The Development of a Mobile Smart Watch Application Utilising a Heart Rate Monitor to Introduce Users to the Practice of Mindful Meditation

A dissertation submitted in partial fulfillment of the requirements for the degree of Bachelor of Science (Honours) in Software Engineering

By L. J. Brown

Department of Computing & Information Systems
Cardiff School of Management

Cardiff Metropolitan University
April 2016
Declaration

I hereby declare that this dissertation entitled The Development of a Mobile Smart Watch Application Utilising a Heart Rate Monitor to Introduce Users to the Practice of Mindful Meditation is entirely my own work, and it has never been submitted nor is it currently being submitted for any other degree.

Candidate:

Signature:

Date:

Supervisor:

Signature:

Date:
ACKNOWLEDGEMENTS

Many thanks to my dissertation advisor Dr. Panicos Georghiades at Cardiff Metropolitan University for the advice and support he provided throughout my dissertation. Thanks to all other members of staff that gave their time to answer my questions. A big thank you to all the interview participants that took the time to discuss their mediation experience, your opinions and advice helped point the application in the right direction.
Contents

List of Tables ................................................................................................................................. v

List of Figures ................................................................................................................................. vi

1 Abstract ........................................................................................................................................... 1

2 Introduction ........................................................................................................................................ 2

3 Literature Review .......................................................................................................................... 4
  3.1 Existing Applications .................................................................................................................. 7
    3.1.1 Buddhist Meditation Trainer, developed by Spacebug ....................................................... 7
    3.1.2 Calm, developed by Calm.com, Inc. .................................................................................... 7
    3.1.3 Guided Journeys Meditation, developed by BalanceInMe.com ......................................... 8
    3.1.4 Headspace, developed by Headspace ............................................................................... 9
    3.1.5 Mindful Minutes, developed by RdyDev ......................................................................... 9
    3.1.6 Smiling Mind, developed by Smiling Mind ..................................................................... 10
    3.1.7 Heart Rate OS2, developed by LFApp ............................................................................ 11
    3.1.8 Literature Review Summary ............................................................................................ 11

4 Methodology .................................................................................................................................. 12
  4.1 Research Methods .................................................................................................................... 12
  4.2 Tools Used in the Development of the Prototype .................................................................... 13
    4.2.1 Android Operating System ............................................................................................. 13
    4.2.2 Android Smart Watch Running Android Wear ................................................................. 14
    4.2.3 Android Studio ................................................................................................................. 14
    4.2.4 Architecture ..................................................................................................................... 15
    4.2.5 Android Activity Lifecycle ............................................................................................... 16
    4.2.6 Waterfall Software Development Lifecycle .................................................................... 17
  4.3 Interview Results ....................................................................................................................... 18
  4.4 Application Requirements ......................................................................................................... 20
  4.5 Testing ....................................................................................................................................... 21
  4.6 Graphical User Interface ........................................................................................................... 23
    4.6.1 First Low Fidelity Designs ............................................................................................... 23
    4.6.2 Second Low Fidelity Designs .......................................................................................... 24
    4.6.3 High Fidelity Design ......................................................................................................... 24

5 Results .......................................................................................................................................... 25
  5.1 Application Demonstration ....................................................................................................... 25
  5.2 Programming .............................................................................................................................. 27
    5.2.1 Loading the progress data on the Main activity ................................................................. 27
    5.2.2 Selecting the session time ............................................................................................... 28
    5.2.3 Reading the heart rate data throughout the meditation session ....................................... 28
    5.2.4 Updating and saving user session data ............................................................................ 29
    5.2.5 Processing results ............................................................................................................. 30
    5.2.6 Counting down the timer ............................................................................................... 31
  5.3 Unified Modeling Language (UML) ......................................................................................... 32
    5.3.1 Use Case Diagram ............................................................................................................. 32
    5.3.2 Class Diagram .................................................................................................................. 33
    5.3.3 Sequence Diagram ............................................................................................................ 34
  5.4 Testing ....................................................................................................................................... 35

6 Conclusion ..................................................................................................................................... 37
  6.1 Development Recommendations ............................................................................................ 39
6.1.1 Using more sensors
6.1.2 Development of a smart phone application
6.1.3 Improving the user interface
6.1.4 Improving accuracy of heart rate data
6.1.5 Social Features
6.1.6 Award feature
6.1.7 Music and guided meditations

7 References

8 Appendices

Appendix A: Interview Transcripts
A1. Interview Participant 1 Transcript
A2. Interview Participant 2 Transcript
A3. Interview participant 3 Transcript
A4. Interview Participant 4 Transcript
A5. Interview participant 5 Transcript

Appendix B: Consent Forms
B1. Participant 1 consent form
B2. Participant 2 consent form
B3. Participant 3 consent form
B4. Participant 4 consent form
B5. Participant 5 consent form

Appendix C: Ethics
C1. Ethics number
C2. Ethics Form

Appendix D: Photo evidence of test results
D1. Starting Application (Photo Evidence)
D2. Setting the Meditation Timer (Photo Evidence)
D3. Starting a New Meditation Session (Photo Evidence)
D4. Completing the Meditation Session (Photo Evidence)
D5. End the Meditation Session Early (Photo Evidence)
D6. View Heart Rate Data at the End of the Session (Photo Evidence)
D7. View Meditation Logs (Photo Evidence)
D8. Close Application (Photo Evidence)

Appendix E: Software source code

List of Tables

4.1 Table containing information on the existing applications discussed in the interview
4.2 Table containing information on the responses to the existing applications
4.3 Testing table containing test use cases, user input and expected outcomes
5.1 Test results table using tests discussed in the Methodology, includes actual outcome
## List of Figures

3.1. Opening screen of the Buddhist Meditation Trainer Application  
3.2. Session countdown screen of the Buddhist Meditation Trainer application  
3.3. Opening screen of meditation application, Calm.  
3.4. Profile screen of the Calm meditation application  
3.5. Photo of smart watch companion application for Calm  
3.6. Opening screen of the Guided Journeys Meditation application  
3.7. Changing the theme in the Guided Journeys Meditation application  
3.8. Countdown screen of the Guided Journeys Meditation application  
3.9. The main screen of the Headspace application  
3.10. Progress screen of the Headspace application  
3.11. The ‘Buddies’ screen of the Headspace application  
3.12. The opening screen of the Mindful Minutes application  
3.13. The rewards feature in the Mindful Minutes application  
3.14. Completed meditation session screen in the Mindful Minutes application  
3.15. The opening screen of the Smiling Mind meditation application  
3.16. The program selection screen of the Smiling Mind meditation application  
3.17. Mood checker feature found in the Smiling Mind meditation application  
3.18. The main opening screen of the Heart Rate OS2 application  
3.19. Photo of the companion smart watch application for Heart Rate OS2  
4.1. Diagram representing the Model View Controller architecture  
4.2. Diagram representing the Android Activity lifecycle  
4.3. Diagram describing the Waterfall development lifecycle  
4.4. Picture of the first low fidelity completed done on paper  
4.5. Picture of the second low fidelity designs completed on paper  
4.6. Screenshot of the final high fidelity design completed graphically  
5.1. Photo evidence of the Main opening activity for HRmeditation  
5.2. Photo evidence of the Session activity for HRmeditation  
5.4. Photo evidence of the dropdown box used for selecting timer amount  
5.4. Photo evidence of the Timer activity with a timer amount of 0:52  
5.5. Photo evidence of the Timer activity with a timer amount of 0:08  
5.6. Photo evidence of the Results activity displaying heart rate data  
5.7. Photo evidence of the Main activity with updated session data  
5.8. Screenshot of the code for the ‘loanInt()’ method  
5.9. Screenshot of the code for the ‘setupCounts()’ method  
5.10. Code run each time an item is selected from the dropdown  
5.11. Screenshot of the code run each time the sensor notices a change  
5.12. Screenshot of the ‘setupSensor()’ method  
5.13. Screenshot of the ‘createInt()’ method used to save to SharedPreferences  
5.14. Screenshot of the ‘updateInt()’ method used to update SharedPreferences  
5.15. Screenshot of code used to calculate the average heart rate  
5.16. Screenshot of the code used to calculate the change in heart rate  
5.17. Screenshot of the ‘setupTimer()’ method explaining the timer function  
5.18. Screenshot of the ‘setTimer()’ method used to update the timer Text View  
5.19. Use Case Diagram representing a typical use of the software  
5.20. Class Diagram used to represent the classes, variables and methods  
5.21. Sequence Diagram used to show how data is passed between objects
1 Abstract

This dissertation explores the topic of meditation when practiced using a mobile application. The literature review explores the history of meditation and the scientific studies that examine its effects. It was found that meditation has the potential to improve one’s health and wellbeing, and can physically alter specific portions of the brain known for processing emotions. Meditation has been proven to improve the symptoms of depression and anxiety, and can support people suffering with substance abuse and obesity. The goal of the project is to develop a stand-alone meditation application developed for an Android smart watch utilising the user’s heart rate. The intention of the application is to introduce people to meditation by using heart rate data to demonstrate its immediate positive effects. After testing the existing software available, it was found that an application of this type does not exist, and based on the opinions expressed in interviews, there is a demand for such an application. Interview results were dependent on the participants meditation experience, the findings suggest that people with less experience are more likely to use a meditation application than people with more experience. It was also discovered that meditation applications seem to be most effective in introducing people to meditation rather than providing long-term assistance. The application has been successfully developed to a prototype standard and recommendations have been suggested to continue development to a market-ready standard. The application has been developed for the Android operating system using the Java programming language and XML markup. The successful test results suggest that the software functions efficiently, meets the application requirements and has the potential for further development.
2 Introduction

Meditation has been practiced for centuries; once only associated with the Buddhist religion, it is now used daily by millions in the ‘Western world’ to improve mental and physical health (NCCIH, 2012). The National Center for Complementary and Integrative Health has funded many investigations that explore meditation. Their studies provide evidence that meditation may reduce blood pressure, symptoms of Ulcerative Colitus, anxiety, insomnia and depression. The NCCIH also found that millions of people around the world practice meditation everyday; in fact, 8% (18 million) of U.S adults practiced meditation in the year 2012 as a ‘mind and body practice’. Meditation is growing in popularity and has been scientifically proven to lower stress levels, boost creativity and cultivate healthy habits. There are a variety of meditation applications available for mobile devices, some of which are discussed in chapter 3. The existing applications on the market are designed to help users track their meditation progress, and some are intended as a meditation guide for beginners. The application developed in this dissertation is focused on a form of Android specifically catered to the Android smart watch, Android Wear. The Android operating system has become hugely popular since Google purchased it in 2005, it now has around one billion users worldwide (Griffiths and Griffiths, 2015). In fact, the amount of Android devices now in use is greater than the number of devices of all other mobile operating systems combined (Burton and Felker, 2015). The increasing popularity of the operating system along with its growing range of platforms makes developing for Android extremely worthwhile.

After exploring the existing applications, it quickly became clear that there is a lack of applications currently developed for the Android smart watch. Android smart watches run a version of Android called ‘Android Wear’, which allows users to interact with their smartphone via Bluetooth to extend their mobile applications from their phone to their wrist. Most Android Wear smart watches utilise a heart rate monitor built into the watch, which at the moment is mainly used for fitness type applications. This dissertation explores an alternative use for the heart rate monitor through the practice of meditation. One of the results of practicing meditation (if performed correctly) is the slowing of one’s heart rate; in fact, there is a meditation technique based around this very process. The ‘Heart Rhythm Meditation’ follows the ‘full, rhythmic and balanced’ beating of one’s heart whilst meditating and is described as a ‘powerful way to energize the heart’ (Bair and Bair, 2007). Measuring one’s heart rate whilst meditating would not only provide another statistic for tracking the user’s progress, it may also help beginners understand the immediate benefits of meditation before they begin to doubt its effects. One of the greatest issues beginners face when practicing meditation is the feeling of dissatisfaction as they expect results too soon. Demonstrating to users how much their heart rate was lowered by due to a meditation session may help to solve this problem; it would provide some immediate positive effects from their practice, which may be motivating.
Semi-structured interviews were conducted on five people with a range of meditation experience. Participants shared information on their own meditation experience, their meditation limitations, and their opinions on existing applications. The information gathered from these interviews helped shape the requirements of the application; this ensures the application is developed to suit its target audience. The literature review in this dissertation explores the academic papers, reference books and scientific studies based on the topic of meditation and mindfulness. The positive and negative effects of meditation are discussed, along with real-world examples of its use. Chapter 3.1 examines a collection of existing meditation applications, the unique functionality of each are discussed, and their features are considered and later discussed with interview participants. It is important to explore existing applications to ensure an application similar to the one being developed in this project does not already exist. The Methodology chapter discusses the dissertation’s research methods and the tools used to develop the application, including a brief overview of the Android operating system. The second half of the Methodology discusses the application requirements, the testing methods and the graphical user interface of the application. Chapter five demonstrates the application features, explains the code behind its main functions, outlines the software using UML diagrams and displays the test results.

The application being developed is a stand-alone Android Wear application that is designed to run independently on an Android smart watch. Android Wear is a relatively new technology, and there are many benefits to developing for a platform at its early stages. Alex Ho (2015) is an Android developer; he explains how critical it is to develop for Android Wear before it becomes widely used, he refers back to how many developers did not foresee the potential of the smartphone and missed out. Developing for Android Wear at this stage may provide opportunities for developers, as there is less competition compared to the smartphone market. Presently, there is only one meditation application available that makes use of an Android smart watch. The application ‘Calm’ is a popular meditation application that provides users with a progress report on a smart watch, however, it does not utilise the heart rate monitor. The only other alternative is ‘Buddha Mind’, an application designed to track meditation sessions whilst measuring the user’s heart rate. To use the application the user is required to purchase an expensive third party heart rate monitor and the application is no longer supported by its developers (its most recent update was 2012). There is currently a gap in the market for a meditation application that makes use of the heart rate monitor built into Android smart watches. With the rising popularity of meditation and the Android platform, now is an appropriate time to act on this gap in the market. The intention of this project is to develop a stand-alone Android smart watch application, designed to help relieve stress through the practice of meditation. Using a heart rate monitor will provide users with an additional method of tracking their progress and may expose beginners to the immediate benefits of practicing meditation. Many have discovered the positive effects meditation has brought to their everyday lives, and the objective of this dissertation is to develop an application that provides beginners with a path to explore these benefits.
3 Literature Review

This dissertation focuses on one of the oldest of the Buddhist meditation practices: ‘Vipassanā’ (Gunaratana, 2002). ‘Vipassanā’ meditation shapes the foundations of many other forms of meditation and translates to ‘seeing deeply or clearly’ (Thrangur and Johnson, 2005). ‘Vipassanā’, also known as ‘Insight’ meditation, emphasises a focus on the breath with the aim of calming the mind (Eisler, 2015). It is used to improve the connection between one’s mind and body through self-observation, it is a form of meditation that has been widely adopted in the Western World (Hart, 1987). ‘Vipassanā’ meditation can be applied by people of any background and does not depend on one’s religion, which likely explains its popularity. The goal of ‘Vipassanā’ meditation is to reach a state of ‘uninterrupted mindfulness’ that shifts awareness (Gunaratana, 2002). The practice takes time, energy and a strict daily schedule; this is where mobile meditation applications can help. At the heart of ‘Vipassanā’ is mindfulness (Kabat-Zinn, 1994). In order to be mindful, one must continually observe their life without criticism and live consciously moment-by-moment (Williams and Penman, 2011). Kabat-Zinn discusses how an ‘ordinary waking state of consciousness is seen as being severely limited’ and describes mindfulness as ‘the opposite of taking life for granted’ and a tool for becoming ‘unstuck’ and ‘waking up’. Sam Harris (2014) compares the experience to ‘being fully immersed in a film, and suddenly realising that you are in the cinema watching a mere play of light on a wall’.

