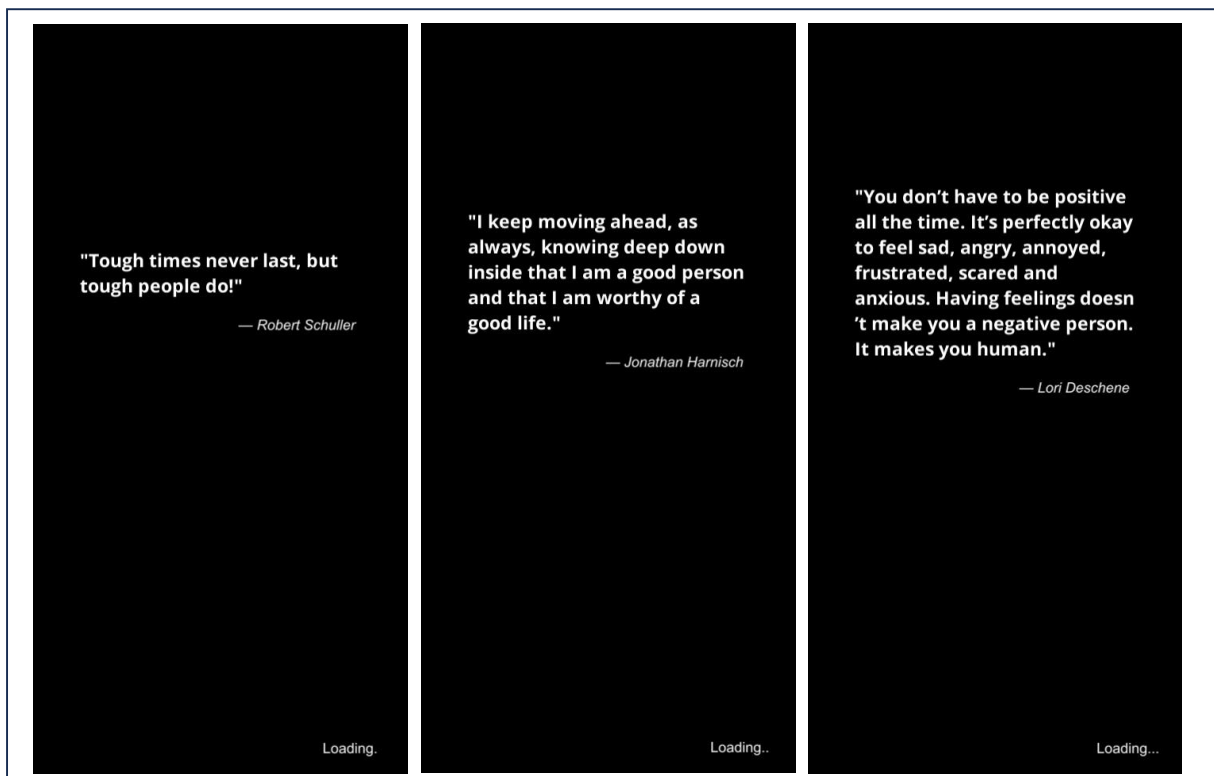

Figure 13: Screenshots of three different "Landing" screens. The quote shown in the middle is selected randomly among 27 quotes when the screen is shown.

Emotion Self-Evaluation

The "Emotion Self-Evaluation" screen will be shown after the "Landing" screen if the user has not performed self-evaluation in that game cycle (see Figure 14). In this screen, the user will be asked to select one of the seven emojis that best represents their current emotion state. The selection will be saved as an integer score point in the user data store. The application will proceed to the next screen after an emoji is selected.
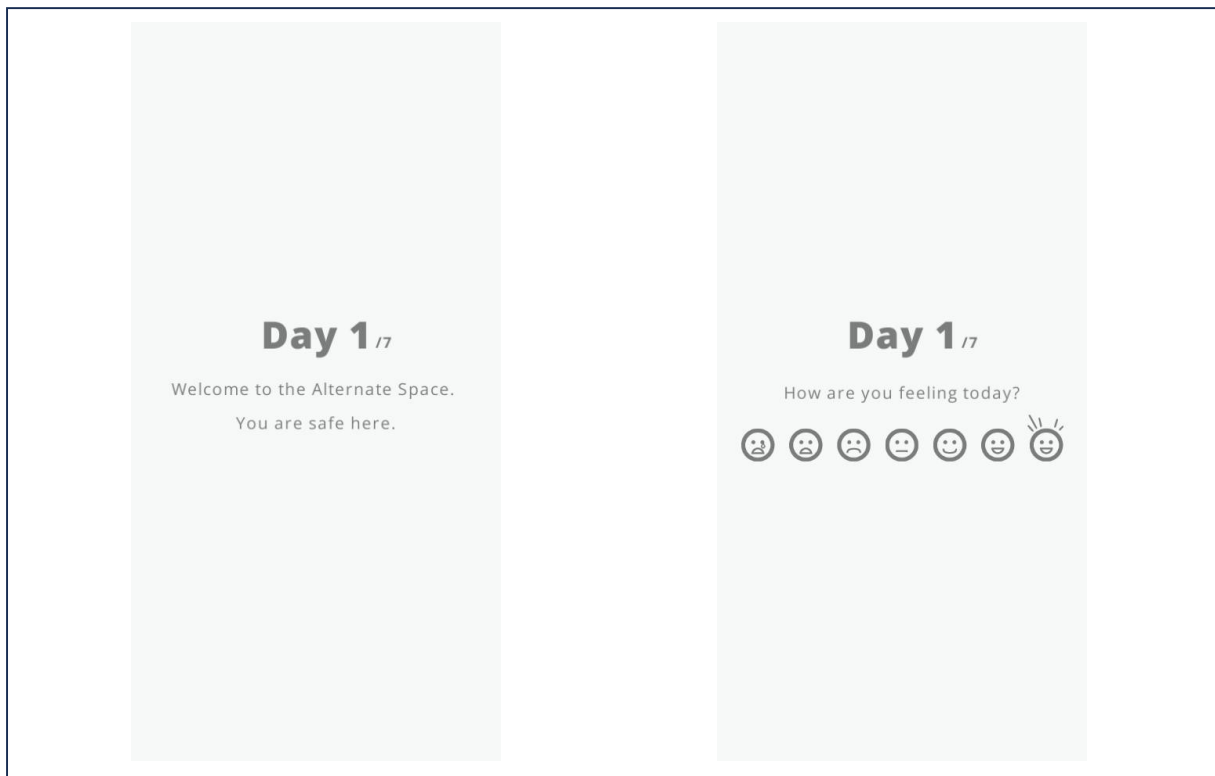

Figure 14: Two screenshots of the "Emotion Self-Evaluation" screen. The application first greets the user (left), the user can then select an emoji that best represents their current emotion (right).

