

Chapter 1

Introduction

1.1 Motivation

According to the NHS, cognitive behavioural therapy (CBT) is a psychological talking therapy which helps patients to manage problems by changing the way they think and act (2). It is one of the most popular types of therapy and can be extremely effective for alleviating symptoms of mental health issues such as anxiety and depression (31; 24). During CBT, patients learn techniques to identify and manage unhelpful emotions, thoughts and behaviours, often using pen and paper workbooks to complete activities to practice these techniques (16). Ideally this is done with the guidance of licensed professionals, however due to a multitude of reasons patients may also be using these workbooks and exercises as part of self-help to teach themselves beneficial techniques.

However, using pen and paper workbooks can present challenges for users, for example they may be inconvenient to regularly fill in and be unengaging. This can lead to a decrease in motivation to complete the workbooks and practise applying the techniques, a risk that can be exacerbated by the fact that a lack of motivation is a common symptom of mental health issues (27). This project aims to alleviate these risks by creating a mobile application which will adapt CBT exercises to a more convenient and engaging mobile form.

1.2 Goals

- The app will guide users in applying self-help strategies based on CBT exercises to situations in their everyday lives. Therefore, the app must clearly and effectively teach these exercises to users.
- Motivational features will be present in the app to encourage users to complete exercises regularly over a longer period of time.
- The unique features of mobile devices should be utilised such that, when compared to pen and paper CBT activity sheets, using the mobile app should provide users with an easier and more convenient experience.

1.3 Scope

- I will not be discussing the validity or effectiveness of the CBT techniques themselves.
- The app will focus on effectively adapting self-help worksheet exercises rather than trying to adapt as many as possible.
- The app is not intended as a replacement for therapy, it is a tool to help users apply CBT exercises to their lives to help them cope with problems. Ideally, CBT techniques would be used in conjunction with professionally administered therapy.

Chapter 2

Background

2.1 Overview of CBT

Cognitive behavioural therapy (CBT) is a type of therapeutic treatment that aims to help patients improve their mood by identifying, understanding and altering unhelpful thought patterns (22; 24). According to the NHS (2), it is one of the most popular treatments for alleviating symptoms of mental illnesses and is highly recommended for those suffering from low mood, anxiety and other mild symptoms of mental illness. Among other factors, this is due to its effectiveness for alleviating symptoms and providing an increased quality of life to patients. CBT has been extensively studied over the years and there are many papers and studies which corroborate this (31; 11; 5).

A core concept of CBT is that those suffering from low mood and mental health issues hold distorted thoughts and beliefs which influence their moods and behaviours (24), with treatment focusing on helping patients to identify and challenge these thoughts (16). Additionally, behaviours also influence moods and thoughts so another focus is encouraging patients to engage in more helpful and positive behaviours (16). CBT can be delivered in a variety of formats, from in-person sessions with a therapist to self-help, with patients commonly receiving exercise worksheets to help them apply CBT techniques to their everyday life. While all these formats have been shown to improve symptoms of depression in patients compared to no treatment, self-help without the involvement of a therapist was found to be less effective than with a therapist (10), therefore it can be concluded that the presence of a professional during the treatment process increases the effectiveness and acceptability of CBT.

2.2 Barriers To Accessing CBT

However, it is not always possible for someone suffering from mental health issues to be able to receive regular support from a therapist. Mental health issues are highly prevalent globally, with studies estimating that at any time approximately 20% of adults over 16 meet criteria for common mental disorders (30). Furthermore, this number has been increasing in recent years according to government studies, potentially exacerbated by the Coronavirus pandemic (6). With demand for therapy skyrocketing and a rising vacancy rate of medical professionals working in mental health services in the UK (4), individuals may find themselves waiting up to 79 days for treatment (7).

At the same time there are barriers that might prevent someone from seeking professional help in the first place. A survey found that 35% of young adults (18-25) who reported difficulties with their mental health did not seek help, citing concerns such as the stigma surrounding mental health, with over 80% of participants feeling discouraged to seek help due to shame and embarrassment (26), a disproportionately common concern in ethnic minority communities (20). Additionally, there is a negative perception among young people of consulting a GP for mental health issues, with fears that they would not be taken seriously being common (8). Seeking help is not always easy, and there are many people who receive no support for their mental health issues.

2.3 Mobile Applications For CBT Self-Help

A mobile application that guides users through CBT exercises could be a solution to the barriers preventing access to support. Due to the high usage rate of mobile phones it would be able to reach a wide range of people and be an easy and inexpensive solution that people experiencing stigma would be able to access without shame. Self-help intervention without guidance from therapists, although less effective than when used with guidance from therapists, is still much better for patients than no intervention at all (5). Therefore a mobile app to teach users CBT techniques, and encourage them to seek additional support from professionals if needed, would be a good solution as a first step towards recovery.

However, a significant factor which affects the extent to which CBT is effective is the motivation and engagement of patients. The client's active role in therapy and willingness to engage and enact change in their lives is crucial for positive outcomes (14). Self-guided therapy has been shown to struggle with engagement rates, with one online CBT study

reporting that only 14% of patients completed all the provided sessions (15). This low engagement is a limiting factor in how effective mobile applications for CBT can be, therefore it is crucial that the mobile application is designed with features to encourage user engagement.

2.4 The Psychology of Motivation

To understand what drives engagement, research was conducted into self determination theory, a physiological framework used to describe motivation. The theory proposes that motivation is connected to 3 basic needs: competence, autonomy and relatedness (25). Respectively, these refer to the needs to feel effective, in control of one's actions and understood by others. For mobile apps, motivational features should be designed around fulfilling these needs, for example the ability to set notifications to encourage healthy behaviour fulfils the need for autonomy by helping the user to decide, and follow through on, desirable actions (32).

Another important aspect to consider is the difference between intrinsic and extrinsic motivation. Intrinsic motivation refers to when a person is motivated to engage in an activity due to finding it inherently rewarding, while extrinsic motivation is motivation that comes from an external reward or outcome (25). In the long term, intrinsic motivation leads to more sustainable engagement, however those suffering from depression and other mental illnesses often have difficulties motivating themselves (27). Therefore, a reasonable approach would be to find ways of facilitating both intrinsic and extrinsic motivation, guided by the 3 needs mentioned previously.

2.5 Case Studies

As part of my research, I examined existing CBT mobile apps on the market. I downloaded 5 apps with the keyword 'cognitive behavioural therapy' and examined what kinds of CBT exercises were implemented, of which I was able to identify 5 that seemed relatively popular. I also investigated features encouraging mindfulness (a technique that encourages being focused on the present without judgement) which, although not part of CBT, is a popular feature for mental health apps to have (29). Additionally, I examined what engagement or motivational features, if any, were present and evaluated whether features of mobile phones had been utilised to provide the user with a different experience

compared to writing in a pen-and-paper workbook. The results of my investigation can be found in Figure 2.1.

Existing apps seem to already cover a good range of therapeutic features, with exercises for recording moods and challenging thoughts being present in all the investigated apps. However, the way the exercises were adapted meant there was largely not a lot of difference between writing in an app and writing on a worksheet besides the convenience of always having the app on hand, likely due to the way the exercises themselves work. Features like linking to other resources and playing media can help to provide a better user experience without changing the fundamental CBT exercises.

I found that motivational features were generally lacking, with 3 out of 5 apps not containing any at all. Of the 2 that did, MindShift featured a forum where users could submit and reply to posts, and CBT Tools for Healthy Living featured a system where users could earn points by completing activities such as writing diary entries or tracking their mood. However, there was nothing to use the points on so the only motivation to earn more points was to watch the number increase, which I found became boring quickly.

| | Setting goals | Recording moods | Decatastrophising | Identifying situations, moods, thoughts | Challenging automatic thoughts | Mindfulness | Other therapeutic features | Engagement features | Usage of phone features |
|-------------------------------------|---|-------------------------------|---|---|--|--|---|---|---|
| CBT Companion | | Diary, setting daily emotions | What if' exercise and thinking of possible solutions | Write down situation, thoughts, core beliefs etc. | Write down thought and more balanced thought | Guided breathing exercises | Guided lessons with information about CBT | | Very little, mostly focused on prompting users to write thoughts |
| Mindshift | Setting goals with notifications | Daily mood and journalling | Identifying fears and brainstorming steps to overcome | | Schedule an experiment to test thought | Guided breathing and muscle exercises with audio | | Community forum (social) | Phone numbers for further support which open in phone app, notifications |
| What's Up | Setting goals with notifications | Diary with mood rating | Information about managing worry | | Information about cognitive distortions | Information about breathing exercises | | | Little, not a lot of engagement encouraged, mostly information pages, notifications |
| My Possible Self | Add enjoyable activities and set goal date (no reminders) | Journal with mood rating | | Write down situation, physical symptoms, moods, beliefs | Choose cognitive distortions for a thought, enter reframed thought | Breathing exercise videos | Podcasts and articles by therapists on various topics | | Links to phone numbers and websites with further support, media such as videos |
| CBT Tools for Healthy Living | Set goals (no reminders) | Diary with mood selection | | Listing thoughts and emotions | Prompt to write a challenge to a thought | | Tests to assess mental state | Points measuring how much you have used the app | Points every time you use the app, leading to feelings of achievement |

FIGURE 2.1: Results of investigation into existing CBT mobile apps.

Chapter 3

Design

3.1 Stakeholder Analysis

The primary stakeholder for my app will be users who are looking to improve their mental health by completing CBT exercises. They may have a range of symptoms and will have different levels of motivation. In order to make the app more generalised I will mainly target users with symptoms of anxiety and depression, the most common mental illnesses worldwide (19). Additionally, I will be aiming for an age range of 18-25 because adults between these ages are the most likely to develop mental health issues but the least likely to seek support (21), meaning there is increased potential for a mobile application. Users will be directly interacting with the app and providing inputs into the system.

The secondary stakeholders are healthcare professionals and therapists who work with users of the app. They will be motivated to understand more about patients and their issues in order to provide the best treatment. Healthcare professionals will be interacting with saved completed CBT exercises, the outputs of the app.

3.2 User Personas

To better understand and empathise with the needs of the target users, the following personas for primary stakeholders were created:

Name: Emily

Age: 19

Occupation: Student

Background: Emily is a first-generation university student who puts great pressure on herself to succeed. Her family has high expectations for her, and when she underperforms she experiences low mood and feelings of worthlessness. Due to cultural reasons, she is embarrassed to speak to a therapist and does not want anyone to know she is struggling.

Needs:

- Easy-to-follow CBT exercises to challenge negative thoughts and increase self-confidence.
- A list of resources for more professional support.