Mindfulness-Based Stress reduction (MBSR) is a form of mindful meditation that is practiced with the intention of reducing stress levels; it has been successfully used to treat a wide variety of illnesses. It was found that MBSR programs are effective at relieving the mental side effects of cancer (Speca et al, 2000). The study consists of 91 cancer patients that each completed a 7-week meditation course. The treatment successfully decreased symptoms of depression, anxiety, anger and confusion, resulting in an overall ‘reduction in Total Mood Disturbance’ of 65%. The study concludes by stating that even greater benefits ‘may accrue to participants who continue to practice over time and become more adept’. Gotink et al. (2015) found similar results when exploring the effects of MBSR programs on cancer sufferers. This study also discovered that cancer patients experienced lower depressive symptoms, anxiety, and an improved overall quality of life upon completing a MBSR program. Designer of MBSR, Dr. Jon Kabat-Zinn (1982) explored the results of MBSR programs on patients suffering with chronic pain. The results of the study found that half of patients experienced a 50% decrease in pain and two thirds of his patients experienced a 30% pain decrease after a 10-week program. Participants also lowered their dependency on pain relief drugs and experienced an increased self-esteem. Mindfulness-based stress reduction programs completed on people suffering with substance abuse proved more effective than waitlist controls and educational support groups (Chiesa and Serretti, 2013, Garland, Froeliger and Howard, 2014). Studies found a reduction in the consumption alcohol, cocaine, amphetamines, marijuana and opiates in participants, and more of an awareness of their addictions. Similarly, another study confirms that addicts can be made more aware of
their drug habits after completing a mindfulness course. Evidence suggests that MBSR programs can reduce the symptoms of many mental illnesses. The practice has been used to prevent the relapsing of individuals suffering with depression and has been proven effective in lowering anxiety and stress whilst improving quality of life (Gotink et al, 2015). Kabat-Zinn (1992) conducted a study on 22 people suffering with anxiety; each participant completed a 3-month MBSR program and relaxation program. 20 of the participants documented reductions in the symptoms of anxiety and depression and ‘the number of subjects experiencing panic symptoms was also substantially reduced’. MBSR programs have also been proved effective in treating obesity (Raja-Khan et al. 2015), Multiple Sclerosis (Mills, 2000) and Diabetes (Hartmann et al. 2012).

As ‘Vipassanā’ meditation has no connection to religion, it has been widely studied by scientists and physiologists in order to explore its effects. There are many studies that have revealed physical alterations in the brains of people who practice meditation. A recent study at Harvard Medical School (Harvard Gazette, 2012) found that after 8-week meditation there were alterations in regions of the brain associated with emotions, memory, empathy and stress. The study found participants that reported reductions in stress levels also had reductions in grey-matter density in the amygdala, an area of the brain that related to anxiety and stress. Luders (2009) also found extra gray matter in regions of the brain associated with attention and managing emotions while studying the brains of people practicing meditation. In a similar study undergone by Harvard University, results suggested that people suffering with chronic pain could potentially relieve symptoms through the practice of meditation (Trafton, 2011). The study found that after an 8-week meditation training program, people were able to demonstrate better control of their alpha rhythms. Alpha rhythms are a specific type of brainwave thought to help lower the impact of ‘distracting sensory information’ such as pain signals. In 1966 the same results were discovered with Buddhist monks. Lutz et al. (2008) discovered physical changes to the brain whilst performing a form of meditation that emphasizes on the projecting of compassion for the people around you. The results of the ‘Compassionate’ meditation study found a higher level of activity in the area of the brain responsible for detecting emotional cues. Other research completed by Lutz found that practicing meditation based around the concentration of a single object (e.g. the breath) increases activity in the region of the brain known to regulate concentration. These scientific studies demonstrate evidence that meditation can physically improve many aspects of one’s life. Due to the complexity of the studies, only more recently have these tests been able to be completed; yet the results support statements made by meditators before these tests were a possibility.

The Huffington Post (Fay, 2015) discusses the ‘dangers’ of mindful meditation, suggesting that mindful meditation may leave people chasing a ‘feel good’ state if not practiced correctly. The news article also explains the meditation may provide a method of avoiding the problem’s in a persons life due to a feeling on contentment. Potential issues have also been raised on the side effects of prolonged meditation sessions (Booth, 2014, Rubin, 2001) practiced by people with little experience. The article explains how meditation
can bring forward bad memories from the past, which could result in negative effects and feelings of depression. People unaware of these potential meditation side effects may find it difficult to contend with the negative emotions that may arise. Part of the practice of meditation involves ‘letting go’ of the past and not thinking about the future. Rubin (2001) describes meditation as an ‘imperfect tool’ that provides a way for one to ignore their thoughts and emotions. He states that meditation can be restricting, especially for people that are unable to face their problems. This point is extended further by Stock (2006), who explains that many unlawful and inhumane acts, such as suicide bombings have been justified with the aid of meditation. Cancer Research UK states that meditation is ‘very safe’ and that negative side effects are rare. However, people with any type of mental illness may worsen negative symptoms such as depression, anxiety and psychosis. People suffering with mental illness may use meditation to bring clarity to their illness, however, this can leads to feelings of sadness and distress.

Scientific studies have shown that meditation may prevent depression, anxiety and stress by positively affecting brain patterns (Williams and Penman, 2011). It has also been suggested that it can improve romantic relationship and lower emotional stress (Barnes et al., 2007). Meditation has been used to decrease aggression in children with autism (Singh et al., 2006) through mindful parenting. 40 Chinese studies displayed higher levels of concentration after 5 days of 20-minute meditation sessions; the study also reported a significant decrease in stress levels, anxiety and anger (Tang et al., 2007). Women in Thailand have used meditation as a way to manage AIDS. Their practice has helped them accept their illness and regain control of their health, in the hope of prolonging their survival (Dane, 2002). Meditation has been used to treat a large array of different illnesses and conditions, and the literature available is vast. The practice is already hugely adopted in the Western World, and its popularity continues to increase.
3.1 Existing Applications

There is a selection of meditation application already available to download from the Android Marketplace. All the meditation applications discussed in this chapter implement the fundamental features required to complete a meditation session, such as a timer and alert feature. This chapter discusses six meditation applications and their unique functionality; although not related to meditation, the seventh application tested is a heart rate monitoring application that uses an Android smart watch.

3.1.1 Buddhist Meditation Trainer, developed by Spacebug

(Figure 3.1 (above left): The opening screen of the application displaying the instructions to the user. Figure 3.2 (above right): The countdown screen of the application where the user completes their meditation session)

Described on the Android Marketplace as a meditation trainer and a ‘trainer to happiness and enlightenment’. The application opens with a welcome screen asking the user to click on the icon in order to start a 3-minute meditation session. Once the user taps the icon, a quote appears along with an image and a timer running across the bottom of the screen. Although the application functions correctly, the design seems outdated and there was no further functionality available, such as a progress tracker or friend feature.

3.1.2 Calm, developed by Calm.com, Inc.
Calm is one of the more popular meditation apps available on the Android Market; it provides users with a range of meditation programs, progress trackers and smart watch functionality. The application is aesthetically pleasing and implements a range of functionality. Calm includes meditation courses that cater to a range of experience and has a login feature for users to track their progress through a personal profile. The companion smart watch application is limited as it only shows a progress report and does not make use of a heart rate monitor.

3.1.3 Guided Journeys Meditation, developed by BalanceInMe.com

Upon opening the Guided Journeys Meditation application the user is able to select a theme from a preset list, such as ‘Forest’ or ‘Star Journey’. Each theme uses a different guided meditation clip and a change in music track. Once the ‘Start Meditating’ button is tapped the session begins and the countdown starts, the user can then either pause or stop the session using the buttons on the screen. The application functions fine as a simple meditation application, the collection of themes are a good and the application is easy to use. However, the interface seems outdated and it lacks features that are found on other applications discussed in this chapter.
3.1.4 Headspace, developed by Headspace

(Figure 3.9 above left): Main screen for Headspace, contains a timeline to show session progress and a tabbed interface for navigation. Figure 3.10 (above centre): Progress screen of Headspace, displays the user’s session data. Figure 3.11 (above right): ‘Buddies’ feature within Headspace that displays all friends and the option to add new friends.)

The Headspace meditation application is a sophisticated piece of software with a creative interface and large collection of features. Headspace has an intuitive interface, detailed progress reports and a ‘Buddies’ feature for connecting with friends. Being able to connect with other users is an interesting feature that was not discovered in the other applications tested. The application is suitable for beginners as it includes step by step tutorials for each meditation session. At this time the application does not make use of an Android smart watch, although it may be added at a later date.

3.1.5 Mindful Minutes, developed by RdyDev

(Figure 3.12 above left): Opening screen for Mindful Minutes displaying a quote, two-minute timer and a start button. Figure 3.13 (above centre): Rewards feature in Mindful Minutes, displaying the users achieved and unachieved ‘Badges’. Figure 3.14 (above right): A completed meditation session, the application displays a message to the user with a button to return to the main screen.)
Mindful Minutes is based around the idea of everyday mindfulness. The application consists of a timer and a quote, once the user taps the ‘Start Mindfulness’ button the timer begins. The application is easy to use and the ‘Badges’ feature is a clever addition. If the user reaches a certain set goal (e.g. 10-day streak) they are rewarded a badge within the application. This bonus feature makes it more likely that a user will continue practicing meditation through the application.

3.1.6 Smiling Mind, developed by Smiling Mind

(Figure 3.15 above left): Opening screen of Smiling Mind displaying the user’s session data and achievements. Figure 3.16 (above centre): The program selection screen in Smiling Mind containing a selection of programs based on the user’s age or ability. Figure 3.17 (above right): Mood checker feature in Smiling Mind, this screen is displayed before a meditation session.

Upon opening the Smiling Mind application, the user is presented with a dashboard showing the amount of meditation minutes they have already completed. The application has a selection of meditation programs that are catered to different ages, once the user selects their age they are presented with suitable guided meditation clips to complete. Before a meditation session begins a screen is displayed asking the user how they are feeling, this is a unique feature that was not found in any of the other applications tested. Smiling Mind does not include a smartwatch companion application.
3.1.7 Heart Rate OS2, developed by LFApp

(Figure 3.18 (above left): The main open screen of Heart Rate OS2, containing a button that begins a heart rate check, some preferences and a progress chart Figure 3.19 (above right): The Android Wear companion application that uses the heart rate monitor within a smart watch.)

Heart Rate OS2 makes use of the heart rate monitor built into the android smart watch. The application tracks changes in the users heart rate over a time and includes an ‘automatic check’ feature that checks the heart rate at set intervals. The application is an example of how the heart rate monitor can be utilised for application that are not fitness related. It has a good interface and provides the user with fast, reliable results. However, the application is limited without paying for an updated version.

3.1.8 Literature Review Summary

It is only more recently that scientists are able to explore the effects of meditation in greater detail by using modern technology to examine the brain. Due to these studies, evidence has been found that demonstrates the physical positive effects associated with the practice meditation. Positive results have also been discovered in real life scenarios such as people suffering with depression and substance abuse. Mediation has an extensive history, and the literature suggests that the practice has undergone little change since its introduction into the Western World. The amount of meditation applications already available confirms that the demand for applications of this type is real. All the existing meditation applications discussed in this chapter include some essential functionality such as a countdown timer, yet each provides its own collection of unique features. Some of these features may be unnecessary, yet some may be the application’s greatest selling point.
4 Methodology

4.1 Research Methods

An interview has been conducted to gather information for the requirements of the application. It was important that the interview participants ranged in meditation experience in order to gather valuable, reliable data. Participants with a lot of experience were likely to deliver information on the effects and issues related to long-term practice and were more likely to have prior experience with using existing applications. While participants with less meditation experience are more likely to provide data related to beginners. It will also be useful to compare the information based on the amount of experience the participant has; for example, someone with more experience may express different opinions on the existing application features to someone with little experience. The participants were interviewed to gather information on the following:

- Their experience with meditation, what type of meditation they practice and what they feel are the biggest challenges that beginners face
- Their experience with meditation applications, what features they liked or disliked
- Their experience as a beginner and their advice towards people new to meditation
- Their opinion on meditation application features that already exist (with examples)
- Their opinion on the application being developed, whether they would consider using it and if they think the heart monitoring feature is unique enough to warrant its development

The interview questions are designed to encourage an open answer from participants to avoid a yes/no answer, this encourages participants to talk freely about their experience. The interviews followed a semi-formatted structure to allow participants to give their honest opinions and to be as open as possible. Semi-structured interviews are a way of gathering information by simply having a conversation with a participant using an open-minded approach (Miles and Gilbert, 2005). Using a semi-structured interview structure gave participants the opportunity to discuss their personal meditation challenges and give their own opinions on existing applications. Giving participants more control over the interview may provide relevant information that was not previously considered (Corbin and Strauss, 2015). The Interviews varied in length (between 10 and 40 minutes) and were recorded, the transcripts can be found in the appendices A. As participants may have varied in experience with using existing meditation applications, a set of existing application features were discussed. Discussing existing application features will determine the most important features that need to be implement into the application. The applications that were discussed are as follows:
<table>
<thead>
<tr>
<th><strong>Application Name</strong></th>
<th><strong>Features to discuss</strong></th>
<th><strong>Expected outcome</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Headspace</td>
<td>Connectivity to friends to compare meditation progress, timeline-style meditation sessions</td>
<td>Good response to social aspects of application</td>
</tr>
<tr>
<td>Calm</td>
<td>Creative interface and amount of different guided meditations</td>
<td>Positive reaction to interface and interested by provided meditations</td>
</tr>
<tr>
<td>Smiling Mind</td>
<td>Mood checker before beginning meditation</td>
<td>Unsure of it’s value to the application</td>
</tr>
<tr>
<td>Mindful Minutes</td>
<td>‘Badges’ feature that rewards user for progress</td>
<td>Positive reaction as it is an interesting way of emphasizing consistency</td>
</tr>
</tbody>
</table>

(Table 4.1: Information on the existing applications to be discussed in the interview)

Each participant was asked the same set of questions related to their meditation experience, their stress levels and their experience with meditation applications. Existing applications were then discussed and the participant was able to give their opinion on the application being developed within this dissertation. Upon completion of the interviews a set of requirements will be structured for the application. The requirements will be created using information gathered from the target audience to ensure the application implements essential features and does not include any unnecessary functionality. Many of the application requests may not be implemented in the prototype due to how advanced they may be. These potential requirements are discussed further in the recommendations section of this project.