Homepage

The "Homepage" screen is shown after the "Emotion Self-Evaluation" screen. If the user has already performed self-evaluation in the current game cycle, then it will be shown after the "Landing" screen. This screen has two states: With, and without an enemy present (see Figure 15). If the enemy of the current game cycle has not been defeated yet, the homepage will display a darker background, and the enemy will be shown in the middle of screen along its health point bar. There are three types of enemies, and they take turns to show up for each game cycle (see Figure 16). In the background, the count of the current game cycle is shown. On the bottom is the menu bar with three buttons. The information button allows the user to learn more
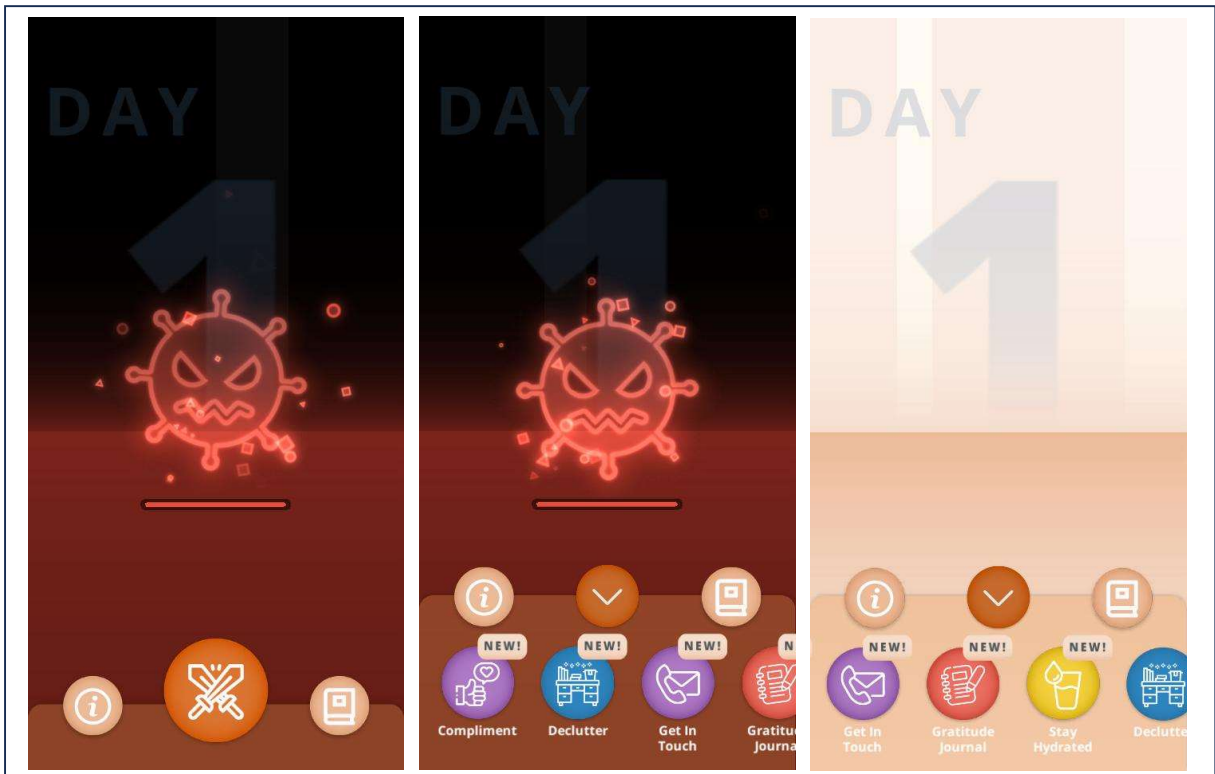
Figure 15: Three screenshots of the "Homepage" screen, showcasing the default state (left), the state when the activity button is pressed (middle), and the state when the enemy is defeated (right).

Figure 16: Two screenshots of the "Homepage" screen showcasing the alternate enemy colours.

about this application. The activity button lets the user to select and perform a self-care activity. The history button displays the achievements and progress of the user. The activity button is a

toggle button, a list of self-care activities will be displayed when the user presses it (see Figure 15). The activity list is sorted by whether it is available first, then it is sorted by the number of times that it has been performed in ascending ord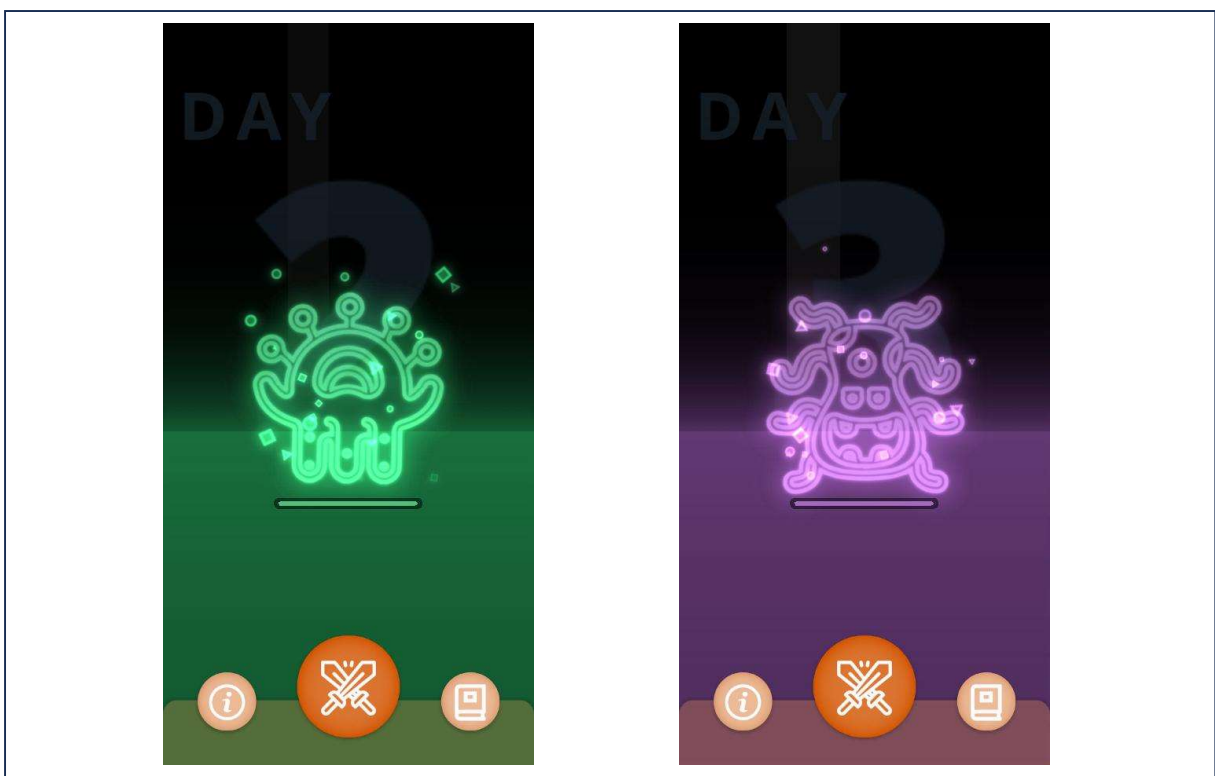er if the activity is available, or it is sorted by the number of in-game cycles required to unlock it if the activity is not available.

Activity

The "Activity" screen is where the users perform the different kinds of self-care activities, it is a dialog view that overlays on top of the current user interface. On this screen, the user is guided through the activity with several steps. In the first step, the information of that activity is shown, including its category, the estimated time to perform it, its attack power, the number of times that it has been performed. A short description of the activity will be shown as well. In the next steps, users will be able to answer simple questions by inputting text (see Figure 17), upload photos (see Figure 18) or watch videos (see Figure 19). The activity is completed when the user presses the "Finish" button in the last step. After that, the dialog window will close, a visual effect will pop up from the bottom of the screen that informs the user the completion of the activity, and the health point of enemy shown in the "Homepage" screen will deduct by an amount defined by the activity.
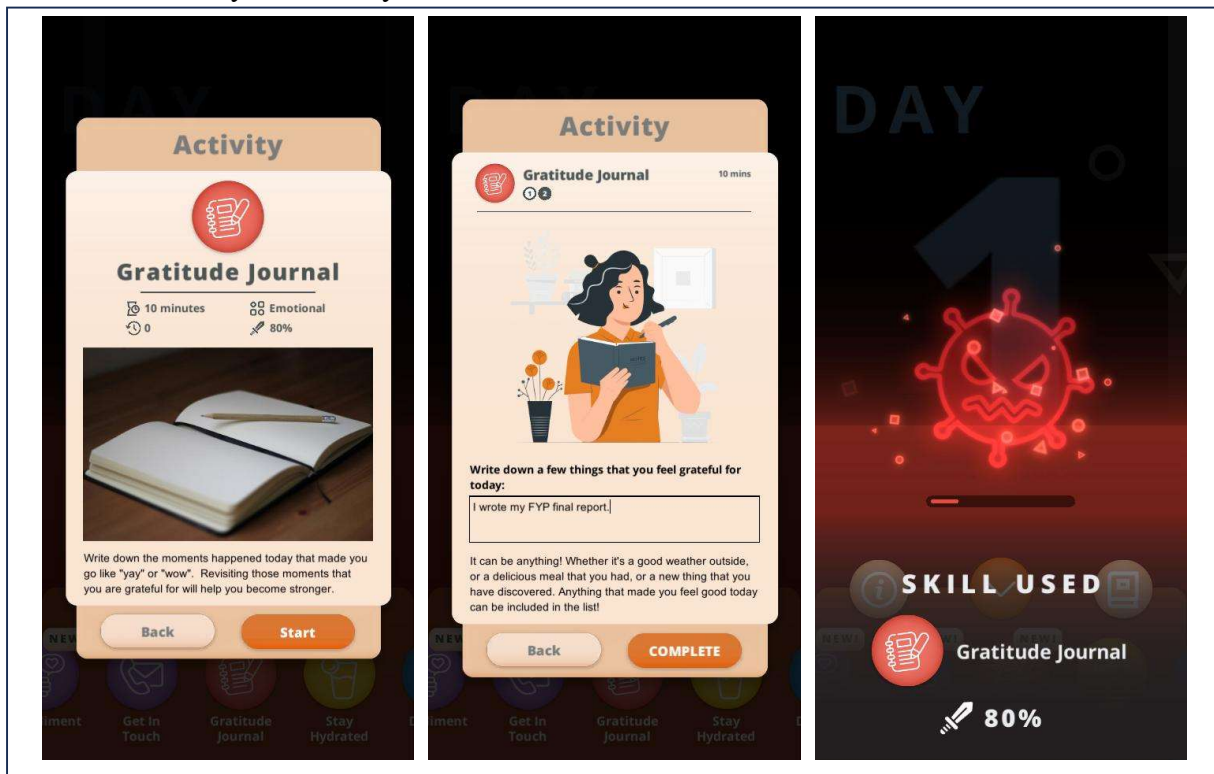
Figure 17: Three screenshots of the "Gratitude Journal Activity" screen. The order of the flow is from left to right. The user can input text in this activity.