Name: Ashley

Age: 21

Occupation: Fast food worker

Background: Ashley has a history of anxiety and saw a private therapist for a few months due to long NHS wait times. They had to stop due to financial struggles, but found the exercise worksheets useful and want to continue using them. They have been finding the fast-paced environment of work stressful but do not have time to get out and complete a worksheet during work breaks.

Needs:

- Easily accessible and easy to use CBT adaptations of worksheets.
- A way to store and revisit completed exercises.

Name: Kevin

Age: 20

Occupation: Unemployed

Background: Kevin has diagnosed depression and has been unable to hold down a job. He struggles with motivation and spends much of his time shut in his room playing video games. He has weekly therapy sessions over the phone but finds it difficult to complete his assigned exercises, resulting in little progress being made.

Needs:

- Extrinsic motivation to complete exercises.
- A way to set notifications to encourage healthy behaviours.

3.3 Requirements

Requirements that the app will fulfil were formulated and are listed in the following table. They have been prioritised using MoSCoW priority, with 'must' requirements being crucial to the project, down to 'won't' requirements which are included to prevent scope creep.

| ID | MoSCoW Priority | Description |
|----|-----------------|---|
| 1 | MUST | The application must guide users through CBT exercises to identify and challenge distorted thoughts and feelings. |
| 2 | MUST | Completed CBT exercises must be stored in the app, with the user being able to easily access and view them. |
| 3 | MUST | Users must be able to set goals with notifications to encourage them. |
| 4 | MUST | There must be motivational features which encourage the user to open and use the app every day. |
| 5 | MUST | There must be motivational features which encourage the user to spend more time completing CBT exercises on the app. |
| 6 | MUST | The application must contain links to further resources for users who need more support. |
| 7 | SHOULD | Users should be able to record their daily moods and activities through writing journal entries. |
| 8 | SHOULD | Completed CBT exercises should be able to be exported to a document format in order to be easily shared with others. |
| 9 | COULD | The app could recommend generic goals that can help the user improve their mood in their daily life. |
| 10 | COULD | Periodic notifications could be used to remind the user to engage with the app if they have not opened it in a while. |
| 11 | COULD | The user could be able to customise the UI of the app. |
| 12 | COULD | The app could play relaxing and calming music in the background. |
| 13 | WON'T | There won't be any online community features (eg. forums, message boards) due to a lack of moderation resources. |
| 14 | WON'T | Artificial intelligence will not be used to guide users through completing CBT exercises. |
| 15 | WON'T | The user's activity outside of the app won't be tracked. |

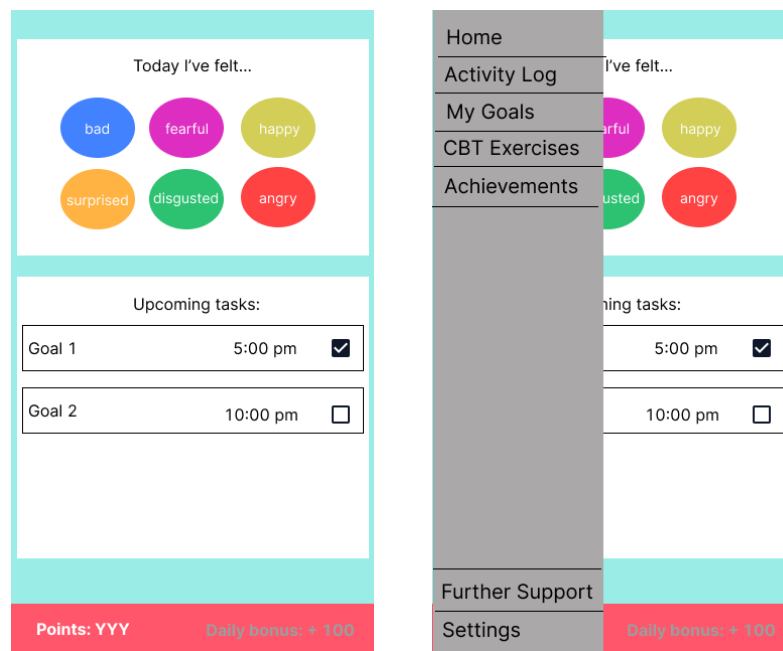


FIGURE 3.1: Wireframes of the home screen and side bar.

3.4 Prototypes and Wireframes

Following the identified requirements, wireframes were created using Figma to prototype how the app would function. Important wireframes are discussed below while additional wireframes can be found in Appendix B.

3.4.1 Home Screen

The first screen the user sees when they start the app will be the home screen, shown in Figure 3.1 left. The user will use a sidebar menu to navigate through the app, shown on the right.

On the home screen, the user will find 6 circles which correspond to moods from the feelings wheel (23), and can tap on them to record that they have felt it. The moods will then be tracked on the activity log screen (Section 3.4.2).

Underneath, there will be a list of the upcoming tasks that the user has set and when notifications have been set to remind them to complete the task. The tasks can be checked off when they are completed.

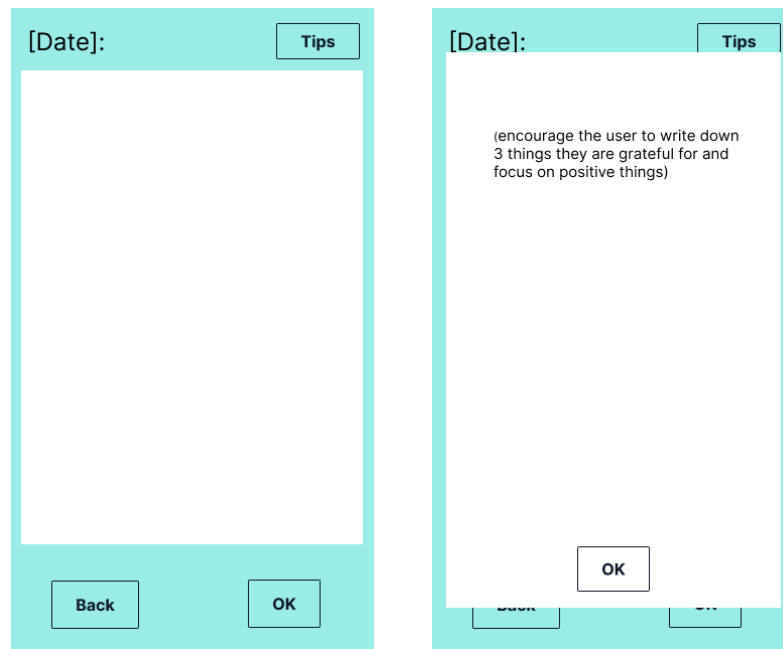


FIGURE 3.2: Wireframes of the journal and journal tip screen.

At the bottom of the screen, the current points and a button to claim daily bonus points can be found. (see Section 3.4.3).

3.4.2 Journal, Activity Log and Goals

Figure 3.2 shows wireframes of the journal page (left) which will allow the user to write about their day. A tip screen (right) can be accessed which will encourage the user to focus on positive occurrences and write down 3 things they are grateful for. This is because focusing on positivity and gratitude has been proven to have positive effects on mood (12; 17).

The Activity Log screen is shown in Figure 3.3 left. Here there will be a calendar overview of the user's emotions with each day having a colour depending on which moods were picked (from Figure 3.1). Underneath, completed CBT exercises and journal entries from that day will be displayed. There will be an option to export activity logs to a PDF document, where the user will be able to select a range of dates or use buttons to easily select the last week or last month of dates (Figure 3.3 right).

The goals screen (Figure 3.4 left) will display the goals that the user has set for themselves. Each goal can be tapped to show why the user set the goal (in order to remind and motivate them) and there will be recommended goals such as exercising and calling a friend. Figure 3.4 right shows the interface for adding new goals.

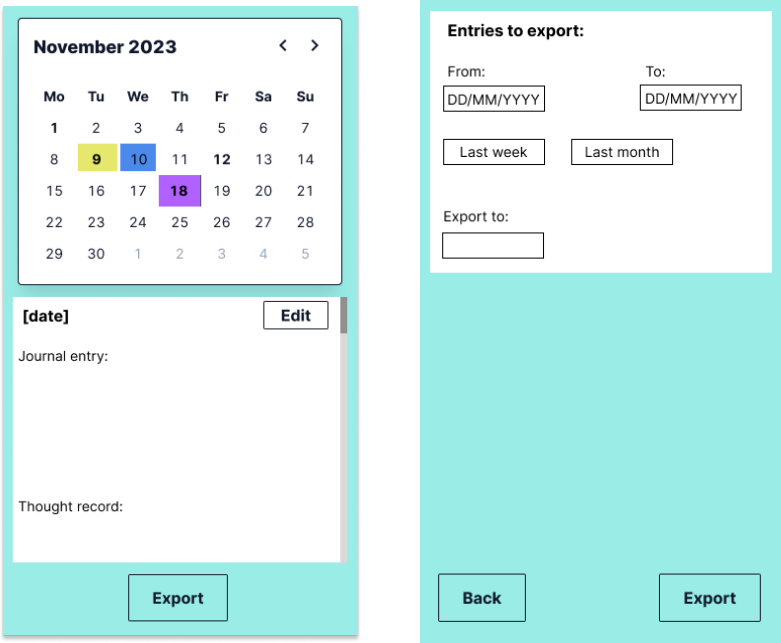


FIGURE 3.3: Wireframes of the activity log and export screens.

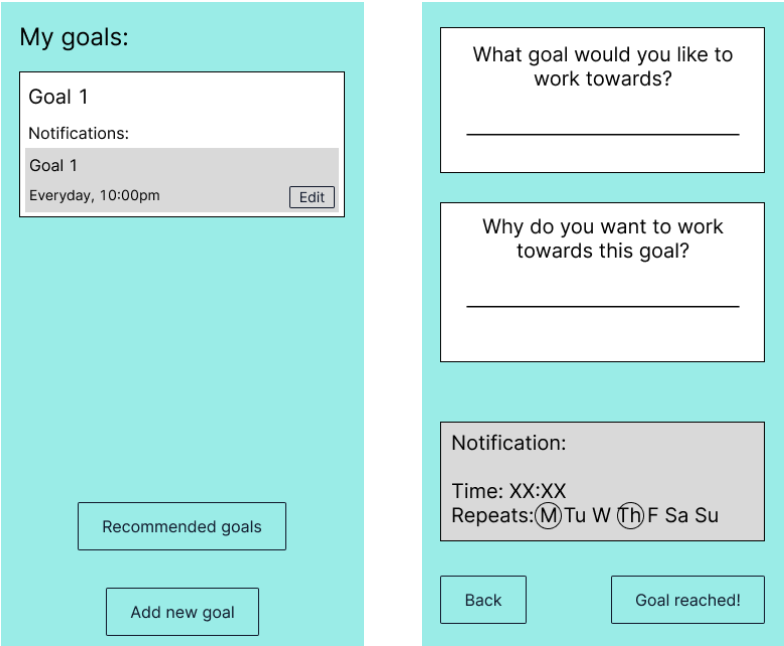


FIGURE 3.4: Wireframes of the goal screens.