4.2 Tools Used in the Development of the Prototype

4.2.1 Android Operating System

The Android operating system is the world’s most popular mobile platform with around one billion active devices around the world (Griffith and Griffith, 2015). Due to its popularity, developing for Android gives developers the potential to reach millions of users worldwide. Android developers are able release their applications across a range of different platforms to reach a wider audience. Android can now be found running on a range of devices, including tablets, wearable technology, cars and televisions. Android's closest competitor is Apple’s iOS. Android is acknowledged as being an ‘open’ platform that gives developers more permission to the overall system than iOS. The application was not developed for iOS as the operating system does not provide enough flexibility for development.
4.2.2 Android Smart Watch Running Android Wear

Most applications available on the Android market are developed for the smartphone operating system; some of these applications include a ‘companion’ smart watch application that is developed for Android Wear. There are stand-alone Android Wear applications available, but they are usually simple and do not rely on any of the functionality built into the smartphone. One of the main reasons for developing a stand-alone Android Wear application is due to the convenience it brings to the user. It is easier for a user to quickly start a meditation session with a tap of a button on their wrist rather than having to use both their smartphone and smart watch together. All the functionality required for the application is built internally into the smart watch, so it only makes sense that the application runs independently. Developing for an Android smart watch has its limitations due to the small screen size and lower processing power. Designing for such a small screen size can quickly become messy and unorganized so it is important that screen space is used as effectively as possible. To overcome these problems, the application’s user interface will be designed using large buttons that are easy to tap and small amounts of large text that is easy to read. Due to the lower processing power available on a smart watch, using resource-hungry components such as high resolution graphics or animations should be avoided as much as possible. The smart watch used for testing and debugging purposes for this project is the 2nd generation Motorola 360 smart watch as it includes a heart rate monitor and some of the latest hardware components available. However, the application will be tested on multiple virtual smart watches to ensure it functions correctly on different screen sizes and older models.

4.2.3 Android Studio

The integrated development environment (IDE) used for this project is the official IDE by Google - Android Studio. Android Studio provides an all-in-one package for Android development by including a range of useful functionality. Android Studio offers the following features that will aid in the development of the application:

- Code editor that allows developers to be more productive by including features such as code suggestions
- Code templates such as Activity templates, Android Studio can automatically set the framework for a new project
- Virtual devices so the application can be tested on a range of devices without having to physically own them
- Multi-screen development for developing on multiple Android platforms, this will be useful when developing for the Android watch

The Android Studio handles all of the ‘heavy lifting’ by including a ‘Gradle-based’ system that is capable of bundling the application to a standard ready for market. Upon creating a new project, Android Studio asks the developer what the minimum Android version the application can be run on. The feature allows the application can reach as many users as possible and includes
support for older versions of Android to ensure users with older devices do not have compatibility issues.

4.2.4 Architecture

The Android Wear application will be developed using XML and Java. XML is a markup language that processes the layout for the application and Java is an object-oriented language that gives the application its functionality. Put simply, an Android application consists of activities and views, activities can be described as the application’s ‘screens’ and the views are essential the content on each activity (e.g. buttons or text). Android applications are designed around the Model-View-Controller (MVC for short) architecture. MVC architecture separates code in a way that makes it easy to understand and control, all objects in an Android application are either a module object, a view object, or a controller object.

- **Model objects** hold all the application data; model objects are not aware of the user interface, their only purpose is to hold data. An example of a model object is a product item in a store.

- **View objects** are essentially objects on the screen that manage the display of information. If an object on the screen can respond to the user, it is a view object. An example of a view object is a button on an application screen.

- **Controller objects** link the view and model objects together by responding to various different events. An example of which is if the user selects a ‘next page’ button, the controller tells the view and model objects to change page and update the information.

(Figure 4.1 (above): Diagram representing the Model View Controller architecture using in Android development)

The diagram above outlines the way in which MVC functions in an Android application. An example of a real life scenario using this architecture is:

1. The user selects a ‘Next Page’ button on the screen
2. The system tells the controller that the view (button) has be interacted with
3. The controller updates the model objects to reflect the changes in page
4. The controller gathers the updated information required for the next page
5. The view is updated and the next page is displayed

4.2.5 Android Activity Lifecycle

Each Android Activity (screen) has a lifecycle, as a user navigates the application, leaves the application and then comes back to the application, the Activity transitions between the following cycles:

(Figure 4.2 (above): Diagram representing the Android Activity Lifecycle explaining the processes an activity may complete in its lifetime)

When the application is opened, the main activity is created, and onCreate() and onStart() is run. Once the user can view the activity, onResume() has been called and the application is classed as ‘running’. If there is an interruption whilst the application is running, such as another activity coming to the front, onPause() is called. Once the interruption is stopped, onResume() is called again and the application continues to run. If the user selects the home button on their device the activity is stopped and onStop() is
called, if the user presses the back button on their device onDestroy() is called. This lifecycle means developers have more flexibility when developing an application, it helps prevents data loss and improves performance when the application is running in the background (Phillip and Hardy, 2015).

4.2.6 Waterfall Software Development Lifecycle

(Figure 4.3 (above): This diagram outlines the processes involved in a Waterfall development lifecycle, each process is followed by the last replicating the flow of a waterfall)

The software development lifecycle (SDLC) is used to structure, plan and control the processes involved in the development of software (CMS, 2008). The Waterfall Development Life Cycle Method is used to represent the development processes involved a downward ‘flow’, like a waterfall. The project is split into sequential steps with each started once the previous step is completed. There are usually around 6 steps involved with the Waterfall method, each step is explained below.

Stage 1 – Requirements
Existing applications are tested to explore their functionality and the unique features of each are noted. Interviews are conducted on the target audience to explore their meditation experience, and their views on the existing applications on the market. The requirements of the application will be based on the literature and the results of the interviews.

Stage 2 – Designing
Based on the requirements, an architecture design is produced for the application. The requirements are transformed into full, detailed designs that outline how the user interacts with the application. This may includes the screen layouts, UML and any pseudocode.
Stage 3 – Implementation
The development stage is where all the code is written. Likely to be the largest stage in the development lifecycle, the application is to be developed to meet the standards of the requirements. The application is developed to a prototype level for this project.

Stage 4 – Verification
Ensures that the full system meets the requirements outlined in the first stage of the development cycle. The application is tested and all bugs are ironed out till it reaches the standard required for release. As this project builds the application to a prototype level, this stage will not be fully implemented.

Stage 5 – Maintenance
Although it does not apply to this project, if the application were to be produced to a full market-ready standard, it would be deployed to the market and the maintenance stage would begin. This stage would include maintenance for the existing users of the application and response to feedback.

4.3 Interview Results

Five people with a range of meditation experience were interviewed in order to explore their own meditation experience. Participants were also asked to express their views on existing applications and their opinion on the application being developed within this dissertation. The interviews offered interesting data as different opinions were discovered depending on the participant’s experience. For example, the participant with the most experience (16 years) said that he/she would not consider using any of the existing applications. Whereas the participant with the least amount of experience (4 months) stated that he/she would consider using all of the existing applications discussed. This suggests that meditation applications are suitable for introducing people to meditation but do not provide a long-term solution. The participant with the most experience agreed that these applications would be suitable for beginners but discussed the importance of becoming independent in your practice after a set amount of time. All interview participants agreed that the heart rate monitor feature makes the application unique enough to warrant its development. The participants showed an interest in the idea and all stated that they would consider using the application to track the changes in the heart rate whilst meditation.

There were some varied responses to the existing application features discussed in the interview. Many of these responses did not follow the expected outcomes discussed in chapter 4.1. The results were as follows:

<table>
<thead>
<tr>
<th>Application</th>
<th>Features discussed</th>
<th>Expected outcome</th>
<th>Actual outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headspace</td>
<td>Connectivity to friends to compare meditation</td>
<td>Good response to social aspects of application</td>
<td>There was not a positive response to this feature. Most</td>
</tr>
</tbody>
</table>
progress, timeline-style meditation sessions

participants stated that the feature makes meditation competitive when it should not be a competitive practice.

**Calm**

Creative interface and amount of different guided meditations

Positive reaction to interface and interested by provided meditations

Good response to the interface of the application. One participant had used the application previously and did not like it.

**Smiling Mind**

Mood checker before beginning meditation

Unsure of it’s value to the application

The main issue discussed with this feature was that fact that it only accepted a digital response (either yes or no). One participant also thought the feature would function better after a session rather than before.

**Mindful Minutes**

‘Badges’ feature that rewards user for progress

Positive reaction as it is an interesting way of emphasizing consistency

4 out of 5 of the participants liked this feature. However, only one participant said they would consider using it.

(\textit{Table 4.2 (above): Table discussing the responses to the existing application features})

Although there were mixed response to the existing application features, all participants could see how the features may assist beginners. The response to the ‘Buddies’ feature in Headspace was unexpected, participants believed the feature gave meditation a competitiveness that it does not need. One participant stated this feature could potentially increase stress levels rather than lower them. It is important that the heart rate feature is unique enough to warrant the development of the application and one of the main objectives of the interview was to confirm this. Thankfully, all interview participants agreed that the application should be developed, as it is unique enough to fill a gap in the market. When participants where asked what they believed were the biggest challenges for beginners, all answers shared a common reply. Each participant discussed the problems associated with expecting results too quickly whilst meditating, which leads to frustration and a lack of motivation. Two participants stated the practicing everyday is difficult and advised that beginners create a routine where they meditate at a set time everyday. Overall, the interview results provided valuable information that greatly influenced the application requirements discussed in the next chapter.
4.4 Application Requirements

Producing requirements has been described as one of the most challenging processes in software development, and one of the most important (Wiegers, 2010). According to the IEEE (1998), the gathering of software requirements helps customers describe exactly what they wish to obtain from the software and helps the suppliers understand the customer’s needs. As this project is only to be developed to a prototype standard, the following IEEE recommended software requirements are addressed:

- What the software is supposed to do
- How the software interacts with people, the system’s hardware and other external hardware
- The performance of the system including response times and recovery times

The application requirements were decided based on the results of the interview, they are as follows:

**Requirement 1 - The application must allow users to set a timer for their meditation session.**
An essential feature found in all of the existing applications tested, a timer is required to alert the user when their meditation session is complete. The timer can be adjusted between 1 minute and 120 minutes depending on the user’s needs.

**Requirement 2 - The application must keep a log of meditation sessions in order to track progress**
Tracking the user’s progress will provide a way of displaying improvements over time that may keep the user motivated. The main objective of the application is to introduce people to the benefits of meditation when used for stress management, these benefits may be easier to discover if the user is able to track their progress over time. All of the interview participants agreed that being able to track their progress is an essential requirement for the application, 4/5 participants also stated that this feature would most likely motivate them to continue their meditation practice.

**Requirement 3 – Heart rate data should be displayed to the user at the end of their meditation session**
The application is required to monitor the user’s heart rate whilst meditating in order to show the changes before and after a session. In principle, this feature will display to the user the immediate effects of meditation. Once a meditation session is complete the application will display how much the user’s heart rate was lowered by.

**Requirement 4 - The heart-rate data should be logged alongside meditation data to track progress**
The heart rate monitoring feature of the application is what makes it unique, therefore, it is important to track the change in heart rate over time. After
discussing this requirement with the interviewees, it was decided that the average heart rate reading from the previous session should be displayed on the main application activity. This way, the user can view the changes in their average heart rate reading as they continue their practice.

4.5 Testing

The application testing begins in the ‘Verification’ stage of the waterfall development method. According to ‘The Art of Software Testing’ (2012) approximately 50% of the time and 50% of the costs involved in the development of software is dedicated to testing. There is a range of testing techniques available, many of which are discussed below, this project implements manual testing. This tests the software manually without the use of any automated tools such as written scripts or downloaded software. Below are a few other types of testing methods:

- **Unit Testing** – Take a small piece of the software and test it outside the rest of the application to ensure it works as expected (Microsoft, 2016).
- **Black Box Testing** – Testing method that tests the system without knowledge of the inner workings of the system. The tester only knows the inputs and the expected outputs for the system.
- **White Box Testing** – The tester is required to understand the internal structure of the software to check what code is behaving incorrectly.
- **Grey Box Testing** – The more knowledge the tester has of the system the more capable they are of testing it. The tester has access to more of the system such as design documents and databases.
- **System Testing** – Entire system is tested based on the requirements set at the start of the project.
- **End-to-end Testing** – Similar to system testing but the tester mimics real world use. This might include network connects or connecting to external hardware.

**White Box Testing**
The Android application will be tested using the White Box testing method. This method of testing is suitable for the project as, being the developer, I have a full understanding of the inner workings of the system. If there is any code in the application that is behaving incorrectly it will be corrected and retested.

**System Testing and End-to-end Testing**

Laurie Williams describes the testing stage as the ‘process of analysing a software item to detect the differences between existing and required conditions’ (2006). In order to do exactly that, once the application is completed to a prototype standard the system will be tested to ensure it meets the software requirements. If the software meets its requirements, the system testing will be classes as successful, if the system does not meet its requirements, changes may have to be considered. End-to-end testing is
essential as it tests the application in a real world situation. Below is a test case table outlining all the tests to be completed:

<table>
<thead>
<tr>
<th>Use Case</th>
<th>Test</th>
<th>Input</th>
<th>Expected Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Starting Application</td>
<td>Testing that the application starts when the icon is selected</td>
<td>User selects application icon</td>
<td>Application loads default activity with no errors</td>
</tr>
<tr>
<td>2 Setting meditation time</td>
<td>Ensuring the user can set the meditation session time</td>
<td>User changes pull-down lists to set a new time</td>
<td>User is able to set the meditation time correctly</td>
</tr>
<tr>
<td>3 Starting new meditation session</td>
<td>Testing that the user can start a new meditation session after setting the session time</td>
<td>User selected the ‘Start’ button</td>
<td>The meditation session begins and the timer begins to countdown from given time</td>
</tr>
<tr>
<td>4 Completing the meditation session</td>
<td>Testing a full meditation session to ensure there are no errors</td>
<td>None</td>
<td>The timer will count down to 0 and the user will be alerted</td>
</tr>
<tr>
<td>5 End the meditation session early</td>
<td>Ensuring the user can end a meditation session early without any errors</td>
<td>User selects the ‘End’ button to end the meditation session</td>
<td>The meditation session will end and the default activity will be displayed</td>
</tr>
<tr>
<td>6 View heart rate data at the end of the session</td>
<td>Testing the heart rate data is displayed correctly at the end of a meditation session</td>
<td>The user completes their session</td>
<td>The average heart rate reading will be displayed along with a reading of how much their heart rate lowered</td>
</tr>
<tr>
<td>7 View Updated Meditation Logs</td>
<td>Ensure that the user can view their meditation logs to track their progress</td>
<td>User views meditation logs on default activity</td>
<td>User will view their updated progress report on the Main activity</td>
</tr>
<tr>
<td>8 Close application</td>
<td>Test that the user can close the application without any loss of data</td>
<td>User closes the application by selecting the ‘Home’ button on their device</td>
<td>The application will close and the users data will be stored.</td>
</tr>
</tbody>
</table>

(Table 4.3: Table containing the testing methods to be completed once development is completed, includes user input and expected outcome)
4.6 Graphical User Interface

Designing a piece of software for a smart watch brings with it some unique limitations. There are many constraints to consider when designing for a mobile device due to different screen sizes and varied performance levels. Luke Wroblewski (2011) explains that 80% of the screen space from a desktop is missing on a mobile phone; a smart watch has an even smaller screen space so it is vital that the space is used efficiently. Steve Krug (2014) discusses the importance of user experience on mobile devices in his book ‘Don’t Make Me Think’. Krug discusses the idea that mobile interfaces must be extremely easy to use and not require any learning time. The user should be able to open the application and know how to use it without having to think about it. The design of the application needs to be clean, easy to use and should follow the design principles of the Android operating system. Android uses a design principle called ‘Material Design’ which Google describes as design that ‘synthesizes the classic principles of good design with the innovation and possibility of technology and science’ (Google, 2016).