Figure 18: Five screenshots of the "Declutter Activity" screen. The order of the flow is from left to right, then top to bottom. The user can upload photos in this activity.
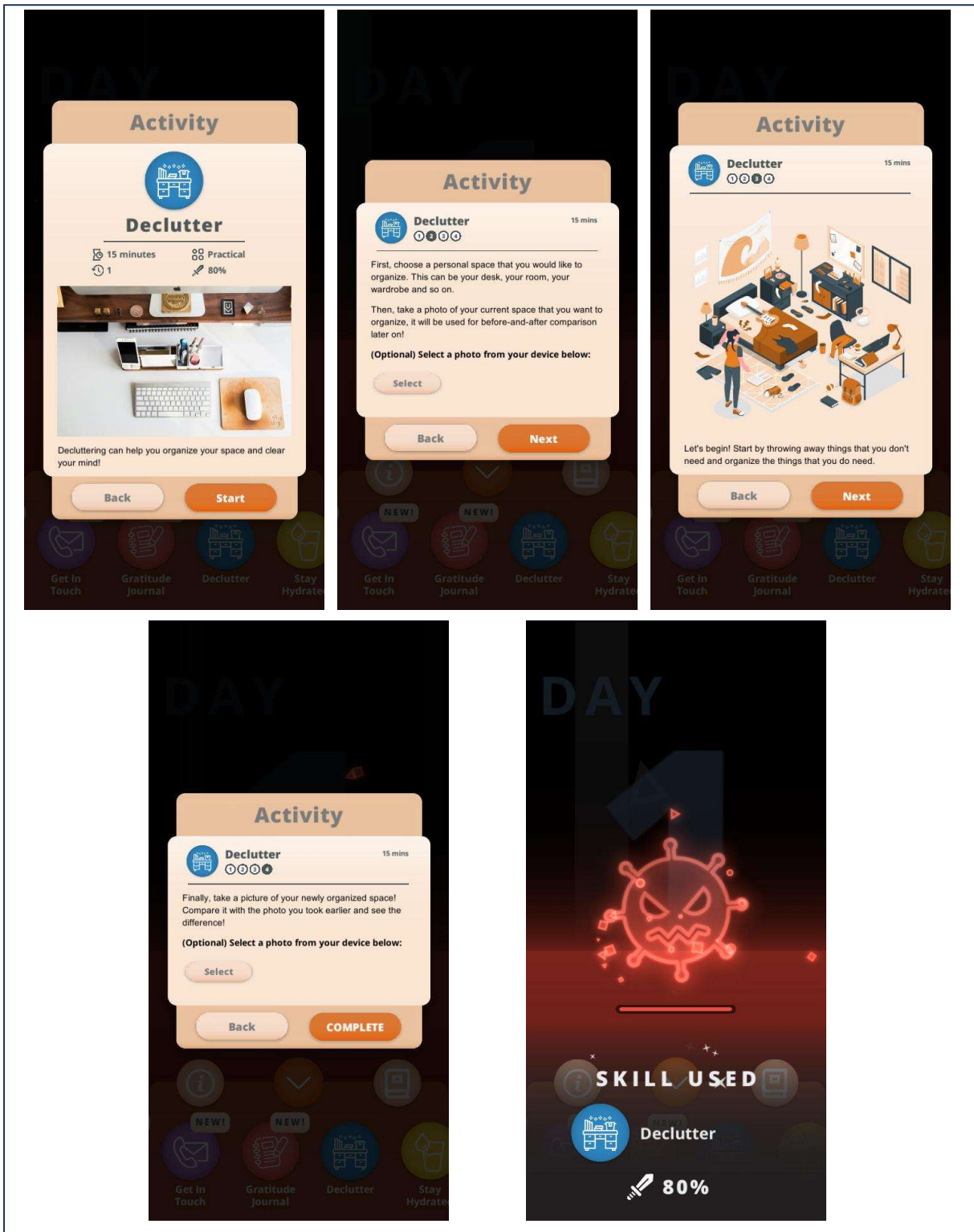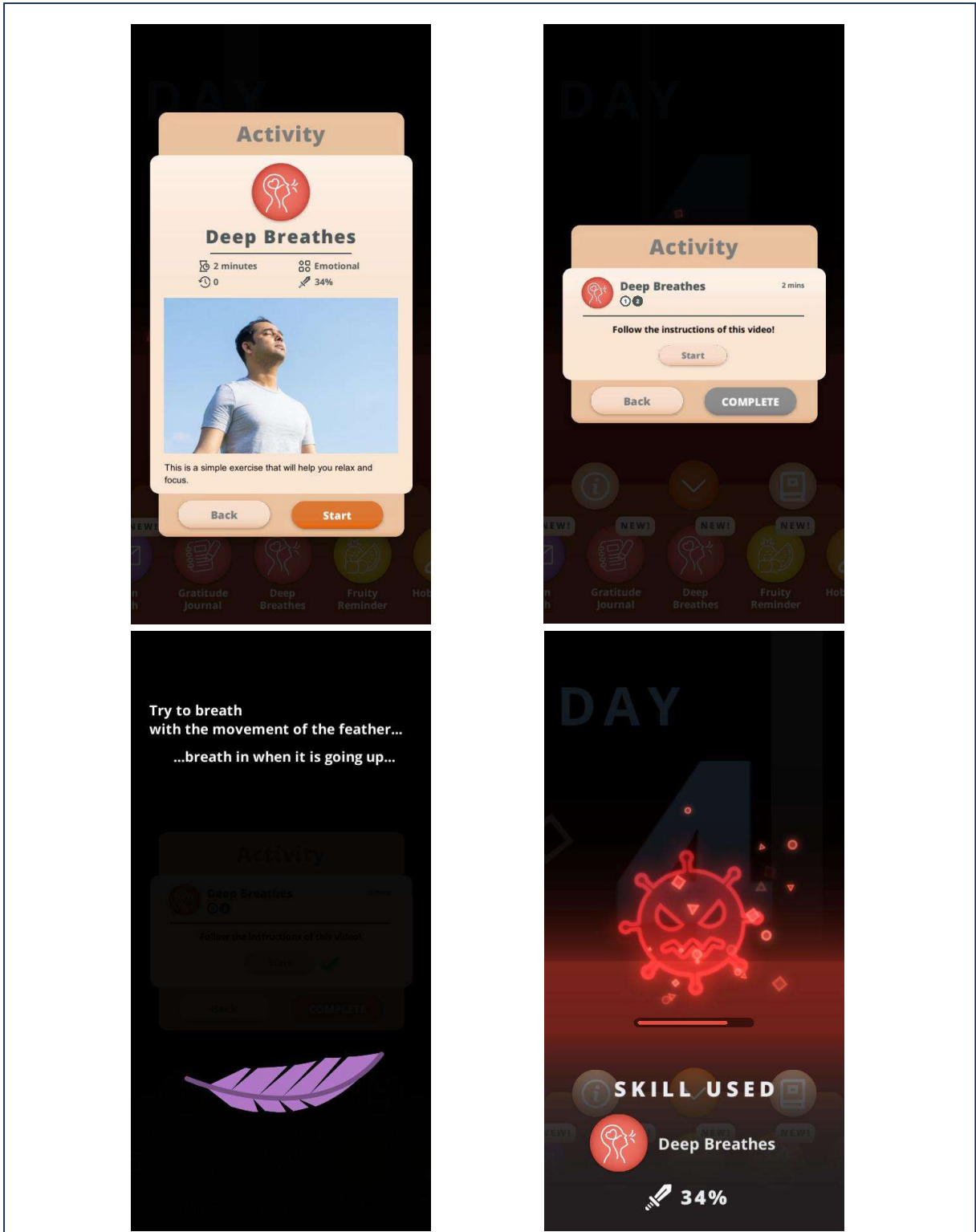
Figure 19: Five screenshots of the "Deep Breathes Activity" screen. The order of the flow is from left to right, then top to bottom. The user can watch a video in this activity.