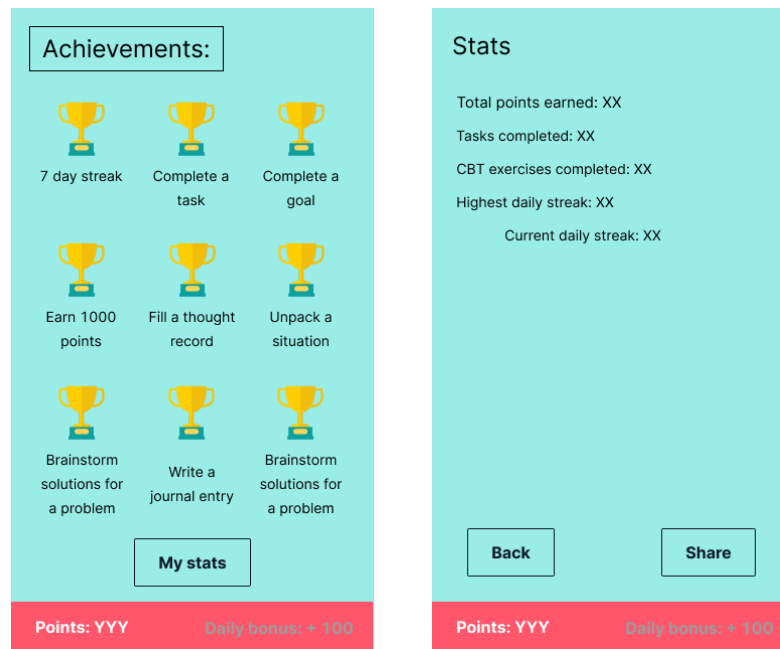


FIGURE 3.5: Wireframes of the achievements and stats screens.

3.4.3 Motivational Features

Figure 3.5 shows the proposed motivational features. These comprise of a point system where users earn points for each exercise or task they complete, as well as daily bonus which the user can earn every day which helps fulfil requirement 4. There will also be achievements/trophies which the user can earn based on how much they are using the app, including for earning certain amounts of points, which helps meet requirement 5. Users are able to view all their stats, which can be beneficial to those who are more naturally motivated.

3.4.4 CBT Exercise Adaptations

The app will feature 3 CBT exercises: Understanding a Situation, Problem Solving and Thought Record. These exercises were chosen due to inspiration from existing mobile apps (see Section 2.4) and the user personas, as well as from personal experience with what I found to be most useful. Each of the exercises will begin with an information page about the exercise and end with a summary and review page.

The 'Understanding a situation' exercise (Figure 3.6) is primarily based on the exercise 'Separating Situations, Moods, and Thoughts' from *Mind Over Mood* by Greenberger and Padesky (16). The user will be prompted to identify and record a situation and add

The figure shows three wireframes for the 'Understanding a Situation' exercise:

- Screen 1:** A text input field with the prompt "What was the situation? (hint: be specific, five Ws)". A "Next" button is at the bottom right.
- Screen 2:** Titled "[Situation]:". It contains a text input field "What were you feeling at the time?" with a "+" icon below it. Below this is a slider labeled "Intensity:" with a range from 0 to 10. "Back" and "Next" buttons are at the bottom.
- Screen 3:** Titled "Select a thought to challenge:". It shows two identical boxes, each containing "[Thought]" and "Belief: X". A "Back" button is at the bottom right.

FIGURE 3.6: Wireframes of the 'Understanding a Situation' exercise.

The figure shows three wireframes for the 'Thought Record' exercise:

- Screen 1:** A text input field with the prompt "What thought do you want to examine?". Below it is a slider labeled "Belief:" with a range from 0 to 10. "Back" and "Next" buttons are at the bottom.
- Screen 2:** Titled "Arguments against:" with a "Tips" button. It contains a text input field "[Thought]" and two colored rectangular boxes (one light blue, one light grey). At the bottom is a "Text message" input field. "Switch sides" and "Next" buttons are at the bottom.
- Screen 3:** A text input field with the prompt "Balanced thought:". Below it is a slider labeled "Belief:" with a range from 0 to 10. "Back" and "Next" buttons are at the bottom.

FIGURE 3.7: Wireframes of the 'Thought Record' exercise.

feelings and thoughts that were present at the time. For each of these, the user will rate the intensity (of feeling) or belief (in the thought) using a slider. The user can then select one of the identified thoughts to challenge, which will automatically lead to the Thought Record exercise (Figure 3.7) with the selected thought filled in.

The 'Thought Record' exercise (Figure 3.7) is based on the exercise of the same name in

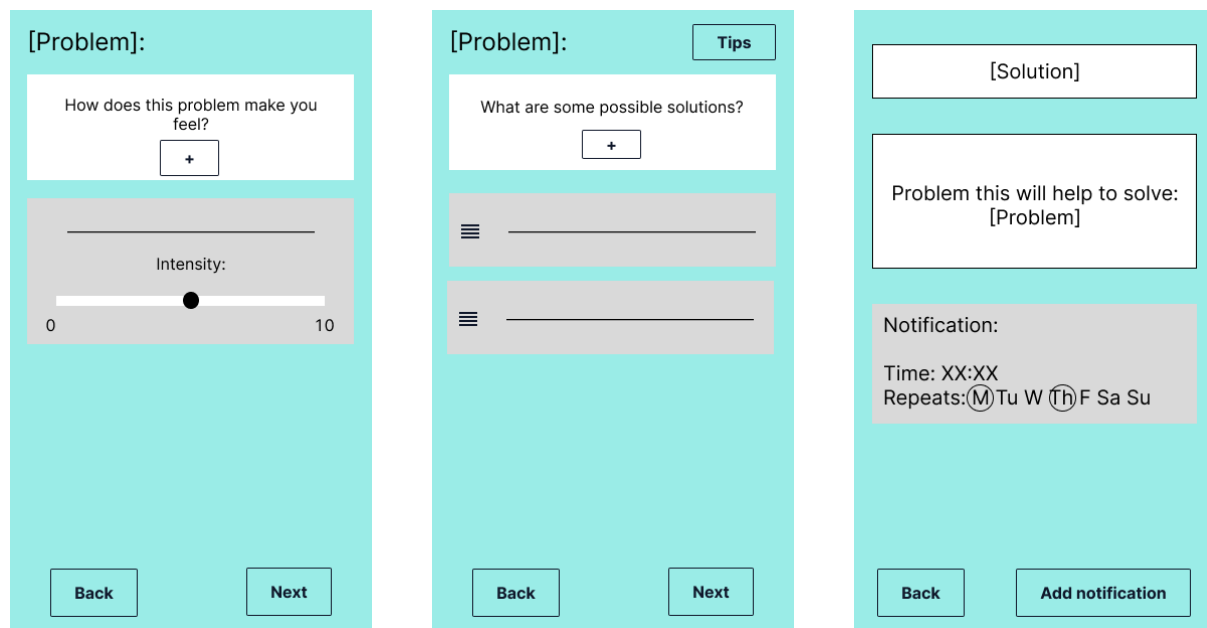


FIGURE 3.8: Wireframes of the 'Problem Solving' exercise.

Mind Over Mood (16) and resources provided by the NHS (1). The user will be prompted to identify a thought and rate their belief in it. They will then be prompted to argue for why they believe the thought is true, then switch sides and argue against the thought, using an interface similar to a messaging app to evoke the feeling of being in an actual text message exchange. The user will be able to switch back and forth between sides until they decide to proceed and enter a more balanced alternative thought.

The 'Problem Solving' exercise (Figure 3.8) is based on resources from the NHS Every Mind Matters website (1). The user will enter a problem they are facing and identify how this problem makes them feel. Then they will be prompted to brainstorm and add possible solutions and reorder the solutions based on which ones they most prefer. For each solution, they will be able to add a notification, which will then be added to the goals section along with details about what problem it will solve.

3.4.5 Further Support Screen

The app will feature a screen which will recommend further support for users who want additional help or urgent support (Figure 3.9). When the user presses on a phone number or website link it will automatically open in the phone app or browser, quickly linking users to helpful resources. This showcases an example of utilising the unique benefits of

a mobile app to enhance the user experience.