4.6.1 First Low Fidelity Designs
The first design ideas for the application are drawn on paper to a low standard to simply experiment with the layout. These designs are likely to change throughout the process.

(Figure 4.6 (above): The first low-fidelity design of the application, created roughly on paper to discover the first iteration of the user interface)

The first design was tested to explore how suitable the design is for a smart watch; the results were as follows:

- The text is easy to read as it is large enough for the small screen size
- Square buttons do not suit the display size and are not consistent with the round buttons used on the ‘Set timer’ screen.
- The round buttons on the second screen are limiting, due to the small screen size the timer can be set to 60 minutes maximum
- The final screen does not display enough detail and could be more exciting
4.6.2 Second Low Fidelity Designs

(Figure 4.7 (above): The second low-fidelity designs drawn roughly on paper, based on the changes suggested after testing the first design.)

Following the results of the test results gathered from the first low fidelity design, the following changes were made:

- Buttons were made to look simpler, larger and round. They are more suited to a screen of this size.
- On the second screen a dropdown box is used to select the timer to expand the amount of timers available to the user.
- The results screen tells the user how much their heart rate was lowered by using a full sentence

4.6.3 High Fidelity Design

(Figure 486 (above): Final application design based on the testing of the low fidelity designs, created graphically to represent the final user interface of the application.)

Above is the graphical representation of the application based on the test results of the final low fidelity design. This is similar to how the final application will look; however, there may be some slight adjustments due to the constraints of the Android operating system. The following changes were made from the low fidelity designs:

- A royalty free background has been used to improve the design of the application, this background has been dimmed to ensure text is still readable
- Colour and a gradient has been added to the buttons to improve their design to ensure they are user friendly
- The start new meditation session button on the first screen has increased in size
5 Results

The application has been successfully developed to meet the requirements discussed earlier within this report. Within this chapter, the main functionality of the application is discussed along with its programming. The software is represented using UML diagrams to explore how the software interacts with its users, how the software objects interact with each other, and how data is passed around the application. Finally, the results of the tests are discussed based on the test use cases discussed in chapter 4.4.

5.1 Application Demonstration

Below is a demonstration of the application in action; its main functionality is discussed along with code examples and screenshots.

1. The user opens the application and the main activity is launched, their total session count, total time and last heart rate readings are displayed along with a button to start a new meditation session.

(Figure 5.1 (above): Photo evidence of the opening activity of the application displayed on a physical smart watch. Displays to the user their progress report and gives the option to begin a new session.)

2. The user starts a new session by selecting the button at the top of the main screen, they are passed to the ‘Session’ activity to select their session time. The session time can then be changed by tapping the arrow and selecting from the drop down list.
3. The meditation session starts and the timer begins to count down, the heart rate monitor begins reading the user’s heart rate and updates the label under the timer each time the heart rate changes. The round button under the heart rate label gives the user the option to cancel their session, if tapped, the user is returned to the Main activity screen and no session data is logged.

(Figure 5.2 (above left): An example of the next application activity that allows the user to set a timer from a dropdown list. Figure 5.3 (above right) the scrollable dropdown box used to set a timer.)

(Figure 5.4 & Figure 5.5 (above): The timer activity which displays a countdown to the user along with their heart rate reading, this reading updates each time the user’s heart rate changes)

4. The meditation session is completed, the watch vibrates to alert the user and the results activity is displayed. The average heart rate reading is shown along with the amount the heart rate was lowered by (In this case, the heart rate was not lowered at all).

(Figure 5.6 (above): The results activity that displays to the user their average heart rate and the amount their heart rate was lowered by)
5. The user is returned to the main activity where the counts have been updated to include the latest meditation session.

(Figure 5.7 (above): The main activity, now displaying updated session data based on the recently completed meditation session)

5.2 Programming

This chapter discusses the programming behind the application, only the main functions are discussed and screenshots taken from Android Studio are used to demonstrate the code. A brief explanation of each piece of code is provided.

5.2.1 Loading the progress data on the Main activity

Upon opening the application, the user is presented the Main activity and their progress data is displayed. This data is stored in the Shared Preferences within the smart watch and is gathered when the activity is created. The method below is used to get the data from the Shared Preference when a key is passed as a parameter.

```java
public int loadInt(String key){
    SharedPreferences sharedPreferences = PreferenceManager.getDefaultSharedPreferences(getApplicationContext());
    int savedValue = sharedPreferences.getInt(key, 0);
    return savedValue;
}
```

(Figure 5.8 (above): The ‘loadInt’ method responsible for retrieving session data from the SharedPreferences)

After the data has been gathered they are stored in variables and used to update the relative Text Views on the activity. This is done with the ‘setupCounts()’ method below:
public void setupCounts()
{
    // Get the session count from the shared preferences and set the textview
    int sessionCount = loadInt("session_count");
    mSessionCountText.setText(String.valueOf(sessionCount));

    // Get the total time count from the shared preferences and set the textview
    int timeCount = loadInt("time_count");
    mTimeCountText.setText(String.valueOf(timeCount));

    // Get the last session heart rate reading from the shared preferences and set the textview
    int lastHR = loadInt("last_hr");
    Log.i("last hr", String.valueOf(lastHR));
    mLastHRText.setText(String.valueOf(lastHR));
}

(Figure 5.9 (above): The ‘setupCounts’ method that updates the views on the activity to display the correct session data)

5.2.2 Selecting the session time

The user is able to change their session time by selecting from the drop down list on the ‘Session’ activity. The list is achieved by using an Android ‘Spinner’ object that uses an array of strings as its data source. Once the user selects an item from the dropdown box, the ‘onItemSelected’ method is called (screenshot below). This method retrieves the item at the position selected and converts it to an integer. This timer value is saved in a variable which is later passed to the next activity via an Intent.

@Override
public void onItemSelected(AdapterView<?> parent, View view, int position, long id) {
    // When an item is selected from the spinner, get its position and store in String
    String timeGathered = (String) parent.getItemAtPosition(position);

    // Extract integers from the string to get the timer amount
    timeGathered = timeGathered.replaceAll("[\D]", "");

    // Set the session time to equal the time selected
    sessionTime = Integer.parseInt(timeGathered);
    Log.i("Minutes selected", timeGathered);
}

(Figure 5.10 (above): This method is run each time an item is selected from the timer dropdown box, it sets the sessionTime variable to the selected timer value)

5.2.3 Reading the heart rate data throughout the meditation session

The application reads the user’s heart rate while the session is active, if the heart rate changes, the Text View on the activity updates. To achieve this, a SensorManager is used, and the ‘SensorEventListener’ interface is implemented so the ‘onSensorChanged’ method can be implemented. This method is run each time the heart rate sensor reading changes, it updates the text on the activity and stores the reading in an array. All the heart rate readings are stored in the array; this array is used later in the software to calculate the average heart rate reading. Below is the ‘onSensorChanged’ method:
public void onSensorChanged(SensorEvent event) {
    // If the timer is above 0...
    if (mTimerView.getText() != "0:00") {
        // If the sensor for heart rate changes
        if (event.sensor.getType() == Sensor.TYPE_HEART_RATE) {
            if(event.values[0] > 0) {
                // Create a string variable that stores change
                String hrMSG = "" + (int) event.values[0];
                hrReadings.add((int) event.values[0]);
            } else {
                Log.d(TAG, "Unknown sensor type");
            }
        }
    }
}

(Figure 5.11 above): Each time the user's heart rate changes this method is run, it retrieves the heart rate data and passes it to the relevant variables and text views.

Below is the ‘setupSensors()’ method that initializes the Sensor Manager and the heart rate sensor:

public void setupSensors() {
    // Setup hr sensor
    mSensorManager = ((SensorManager)getSystemService(SENSOR_SERVICE));
    mHeartRateSensor = mSensorManager.getDefaultSensor(Sensor.TYPE_HEART_RATE);
    mSensorManager.registerListener(this, mHeartRateSensor, 3);
}

(Figure 5.12 above): This method initiates the heart rate sensor by using a SensorManager and a Listener on the heart rate sensor.

5.2.4 Updating and saving user session data

The session data is stored in the smart watch Shared Preferences, once the user completes a session the total session count is incremented by 1, the latest session time is added to the total session time and the latest heart rate data is updated. Below is the methods used for creating or replacing data in SharedPreferences:

public void createInt(String key, int value) {
    // Shared preferences store the user's progress
    SharedPreferences = PreferenceManager.getDefaultSharedPreferences(getApplicationContext());
    SharedPreferences.Editor editor = sharedPreferences.edit();
    // Store new value and key
    editor.putInt(key, value);
    editor.commit();
}

(Figure 5.13 above): The method responsible for adding a new integer to the SharedPreferences.
Below is the method used for updating the data in SharedPreferences, this method is used to update the total session count and total meditation time completed:

```java
public void updateInt(String key, int value){
    //Shared preferences store the user's progress
    SharedPreferences = PreferenceManager.getDefaultSharedPreferences(this);
    SharedPreferences.Editor editor = sharedPreferences.edit();
    //Get current value and add the new value to it
    int oldValue = loadInt(key);
    editor.putInt(key, oldValue+value);
    editor.commit();
}
```

(Figure 5.14 (above): The method responsible for updating an integer already stored in SharedPreferences)

### 5.2.5 Processing results

Once the user completes their meditation session they are taken to the ‘Results’ activity where their heart rate data is displayed. In order to display the data, the average heart rate and heart rate decrease needs to be calculated. Each heart rate reading is stored in an array; the readings are added together and divided by the array size to calculate the average:

```java
//Loop through all hr readings and set averageHR to the average of them all 
int averageHR = 0;
for(int i =0; i < hrReadings.size(); i++){
    averageHR = averageHR + hrReadings.get(i);
}

averageHR = averageHR/hrReadings.size();
//Store average HR and save it to sharedPreferences
createInt("last_hr", averageHR);
```

(Figure 5.15 (above): A screenshot of the code used to calculate the average heart rate and store it in SharedPreferences)

To calculate the decrease in the user’s heart rate after the meditation session, the difference between the 3rd heart rate reading (the first two reading are inaccurate) and the last heart rate reading is used. If the application were fully developed it may be suitable to use a more accurate method to measure this.

```java
//Set hrDifference to be third reading take away last
int hrDifference = hrReadings.get(3) - hrReadings.get(hrReadings.size()-1);
```

(Figure 5.16 (above): The calculation used to find the amount the user’s heart rate was lowered by after their session)

The result data is then shared with the ‘Results’ activity via an Intent, and the data is then displayed to the user.
5.2.6 Counting down the timer

The CountDownTimer method is included within the Android operating system used to create a timer. The application uses this method to create the timer used for the meditation session. It accepts the timer value that the user selected on the previous activity and updates the text as the timer ‘ticks’ down.

```java
public void setupTimer(){
    new CountDownTimer((timerValue * 60) * 1000 + 100, 1000) {
        @Override
        public void onTick(long millisUntilFinished) {
            //Divide it by 1000 to get number of seconds
            setTimer((int) millisUntilFinished / 1000);
        }
    }
}
```

(Figure 5.17 (above): An snippet of the ‘setupTimer’ method to explain how the timer function is used to count down the user’s meditation session)

The ‘setTimer’ method updates the text on the activity each time the timer goes down by one. To ensure the text is displayed correctly to the user a small amount of validation is required to set the format to that of a clock countdown. Without this validation the timer would display ‘0:9’ instead of ‘0:09’. The ‘setTimer’ method is below:

```java
public void setTimer(int secondsLeft){
    //Get Minutes left
    int minutes = (int)secondsLeft/60;
    //Get seconds left
    int seconds = secondsLeft - minutes * 60;
    String secondString = Integer.toString(seconds);
    if(seconds <= 9){
        secondString = "0"+secondString;
    }
    mTimerView.setText(Integer.toString(minutes) + ":" + secondString);
}
```

(Figure 5.18 (above): The ‘setTimer’ method above is used to update the text view on the application activity. This is run each time the timer decreases by one, it converts the time to a String and updates the text accordingly.)
5.3 Unified Modeling Language (UML)

The Unified Modeling Language (UML) is the standard modeling method used to visualize the software through the use of various diagrams (Miles and Hamilton, 2006). UML helps to represent the structure and behaviour of the system to anyone that may need the information. This chapter contains three UML diagrams; the Use Case Diagram below represents an example use of the application where the user opens the application, begins a meditation session, completes the session and logs their progress. The Class diagram represents the class files, their relationships and their variables and methods. Finally, the sequence diagram shows how data and processes are passed between the objects within the software.

5.3.1 Use Case Diagram

(Figure 5.19 (above): Use Case Diagram representing a typical use of the application, the user (Meditator) opens the application, uses all its features and closes the application)
5.3.2 Class Diagram

(Figure 5.20 (above): The Class Diagram above represents the Class files within the application, each table contains the class variables and methods. The symbols are used to state whether the item is public (+), private(−), overwritten(#) or none (~))
5.3.3 Sequence Diagram

(Figure 5.21 (above): The Sequence Diagram above explains how data and processes are shared between the software's objects over time.)
5.4 Testing

HRMeditation has been developed to a prototype standard; tests have been completed to ensure the application meets its requirements. The tests are based on the Testing chapter (4.5) in the Methodology and are designed to represent a real life use of the application. Photo evidence of the results can be found in section E of the appendix; the test results are as follows:

<table>
<thead>
<tr>
<th>Use Case</th>
<th>Test</th>
<th>Input</th>
<th>Expected Output</th>
<th>Actual outcome</th>
<th>Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Starting Application</td>
<td>Testing that the application starts when the icon is selected</td>
<td>User selects application icon</td>
<td>Application loads default activity with no errors</td>
<td>Main screen appears correctly with no errors</td>
<td>Photo evidence in Appendix D1</td>
</tr>
<tr>
<td>2 Setting meditation time</td>
<td>Ensuring the user can set the meditation session time</td>
<td>User changes pull-down lists to set a new time</td>
<td>User is able to set the meditation time correctly</td>
<td>After tapping the ‘+’ button the next activity is run. The meditation time can be adjusted using a scrollable dropdown list</td>
<td>Photo evidence in Appendix D2</td>
</tr>
<tr>
<td>3 Starting new meditation session</td>
<td>Testing that the user can start a new meditation session after setting the session time</td>
<td>User selected the ‘Start’ button</td>
<td>The meditation session begins and the timer begins to countdown from given time</td>
<td>Once the timer has been set, tapping the ‘&gt;’ button takes the user to the next screen and the countdown begins</td>
<td>Photo evidence in Appendix D3</td>
</tr>
<tr>
<td>4 Completing the meditation session</td>
<td>Testing a full meditation session to ensure there are</td>
<td>None</td>
<td>The timer will count down to 0 and the user will</td>
<td>The timer reaches 0, the results are displayed and the</td>
<td>Photo evidence in Appendix D4</td>
</tr>
</tbody>
</table>