Result

The "Result" screen is shown when an enemy is defeated (see Figure 20). On this screen, a list of activities that the user performed in this game cycle will be displayed. It will also show the list of activities that has become available in the next upcoming game cycle.
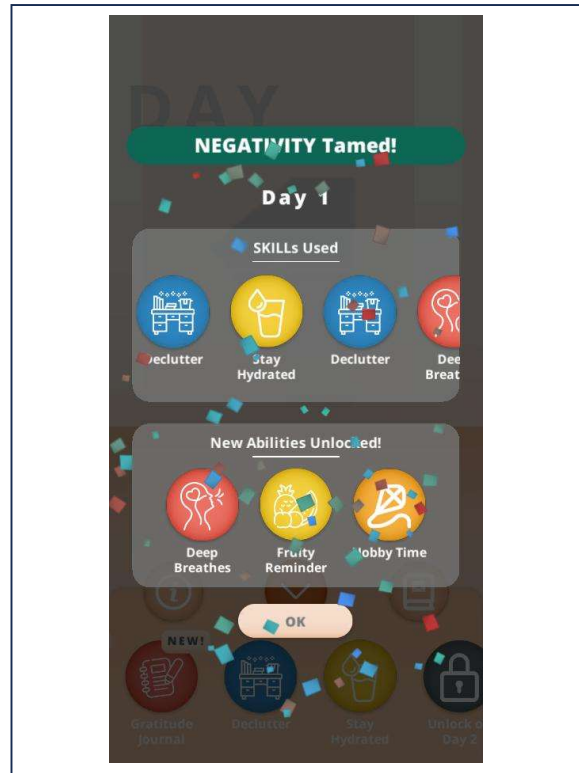
Figure 20: A screenshot of the "Result" screen.

History

The "History" screen is shown when the user presses the history button in the "Homepage" screen. This screen is a dialog window that shows the number of activities performed, the number of enemies defeated, as well as a list of activities that the user has performed in the past (see Figure 21). When the user select a past activity, the "Activity" screen will be displayed with the data that the user has inputted when that activity was performed. This "Activity" screen is not editable and is for viewing only.
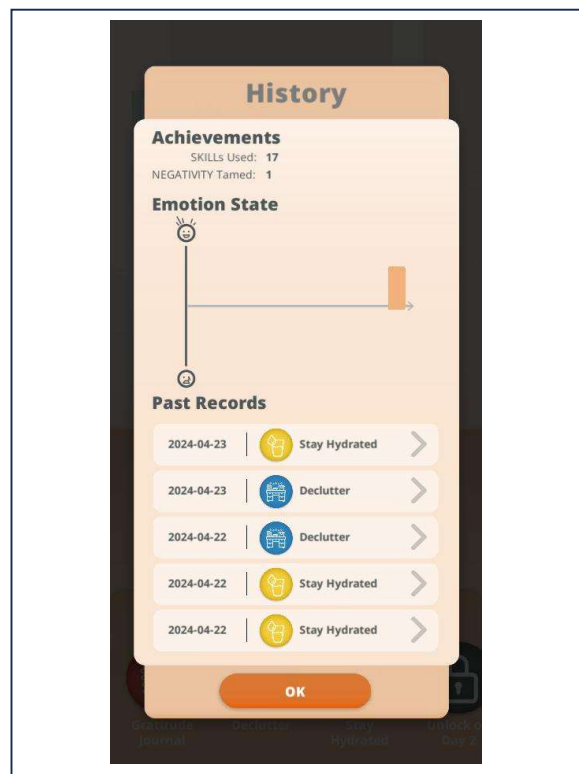
Figure 21: A screenshot of the "History" screen.

26

Information

The "Information" screen is shown when the user presses the information button in the "Homepage" screen. It is a dialog window that contains the same information that has been displayed on the "Introduction" screen (see Figure 22). The users can also see the privacy policy from this screen.

Tutorial

There are two "Tutorial" screens in this game (see Figure 23). The first one is shown when the user enters the "Homepage" screen for the first time, which informs the user on the basic mechanics of the game. The second "Tutorial" screen is shown when the user defeats an enemy for the first time, it tells the user that the enemy will show up once again the next day.
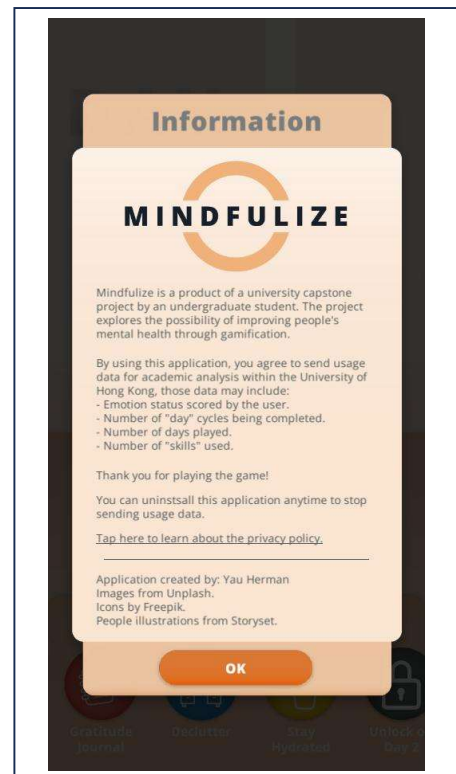
Figure 22: A screenshot of the "Information" screen.
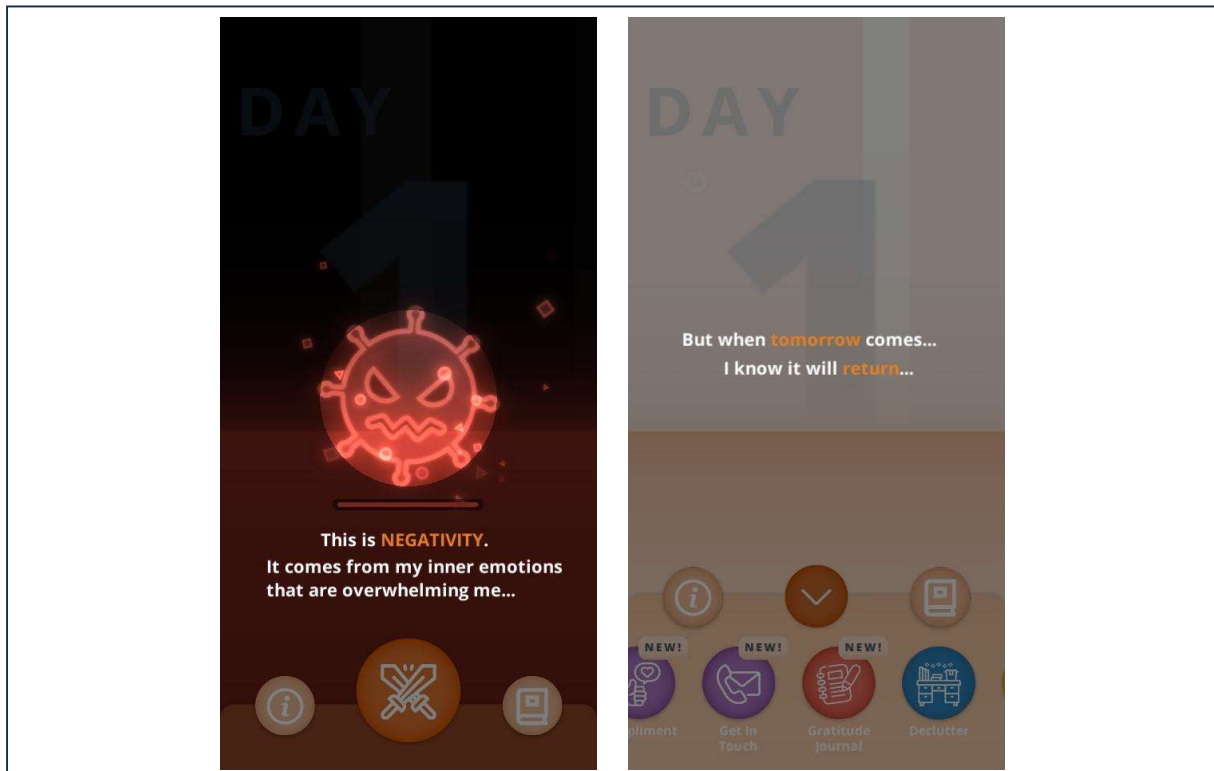
Figure 23: Two screenshots of the "Tutorial" screen. The left screen is shown when the user enters the "Homepage" screen for the first time. The right screen is shown when the user defeats an enemy for the first time.