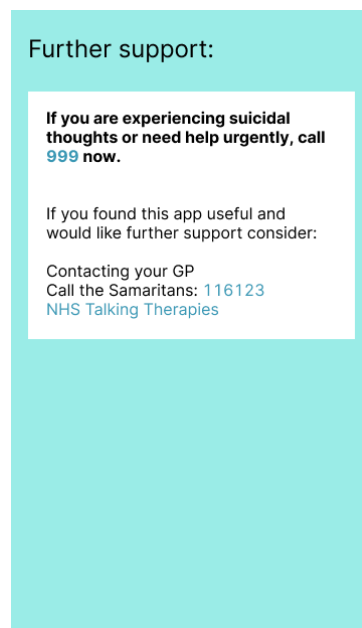
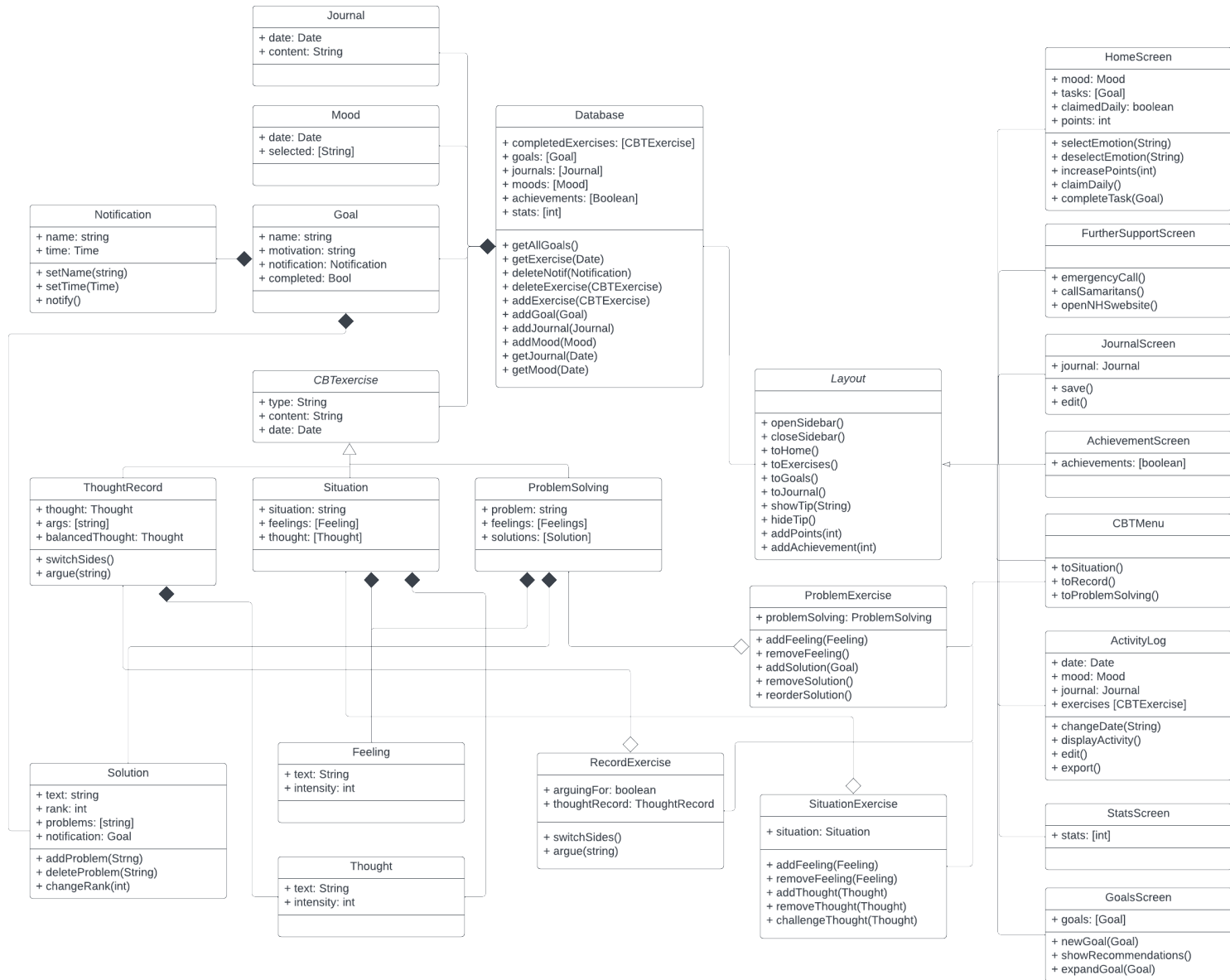


FIGURE 3.9: Wireframe of the further support screen.

3.5 Class Diagram

The following class diagram was constructed to aid development:



Chapter 4

Implementation and Testing

4.1 Tools Used

- **Android Studio:** I chose to develop an Android app over a web app in order to allow offline access for additional availability, and chose Android over other operating systems like IOS due to needing to test the app on my own Android phone. Android Studio is a popular IDE that supports Java, the language I chose to use over Kotlin due to having more prior experience. It also features an easy-to-use and reliable layout manager for creating XML layouts which makes the process of designing and building the front-end quick and easy. Additionally, the IDE is very similar to IntelliJ, which I have used in projects before, adding a level of familiarity and comfort that made this my preferred tool.
- **GitHub:** Version control was crucial during the development of the app due to needing to occasionally reverse changes when new features were not working as intended. GitHub was used over alternatives like GitLab due to its reliability and personal preference from being a tool that I was already experienced in.

4.2 Building the Application

In the following section, important design and implementation decisions are discussed. Additional screenshots of app screens can be found in Appendix C.

The figure displays two side-by-side mobile app screens. The left screen is titled 'What did you do in response to the situation?' and features a purple button with a '+' icon. Below this is a section labeled 'Behaviour 1' with a horizontal line. Underneath is the question 'How happy are you that you did this?' followed by a horizontal scale from 0 to 10 with a dot at approximately 6. At the bottom are 'Back' and 'Next' buttons. The right screen is titled 'What physical reactions did you notice?' and also has a purple '+' button. Below is a section labeled 'Reaction 1' with a horizontal line. Underneath is the question 'Intensity' followed by a horizontal scale from 0 to 10 with a dot at approximately 6. At the bottom are 'Back' and 'Next' buttons.

FIGURE 4.1: The added screens to enter behaviours (left) and physical reactions (right) in the 'Understanding a Situation' exercise.

4.2.1 CBT Exercises

As mentioned in Section 3.4.4, the app features 3 adaptations of CBT exercises based on paper worksheets. An important CBT technique is identifying automatic thoughts and feelings, which is an integral part of all 3 exercises. As shown in the wireframes and in Figure 4.1, the app implements separate screens for each different phenomena where users can add and rate as many examples as they want.

In general, implementation went according to design with only a few changes. One was the addition of 2 extra screens to the 'Understanding a Situation' exercise for the user to enter behaviours and physical reactions that they noticed in response. Although these were not included in the original exercise in *Mind Over Mood* (16) that this exercise is based on, the book also identifies 5 interconnected areas that influence each other: situations, physical reactions, moods, thoughts and behaviours. I felt that all these areas were extremely important when unpacking and understanding complicated situations, which is why I added the remaining 2 areas to the exercise. The layout of these screens is the same as the screens for entering thoughts and feelings and can be seen in Figure 4.1.

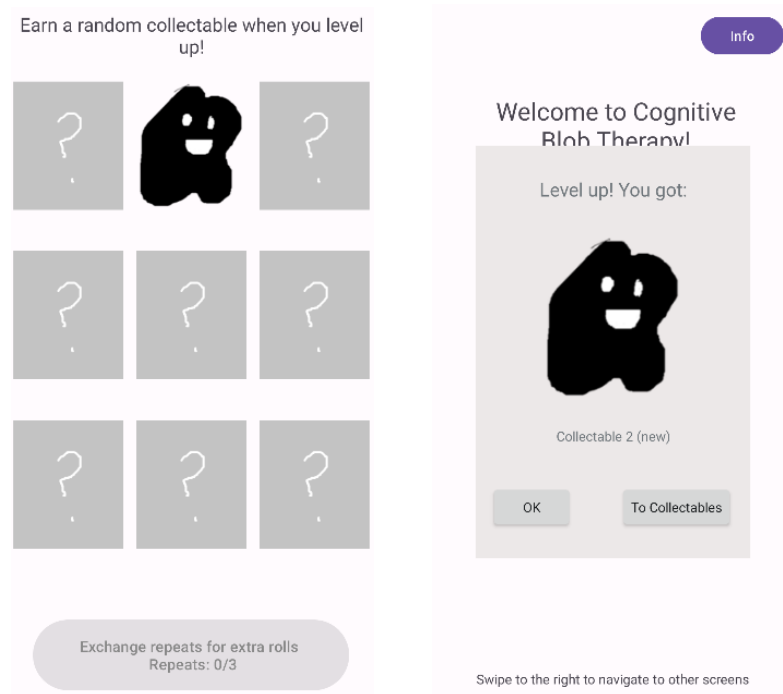


FIGURE 4.2: The collectible screen (left) and the pop-up which appears when a new collectible is earned (right).

4.2.2 Motivational Features

During development, several disadvantages with the original motivation features detailed in Section 3.4.3 were identified, expanded on in Appendix D. Most importantly, the achievement system had little integration with the points, with there being no use for the points earned aside from earning achievements based on amount. Therefore, I decided to select a more appropriate and well-integrated way of keeping users engaged by identifying several possible motivational features based on research and my own personal experiences and preferences. I then evaluated how useful and appropriate each feature would be in the context of my app, shown in Appendix D.

Based on my evaluation, the motivational feature deemed most appropriate was the addition of in-app collectibles which can be earned through a random chance system. This system, shown in Figure 4.2, avoid the issues with the achievements system by allowing points to be 'used' to earn collectibles, giving them a greater purpose which lasts a longer time. Additionally, the stats page from the original design was kept due to its straightforward implementation and is shown in Figure 4.3. Here the user can to view their statistics (ie. number of exercises completed, points earned etc.) for a numerical representation of their progress, fostering and increased sense of competence.

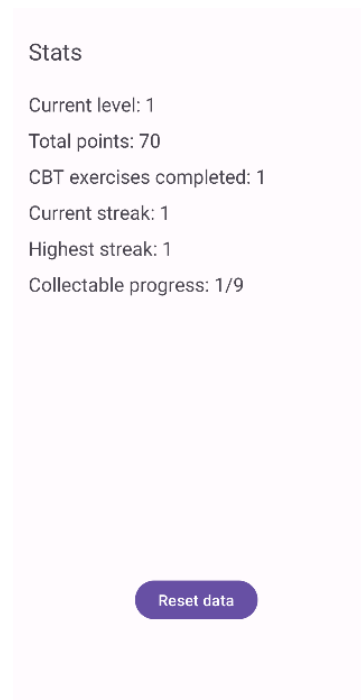


FIGURE 4.3: The stats screen.

The random chance system operates similar to a lottery where the user rolls for a 'random' collectible every time they 'level up'. The original points system was repurposed so that users earn points from completing exercises (20 points) or claiming daily bonuses (10 points), 'levelling up' once they reach a certain amount of points. This amount follows a linear growth, starting at 20 points and increasing by 40 for every level. The low starting amount helps introduce users to the collectible system early and increasing the amount of points for each level creates a sense of progression which can be appealing for users (28).

Another feature to note is that the collectibles are not weighted equally when rolling, with some collectibles having a greater likelihood of being rolled than others (eg. there is a 20% chance of rolling collectible 4 but only a 5% chance for collectible 6). This means that there is a high chance that the user will get a collectible that they have already obtained, in which case they will earn a 'repeat'. Once a user has earned 3 'repeat's, they will be able to exchange them for an extra roll. All of this contributes to increasing the time needed to obtain every collectible and therefore the amount of time the user is motivated to use the app due to the collectibles. Additionally, the process of creating more collectibles and adding them to the app is quick and easy, meaning that this feature could be easily scaled to add new collectibles for users to work towards obtaining.

4.2.3 Data Storage

Due to my inexperience with Android development, an aspect that I struggled with was storing data locally. Initially I planned on writing information to a local file in order to save data between instances, an approach that has worked well in previous projects. This is how user statistics like number of points earned and exercises completed is stored: the data is written to a text file in local storage that is read when the app is opened.