35
<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td><strong>End the meditation session early</strong></td>
<td>Ensuring the user can end a meditation session early without any errors</td>
<td>User selects the ‘End’ button to end the meditation session</td>
<td>The meditation session will end and the default activity will be displayed</td>
</tr>
<tr>
<td>6</td>
<td><strong>View heart rate data at the end of the session</strong></td>
<td>Testing the heart rate data is displayed correctly at the end of a meditation session</td>
<td>The user completes their session</td>
<td>The average heart rate reading will be displayed along with a reading of how much their heart rate lowered</td>
</tr>
<tr>
<td>7</td>
<td><strong>View Updated meditation Logs</strong></td>
<td>Ensure that the user can view their meditation logs to track their progress</td>
<td>User views meditation logs on default activity</td>
<td>User will view their progress on the bottom of the main activity screen</td>
</tr>
<tr>
<td>8</td>
<td><strong>Close application</strong></td>
<td>Test that the user can close the application without any loss of data</td>
<td>User closes the application by selecting the ‘Home’ button on their device</td>
<td>The application will close and the users data will be stored.</td>
</tr>
</tbody>
</table>

*(Table 5.1: Test results gathered based on the Use cases and expected outcomes discussed in the Methodology.)*
6 Conclusion

The objective of this dissertation was to develop a meditation application that utilises the user’s heart rate data to view results and track progress. At the time of writing, no other application on the market currently offers this functionality. The Android smart watch is still a relatively new technology, but it has real potential to become a bigger platform for developers and consumers. The limitations of Android Wear could also be viewed as some of its biggest strengths. The small screen size makes it unique, simple to use, easily accessible while on the user’s wrist and its range of sensors have the potential to extend and compliment a smartphone. Many users find it difficult to feel committed to meditation when they do not see immediate results; the application developed in this dissertation helps to tackle this problem. One of the biggest issues beginners experience when practicing meditation is the feeling of doubt; they expect too much from their practice and do not continue long enough to experience the benefits for themselves. Informing users on the amount their heart rate was lowered via meditation provides immediate positive results. Without this data, users may be doubtful of the effects of meditation and decide to not continue with their practice. Interviews were conducted on participants with meditation experience ranging between 4 months and 16 years. It was found that views on existing application were dependent on the amount of meditation experience. Interestingly, the participant with the greatest amount of experience would not consider using any other the applications discussed in the interview. Whereas the participant with the smallest amount of experience would consider using all of the applications. This result suggests that meditation applications should be developed for beginners as an introduction to the practice, rather than to provide long-term assistance. Certain application features were better received than others, for example, 4 out of 5 or the participants approved of the rewards feature in Smiling Mind as way of motivating users. But all participants found the ‘Buddies’ feature in Headspace to an unnecessary addition to the application. The feature may introduce competitiveness to a practice that should not be competitive, and comparing progress to other users could introduce negative effects as people may rush their practice.

The Android operating system gives developers the opportunity to reach millions of users worldwide through a variety of devices. The tools discussed in the Methodology were particularly helpful when developing for HRmeditation. The Android Studio IDE completes much of the heavy lifting required for building an application, and the MVC architecture makes programming more efficient. HRmeditation successfully reaches the requirements discussed in the Methodology of this dissertation, tests were run to ensure the application functions efficiently and utilises the heart rate monitor correctly. One of the greatest requirements of the application was that it must store and retrieve user data. The application successfully stores data based on the amount of sessions the user has completed, the total time completed and the latest heart rate reading. This would not have been possible without SharedPreferences as they provided a method of storing data directly onto the smart watch. Without using SharedPreferences, the
application would depend upon storage built into a smartphone, so it would not be classed as a stand-alone application.

The Android Marketplace now houses over 2 million applications and this number is growing everyday. In an age where the competition is tougher than ever and originality is rare, is there space for a meditation application that makes use of a heart rate monitor? The objective of this project was to answer this question. The existing literature provides enough evidence to suggest that meditation is a beneficial practice that continues to grow in popularity. Without this confirmation the application would have become unfeasible before development had even began. Some of the most significant research proposes that the long-term practice of meditation can physically grow and alter gray matter in areas of the brain known to deal with concentration and emotion handling. Other studies found that meditation can be an effective treatment for depression, anxiety, drug abuse and obesity. With a range of benefits and lack of negative side effects, meditation becomes a difficult practice to argue against.

Due to the amount of meditation applications already available, it was important to confirm the need for another application of the type. The unique feature of HRmeditation is the use of a heart rate monitor and the fact that it is developed exclusively for the Android Wear smart watch. Both these features were not found amongst existing applications, so it was essential to confirm that these features were enough to warrant the development of the application. Thankfully, all participants agreed that the heart rate feature is unique enough to merit the development of HRmeditation. Although the use of Android Wear is one of the applications prime features, it was also the source of many of its limitations. Ensuring the application was easy to use, reliable and aesthetically pleasing was challenging due to the lower processing power and smaller screen size found on an Android smart watch. If development for the application were to continue it may be worth considering a more suited user interface. Google have a set of recommended design patterns to follow for Android Wear, these design patterns make an application easier to use on a smaller screen. Recommendations for further development are discussed further in the chapter below. Meditation is a long practiced, integral part of the Buddhist religion that has recently been adopted into the Western World. Therefore, using an application to assist with the practice is a new idea, and some may argue against the necessity of meditation applications. After all, it was practiced for centuries before the invention of the smartphone. One may successfully incorporate meditation into their life without the need of an application, but for those who are uneducated or newly introduced to the practice, an application may be their only source for discovery. If meditation applications introduce the practice to a large amount of people that may not have discovered it otherwise, then they are worthwhile.
6.1 Development Recommendations

The application has been successfully developed to a prototype standard in order to test the concept, if the application were to be fully developed to a market-ready standard there are a few recommendations that would need to be considered. These recommendations are discussed in detail in this chapter.

6.1.1 Using more sensors

At the moment, the application makes use of the heart rate monitor built into the smart watch, making use of the other sensors available may provide a more accurate result. All Android smart watches currently on the market include a range of other sensors that could be used within the application. For example, the accelerometer, gyroscope and orientation sensors could all be used to collect movement data from the user, this data could be used to suggest how relaxed the user is throughout their meditation session. Other sensors could also be used to extend the application to support other forms of mediation such as walking meditation. Walking meditation is the process of mediating whilst walking with the intention of being more aware of the body and the present moment (Ford, 2011). Using the step counter within the watch could be used to measure the steps taken whilst practicing walking mediation. Using multiple sensors would provide more interactivity with the user and may produce more accurate session results.

6.1.2 Development of a smart phone application

Developing a ‘companion’ application for Android smart phones would add some valuable functionality. The larger screen sizes and more powerful processors found on smart phones could be used to improve the application and add some features that are not possible with a stand-alone Android Wear application. More detailed progress reports could be implemented by using the extra screen space, these reports could show the user’s progress over weeks, months or years. It would be difficult to implement some of the features found in existing applications without expanding to the smart phone. For example, it would be impossible to implement a guided meditations feature without developing for the phone as it would require a speaker or headphone output, both of which are not available on a smart watch.

6.1.3 Improving the user interface

Designing for the smart displays found on an Android smart watch creates many limitations, these limitations need to be kept in mind when designing the user interface of the application. Google states that developers should ‘design for the corner of the eye’ and ‘design for big gestures’ in their guide for Android Wear design principles. Using a different design structure would make the application more user friendly and more fun to use. For example, a 2D picker could be used to navigate through the application using gestures and a ‘Selection List’ could be used to easily scroll through meditation times.
Both these design structures are specific to the Android Wear operating system and implementing them into the application would most likely improve the user interface.

6.1.4 Improving accuracy of heart rate data

In its current state, HRMeditation calculates the difference between the third heart rate reading (the first two are inaccurate) and the last heart rate reading in order to calculate how much the user’s heart rate was lowered. Although this works well with short meditation sessions such as 1 or 5 minutes, it becomes less accurate when used with longer meditation sessions. It would be more accurate to use more data to make this calculation. For example, if the difference between the average of the first 10 heart rate readings and the average of the last 10 heart rate readings were calculated a more accurate result would be found. To improve accuracy further, the amount of data collected could be increased when the session time increases, this would help reduce unreliable data and disregard anomalies.

6.1.5 Social Features

Many of the existing meditation applications implement a social feature for connecting with friends to compare progress or share experiences. Developing a similar feature for HRMeditation would allow users to share their progress and discuss their practice inside the application. This may motivate users to continue meditating through the support of their friends and may also provide some healthy competition. The ‘Buddie’ feature in the application Headspace received some good feedback from interview participants, implementing a feature similar to this would be ideal. Implementing this feature may also bring more users to the application, especially if there is an option to log in via a social network account.

6.1.6 Award feature

Another feature well received by interview participants was the awards system found in the application ‘Mindful Minutes’. Developing an awards based system for HRMeditation may keep users motivated to continue meditating in order to reach their next award. For example, the user may receive an award if they reach 60 minutes of total meditation time or if their heart rate reading remains low. Reaching these goals could potentially unlock extra functionality within the application and the awards could be displayed on the user’s profile to be viewed by friends.

6.1.7 Music and guided meditations

Guided meditation sessions are videos or audio recordings to help guide people through their session. Implementing this feature would require a large amount of extra resources and would likely take a lot of time. Providing an option to use a guided meditation may be particularly helpful for users who have no meditation experience.
7 References


Barnes, S. et al. (2007) "The Role Of Mindfulness In Romantic Relationship Satisfaction And Responses To Relationship Stress". *J Marital Family Therapy* 33.4 : 482-500. Web.


Heart Rate OS for Android Wear. (2016) LFApp. (0.5.0) [Mobile application software]. Retrieved from http://play.google.com


# 8 Appendices

Appendix A: Interview Transcripts

## A1. Interview Participant 1 Transcript

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>How long have you been meditating?</td>
<td>5 years.</td>
<td>Participant has been meditating for 5 years</td>
</tr>
<tr>
<td>How do you do it often?</td>
<td>Once a day for half an hour.</td>
<td>Participant meditates for 30 minutes everyday</td>
</tr>
<tr>
<td>How did you get into meditation?</td>
<td>It's something my parents did and it helped them out a lot, so I took a leaf out of their book and decided to get into it.</td>
<td>Participant was introduced to Meditation through his parents</td>
</tr>
<tr>
<td>As a beginner what sort of challenges did you face, if you remember them? And what sort of challenges do you think beginners now would be facing?</td>
<td>Well, I guess its like a mental thing so, I guess finding that kind of... getting that, that sort of place in your mind and kind of being able to be that focused on it. I'd say that's a big challenge. And back pain as well.</td>
<td>One the biggest challenges for beginners is getting the correct state of mind and adjusting to back pain</td>
</tr>
<tr>
<td>Do you find it difficult to keep up the practice and be dedicated to the practice?</td>
<td>Yeah, it does take a lot of commitment. Especially if we’re talking half an hour a day. It does take some practice.</td>
<td>Meditation takes commitment and practice</td>
</tr>
<tr>
<td>Are there any meditation problems you have experienced?</td>
<td>It took a while to get use to it I'll say that. When I first started it I didn’t really get it, I would say. I wasn’t really that into it so it took a while of doing it to kind of understand it’s effectiveness.</td>
<td>Participant had issues getting familiar with the practice and to understand its effects</td>
</tr>
<tr>
<td>Do you have any experience with meditation apps already?</td>
<td>No.</td>
<td>Participant has no prior experience with existing applications</td>
</tr>
<tr>
<td>I’ve got some apps here that I would like to discuss some features if you don’t mind. I’m just going to show you an app called calm, what do you think of its interface?</td>
<td>It looks nice and easy to use.</td>
<td>Participant describes the application ‘Calm’ as nice and easy to use.</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Here’s an app called headspace which is a type of social app, and the main features on this I want to discuss are the social features, the way you can connect with friends, like the buddy section and how you can add friends and discuss your meditation with you friends and compare progress. Do you think that’s something that would motivate you? If you were new to meditating and you could connect with your friends, do you think that would motivate you to continue your practice?</td>
<td>Yeah, definitely. It’s like positive re-enforcement from those around you.</td>
<td>Participant likes the friend feature in the Headspace application.</td>
</tr>
<tr>
<td>The next app is an app called smiling mind. The feature on this app is an awards based system, so if you reach a certain amount of meditation time and things like that, you get awards and badges. You get achievements if you complete your first meditation session, if you complete a certain amount of time. Do you think something like this would motivate you to use the application more and to meditate more, if there was a goal you could reach and get</td>
<td>Yeah, definitely. I mean when I started out the goals seemed more far away and distant, this seems a little bit more immediate.</td>
<td>Participant likes the awards feature found in Smiling Mind as the rewards are immediate.</td>
</tr>
<tr>
<td>Question</td>
<td>Answer</td>
<td>Notes</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
<td>------------------------------------------------------------</td>
</tr>
<tr>
<td>The last application is awarded for reaching those goals?</td>
<td>Yeah, definitely.</td>
<td>Participant likes the mood checker feature found in Mindful Minutes</td>
</tr>
<tr>
<td>The last application is on an application called mindful minutes. So it</td>
<td></td>
<td></td>
</tr>
<tr>
<td>starts by asking you for a feeling test, like a pre-evaluation test, so</td>
<td></td>
<td></td>
</tr>
<tr>
<td>you can set your mood before you start meditating and you can say that</td>
<td></td>
<td></td>
</tr>
<tr>
<td>you’re feeling calm, or stormy, or tired, do you think that’s a nice</td>
<td></td>
<td></td>
</tr>
<tr>
<td>feature and useful?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Would you consider yourself to be a calm person?</td>
<td>Now, I would, yeah. I mean obviously the whole reason I started out</td>
<td>Meditation has helped the participant become calmer and manage his stress</td>
</tr>
<tr>
<td>Do you think you would be interested in a meditation app that tracks</td>
<td>Yeah, I think so. I mean whatever helps. When I started out I didn’t</td>
<td>The heart rate feature is a useful feature</td>
</tr>
<tr>
<td>your heart rate as well?</td>
<td>really have this help.</td>
<td></td>
</tr>
<tr>
<td>Do you think seeing your heart rate change would motivate you to keep</td>
<td>I mean I tracks progress really, it see’s how well you’re doing. When</td>
<td>Participant agrees that the changes in heart rate would help motivate users to continue meditating as its another form of tracking progress</td>
</tr>
<tr>
<td>going?</td>
<td>its just you on your own doing this stuff its only your own judgment</td>
<td></td>
</tr>
<tr>
<td>The idea is to get a stand-alone app on your smart watch, that is a</td>
<td>Yeah, absolutely.</td>
<td>Participant likes the idea of the application</td>
</tr>
<tr>
<td>meditation app. So when you want to track you meditation you hit start</td>
<td></td>
<td></td>
</tr>
<tr>
<td>and set a timer, whether that’s 10 minutes or 2 hours, and then it</td>
<td></td>
<td></td>
</tr>
<tr>
<td>counts down. As it is counting down it checks your heart rate, so it see’s the changes in your heart rate and at</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
the end it tells you what your average heart rate was and how much your heart rate was lowered. Do you think you would use something like that, if you had a smart watch?