End Game

"End Game" screen is shown when the user defeats an enemy on the seventh game cycle (see Figure 24). This is a dialog window that thanks the user for playing the game and inform them that no new content will be available after this point.
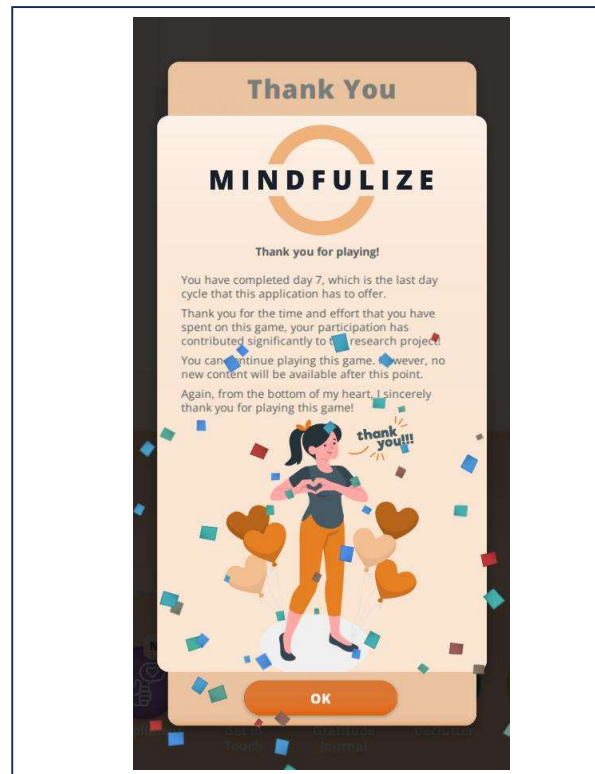
Figure 24: A screenshot of the "End Game" screen.

2.3   Evaluation Stage

During the last phase of the project, the application is released in a major distribution platform for the public to download. Then, usage data of the application are collected to evaluate the effectiveness in achieving the goals.

2.3.1   Application Publication

The application is published to major mobile application distribution platforms to allow the public to download and install the game. Two candidates have been chosen as the target platforms to publish the application due to their large audience and global availability: Google Play Store and Apple App Store (see Table 3). However, this project decided to discard the

Distribution Platform	Target Operating System	Cost	Selected for this Project?
Google Play Store	Android	One-off USD $25	Yes
Apple App Store	iOS	$99 USD / Year	No

Table 3: A comparison of the two mobile application distribution platform candidates for this project.

Apple App Store due to its high cost for application publishing, which has exceeded the budget for this project.

The application has been submitted to Google Play Store on 2nd April 2024.Google has approved the submission on 4th April 2024 and the application is published to a beta testing program. Then, the project recruited 33 testers to test application through an online discussion platform, Reddit, by inviting them to opt-in in this program. The application gained the permission to apply a deployment to the production environment of Google Play Store on 22nd April. However, other materials that have been published by this project have already contains web URLs to the application within the testing program. To ensure the access to the application is retained, the project chooses not to deploy to production.

To download the application, the public needs to first join a specific Google Group[1]. Then, they can download the application through the Google Play Store[2].

2.3.2 Data Collection

To collect usage data, the application will connect to the Unity Cloud analytics service. During the usage of the application, it will send custom events loaded with data to the analytics service (see Table 4 and Figure 25). Those data are then retrievable using SQL queries on the console of the service (see Figure 26).

Event Name	Description	Extra Data
Consent Given	The user has consented to sending usage data.	N/A
Emotion Scored	The user has given a score in the "Emotion Self-Evaluation" screen.	The score as integer.
Activity Completed	The user has completed a self-care activity.	The activity name as string and the current cycle number as integer.
Day Completed	The user has defeated the enemy of that day cycle.	The current cycle as integer.

Table 4: A table illustrating the data analytics custom events send to the Unity Analytics service.

---

[1] The Google Group can be accessed at: https://groups.google.com/g/mindfulize
[2] The Google Play Store page can be accessed at:
https://play.google.com/store/apps/details?id=hk.hku.yauherman.mindfulize
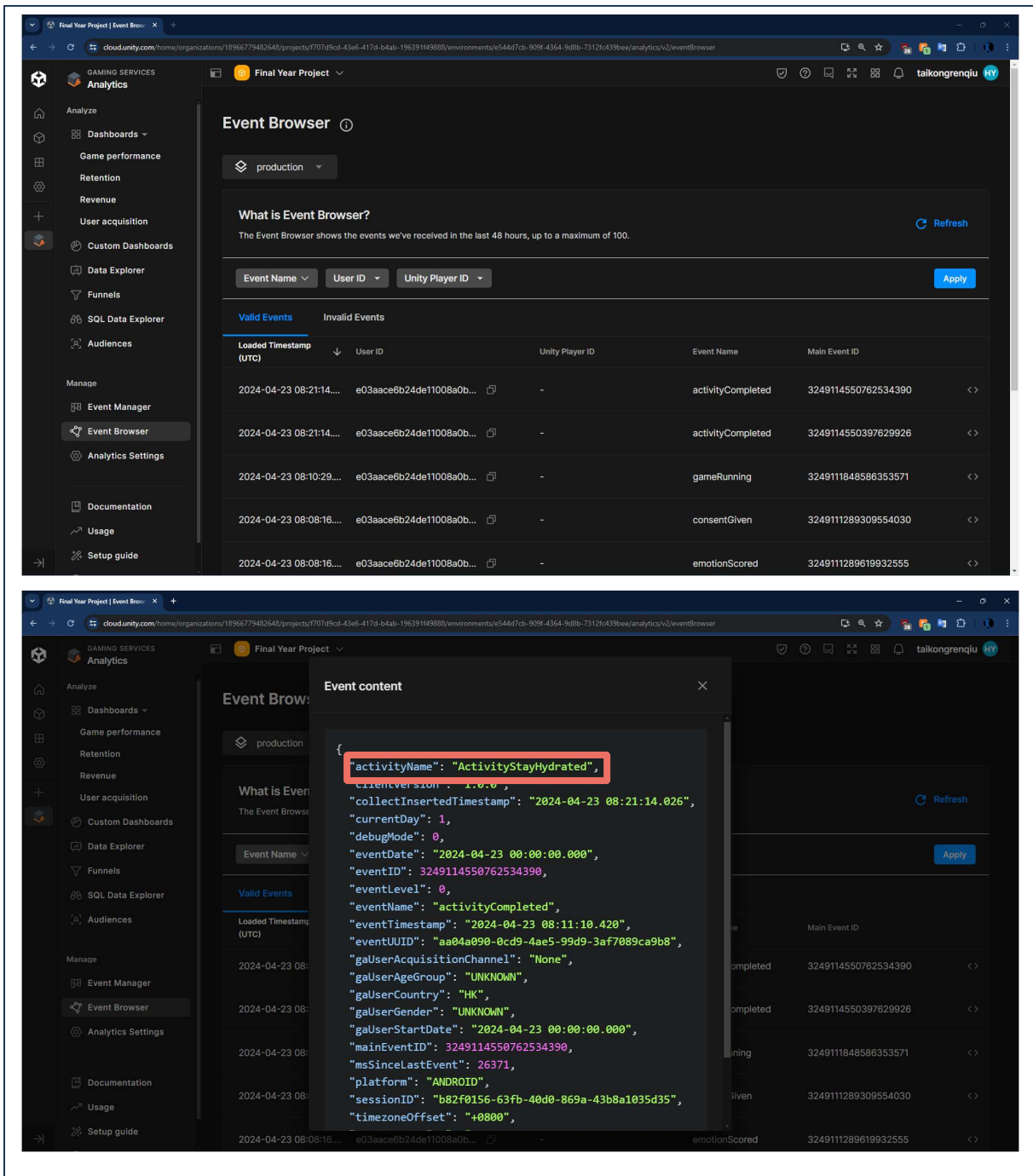
Figure 25: A sample of a custom event being sent to the Unity Cloud. The custom event can be browsed in the Unity Cloud console (top), it was equipped with a string type custom data as highlighted in the red rectangle (bottom).
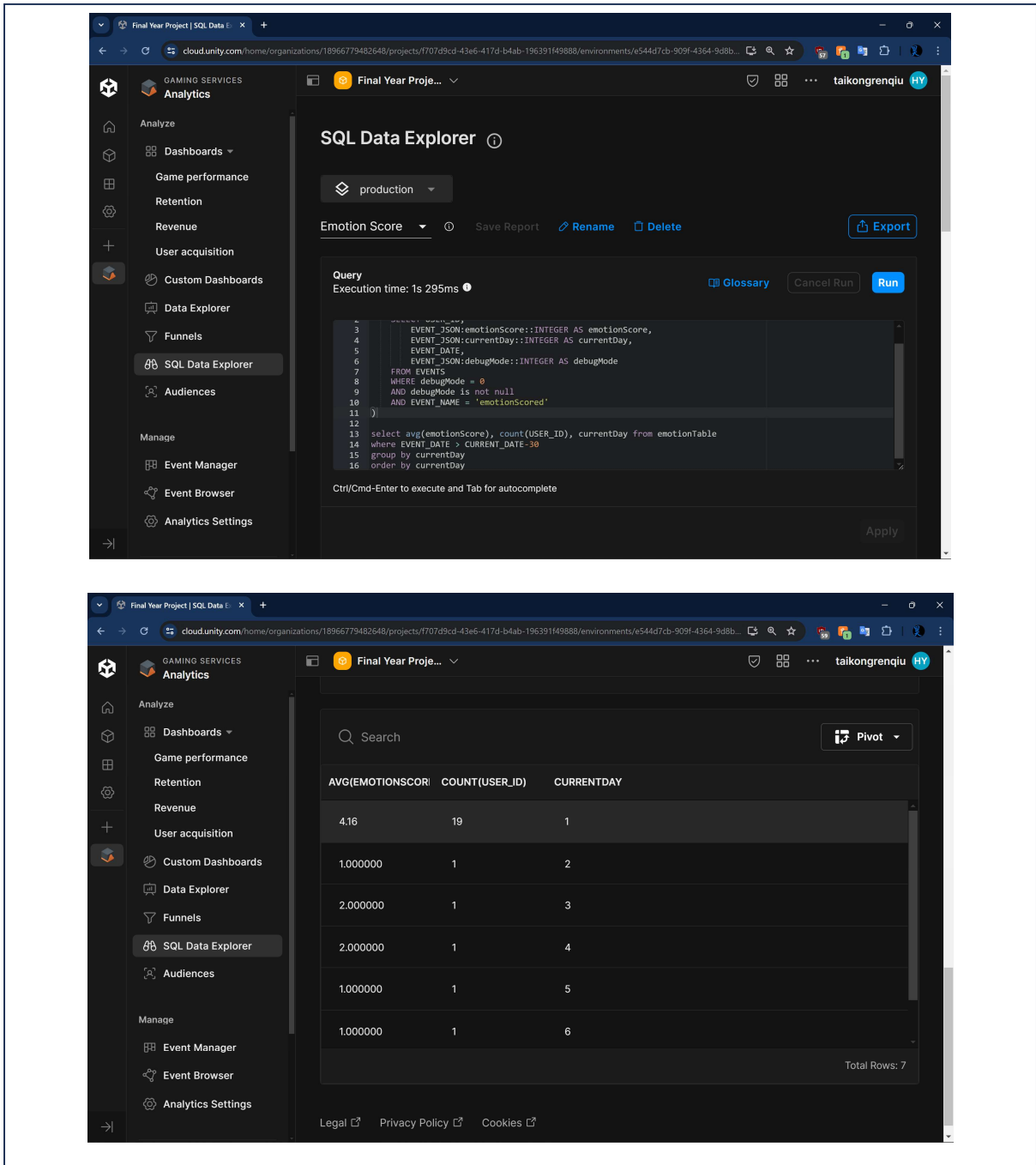
Figure 26: A screenshot of the console of Unity Cloud analytics service. An SQL query (top) was performed to retrieve data (bottom).