However, when implementing the storage and retrieval of completed CBT exercises, this method became unsuitable due to the complexity of the data being stored. It was also necessary to be able to retrieve all completed exercises from a given day so that they could be displayed on the activity log screen, something which would be too complicated to implement using text files. Instead, the Android local database Room, which provides an abstraction layer for an SQL database, was used. Objects (in this case activity logs containing the date, text and type of CBT exercise) are stored as entities which correspond to a table in the database. The tables can be accessed and modified through SQL commands in a data access object. Notifications are also stored in this manner, with the entity containing the notification text, time, weeks to repeat and days to repeat on.

Yet another approach to data storage was utilised to store collectible progress. This is because for each of the 9 collectibles a variable needed to be stored indicating whether the corresponding collectible had been obtained. Since this is only a small and unchanging number of variables, it would be unnecessarily time-consuming to use Room since I would need to create a new table, entity, and new commands. Instead, SharedPreferences was used, which stores simple data as key-value pairs so that each collectible could have a corresponding Boolean variable stored to indicate if it had already been obtained.

As well as being simple to implement, SharedPreferences has the added benefit of being able to easily update data, with data automatically overwriting if the key is the same. Additionally, when trying to access data which does not exist, a default value can be specified. Because of this, SharedPreferences was also used for the daily streak and daily bonus point features: when a bonus is claimed on the home screen, the Boolean 'true' is stored with the key being the current date. To check if the user has claimed the daily bonus, the application tries to access the value corresponding to the current date, with the default value of 'false' returned if a value is not found. If the value corresponding to yesterday's date is also 'false' the daily streak has been broken and is subsequently reset to 0, while if it is 'true' the streak can be increased by one.

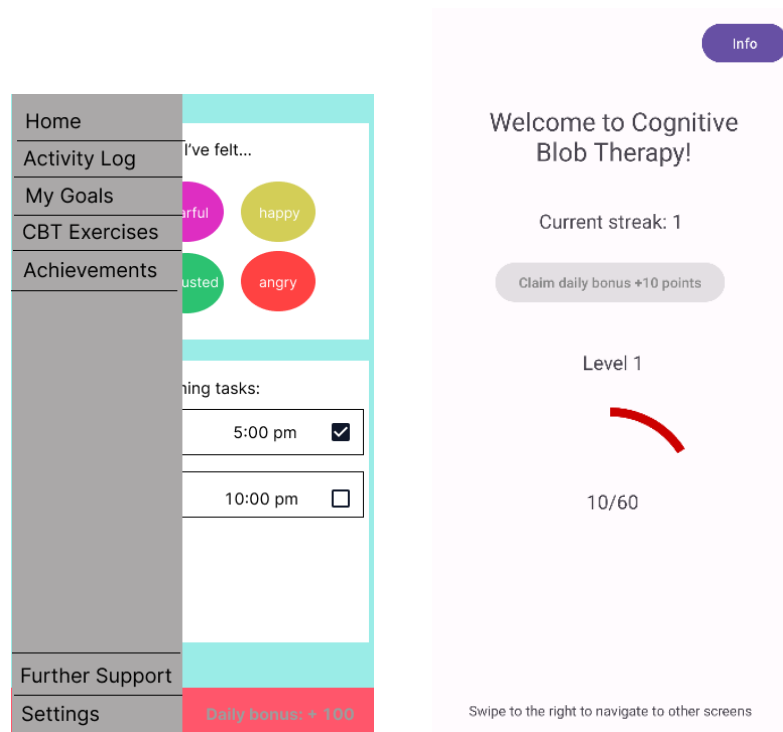


FIGURE 4.4: Comparison of the wireframe (left) and actual implementation (right) of the home screen.

4.2.4 Home Screen

The home screen underwent a major redesign compared to the original wireframes (Figure 4.4) because of the journal and mood selection features being discontinued due to time constraints (see Section 6.2). The choice was also made to remove the overview of upcoming tasks/notifications because, although an integral feature of the app, notifications are not the main purpose of the app. I wanted the focus of the app to be the CBT exercises since there are already many existing apps for notifications and goal settings, therefore the home screen was re-designed to place a greater emphasis on the motivational features to encourage users to complete more exercises.

The new design features a circular progress bar which fills up according to the current points earned and the amount of points needed to level up, providing a visual way for users to track their point acquisition. Above the progress bar, the current streak of the user is shown along with the button to claim the daily bonus points. An information button is present in the top-right corner which opens a pop-up containing guidance and disclaimers for using the app. This new design is less cluttered and more simplistic than the old design which I felt was important so that the user is not overwhelmed with information when they open the app.

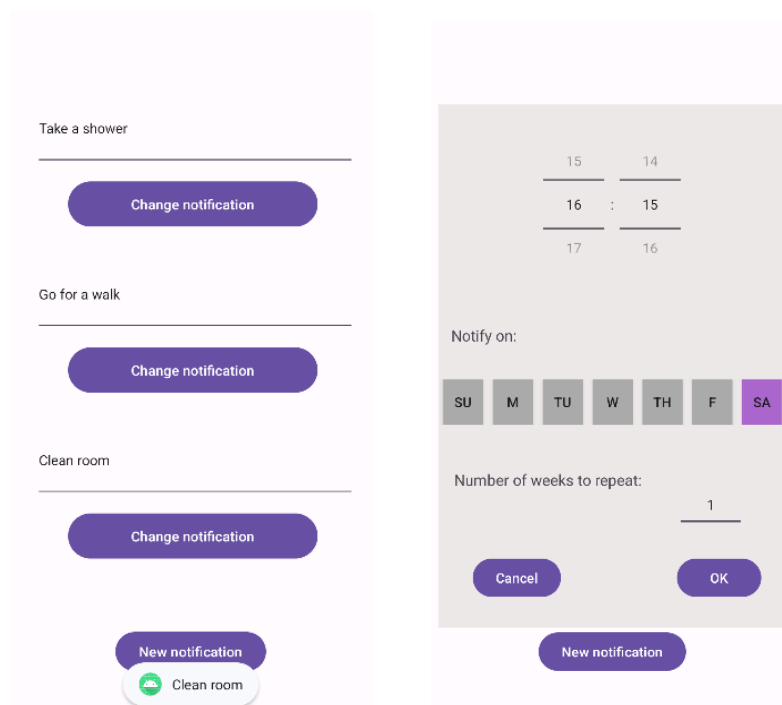


FIGURE 4.5: The notification screen (left) with the notification pop-up at the bottom and the screen to set notifications (right).

4.2.5 Notifications

As mentioned in Section 4.2.3, notifications are stored in a Room database once they have been added, making for easy retrieval and display in the notifications screen (shown in Figure 4.5 left). Notifications can be added either through this screen of the 'Problem Solving' exercise.

The layout of the screen where users set notifications (Figure 4.5 right) was inspired by the alarm setting screen of the Samsung alarm app. This was due to my opinion that its popularity and intuitiveness allow users to quickly and easily learn how it works. Also, this design places greater emphasis on repeating alarms over one-off alarms, fitting well with CBT's aim of promoting better mental health through formation of healthy habits over a longer period of time (13).

When a notification goes off, a pop-up appears on screen (shown in the bottom of Figure 4.5 left) displaying the name of the notification, along with a short sound effect. If the notification repeats, the next notification automatically sets itself, while if there are no more repeats the notification is deleted from the database.

4.3 Functional Testing

Throughout development, the functionality of the app was tested against the 6 'must' requirements from Section 3.3.

- **The application must guide users through CBT exercises to identify and challenge distorted thoughts and feelings.**

Black-box testing was used to assess this requirement from the perspective of an end user. The following tests specify which area each is for by using this key:

S: 'Understanding a Situation' exercise

P: 'Problem Solving' exercise

T: 'Thought Record' exercise

M: CBT Menu

| Area | Test | Result (P/F) |
|-------|--|--------------|
| M | Can start an exercise by selecting from the exercise menu | P |
| S/P/T | Exercises start at the information screen for that exercise | P |
| S/P/T | 'Next' and 'Back' buttons navigate to respective screens | P |
| S/P | Can enter a situation to understand/problem to solve | P |
| S/P | Can add feeling/thought/behaviour/physical symptom and edit the text | P |
| S/P | Can change slider for feeling/thought/behaviour/physical symptom | P |
| S/P | Can scroll list of feelings/thoughts/behaviours/physical symptoms | P |
| S/P/T | Can select 'Tip' button to open tip pop-up | P |
| S/P/T | Review screen at end of exercise shows what has been entered | P |
| S | 'Challenge a thought' button opens screen with the entered thoughts | P |
| S | Clicking thought in 'Challenge a thought' screen opens thought record exercise with selected thought already entered | P |
| S/P/T | 'Finish' button exits to home screen | P |
| P | Can add possible solutions | P |
| P | Can scroll through possible solutions | P |
| P | Can reorder possible solutions by dragging | P |
| P | Can add a notification to a solution | P |
| P | Can edit existing notifications for solutions | P |
| T | Entering text into message box and pressing send displays text on screen as a text message | P |

| | | |
|---|---|---|
| T | Pressing 'Switch sides' button changes title text and colour/placement of new text messages | P |
| T | Can enter and rate thought to examine and balanced thought | P |

- **Completed CBT exercises must be stored in the app, with the user being able to easily access and view them.**

Figure 4.6 shows the activity log screen which contains a calendar display on the top half. The user can select a date on the calendar (with the default date being the current date) to display the completed CBT exercises for that day in the bottom half of the screen.

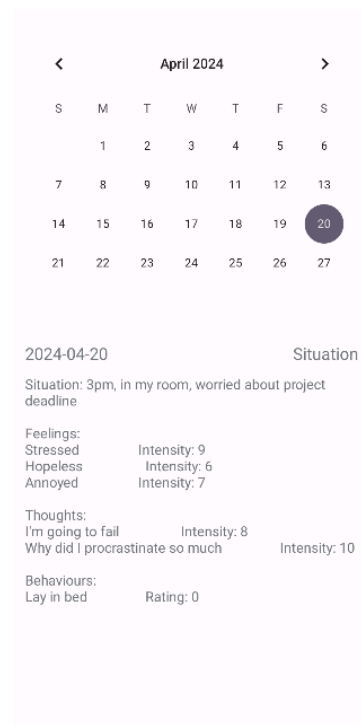


FIGURE 4.6: The activity log screen.

- **Users must be able to set goals with notifications to encourage them.**

Users can set notifications from both the notification screen and as part of the 'Problem solving' exercise. Section 4.2.5 contains more details on the implementation of the notifications. Notifications were tested across the span of one week and consisted of a range of times and repetitions, including notifications that repeated each day and ones that repeated in various patterns. All went off at the right time.