<table>
<thead>
<tr>
<th>Are there any features you would note that would be useful to have? Any of these features that we've discussed in existing apps you think would be good to be included on the smart watch app?</th>
<th>The one that tracks the stress levels that would probably be the best because it is definitely a motivational tool seeing how much progress you've made. Seeing the effect it's having is definitely one of the best pieces of motivation.</th>
<th>Participant thinks the best feature including in existing software is the option to record progress as it's the best way of motivating a user</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you think the connecting with friends feature would be good for this app as well? If there was some way you could compare your progress to your friends on your watch?</td>
<td>Yeah definitely. Seeing how well you're doing compared to them gives a competitive edge.</td>
<td>Participant likes the idea friendship feature as it offers a competitive feel to the application</td>
</tr>
<tr>
<td>Any other comments that you would like to make?</td>
<td>No.</td>
<td>No further comments.</td>
</tr>
<tr>
<td>Question</td>
<td>Answer</td>
<td>Summary</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
</tr>
<tr>
<td>How long have you been meditating?</td>
<td>I have been meditating for 16 years, since I was 18 and I’m 34 now.</td>
<td>Participant has been meditating for 16 years</td>
</tr>
<tr>
<td>How often do you practice on average?</td>
<td>It’s a bit complicated because its different forms of meditation that I undertake. After doing yoga, I practice then—that’s to calm all the energy centres down and rebalance the energy. But every night before I go to bed, as I’m lying in bed I get into a meditative area to help me sleep.</td>
<td>Participant meditates everyday after a yoga session and before he sleeps</td>
</tr>
<tr>
<td>Is there a rough sort of time every day or does it vary?</td>
<td>Yeah, it varies. I’ve been known to spend an hour and a half meditating; I’ve been known to spend 10 minutes meditating. It depends how quickly you can get to the place that you need to get to.</td>
<td>Meditation session time varies between 10 minutes and 120 minutes</td>
</tr>
<tr>
<td>Do you set timers or do you just go with the flow and see how you feel?</td>
<td>I just go with the flow, because I find its better to let it be an open arrangement. Because you can’t say when you’re going to get to a certain place, because that is your bodies own. And if you’ve got to deal with stress, then it has to find its own balance.</td>
<td>The participant does not use timers when meditating as they can be distracting</td>
</tr>
<tr>
<td>In your opinion, what do you think the biggest challenges are for beginners? Or are there any challenges you faced as a beginner 16 years ago?</td>
<td>I still class myself as a beginner now to be honest with you. I don’t think anyone is ever not a beginner because you are always taken to certain places that are new to you. Just when you think you’ve got something, when you think you have that</td>
<td>Participant still classes himself as a bigger, he discusses how meditation can take you by surprise and every experience can be different. He goes on to describe how mediation experience is unique to the person. The participant finds the</td>
</tr>
</tbody>
</table>
meditation part covered, you get taken somewhere else and you're like 'wow'. And you realise, that you’ve actually had something happening to you that people are describing as 'mega' advanced, and you think ‘well that’s been happening to me since I started’. Then you take that on board and you start using that in a different way. The greatest thing is the more you expect the less you achieve. Because meditation is a spiritual basis – you can't rush it. Guided meditation is great, don’t get me wrong, it can help you but I personally think no body can guide your meditation except your inner self and your higher self. Its good to have guided meditation because they point you in the direction of where you could be going with that particular type of meditation because there are so many different types of meditation. But only you know when to take the next step, and only your higher self can tell you when.

| Is there a name for the type of meditation you do? I know there is one called Vipassana where you focus on your breath? | Personally, I think you have to focus on your breath all of the time, but I think meditation is about getting back to your routes of what you are as a human being. So then you can find the next level, the spiritual | biggest challenges beginners is discovering their own methods without relying on guided meditations or the opinions of others. He sates the ‘only you know when to take the next step’. |
level, the mental level e.t.c. In order to do that, the most basic thing that we can control is subconscious breathing. When you can control your breath that means you can control your blood flow, your stress levels. If you can control your breath you can control all that, and then you can get in to controlling your heart rate. I think a heart rate is a good indication... if you wanted a physical manifestation of the point to take the next step in meditation, I would say probably heart rate, and on a very basic level is a good indication of that.

| Is there any sort of problems you experience with meditation? | The problems I use to experience are expecting too much and rushing and wanting to be a Jedi. Not realising that it's like singing in a way. You can try to sing like someone else but its only when you find your own voice will you sing in tune. With meditation, when you realise its not about finding what someone else needed in meditation – its about finding yourself. And it's about finding harmony with yourself, and making yourself in harmony with the universe and all existence. When you get to that concept, a lot of the problems fall away because you're | The biggest problems the participant faced was expecting too much from his practice. He describes meditation as similar to singing, saying that you can try and sing like someone else but you must find your own voice. He says that one of the main points of meditation is finding harmony with yourself, once you reach this you can succeed. One of the biggest problems the participant faced when starting meditation was trying to fulfill everyone's objectives. The participant began meditating to bring the practice back into his family. He believes that people are too materialistic and that the |
suddenly not trying to achieve something or expect anything. At that point, that’s when you can really excel. That’s when you are free to let the energy flow, to let the energy of evolution – which is one of the things you are trying to release in meditation – that flows free when you remove expectations. One of the original problems that I got was that, and since I realised that it’s not about fulfilling everyone else’s objectives, it’s not even about fulfilling the physical objective – like my Nan was a witch and she used to practice meditation to achieve telekinesis, casting spells and speaking to the other side. So I wanted to re-get that back into my family, because I have always been brought up with that. Yoga, Spiritual and meditation were normal to me. I just wanted to find that spiritual thing, and I think that’s the problem. I think a lot of people approach meditation and yoga wanting it to be a western physical exercise and it isn’t. It’s about finding yourself, so that you can be in harmony with the universe and the all. Yoga and meditation makes you the best you can be, so it actually excels you in life. But only important thing in life is to be in peace and harmony. Finally, he discusses how meditation can help you ‘draw the line’ on your problems, saying that the ultimate goal is to look after yourself.
the problem is, because we grew up in a physical realm, we think excelling in life is having lots of money, driving Ferraris and jaguars and it isn't. None of that is important; it's all absolute rubbish. The only thing that is important is being in harmony, being at peace and happy, and helping everyone that you can. Sometimes you cannot help people because it is detrimental to yourself, and at the end of the day you've got to draw that line and I think meditation teaches you that you have to draw the line. At the end of the day, there's no point in chopping your legs off because someone else hasn't got legs. You can go 'have my legs', I mean you might help him but it means you just given him legs that aren't attached to his body. That's a very extreme example but if you look at it, yoga and meditation, teaches you to be very black and white about things like that and I think that is the way to be. Its great to have compassion, it is the ultimate goal, but you still have to look after yourself.

| Have you ever experienced any mobile apps for meditation? Have you used any apps that help you | I have never used apps because I personally think that these things, technology even a book from an ancient | The participant has no prior experience in using meditation applications. He believes that people practicing meditation |
| **meditate?** | yogi/guru, they’re great because they guide you but there’s a point when you have to take the stabilisers off. I think that for someone who approaches meditation and yoga in terms of what we spoke about earlier – the western world – this is brilliant. (Speaking about the calm app). This is amazing because they need to be told things because of the grand magistrates and a lot of people don’t have minds of their own. So, therefore, things like this are great because it at least gives them that first step on the path of coming to that area where they can be with themselves. But personally, I would not use them. | should find there own journey and should not rely on anything else. However, he does discuss how useful these applications may be to a beginner as it could provide the first step for someone. The participant would not use the applications himself but discusses how useful they may be to people looking to use meditation as a way of lowering stress levels. |
| **This app called ‘headspace’ has a buddy system where you can add friends and compare your progress. What do think of it?** | I think that’s a really bad idea because yoga and meditation – the whole point of it is that you are not comparing to other people. You are only comparing to yourself. Saying that, on the flip side of the coin, that is probably a thing the western world finds difficult to assimilate. In which case perhaps yeah, it’s good. In terms of to begin with I think its good, but I think people should be made to realise they have to walk the path on their own because it is their path. It’s their spiritual path. But again this is | The participant does not like the friend feature found in Headspace as users are comparing their progress to others, which is one of the worst things someone can do. However, it may be useful to some users that need motivation. The participant says that this feature may be useful to users who are not using meditation on a spiritual level but as a way of lowering stress. He says that the friends system in Headspace could potential cause stress for users as they are comparing their progress to others. He |

This app called ‘headspace’ has a buddy system where you can add friends and compare your progress. What do think of it? | **This app called ‘headspace’ has a buddy system where you can add friends and compare your progress. What do think of it?** | I think that’s a really bad idea because yoga and meditation – the whole point of it is that you are not comparing to other people. You are only comparing to yourself. Saying that, on the flip side of the coin, that is probably a thing the western world finds difficult to assimilate. In which case perhaps yeah, it’s good. In terms of to begin with I think its good, but I think people should be made to realise they have to walk the path on their own because it is their path. It’s their spiritual path. But again this is | The participant does not like the friend feature found in Headspace as users are comparing their progress to others, which is one of the worst things someone can do. However, it may be useful to some users that need motivation. The participant says that this feature may be useful to users who are not using meditation on a spiritual level but as a way of lowering stress. He says that the friends system in Headspace could potential cause stress for users as they are comparing their progress to others. He |
| This app is called ‘mood checker’. It asks you how you're feeling and is quite unique. You can compare each day and see how it has improved your mood. What do you think of that as a concept? | I'm trying to think in terms of people who are attacking meditation from a western perspective. What I would say is – fair enough, I don’t have a problem with that, though I think because its analogue rather than digital – I think one day someone could be feeling this happy; and the next day be feeling more happy but not be able to put that. It would be more accurate to have a rating out of 10, so that you can know exactly where you are. If you want to get good results from people, you | The participant describes some potential issues with the mood checker feature in the application. The feature is not specific enough as it only offers an analogue input, so the user can either be happy or unhappy. There may be problems if the user is feeling a little happy or a little sad, as there is no option to select these. The participant thinks that rating feels out of 10 would be a more accurate measure. He feels that the system is over complicated, saying that a better |
need to make it as simple as possible. It could also add a bit of anxiety to people. It could make people question if they are feeling the same kind of happy as yesterday. Something like that could probably stress some people out. I don’t know if something like that is a great idea. It could perhaps help a beginner. I think that needs to be included in a meditation app, a beginner time and once they’ve reached a certain amount of hours they can take the stabilisers off. Take them off bit by bit. You could probably tell a lot about that by heart rate – heart rate can’t lie. It tells you if you are calm or not. You could probably figure it all out from a heart rate. It’s the only thing that is close to breath reading, and length and depth. But you can’t measure that from an app, and I think heart rate is a phenomenal way to tell.

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Would you consider yourself to be a calm person?</td>
<td>I get annoyed sometimes but I think everyone does, if you didn’t get annoyed you wouldn’t be human. I think I am a pretty calm person, I wasn’t in the past but I am now.</td>
<td>The participant is a generally calm person but does sometimes get annoyed, saying that ‘if you don’t get annoyed you wouldn’t be human’.</td>
</tr>
<tr>
<td>Would you say meditation has helped you manage your stress levels?</td>
<td>Totally. Unfortunately, I’ve got one hell of a temper. It’s not great, but it’s got me out of some really dangerous</td>
<td>Meditation has helped the participant manage his stress levels. Meditation has helped him control his anger to</td>
</tr>
</tbody>
</table>
situations to say the least, but meditation has helped me control how to use it. Meditation has helped me control how to utilise that temper rather than allow it to control me. I think that’s another key, if you can learn to control yourself, I think that’s what meditation can bring you. But if we focus too much on the western way of looking at it, then we forget all things like that. When you’re meditating, you can start getting really angry whilst you’re meditating and that’s because you are expecting something to happen and then eventually, meditation teaches you to control that anger and you get past that blockage in the road onto the next junction.

I have read where meditation can actually bring back bad experiences for people whilst they’re meditating.

Yeah because people don’t understand meditation, they don’t know the spiritual background to it. That’s where the problem is. Meditation brings up all the blockages in your body, in this particular life, that has caused you stress and strain – people think it’s a negative thing, but it’s a great thing. What its actually doing is clearing that negativity and tension out of your system and your brain and memories. Yoga also helps you remove those blockages from

The participant explains that meditation can introduce bad experience from the users past, but it is not a negative thing. He explains that this process is clearing out the negativity and tension in your system.
| I didn’t realise how closely meditation and yoga were linked. | I believe they are intrinsically linked to each other. Like every time you do yoga you have to meditate in order to balance the spiritual energies otherwise you can cause yourself mental damage and spiritual damage. | The participant describes how important yoga is alongside meditation, stating that a meditation session is required after every yoga session. |
| My idea is an app built into an android smart watch so when you meditate it tracks your heart rate and at the end of the session it tells you how much your heart rate was lowered and your average heart rate. Do you think that’s a good idea, or something you would use? | To be honest with you, I actually definitely think it would be something I would initially use just to see what it’s like. Just to see what my heart rate did. I wouldn’t use it for an on-going period to be honest, but I would if I was trying to get someone into yoga. If I wanted to get them into yoga I would certainly use it. I think it’s a good place for people to start but I think you should give people background to meditation. About them not expecting things and just finding piece with themselves. | The participant would consider using the application being developed in this dissertation. He would not use it long-term but says that it is a good step for people to be introduced to meditation. |
| Is there anything else you would like to add? | I definitely think something like this is a good start, but you need to give guidelines before and there should be a limit on it, and to show it is a beginner app. Tell them that is it their journey. You could have a notification that says ‘okay, a point has been reached where you need to take the stabilisers off’. It’s your choice now. You can | The participant suggests giving guidelines within the application that explain to the user the effects of meditation. He also thinks that the application should give the user the option to continue the practice without using the application so they can ‘undertake the journey’ themselves. |
continue using the app, or you can undertake the journey yourself. If people want to advance into the spiritual realm they need to be destabilised. But then again, on the flip side of the coin, I don’t think the people who would want this app would be looking to go into the spiritual realm. But then again, contradicting myself, the problem is if I was just starting now I would have gone down this route but I think I would have naturally progressed into the non-stabilised meditation. But I think it’s great for a beginner, I really do.
## A3. Interview participant 3 Transcript