2.3.3 Data Analysis

Usage data will be analysed to determine the successfulness of the application in solving the problems mentioned in the previous sections of this report. Three major areas will be examined (see Table 5). First and most importantly, the project will look for any trend or fluctuation in

the users' emotions. More specifically, whether a change in users' level of happiness can be seen. Second, the project will examine user retention rate, which is the percentage of users who still use the application a certain number of days after install. Third, the application crash rate will be checked to ensure the stability of the program.

Key Metrics	Description	Relevant Data
User Emotion Scores	The trend of the emotion scores given by the user over the time of using this application.	• Emotion Score • Current Game Cycle Number • User ID
User Retention Rate	The number of users that continue using the game as time goes on.	• Current Game Cycle Number • User ID
Application Crash Rate	The amount of crash reports received from the clients.	• Application Crash Report Count

Table 5: A table illustrating three key metrics used to measure the effectiveness of the project.

3   Results

For this project, data comes from two sources. Section 3.1 will showcase the statistics provided by Unity Analytics, while section 3.2 will show the statistics that comes from the Google Play Store console. The data are collected on 25th April 2024.

3.1   Unity Analytics Statistics

Data collected from the Unity Analytics Service shows that 20 users have consented to data collection in the "Introduction" screen. The number of users who has given their emotion scores in the first game cycle is 19. However, this number drops to 1 in all the following cycles up till the seventh cycle, which is the last cycle that this game has designed (see Figure 27).

The number of users who completed the first cycle is 3. When compared to the number who consented to data collection and started playing the game, the retention rate of completing the first cycle is 15%. The number of users who completed the second cycle and onward is only 1, which translates into a retention rate of 3% (see Figure 27).

Number of Users over 7 In-game Cycles
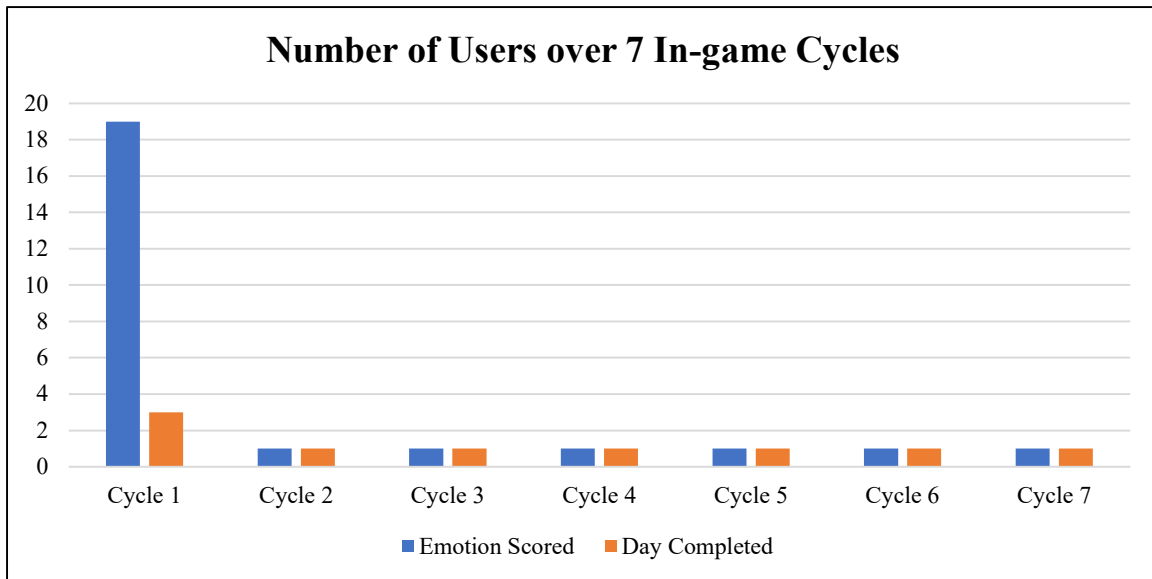
Figure 27: A graph showing the number of users who scored their emotion state (Emotion Scored) and completed the specific in-game cycle (Day Completed) over 7 in-game cycles.

The 7 emojis provided in the "Emotion Self-Evaluation" screen has been translated into a 7-point-scale from -3 to 3, where negative scores represent a negative emotion state and vice versa. The emotion scores provided by the users have shown that the score is 1.16 on the first cycle on average, then the score drops to the negative emotion state between -2 and -1 from cycle two to cycle six, before improving back to 1 in the last cycle (see Figure 28). However, due to the small sample size as shown previously, this project is unable to make any statistically accurate conclusion or determine whether the project is effective in improving users' mental health state.