Unfortunately, due to time limitations, tests of repeated notifications for longer than one week were not possible.

- **There must be motivational features which encourage the user to open and use the app every day.**

These motivational features are the daily streak and daily bonus points which were tested with the other motivational features below.

- **There must be motivational features which encourage the user to spend more time completing CBT exercises on the app.**

These motivational features are the points system, statistics page and random-chance collectibles discussed in Section 4.2.2. The following tests were conducted to make sure they, and the daily motivational features mentioned previously, work as intended.

| Test | Result (P/F) |
|--|--------------|
| Default statistics of 0 are created when app is first opened | P |
| Stat screen displays current level, points, exercises completed, current streak, highest streak and collectible progress | P |
| Clicking 'Finish' on a CBT exercise increases points by 20 | P |
| Clicking a thought to challenge in 'Understanding a Situation' exercise increases points by 20 | P |
| Clicking 'Finish' on a CBT exercise increases exercises completed by 1 | P |
| Earning enough points increases level by 1 and resets points to 0 | P |
| Points needed to level up starts at 20 and increases by 40 for each level | P |
| Clicking the 'Claim daily bonus' button increases points by 10 | P |
| Clicking the 'Claim daily bonus' button increases streak by 1 | P |
| 'Claim daily bonus' button disables after being clicked | P |
| 'Claim daily bonus' button re-enables the next day | P |
| Current streak resets if bonus is not claimed for 2 consecutive days | P |
| Highest streak updates automatically in stats screen | P |
| Home screen displays current streak and level | P |
| Home screen displays points in progress bar proportionate to points needed to level up | P |

| | |
|--|---|
| Collectible roll pop-up appears when user levels up | P |
| Collectible roll is 'random' | P |
| Collectibles obtained can be seen in collectibles screen while ones not obtained are hidden | P |
| 'Back' and 'To collectables' buttons on collectible roll pop-up close the pop-up and open the collectible screen respectively | P |
| Number of 'repeats' increases by 1 if user obtains an already obtained collectible | P |
| Can press button to roll again if there are 3 or more 'repeats' | P |
| Number of repeats decreases by 3 once the repeat roll button has been pressed and the button deactivates if there are then less than 3 'repeats' | P |
| Collectible progress updates based on how many unique collectibles have been obtained | P |

- **The application must contain links to further resources for users who need more support.**

Figure 4.7 shows the further support screen which has links to the phone numbers of the emergency services and the Samaritans. When pressed, the phone app opens with the number entered. There is also a link to the NHS Talking Therapies website which opens on the phone's default browser.

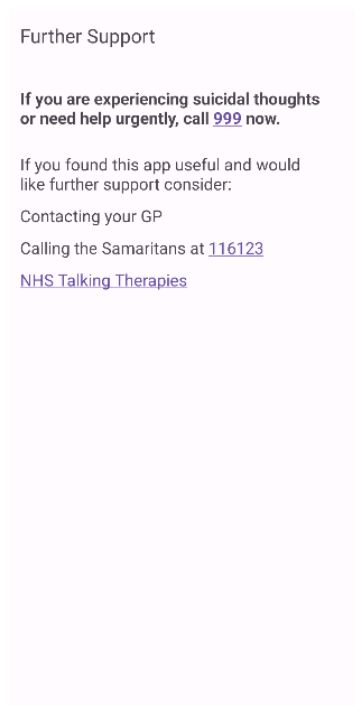


FIGURE 4.7: The further support screen.

Chapter 5

Evaluation

5.1 Evaluation Design

In order to evaluate the app from a qualitative standpoint, a user study targeting fellow students at the University was conducted. The study was approved by the University of Southampton Ethics Committee under ERGO/FEPS/90840 (see Appendix E for a copy of the ethics application) and received 13 participants.

During the study, participants were given a brief explanation on CBT and the role of the app. A scenario was provided in order to help participants get into the frame of mind of a user who wants to manage their emotions through CBT. The scenario was as follows: "Pretend you are extremely anxious about an upcoming exam and are finding it hard to focus on revision due to the anxiety". I chose this scenario due to the high likelihood that most of the participants had experienced something similar before, meaning they would find it easy to relate. Additionally, despite being a common scenario, it is also moderate enough to avoid participants feeling too uncomfortable. They were then presented with a mobile phone which had the app opened, and given free range to explore the features.

After about 10 minutes, most participants had explored all the features, at which point they were asked to fill in a digital questionnaire (included in Appendix F). The questionnaire assesses whether the participant would use the app over pen-and-paper worksheets, what factors influenced their decision, their experience of the CBT exercises, and general questions about the app's usability. The full questionnaire results can be found in Appendix G.

On a scale of 1 to 5, how likely would you be to use the mobile app over a pen-and-paper worksheet?

13 responses

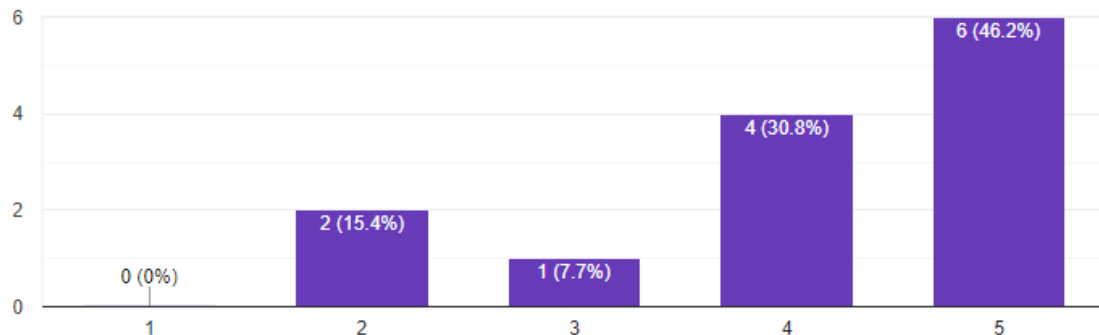


FIGURE 5.1: Responses for question 1

5.2 Results and Discussion

As shown in Figure 5.1, 76.2% of participants gave scores of 4 or 5 when asked if they would be likely to use the app over pen-and-paper worksheets. These scores correspond to 'agreeing' and 'strongly agreeing' respectively, clearly showing the positive reception the app received. Most users cited the availability of phones as the factor most influencing this decision (10 users), with the ease of storing and accessing completed exercises coming second (8 users). Although other features like notifications and points were well-received, with 2 out of 8 long-form responses for question 9 highlighting notifications as a particularly useful feature, only 6 and 5 users respectively said it influenced their decision. It seems the inherent convenience of using a mobile app is the biggest deciding factor, with the other features being seen as added bonuses.

The CBT exercise adaptations also received mainly positive feedback, with one comment noting that "having already set questions really helps process your thoughts". Figure 5.2 shows the average of how clear and useful each of the 3 exercises were. Most participants felt that the understanding the situation and problem solving exercises were clear and easy to use, with averages of over 4.4 out of 5 for clarity and 4.0 for usefulness. However, the average score for the thought record exercise was slightly lower, at 3.8. The reasons for this were elaborated on verbally and are discussed in Section 5.3. All 3 exercises were deemed very useful by participants, with all having average scores of 4 or above. Based on responses to the long-answer question, the thought record exercise was noted as especially useful, which is clearly shown in the data with an average of 4.6, the highest of the 3

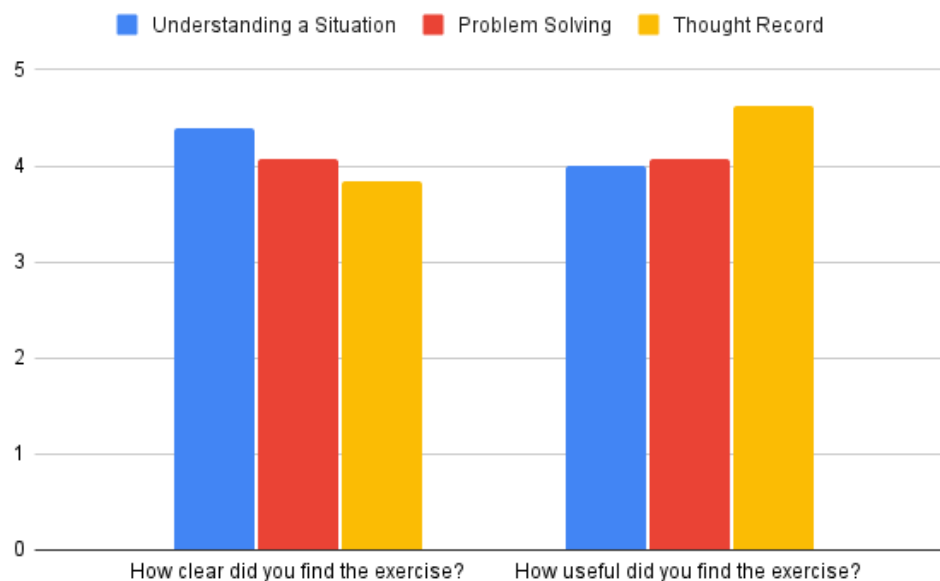


FIGURE 5.2: Average scores for questions 3-8.

exercises. One respondent said they "didn't really see the point of [the] problem solving [exercise]", but this is not particularly reflected by the average scores, however I thought this was important to note as a possible indication that the information explaining the exercise's purpose, which is provided at the start of the exercise, could be improved.

Questions 3-8 were taken from the System Usability Scale (9), a widely used method for evaluating usability. Because I felt that some of the questions were too similar to each other (eg. "I thought the system was easy to use." and "I found the system very cumbersome to use."), I condensed the questions to the 5 that I felt most important and distinct out of the original 10. This was an oversight on my part since it meant the normal formula for calculating SUS score could not be used, but since all 5 questions were originally odd questions where a higher score is better, a simple calculation of the average of each participant's total score gives a rough estimation of the usability of the app. The average total score was 19.7 out of 25, or around 78.8 out of 100, which is within the top 70th percentile and considered an above average score.

Figure 5.3 shows the average score and standard deviation for the SUS questions. Questions 11-14 follow roughly the same distribution, with a mean of around 4.0 and standard deviation of around 0.8. However, question 10 ("I thought the app was easy to use") differs from this trend with a lower average (3.5) and higher standard deviation (1.0). Furthermore, a comment from question 16 states that "the reliance on a big chunk of text to explain the exercise (sic) is not so good" and that it might be more readable if the text was spread out throughout the exercise, a possible contributor to the lower score.