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>How long have you been meditating?</td>
<td>On and off, I did Tai Chi around 10 years ago when I lived in China, but I have been practicing conventional meditation for the last couple of years.</td>
<td>Participant has been meditating for the last few years after practicing Tai Chi in China 10 years ago.</td>
</tr>
<tr>
<td>How did you get into Tai Chi in China?</td>
<td>I was teaching English in China and they told me that I could learn Tai Chi, I trained with the P.E teacher once a week and we were performing ourselves just to get into the zone. Its quite a good muscle exercise as well as mental. I did it a bit when I got back to the UK but due to commitments I had to give it up. I never did conventional meditation until a couple of years ago. The practice of sitting and getting lost in your thoughts... or not getting lost in your thoughts rather.</td>
<td>The participant learnt Tai Chi whilst teaching English in China and practiced for a short amount of time after returning to the UK. It wasn’t until a couple of years ago that he started meditating.</td>
</tr>
<tr>
<td>How often do you meditate?</td>
<td>I try to do it everyday depending on how much time I have. Usually no more than 15/20 minutes but it can be a lot shorter. Sometimes I do it just before I eat or before I go to sleep.</td>
<td>The participant meditates for around 15/20 minutes a day usually before meals or before sleep.</td>
</tr>
<tr>
<td>Do you have any advice for beginners? Are there any challenges that they mind be facing?</td>
<td>Well there’s a big thing about overcoming what you’re thinking, so people would say the best way to do it is concentration meditation by listening to your breathing rather than having a void of thoughts and trying to</td>
<td>One of the biggest challenges beginners face is trying to concentrate on the breath and not be distracted by other thoughts. It’s about clearing your mind as much as possible and focusing on the breath.</td>
</tr>
<tr>
<td>Question</td>
<td>Response</td>
<td></td>
</tr>
<tr>
<td>----------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Do you think people get negative side effects because they are trying too hard?</td>
<td>I think so; it can be very stressful, as you can't just push out all thoughts. Especially a lot of people get into meditation because they have a stressful life, so trying to push out these immediate thoughts must be infuriating. So I learnt concentration meditation is the best way into it, concentrate on your breathing. Usually you will come back to those thoughts so its best to try and concentrate on your breathing and you will eventually go off into something else. Do it in small chunks, if you try and set yourself an hour everyday at first you wont find the time so you wont be able to sustain an empty mind.</td>
<td></td>
</tr>
<tr>
<td>Do you experience any meditation problems at the moment?</td>
<td>Not really, just finding the time. Sometimes I work a busy long day and try to be social outside of that too. So its difficult to sometimes find the time to do it. Sometimes I will forget and get into bed and the participant sometimes finds it difficult to find the time to meditation. He says that the best solution to this is to set a time to meditate everyday and stick to that.</td>
<td></td>
</tr>
<tr>
<td>Question</td>
<td>Answer</td>
<td>Notes</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Do you have any experience with any meditation applications?</td>
<td>I haven’t had any good experience, I have briefly used one called Calm, which seemed ok. It would tell you a bit about and remind you to do it but it did have some naff sound effects on it. So I wouldn’t really recommend it.</td>
<td>The participant has some experience with using the Calm application.</td>
</tr>
<tr>
<td>Are there any features that you did like about Calm?</td>
<td>It’s a nice interface for your phone, I guess. But it didn’t really become too useful, as it wasn’t really telling me anything I didn’t know. The only thing it was really telling me was to do it, which is really useful but I can do that on an alarm.</td>
<td>The participant liked the interface of Calm but said it was lacking features. He says that the application could be replaced by an alarm.</td>
</tr>
<tr>
<td>Would you consider yourself to be a calm person?</td>
<td>Um, I feel like I am a calm person but I do suffer from stress.</td>
<td>The participant is calm but suffers from stress.</td>
</tr>
<tr>
<td>Has meditation helped you deal with that stress?</td>
<td>Definitely, yes. It takes away stress and gives you time to reflect and understand what’s going on. But also to just have a chill out. Sometimes you won’t stop, you will get up in the morning and you will have these jobs you need to do and you might be consumed with Netflix or something. You feel like you’re relaxing but your brain is always consumed with</td>
<td>Meditation has helped the participant deal with his stress and to reflect on what is going on in his life. He says that meditation is really the only way to ‘unengage’.</td>
</tr>
<tr>
<td>If you were to use a new meditation application that uses your heart rate, would that be something that interests you?</td>
<td>Yes I think so, what would you want to use with it?</td>
<td>The participant asked what the application is used with</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>The application is to be developed for an Android smart watch. <em>Describes the application</em></td>
<td>Ok, its kind of like what I was saying before about the Calm application not giving me much information. It would be good to give me an option to actually see something, which is different to just viewing it. I don’t have a watch at the moment but I have always associated them with sports. This is kinda the opposite of that, it’s a bit more rare and something I would consider.</td>
<td>The participant thinks that a heart rate reading would provide a good way of seeing something different. He does not have a watch at the moment and thought that most applications that use the heart rate monitor are sports based.</td>
</tr>
<tr>
<td>What do you think of the interface of Calm?</td>
<td>I have used it before a bit but the sound effects are really annoying. But it was nice and easy to use, that aspect of it is great. Also telling me to do it was great, apart from that it was a big of a glorified alarm clock. Having something else like a heart beat would be more worthwhile.</td>
<td>The sound effects in Calm are annoying, but the application is nice and easy to use. However, it’s a bit like a glorified alarm clock.</td>
</tr>
<tr>
<td>What do you think of the ‘Buddies’ system in the Headspace application?</td>
<td>I probably wouldn’t use it myself. Maybe other people would find that good, im not that competitive. Especially with something that is not supposed to be competitive. So, probably not on that one. But it looks nice.</td>
<td>The participant would not use the friend feature in Headspace himself.</td>
</tr>
<tr>
<td>So do you think this</td>
<td>Yeah, I have had apps</td>
<td>The participant thinks</td>
</tr>
<tr>
<td>Question</td>
<td>Participant's Response</td>
<td>Other Participant's Response</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>feature may cause users to rush into it too much?</td>
<td>for cycling, what’s it called? I can't remember. It’s a social one I got on my phone. The idea was that you could be social with it to compare with friends. With is good and competitive for him and that motives you. I am not sure about meditation but I am sure it would be useful for some other people.</td>
<td>this feature works well with other applications such as a cycling one but not ideal for meditation. He says that the feature may be useful for some other people.</td>
</tr>
<tr>
<td>What do you think of the mood checker in Smiling mind? <em>Describes the feature</em></td>
<td>Um, I guess its useful to be more aware as you have to make those decisions on which way to put your counter. Um, I am not sure if it would be too useful for me, would you do it afterwards aswell?</td>
<td>The participant thinks the mood checker feature may make users more aware of their decisions. He asks if it checks your mood after the session too.</td>
</tr>
<tr>
<td>I think the idea is that you clock it before, and over time check how your mood is changing.</td>
<td>I guess its, again it would probably be useful for some people. I don't feel like I would use it as meditation is not really about tracking that specific thing, just emotions.</td>
<td>He does not feel that he would use the feature himself as meditation is not about tracking a specific thing.</td>
</tr>
<tr>
<td>Do you think this could have negative impacts on users expecting to see results?</td>
<td>Possibly, they are going to have to do it before meditation so it defeats the purpose in some ways. It may be better to do it afterwards and see how you changed your feeling. Meditation can help you a lot in life but it won't change the fact that you had a bad day. Its your choice if you get angry or upset, but people are still human. So maybe it would be better to have the mood after.</td>
<td>The participant feels that it may be better to check the user's mood after the meditation session rather than before. He says that meditation can help you in life but won't change the fact that you had a bad day.</td>
</tr>
<tr>
<td>What do you think of the award system in Mindful</td>
<td>Not sure. I have had something similar, I got</td>
<td>The participant thinks the award feature in</td>
</tr>
<tr>
<td>Minutes?</td>
<td>an app called ‘Waves’, which is a GPS one that awards you for how many miles you have done. It's kind of useful but I don’t know, this one is trying to make you change your meditation sessions. I guess it could spur someone on and you might find that you enjoy meditation before work or something and you wouldn’t find that without these badges. All these apps are just trying to make you do it. What you were saying about the heart rate monitor is actually something I would be more interested in, rather than just trying to urge me to do it. Because I can set alarms and use my own time to do it, but actually having something to tell me something different that I don’t know would be useful.</td>
<td>Mindful Minutes may motivate some people but he is unsure if it would motivate him. He says that the feature may be useful for discovering different times to meditate that may not be discovered otherwise.</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>The main feature for this project is the heart rate monitor. If you think that the feature is unique enough to warrant another application into a crowded market than that's good.</td>
<td>Definitely.</td>
<td></td>
</tr>
<tr>
<td>Do you have any other comments?</td>
<td>No I think we covered most of it. It seems like a good app to do and I would definitely be interested in it as it takes away from everything else and it’s a unique app, yeah, I would be interested in it.</td>
<td>The participant likes the idea of the application and is interested.</td>
</tr>
<tr>
<td>Question</td>
<td>Answer</td>
<td>Summary</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>How long have you been meditating?</td>
<td>Probably about 4 months</td>
<td>The participant has been meditating for 4 months</td>
</tr>
<tr>
<td>How often do you practice?</td>
<td>At least once a day for around 20 minutes.</td>
<td>The participant meditates for 20 minutes around day</td>
</tr>
<tr>
<td>Has it been 20 minutes a day since you started?</td>
<td>No, when I first started it was about 10 minutes, maybe even less.</td>
<td>When the participant started meditating it was only for around 10 minutes a day.</td>
</tr>
<tr>
<td>What do you think the biggest challenges that beginners face?</td>
<td>Keeping up with it and remembering to do it everyday. Not getting disheartened when you don't really see any effects and just clearing your mind is hard.</td>
<td>The biggest challenges beginners face is remembering to do it everyday, not getting disheartened and clearing your mind.</td>
</tr>
<tr>
<td>Do you experience any other meditation problems yourself?</td>
<td>Um, not really. Sitting for too long hurts your back. I struggle with getting bored, which is something that shouldn't happen. I'm getting disheartened with that but I suppose if I keep up with it I wouldn't get bored.</td>
<td>The participant struggles with back pain and gets bored when meditating.</td>
</tr>
<tr>
<td>Do you have any experience with meditation apps?</td>
<td>No, I downloaded Headspace but did not open it.</td>
<td>The participant does not have any previous experience with meditation applications</td>
</tr>
<tr>
<td>Do you think meditation has the potential to reach a wider audience through applications?</td>
<td>Definitely, everything is on the internet and everybody uses apps. People would be more likely to do meditation if they could do it with an app as its guided</td>
<td>The participant thinks that meditation could potentially reach a wider audience through applications</td>
</tr>
<tr>
<td>Would you consider yourself to be a calm person?</td>
<td>I think the majority of the time I am calm but then I can get angry quickly and I think I meditate in order to stop that happening. It seems to be working slightly so far.</td>
<td>The participant feels that they are usually calm but can get angry quickly</td>
</tr>
<tr>
<td>So, meditation has</td>
<td>Yes.</td>
<td></td>
</tr>
<tr>
<td>Question</td>
<td>Response</td>
<td>Response</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Helped you deal with your stress levels?</td>
<td>Definitely. If you could see how calm it makes you it would definitely have a positive impact on your practice. I think it would be really useful, especially for people that deal with major stress issues like my Mum. I think it would be good to show her how much meditation improves that area.</td>
<td>Would definitely consider tracking their heart rate when meditating. The participant thinks it would be really useful for people dealing with major stress.</td>
</tr>
<tr>
<td>Would you consider tracking your heart rate to track your meditation?</td>
<td>Yes I think the immediate results would be a great aspect of that.</td>
<td>The participant thinks the immediate results from a heart rate monitor would be good.</td>
</tr>
<tr>
<td>Do you think that the immediate results that a heart rate reading would give would motivate a user to continue their practice?</td>
<td>It sound peaceful and looks good. I would consider using an application like this. Its my kind of thing.</td>
<td>The participant likes the interface in Calm and would consider using it.</td>
</tr>
<tr>
<td>What do you think of the interface of the Calm application?</td>
<td>Can you slide it across a little either way or is it one or the other? If you could change the slight rating on it I think that would be better as you are usually never one or the other. Otherwise it’s a good aspect as you can keep track of how you are feeling each day. If you see progress with that its good. It’s a bit inaccurate as you are doing the ratings yourself but as long as you are honest.</td>
<td>The participant thinks the mood checker in Smiling Mind would be better if it were more flexible.</td>
</tr>
<tr>
<td>What do you think of the mood checker in Smiling Mind?</td>
<td>I have never heard of something like that but, yes. I am quite competitive so I would like something like that myself. I think that reaching these goals</td>
<td>The participant would enjoy the as they are competitive. He/she then states that meditation is not about being competitive.</td>
</tr>
<tr>
<td>Discuss the award feature in Mindful Minutes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
could help inspire people to meditate. But meditation is not about being competitive. If there is the prospect to be praised for what you are doing then that would work well.

<table>
<thead>
<tr>
<th>What do you think of the application idea for this project?</th>
<th>I think it is definitely interesting. I think, obviously that shows you the immediate effects and I would be really interested in that just to see how my heart rate changes while meditating. I would use that.</th>
<th>The participant thinks the idea for the application is interesting as it would show users the immediate effects of meditation.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you think the heart rate feature makes it unique enough to warrant the development of the application?</td>
<td>Yeah I think so, because it does not seem like there is anything out there for smart watches. So, I think it’s a good time to get started doing that.</td>
<td>The participant thinks the heart rate feature makes the application unique enough to warrant its development.</td>
</tr>
<tr>
<td>Do you have any other comments?</td>
<td>No, sorry.</td>
<td></td>
</tr>
</tbody>
</table>
### A5. Interview participant 5 Transcript