Average Emotion Score over 7 In-game Cycles

Figure 28: A graph showing the average emotion score given by the users over 7 in-game cycles. The score is scaled from -3 to 3, where a negative score represents a negative emotion state and vice versa.

3.2   Play Store Console Statistics

Statistics from the Google Play Store Console has shown that there are 17 downloads in total. The download is lower than the user count because it excludes the number of testers at Google who installed the application to review the submission. Users come from different regions or countries, 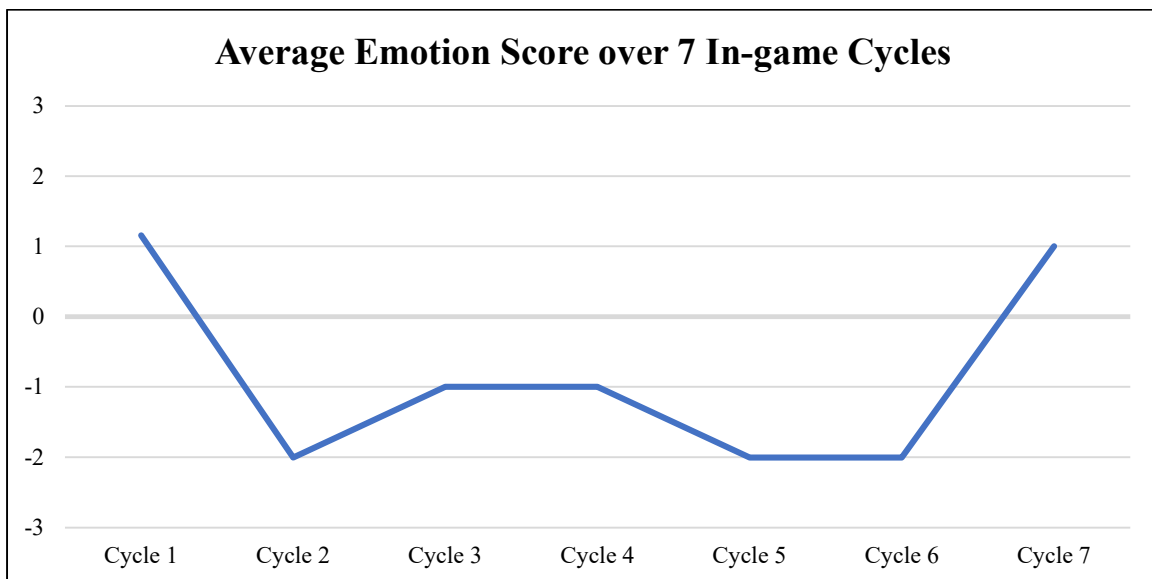4 users are from the United States, while Indonesia has 2 users. The rest of the users are scattered in different places such as New Zealand, Portugal, and Bulgaria. The number of crash reports received is 0, which shows that the program is in a very stable state and is able to provide its functionality reliably.

4   Discussion

While the project is unable to draw any conclusions from the data being collected, it has recognized some limitations that future may improve on. Section 4.1 will explain how the evaluation phase and the societal impact of the project is being limited to the user base size. And in section 4.2, the inaccuracy of mental self-evaluation will be explained. Then, section 4.3 will highlight how the rapid change in the technology environment has made an impact to the project's development. Finally, section 4.4 will emphasize how this project has demonstrated the use of digital games as a tool for data collection in academic research.

4.1   Evaluation is Dependent on User Base Size

The current sample size is not big enough to conduct a valid data analysis. The low sample size has two potential causes. First, the application is limited to the Google's testing program, therefore the sample is biased towards the people whose intention is to test the application only, and not to improve their mental health. Second, it is difficult to have a successful launch in the mobile application market. The market for mobile application is highly saturated, the number of app downloads in 2022 for the google play store is around 110 billion [33], but there are also around 2.69 billion apps in the store at the end of 2022 [34], which means the average download count for each app per year is merely around 40.9.

While this project may potentially improve individuals' health, the scale of change that this project can bring to the society is highly dependent on the size of the user base of the application.

The larger the user base, the more people can be potentially benefitted from this project, and the more accurate the evaluation process is for the project. However, due to limited resources and time, the promotion of this project's product has been excluded from the scope of the project.

4.2   Discrepancies between Self and Profession Evaluation

To determine whether the project is effective in improving people's mental state, the evaluation of the project relies on the emotion scores given by the users, which might not reflect their true emotion state. Studies have shown that there is a discrepancy between self and professional evaluation of an individual's mental state [35], such discrepancy is predictable from that individual's personality traits. Professional evaluation is conducted by mental health professionals who are trained to maintain objectivity and use standardized assessment tools and clinical knowledge to minimize the influence of personal biases, while self-evaluation can be affected by personal biases, desires, fears, and other influences. Therefore, the user might give an inaccurate score for their current emotional state.

However, professional evaluation is also limited to its inaccessibility and high cost. The project aims to look for a change in user's emotion state, which can still be observed from user's self-evaluation. Despite its inaccuracy, users are more likely to give a higher emotion score if they find improvements because emotion score is measuring a subjective change in their mindset, which can be easily identifiable. While the lack of objectivity will disrupt the consistency of scores across different users, the changes in the emotional state can still be observed and therefore it is still more preferrable for this project.

4.3   Rapid Change in Development Environment

Rapid changes in the development environment have posed challenges for this project. Google updated its app publishment policy for Play Store in November 2023 and requires app developers to recruit 20 testers and conduct a closed testing for 14 days as a requirement for applying the deployment of the application in the production environment [36]. However, the project did not acknowledge this change until April, which causes the project to conduct the evaluation process within the testing program only, and resulted in a small and biased sample

size as discussed in the previous section. An earlier detection in the change could result in more options of mitigations and potentially lessen its impact on the project.

To cope with the frequently changes in guidelines and new features of these distribution platforms, app developers should keep a close eye on the market trends to ensure the product remains relevant by adopting agile methodologies and invest in continuous learning and training.

4.4   Digital Game as a tool for Data Collection

While this project is inconclusive to whether mobile games can improve people's mental health, the game has however demonstrated a unique medium for data collection for academic use. There are several advantages of using digital games for data collection.

First, digital games allow researchers to collect behavioural data at a lower cost. Games can present situations to users where they must make decisions and solve problems, and those interactions can be logged and analysed to understand the decision-making processes, strategy development and problem-solving skills. The cost of replicating this using other mediums is higher, as it often requires researchers to conduct face-to-face experiments under a controlled environment.

Second, social dynamics and team behaviours can be analysed. Many modern games now feature cooperative or competitive multiplayer aspects that require players to interact with others socially to achieve some goals. By analysing those interactions, researchers can study social behaviours, leadership roles, group decision making, and conflict resolution.

Third, games allow researchers to create a controlled experimental environment. As a digital medium, games can replicate environment there is consistent across participants, which can greatly enhance the reliability and the validity of the experiment. Researchers can also modify the game environments to study how changes in variables can affect an individual's behaviour. This can be especially useful in psychological and social research.

Finally, games naturally engage players through their rewarding nature. This can motivate participants to perform well and reduce the drop-off rates common in traditional research methods like surveys or lab-based tasks.

This project has demonstrated the use of digital games as a versatile tool for collecting data by examining at the change in users' emotion state, so that the scale of the impact of the mental health information and self-care guidance provided by the application can be measured. By utilizing digital games, research can benefit from high engagement and precise measurement of participant across cognitive, behavioural, and social spectrums. As technology advances, the potential for digital games as a medium is likely to increase even further.

5 Conclusion

Mental health of children and adolescences is one of the major challenges to be solved in the world. The increasing number of people suffering from poor mental health condition is sounding an alarm for an accessible, affordable, and effective solution.

This report has proposed a mobile game application to tackle such issue. This application aims at helping youths to incorporate self-care into their daily routine through gamification. The application has been implemented through the process of product design, development, and evaluation. The product has been published to a major mobile application distribution platform and with usage data successfully collected using a third-party cloud service. However, the sample size of the results is too small for the project to make any valid observations. The project has recognized its shortcomings, including the dependency on the popularity of the application and potential inaccuracy of the emotional state measurement.

The promotion of the game to the public could be a potential future work upon the completion of this project to increase its impact. The data analysis from the application may also provide insights into the routine and mental state of youths, allowing other potential solutions to be developed. Other psychological research may also take advantage of the use of digital games as a tool for data collection as demonstrated in this project, which could result in a higher engagement rate and a more comprehensive analysis. It is hoped that this project can contribute to solving the challenge with early intervention and prevention through the promotion of self-care, so that more people can live healthy in a society with a better future.