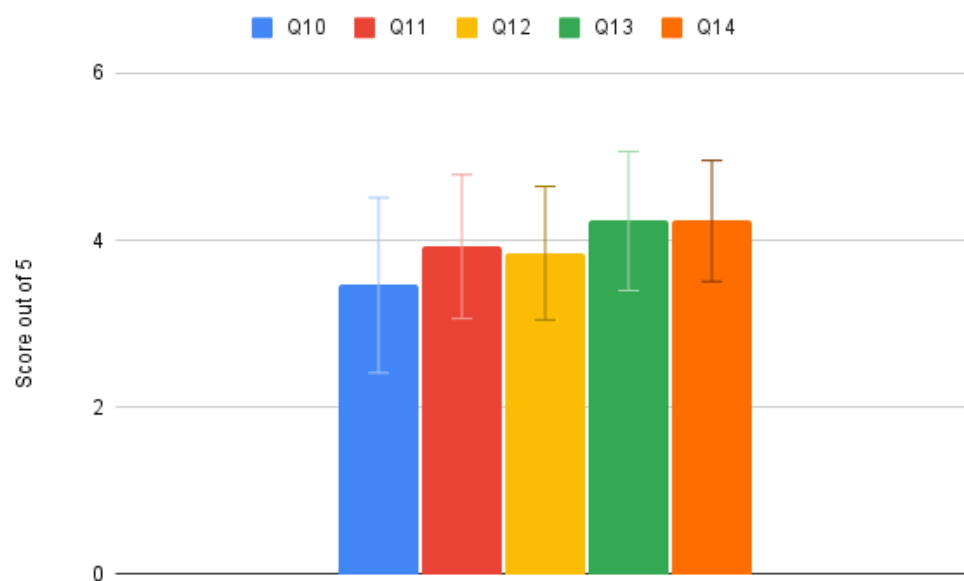


FIGURE 5.3: Average score and standard deviation for questions 10-14

Despite this, the majority of participants thought that most people would be able to learn to use the app very quickly which is a positive result.

Participants were also asked to rate how much each motivational feature made them want to return to the app, with Figure 5.4 showing the average and standard deviation for each. Since motivation is a very subjective topic, the standard deviation was expected to be high. This was indeed the case, with a standard deviation of up to 1.0 (for 'earning points for the sake of points'), with one big exception: 'earning points in order to obtain collectibles' had a standard deviation of 0 and an average score of 4. Out of the 13 responses, only 1 person gave a rating other than 4 or 5, making it is clear that the collectibles were a superior choice over only earning points for the sake of points that successfully increased the engagement of almost every participant. It should be noted that, due to time constraints, a study across multiple days was not able to be conducted, therefore participants could not use the daily streak and daily bonus point features in the way they were designed for. Based on only using the app for a short time, the daily streak feature increased engagement more than the bonus points, possibly due to loss aversion where the loss of a streak feels more impactful than gaining extra points, but a longer evaluation is needed to verify this hypothesis.

Participants were also given the chance to add any further comments and feedback. One person brought up whether a level up system could have negative connotations, for example a user might see that they have a high level and interpret it as them having "many issues" instead of perceiving it as a reflection of their efforts to improve their mental

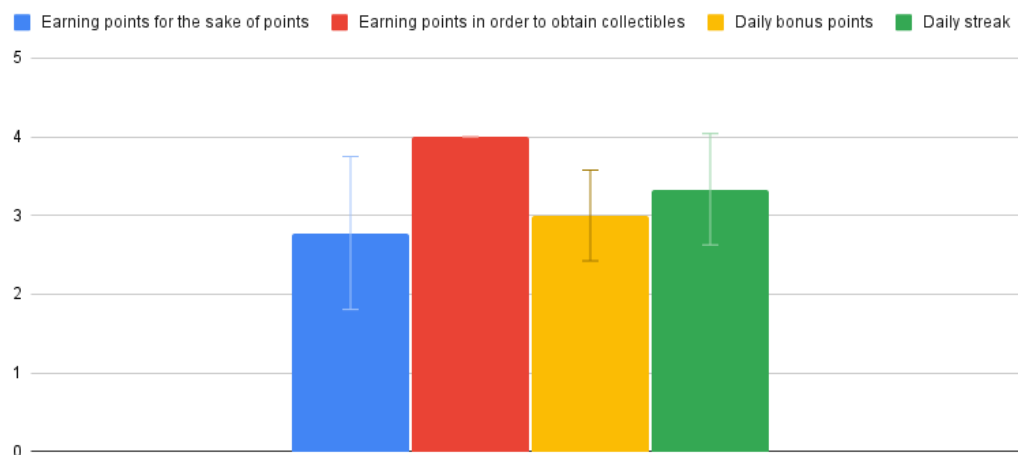


FIGURE 5.4: Average score and standard deviation for questions 15

wellbeing. This was a big concern throughout the project and reflects the unconscious stigma deeply entrenched in society that those who seek therapeutic help have something “wrong” with them. A limitation of this project is that the users who download the app are assumed to have a positive view of therapy, so the app does not focus on alleviating the surrounding stigmas.

Overall, the app was positively received, with all 3 exercises being rated more than 3.5/5 for clarity and 4/5 for usefulness. The usability of the app was rated well by participants, although there is room for improvement in terms of making the app more user-friendly. Motivational features were also successful in increasing user engagement, especially the collectible feature which 12 out of 13 respondents said made them want to use the app more. However, a significant limitation of the evaluation was its short time-frame, with users being unable to experience the features, particularly notifications, daily streak and daily bonus points, across multiple days. In the future, a longer study would be greatly beneficial to observe how the users’ attitude and engagement change over time. Finally, possible areas for improvement and future work were identified such as breaking down the introductory text for exercises into smaller sections and introducing features to challenge stigmas surrounding therapy. These ideas are expanded upon in Section 7.2.

5.3 Changes Made Due To Evaluation

During the testing of the app, some participants expressed confusion on how to switch sides during the Thought Record activity, assuming that the sides would switch automatically between messages. The exercise was able to be finished without switching sides

at all, something which testers felt was unsatisfactory due to the purpose of the exercise being to prompt the user to consider both reasons for and against their thought. To remedy this, changes were made (after the conclusion of the study) so that the 'Next' button is initially deactivated and only activates once the user has pressed the 'Switch sides' button (Figure 5.5). The colour of the button was also changed to make it stand out so that it would be more noticeable for users.



FIGURE 5.5: The thought record exercise after changes.

Additionally, some of the testers expressed that the information about the app (which is shown when the user presses the 'Info' button on the home screen), in particular the disclaimer about the app not being a replacement for therapy, is of vital importance and should be shown to users on start-up so they are guaranteed to see it. The information pop-up now opens automatically when the app starts.

Chapter 6

Project Management

6.1 Project Planning

Due to the length of this project, a project plan with estimated time-frames was necessary in order to manage time and prevent tasks from overrunning. A rough Gantt chart was made at the start of the project (included in Appendix H) and was refined after the progress report. More details were added, mainly in the implementation phase, which was split into 4 sub-sections. The first is a short period allowing time for setting up and learning the basics of Android Studio. After that, the development of the app begins proper, with the CBT exercises to be implemented first before focusing on other features. Finally, I allowed 2 weeks dedicated to catching up and ensuring the quality of the app. The updated planning chart is shown in Figure 6.1.

Throughout the project, progress was tracked with a separate Gantt chart which is also shown in Figure 6.2. The most notable difference between the planned and actual time-frames is in the implementation, which was started a week later than planned due to needing more time to refine the design, pushing subsequent tasks back by a week. Additionally, the development of the CBT exercises and other features each took roughly a week longer than planned (see Section 6.2). However, this situation was anticipated and accounted for with the extra time in the plan allotted for catch up, therefore implementation only ran over by one week in total. Overall, the time spent writing the final report had to be cut down by 2 weeks, however this was a manageable reduction in time. All in all, the actual progress of the project followed the plan sufficiently well.

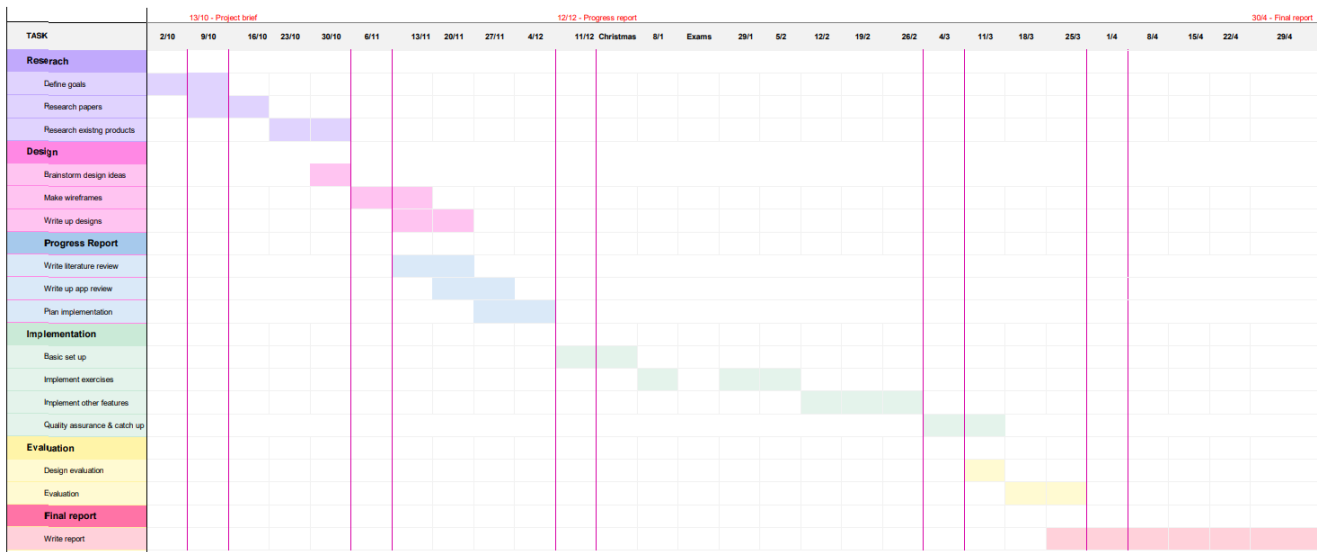


FIGURE 6.1: Planning Gantt chart made after progress report.