References

[1] World Health Organization, "World mental health report. Transforming mental health for all," Geneva: World Health Organization, 2022.

[2] GBD Results Tool. Global Health Data Exchange (n.d.). Seattle: Institute for Health Metrics and Evaluation [Online]. Available: https://ghdx.healthdata.org/gbd-results-tool?params=gbd-api-2019-permalink/2537ec0fb3bbbf9114a868394976128b, [Accessed: 25 March 2022].

[3] GBD Results Tool. Global Health Data Exchange (n.d.). Seattle: Institute for Health Metrics and Evaluation [Online]. Available: http://ghdx.healthdata.org/gbd-results-tool?params=gbd-api-2019-permalink/5066348dc958b095cb6ceb4bfd9c3e07, [Accessed: 25 March 2022].

[4] Food and Health Bureau, Hong Kong Special Administrative Region Government, "Mental Health Review Report," Food and Health Bureau, Hong Kong Special Administrative Region Government, April 2017.

[5] Chesney E, Goodwin GM, and Fazel S, "Risks of all-cause and suicide mortality in mental disorders: a meta-review," World Psychiatry, 2014.

[6] Global Health Estimates 2019: Deaths by cause, age, sex, by country and by region. (2000–2019). Geneva: World Health Organization [Online]. Available: https://www.who.int/docs/default-source/gho-documents/globalhealth-estimates/ghe2019_deaths-2000-country1d20517f-89e3-4787-b639-26acbda9b8f8.xlsx?sfvrsn=51458b03_7 [Accessed: 25 March 2022].

[7] Global Health Estimates 2019: Deaths by cause, age, sex, by country and by region. (2000–2019). Geneva: World Health Organization [Online]. Available: https://www.who.int/data/gho/data/themes/mortality-and-globalhealth-estimates/ghe-leading-causes-of-death [Accessed: 25 March 2022].

[8] HKU HKJC Centre for Suicide Research and Prevention. (2023). Statistics of Suicide Data in Hong Kong (By Year) [Online]. Available: https://csrp.hku.hk/statistics/ [Accessed: 21 January 2024].

[9] Bloom DE, Cafiero ET, Jané-Llopis E, Abrahams-Gessel S, Bloom LR, Fathima S, et al. (2011). The global economic burden of noncommunicable diseases. Geneva: World Economic Forum [Online]. Available: http://www3.weforum.org/docs/WEF_Harvard_HE_GlobalEconomicBurdenNonCommunicableDiseases_2011.pdf [Accessed 25 March 2022].

[10] rthk.hk News. (2024. Jan. 03). Thousands of HK kids attempting suicide: govt survey [Online]. Available: https://gbcode.rthk.hk/TuniS/news.rthk.hk/rthk/en/component/k2/1734775-20240103.htm [Accessed: 21 January 2024].

[11] Eisenberg D, Downs MF, Golberstein E, and Zivin K, "Stigma and help seeking for mental health among college students," Med. Care Res, 2009.

[12] Eisenberg D, Gollust SE, Golberstein E, and Hefner JL, "Prevalence and correlates of depression, anxiety, and suicidality among university students," Am J Orthopsychiatry, 2007.

[13] Funk M, Drew N, Freeman M, and Faydi E. (2010). Mental health and development: targeting people with mental health conditions as a vulnerable group. Geneva: World Health Organization [Online]. Available: https://www.who.int/publications/i/item/9789241563949 [Accessed: 25 March 2022].

[14] Gaebel, W, and A Kerst. "The debate about renaming schizophrenia: a new name would not resolve the stigma." Epidemiology and psychiatric sciences vol. 28,3, 2019.

[15] Lam, L. C., Wong, C. S., Wang, M. J., Chan, W. C., Chen, E. Y., Ng, R. M., Hung, S. F., Cheung, E. F., Sham, P. C., Chiu, H. F., Lam, M., Chang, W. C., Lee, E. H., Chiang, T. P., Lau, J. T., van Os, J., Lewis, G., and Bebbington, P, "Prevalence, psychosocial correlates and service utilization of depressive and anxiety disorders in Hong Kong," HKMMS, Social psychiatry and psychiatric epidemiology, 2015.

[16] Wong VT, "Recruitment and training of psychiatrists in Hong Kong: what puts medical students off psychiatry--an international experience," Int Rev Psychiatry, 2013.

[17] Waiting Time for New Case Booking at Psychiatry Specialist Out-patient Clinics. (n.d.) Hong Kong Hospital Authority. [Online]. Available: https://www.ha.org.hk/visitor/sopc_waiting_time.asp?id=7&lang=ENG [Accessed: 1 October 2023]

[18] Maple Tree Counselling. (n.d.) Frequently asked questions [Online]. Available: https://www.mapletreecounselling.com/faqs/ [Accessed: 21 January 2024].

[19] The Ultimate Guide to Psychiatrists in Hong Kong. (n.d.) Healthy Matters. [Online]. Available: https://www.healthymatters.com.hk/the-ultimate-guide-to-psychiatrists-in-hong-kong/ [Accessed: 1 October 2023]

[20] Kane JM, Robinson DG, Schooler NR, et al, "Comprehensive Versus Usual Community Care for First-Episode Psychosis: 2-Year Outcomes From the NIMH RAISE Early Treatment Program," Am J Psychiatry, 2016.

[21] Kessler R, Berglund P, Demler O, Jin R, Merikangas K, "Lifetime prevalence and age-of-onset distributions of DSM-IV disorders in the National Comorbidity Survey replication," Arch Gen Psychiatry, 2005.

[22] Wellcome Global Monitor 2020: Mental health. (2021). London: Wellcome Trust. [Online]. Available: https://wellcome.org/reports/wellcome-global-monitormental-health/2020 [Accessed: 25 March 2022]

[23] Cuijpers P, Donker T, van Straten A, Li J, and Andersson G, "Is guided self-help as effective as face-to-face psychotherapy for depression and anxiety disorders? A systematic review and meta-analysis of comparative outcome studies," Psychol Med. 2, 2010.

[24] Mun, Sujeong et al. "Self-care use patterns in the UK, US, Australia, and Japan: a multinational web-based survey." Integrative medicine research vol. 5,2, 2016.

[25] Granic, Isabela, Adam Lobel, and Rutger CME Engels. "The benefits of playing video games." American psychologist 69.1, 2014.

[26] Omocat. (n.d.) Omori. [Online]. Available: https://www.omori-game.com/en [Accessed: 21 January 2024].

[27] Nintendo. (2020) Ring Fit Adventure [Online]. Available: https://ringfitadventure.nintendo.com/ [Accessed: 21 January 2024].

[28] Kahoot!. (2024) Kahoot! [Online]. Available: https://kahoot.com/ [Accessed: 21 January 2024].

[29] Tom Wijman. (8 May 2020). The World's 2.7 Billion Gamers Will Spend $159.3 Billion on Games in 2020; The Market Will Surpass $200 Billion by 2023. [Online]. Available:

https://newzoo.com/resources/blog/newzoo-games-market-numbers-revenues-and-audience-2020-2023 [Accessed: 1 October 2023]

[30] Lenhart, Amanda, et al, "Teens, Video Games, and Civics: Teens' Gaming Experiences Are Diverse and Include Significant Social Interaction and Civic Engagement," Pew internet & American life project, 2008.

[31] Darvesh, Nazia, et al. "Exploring the prevalence of gaming disorder and Internet gaming disorder: A rapid scoping review." Systematic reviews 9, 2010.

[32] D Griffiths, Mark, Daria J Kuss, and Daniel L King. "Video game addiction: Past, present and future." Current Psychiatry Reviews 8.4, 2012.

[33] Laura Ceci. Annual number of app downloads from the Google Play Store worldwide from 2016 to 2022 [Online]. Available: https://www.statista.com/statistics/734332/google-play-app-installs-per-year/ [Accessed: 21 January 2024].

[34] Laura Ceci. Number of available applications in the Google Play Store from December 2009 to December 2023 [Online]. Available: https://www.statista.com/statistics/266210/number-of-available-applications-in-the-google-play-store/ [Accessed: 21 January 2024].

[35] Enns, Murray W., Derrick K. Larsen, and Brian J. Cox. "Discrepancies between self and observer ratings of depression: the relationship to demographic, clinical and personality variables." Journal of affective disorders 60, no. 1, 2000.

[36] Google. (2023) App testing requirements for new personal developer accounts [Online]. Available: https://support.google.com/googleplay/android-developer/answer/14151465?hl=en [Accessed: 26 April 2024].