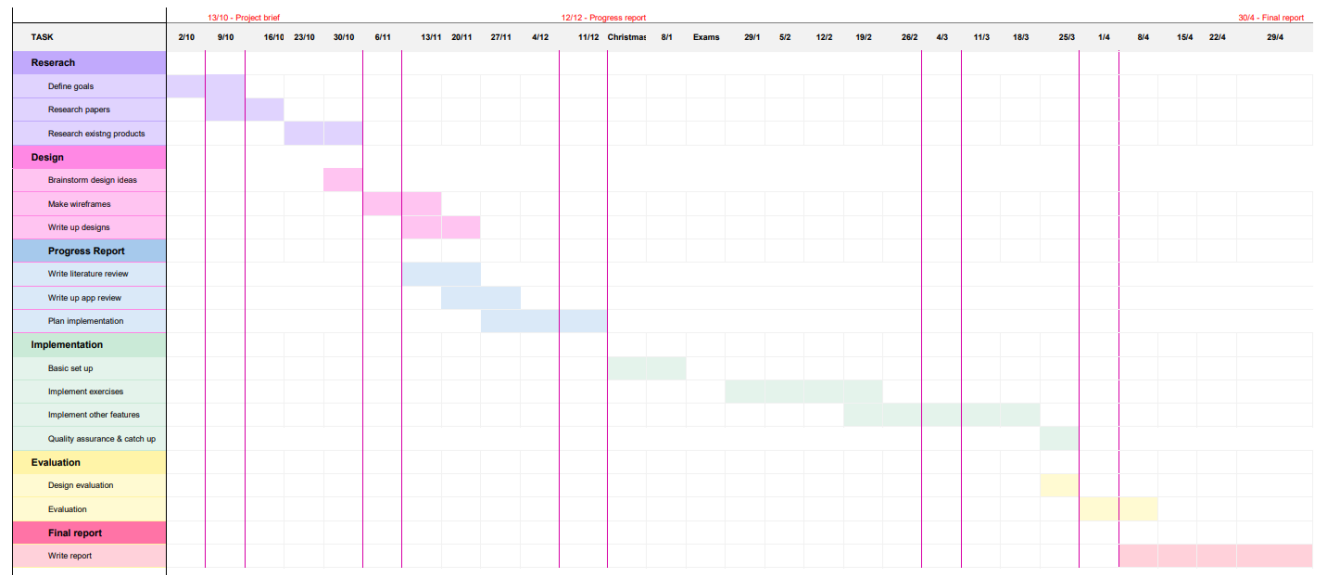


FIGURE 6.2: Gantt chart documenting project progress.

6.2 Sprint Planning

An agile methodology was utilised for the implementation of the app, with development being organised into short, iterative sprints. This approach was chosen due its emphasis on adaptivity and producing working software as soon as possible (18). As more research was being undertaken at the same time as the development, requirements were likely to change, therefore an agile approach was optimal for allowing the requirements of the app to evolve while ensuring that the a working version of the software would still exist no matter what changes were made.

Each sprint lasted 2 weeks, with tasks based on the requirements in Section 3.3 identified and formulated at the start of each sprint. The IDs of each task identify which requirement they fulfil (eg. task 1.1 fulfils requirement 1), with IDs beginning with 'APP' correlating to tasks that do not fulfil a specific requirement but that I deemed necessary for the quality of the user experience of the app.

Tasks were prioritised based on both the priority of the requirement it fulfilled and the importance of the task itself. Tasks prioritised as 'must' were given the highest priority, with the exception being the implementation of the motivational features which only occurred in the final sprint. While a vital part of my project, implementation was delayed due to my decision to re-think what motivational features would be most suited to the project (see Section 4.2.2). However, this was not a significant issue as the nature of agile methodology supports being able to change requirements during development. Developmental delays also occurred due to lack of previous experience developing Android apps, leading to inefficient code in some places. All of these factors made it clear that features would need to be cut to keep to a reasonable time-frame.

Notably, the journal (Section 3.4.2) and mood-selection (Section 3.4.1) features were included in the design but cut from the prototype. These features were chosen to be discontinued due to only being prioritised as 'should', as well as the fact that they are mostly independent features which other features do not rely on, meaning the impact of removing them is small and the app still functions well without them. Additionally, there are several existing journalling apps with mood tracking features already available, therefore I decided to shift the focus of the app more towards other features, particularly the motivational ones.

Burndown charts were constructed for each sprint and colour-coded based on task priority. As an example, Figure 6.3 shows the chart for sprint 2 while the rest can be found in Appendix H.

| ID | MoSCoW | Description | Size |
|------|--------|--|------|
| 1.3 | MUST | Implement 'Thought Record' exercise (carried over) | 3 |
| 2.1 | SHOULD | Store and view completed exercises | 4 |
| APP1 | COULD | Sidebar menu navigation | 2 |
| 5.1 | MUST | Points for completing exercises | 2 |

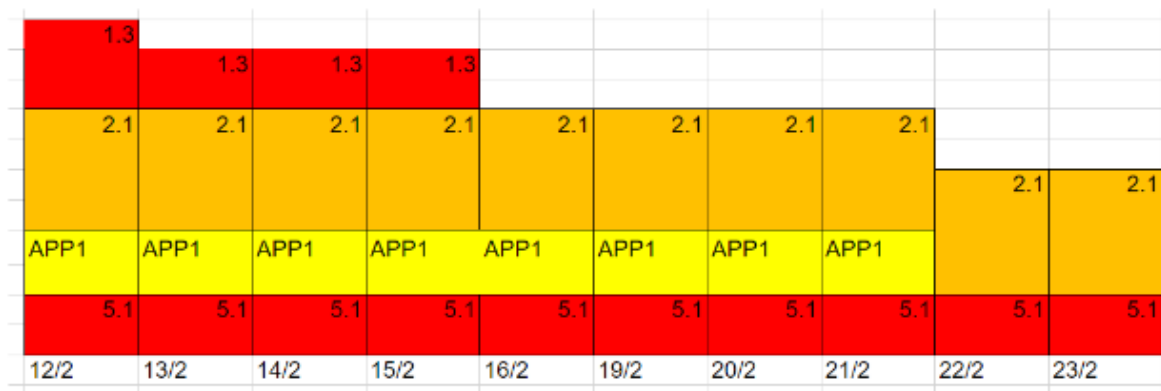


FIGURE 6.3: Tasks and burndown chart for Sprint 2.

6.3 Risk Management

Identifying risks and mitigation strategies at the start of the project was instrumental to project success and ensured quick recovery from unforeseen circumstances. My risk assessment is shown below:

| Risk | Severity | Probability | Total | Mitigation |
|---------------------------------|----------|-------------|-------|---|
| Underestimated scope of project | 4 | 3 | 12 | Prioritise the most important features when implementing the app. Allow for some features to be able to be removed or simplified. |

| | | | | |
|--|---|---|----|--|
| Loss/corruption of files | 4 | 2 | 8 | Use version control software for code (GitHub) and make sure it is always up to date. Keep frequently updated backups of other important files in cloud storage. |
| Lack of participants for evaluation | 4 | 2 | 8 | Use existing connections and social media to advertise. |
| Illness or other unfortunate situation | 5 | 2 | 10 | Familiarise myself with the special considerations process so I can apply for them if needed. Keep in regular contact with the project supervisor. |
| Clashes with other deadlines | 3 | 2 | 6 | Be aware of deadlines well in advance and plan time accordingly. Leave extra time in the project plan so I may take a few days to prioritise another deadline if needed. |
| Underestimated duration of tasks | 4 | 3 | 12 | The project planning Gantt chart allows for 2 weeks dedicated to catching up on tasks which took longer than expected. |

Chapter 7

Conclusion

7.1 Project Summary

During this project, a literature review into cognitive behavioural therapy (CBT) found that factors such as lack of medical personnel and the stigma of mental health issues can pose barriers to accessing support (26). During CBT, patients are guided through exercises and techniques, commonly involving filling in paper worksheets. These worksheets can also be used as part of self-help, where users work through exercises by themselves, an appealing choice for those experiencing barriers to accessing professional therapy. However, existing self-help resources have suffered from a lack of adherence, leading to a decrease in efficiency (14). To combat this, a mobile app to guide users through CBT exercises and increase engagement through motivational features was proposed as an accessible and convenient solution.

Requirements for the app were formulated based on an analysis of stakeholders and user personas, and a detailed design was created. A prototype for an Android app was subsequently developed using agile methodologies. To ensure fulfilment of the requirements, functional testing was carried out before a critical evaluation involving 13 participants was conducted. Evaluation results revealed that over 75% of the participants expressed a preference for the app over pen-and-paper worksheets, with the CBT exercises being well received and the motivational features, particularly the in-app collectibles, notably increasing engagement.

7.2 Future Work

Since the app features a modular approach to CBT exercises, new exercises can be easily added, for example the fear ladder and activity record from Mind Over Mood (16), which would especially benefit from the ability to access them at any time, are particularly well-suited to the app. More motivational features can also be added to further increase engagement, especially social features to fulfil the need of relatedness, although careful consideration would be needed due to the risk of negative interactions causing distress. A possible idea could be letting users connect with friends and send motivational notes, moderated with keyword filtering and machine learning. This would also help to decrease the stigma surrounding therapy by fostering a supportive and positive environment.

Due to time constraints, several features present in the original design were not implemented, for example journal and mood selection/tracking features, which could be added. Additionally, improvements can be made to existing features, notably splitting up the introductory text for exercises into shorter, more readable sections to create a more guided experience. One method for this could be a tutorial-like system where each new screen of an exercise is introduced with a small amount of text and a visual demonstration. Another recommendation from the evaluation was including built-in suggestions for feelings, which could take the form of a selectable diagram of the feelings wheel (23) or a drop-down menu. This idea could also be extended to thoughts, physical sensations and behaviours.

An interesting future expansion could be to move healthcare professionals from secondary to primary stakeholders by allowing them to connect with patients and view their completed exercises on the app. Chat and messaging features could also be added to allow patients to easily receive advice and guidance, which could even be extended to phone and video calls so users can complete exercises with real-time assistance from professionals. Since sensitive information would have to be stored online, sufficient security measures would be necessary to consider.

Finally, a longer study to investigate how users interact with the app over a longer period of time would offer beneficial data on how to improve the app. An additional study with medical professionals could also prove insightful by drawing on their extensive training and experience to consider a unique viewpoint.

7.3 Final Conclusions

This project saw the proposal, design and development of a prototype mobile app for CBT exercises, successfully translating pen-and-paper worksheets to digital form and increasing engagement of test users. The app shows great potential, and areas for improvement and future work have been identified to increase performance further. It is hoped that future developments in this area can lead to greater accessibility for mental health and wellbeing support so that we can strive for a world where everyone has the necessary resources to overcome adversity and enjoy the full extent of a happy, healthy life.