<table>
<thead>
<tr>
<th>Question</th>
<th>Response</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>How long have you been meditating?</td>
<td>Probably about 6 months now.</td>
<td>The participant has been meditating for around 6 months</td>
</tr>
<tr>
<td>How often do you practice?</td>
<td>I try and practice daily but I often forget.</td>
<td>The participant practices everyday but often forgets</td>
</tr>
<tr>
<td>What sort of challenges do you think you face as a beginner?</td>
<td>Probably just getting into the routine of doing it daily. There are just so many things to think about doing in a day and I find that finding time to meditate really does help. But its just kind of remembering to take that time, or finding a slot or a space to take that time out.</td>
<td>The participant finds it difficult to get into a meditation routine</td>
</tr>
<tr>
<td>Do you think if you got into a routine of doing it, the same time everyday, it would become a habit?</td>
<td>Yeah, definitely. That’s what I try to do.</td>
<td>The participant tries to make meditation a habit</td>
</tr>
<tr>
<td>Aside from that, do you face any other problems with meditation?</td>
<td>Once I’m in the zone and I’m there then I’m good to go. Its just kind of getting to that point where I’m happy to zone out and let go, it is quite difficult. And I also find that I kind of struggle with seeing exactly how it’s helping.</td>
<td>The participant finds it difficult to ‘let go’. Also, the participant struggles to see any benefits of the practice so far.</td>
</tr>
<tr>
<td>So do you feel demotivated if you don’t see results?</td>
<td>Well, yeah, definitely. Especially because it is quite new for me. I do feel that it’s helping but it would be great if there was a way in which I could track my progress.</td>
<td>The participant feels demotivated by the lack of results</td>
</tr>
<tr>
<td>Leading on from that, have you used any meditation apps that track your progress?</td>
<td>No, I haven’t.</td>
<td></td>
</tr>
<tr>
<td>Do you feel that using meditation apps would</td>
<td>Yeah, definitely because I think you need to be</td>
<td>The participant thinks that meditation</td>
</tr>
<tr>
<td>Question</td>
<td>Response</td>
<td>Notes</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>reach a wider audience?</td>
<td>the right kind of person to have the energy needed to organise that, and I think an app which would prompt you and encourage you to engage would be a great help. Because you otherwise can just kind of forget about it, or think that it’s useless – when in reality it’s actually something really beneficial.</td>
<td>applications are good for encouragement and time management.</td>
</tr>
<tr>
<td>Would you consider yourself to be a calm person?</td>
<td>I guess so. I mean the whole reason I am meditating is because I feel that I take on a lot of stress from people around me, so I try and be a calm person. Like, I am a functional person but I do think I can be quite stressed at times.</td>
<td>The participant considers himself/herself to be a calm person but has stressful moments</td>
</tr>
<tr>
<td>So, meditation has definitely helped you manage your stress levels?</td>
<td>Definitely. I suffered with terrible panic attacks before I started meditating.</td>
<td>The participant suffered with panic attacked before meditating.</td>
</tr>
<tr>
<td>Do you think you would consider tracking your heart rate as a way to manage your stress and track your meditation sessions and see results?</td>
<td>Definitely, because whenever I get a panic attack the whole thing is my heart starts beating so quickly, my breathing gets faster. And I feel like, meditation is the answer to that because it is the complete opposite. It really helps me control my breathing and my heart rate, so yeah definitely.</td>
<td>Meditation has helped the participant control his breathing and his heart rate after a panic attack. Using a heart rate monitor would benefit the participant greatly in their practice</td>
</tr>
<tr>
<td>Moving on to some existing apps. I’m just going to show you some of the features and you can tell me your honest opinions and if you think you would use some of these. The one thing I want to talk about with</td>
<td>Definitely, I don’t think I would want to be swarmed with loads of options or buttons hounding me at once because then it’s just too many things to think about. The whole point of meditation is to wind</td>
<td>The participant likes the interface of Calm as it is not cluttered and looks easy to use.</td>
</tr>
<tr>
<td>the app 'calm' is its interface. It's a really nice easy to use and clean design. Do you think that's something you would be interested in?</td>
<td>down, and I don't want to see a complicated user interface.</td>
<td>So, the next application is called ‘Headspace’ which is a massive meditation application with a friend's feature. It has a buddy system, you can add friends and compare your progress to friends, as a bit of competitiveness. Do you think that’s a useful feature?</td>
</tr>
<tr>
<td>Do you think this app is maybe bringing a competitive edge to something that shouldn’t be competitive at all?</td>
<td>Exactly, yeah. I think you’ve got it right on the mark there.</td>
<td>Moving on to another app called ‘smiling mind’. There is a feature in this called a mood checker. So before you start a session it comes up and asks you how you’re feeling. Do you think that’s something that would help you in your practice?</td>
</tr>
<tr>
<td>Another application is in an app called ‘mindful minutes’ which uses a reward based system. So once you’ve reached these certain goals you</td>
<td>I like the idea of being able to track exactly how many days in a row you are doing it and the fact it is prompting and rewarding you for that,</td>
<td></td>
</tr>
</tbody>
</table>
get badges. For example if you reach one minute you get a reward, if do 365 days, if you meditate before 7pm, if you meditate on Christmas day – you gain all these different rewards. Do you think that’s something that would motivate you to meditate?

<table>
<thead>
<tr>
<th>So, the last section I am going to discuss the app that is actually being developed in this dissertation. It is an app that is designed for an android smart watch, and it uses your heart rate as a way of tracking your progress. So the user would log onto their app on the watch, and they would start a session and as it counts down the heart rate would be displayed and at the end of the session it can tell you how much your heart rate was lowered. Do you think that’s something you would use?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definitely, especially because the whole point for me is to help stave off these panic-attacks that I tend to get. And I find by visibly seeing that I am able, by using my own mind and using my body and using my breathing to lower my heart rate, I feel that I am actively beating what I guess is almost an illness.</td>
</tr>
<tr>
<td>The participant supports the dissertation idea as it would provide a visible way of seeing how meditation lowers their heart rate.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Do you think seeing the immediate effects of your heart rate being lowered even after one session, do you think that is something that would motivate you to continue?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definitely, I think feeling within my body that what I am doing is working and being able to see that on a screen, or on a watch, would definately be very motivating.</td>
</tr>
<tr>
<td>The participant feels that the heart rate feature would be very motivating</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>One last question, in a market place that is swarmed with apps do you think there is space</th>
</tr>
</thead>
<tbody>
<tr>
<td>Well I didn't see anything else that was like what you've shown me there. So I think it's</td>
</tr>
<tr>
<td>The participant is not familiar with any other meditation application that uses a heart rate</td>
</tr>
</tbody>
</table>
for another application like this? Do you think that this unique feature, the heart rate monitor, is unique enough to warrant the development of the app in such a crowded market?

| definitely unique and it’s a feature that I personally would be really interested in. |
| monitor. The participant feels it is a unique idea that would be interesting. |

That’s about it, is there any other comments you wanted to make?

| No, I think we have covered a good amount. Good luck with your dissertation! |
Appendix B: Consent Forms

B1. Participant 1 consent form

Cardiff Metropolitan University
Ethics Committee

PARTICIPANT CONSENT FORM

Cardiff Metropolitan University Ethics Reference Number:
Participant name or Study ID Number:
Title of Project: The Development of a Mobile Smart Watch Application Utilising a Heart Rate Monitor to Introduce Users to the Practice of Mindful Meditation
Name of Researcher: Luke Brown

Participant to complete this section: Please initial each box.

1. I confirm that I have read and understand the information sheet for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.  

2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason.

3. I agree to take part in the above study.

1. I agree to the interview being audio recorded
2. I agree to the interview being video recorded
3. I agree to the use of anonymised quotes in publications

\[signature\] \[3/2/16\] 
Name of person taking consent \[3/02/16\]

*When completed, 1 copy for participant & 1 copy for researcher site file*
Cardiff Metropolitan University
Ethics Committee

PARTICIPANT CONSENT FORM

Cardiff Metropolitan University Ethics Reference Number:
Participant name or Study ID Number:
Title of Project: Development of a mobile application with the intention of managing everyday stress via the practise of meditation
Name of Researcher: Luke Brown

Participant to complete this section: Please initial each box.

1. I confirm that I have read and understand the information sheet for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.

2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason.

3. I agree to take part in the above study.

1. I agree to the interview being audio recorded
2. I agree to the interview being video recorded
3. I agree to the use of anonymised quotes in publications

Signature of Participant ___________________________ 12/02/16

[Signature of Participant]

Name of person taking consent ___________________________ 17/02/16

Signature of person taking consent ___________________________

* When completed, 1 copy for participant & 1 copy for researcher site file
B3. Participant 3 consent form

Cardiff Metropolitan University
Ethics Committee

PARTICIPANT CONSENT FORM

Cardiff Metropolitan University Ethics Reference Number: [Blank]
Participant name or Study ID Number: [Blank]
Title of Project: The Development of a Mobile Smart Watch Application Utilising a Heart Rate Monitor to Introduce Users to the Practice of Mindful Meditation
Name of Researcher: Luke Brown

Participant to complete this section: Please initial each box.

1. I confirm that I have read and understand the information sheet for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. [ ]

2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason. [ ]

3. I agree to take part in the above study. [ ]

1. I agree to the interview being audio recorded [ ]

2. I agree to the interview being video recorded [ ]

3. I agree to the use of anonymised quotes in publications. [ ]

_________________________  ____________
Signature of Participant Date

_________________________  ____________
Luke Brown Date

Name of person taking consent Date

Signature of person taking consent

* When completed, 1 copy for participant & 1 copy for researcher site file
Cardiff Metropolitan University
Ethics Committee

PARTICIPANT CONSENT FORM

Cardiff Metropolitan University Ethics Reference Number: [Blank]
Participant name or Study ID Number: [Blank]
Title of Project: The Development of a Mobile Smart Watch Application Utilising a Heart Rate Monitor to Introduce Users to the Practice of Mindful Meditation
Name of Researcher: Luke Brown

Participant to complete this section: Please initial each box.

1. I confirm that I have read and understand the information sheet for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.
   
   Signature of Participant: [Signature]
   Date: 10/2/16

2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason.
   
   Signature of Person taking consent: [Signature]
   Date: 10/2/16

3. I agree to take part in the above study.

   Signature of Participant: [Signature]
   Date: 10/2/16

1. I agree to the interview being audio recorded
   
   C.B

2. I agree to the interview being video recorded
   
   C.B

3. I agree to the use of anonymised quotes in publications
   
   C.B

* When completed, 1 copy for participant & 1 copy for researcher site file

[Signature]

Name of person taking consent

Date
PARTICIPANT CONSENT FORM

Cardiff Metropolitan University Ethics Reference Number:  
Participant name or Study ID Number:  
Title of Project: The Development of a Mobile Smart Watch Application Utilising a Heart Rate Monitor to Introduce Users to the Practice of Mindful Meditation  
Name of Researcher: Luke Brown

Participant to complete this section: Please initial each box.

1. I confirm that I have read and understand the information sheet for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.

2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason.

3. I agree to take part in the above study.

1. I agree to the interview being audio recorded  
2. I agree to the interview being video recorded  
3. I agree to the use of anonymised quotes in publications

Signature of Participant: [Signature]  
Date: 10/02/2016

Name of person taking consent: [Name]  
Date: 10/02/2016

Signature of person taking consent: [Signature]

*When completed, 1 copy for participant & 1 copy for researcher site file*
Appendix C: Ethics

C1. Ethics number

2015D0401

C2: Ethics Form

PART ONE

<table>
<thead>
<tr>
<th>Name of applicant:</th>
<th>Luke Brown</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supervisor (if student project):</td>
<td>Dr. Panicos Georghiades</td>
</tr>
<tr>
<td>School:</td>
<td>Cardiff School of Management</td>
</tr>
<tr>
<td>Student number (if applicable):</td>
<td>ST20052262</td>
</tr>
<tr>
<td>Programme enrolled on (if applicable):</td>
<td>Software Engineering</td>
</tr>
<tr>
<td>Project Title:</td>
<td>The Development of a Mobile Smart Watch Application utilising a Heart Rate Monitor to Introduce Users to the Practice of Mindful Meditation</td>
</tr>
<tr>
<td>Expected Start Date:</td>
<td>15/2/2016</td>
</tr>
<tr>
<td>Approximate Duration:</td>
<td>6 weeks</td>
</tr>
<tr>
<td>Funding Body (if applicable):</td>
<td>N/A</td>
</tr>
<tr>
<td>Other researcher(s) working on the project:</td>
<td>None</td>
</tr>
<tr>
<td>Will the study involve NHS patients or staff?</td>
<td>No</td>
</tr>
<tr>
<td>Will the study involve taking samples of human origin from participants?</td>
<td>No</td>
</tr>
</tbody>
</table>

In no more than 150 words, give a non technical summary of the project

The project will explore the demand for a meditation mobile application that assists users in their practise of meditation by using heart rate data. The purpose of the project is to develop a mobile application with the intention of introducing users to the practice of meditation as a way of managing stress. The application will make use of existing technology in the form of a smart watch to monitor in order to gather the heart rate data. Using the heart rate monitor will allow the application to log when the user’s heart rate rises, at the end of a meditation session the user can view the amount their heart rate was lowered by. Session data will be stored so the user can track their progress, including the latest heart rate reading, the total session count and the total meditation time completed.

Does your project fall entirely within one of the following categories:

| Paper based, involving only documents in the | No |

80
public domain
Laboratory based, not involving human participants or human tissue samples | No
Practice based not involving human participants (eg curatorial, practice audit) | No
Compulsory projects in professional practice (eg Initial Teacher Education) | No

If you have answered YES to any of these questions, no further information regarding your project is required.
If you have answered NO to all of these questions, you must complete Part 2 of this form

DECLARATION:
I confirm that this project conforms with the Cardiff Met Research Governance Framework
Signature of the applicant: L. Brown  Date: 14/1/2016

FOR STUDENT PROJECTS ONLY
Name of supervisor: Dr Panicos Georgiades  Date: 24th January 2016
Signature of supervisor: PGeorghiades

Research Ethics Committee use only
Decision reached:  Project approved [ ] Project approved in principle [ ] Decision deferred [ ] Project not approved [ ] Project rejected [ ]

Project reference number: Click here to enter text.
Name: Click here to enter text.  Date: Click here to enter a date.
Signature:
Details of any conditions upon which approval is dependant: Click here to enter text.

PART TWO
A RESEARCH DESIGN
A1 Will you be using an approved protocol in your project?  No
A2 If yes, please state the name and code of the approved protocol to be used
N/A
A3 Describe the research design to be used in your project

1 An Approved Protocol is one which has been approved by Cardiff Met to be used under supervision of designated members of staff; a list of approved protocols can be found on the Cardiff Met website here
I will be interviewing 5 people that already practice meditation; their meditation experience will be discussed as well as their experience with existing applications. The interview results will help shape the requirements of the application. The interviews are required to explore what functionality people may feel is missing from current meditation applications and what features they expect from this application. The interview is to follow a semi-structured format so participants can be as open as possible.

The research strategy used will be deductive as the theory has already been decided and a “top-down” approach will follow. Purposive sampling is used as the subjects are selected due to the fact that they practice meditation. In order to decide on the requirements of the application the interview results will be analysed and the most common features mentioned may be included in the application, this is a form of Thematic analysis.

The results will be analysed to decide on suitable requirements for the application. The results will be compared with my own requirements for the application to complete a full specification. Participants will confirm their consent to participate in the interview and will be able to withdraw at any time. All interview data will be kept confidential, participants will remain anonymous and no names will be discussed within the project.

| A4 | Will the project involve deceptive or covert research? | No |
| A5 | If yes, give a rationale for the use of deceptive or covert research | N/A |
| A6 | Will the project have security sensitive implications? | No |
| A7 | If yes, please explain what they are and the measures that are proposed to address them |  |

**B PREVIOUS EXPERIENCE**

B1 What previous experience of research involving human participants relevant to this project do you have?

A previous university project required me to gather information in the form of a survey based on social media usage, 20 people completed the survey in total.

**B2 Student project only**

What previous experience of research involving human participants relevant to this project does your supervisor have?

He has been involved with academic research and dissertation supervisions for over 20 years.

**C POTENTIAL RISKS**

C1 What potential risks do you foresee?

Risk 1. Risks to the researcher: Not have enough time to complete the project, potential travel risks
Risk 2. Risks to the subject: Mobile phone use, application download risks, data losses

Risk 3. Risks to project: Lack of participants to interview, lack of information gathered from interviews, subject may not own a smartphone

Risk 4. Risks to University: No risks to university

<table>
<thead>
<tr>
<th>C2 How will you deal with the potential risks?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Solution 1.</strong> Risks to the researcher: Good time management and taking precautions when travelling.</td>
</tr>
<tr>
<td><strong>Solution 2.</strong> Risks to the subject: Ensure each subject that the premises used comply with Cardiff Metropolitan health and safety rules. Ensure the subject that their information is gathered ethically and lawfully, no participants under 18, no personal information will be held and all data will be secured using passwords.</td>
</tr>
<tr>
<td><strong>Solution 3.</strong> Risks to project: Consider a different application or try and find more interview participants, backup data.</td>
</tr>
<tr>
<td><strong>Solution 4.</strong> Risks to University: I will contact my supervisor in the event of a health and safety issue.</td>
</tr>
</tbody>
</table>
Appendix D: Photo evidence of test results

D1. Starting Application (Photo Evidence)

D2. Setting the Meditation Timer (Photo Evidence)
D3. Starting a New Meditation Session (Photo Evidence)

D4. Completing the Meditation Session (Photo Evidence)
D5. End the Meditation Session Early (Photo Evidence)

D6. View Heart Rate Data at the End of the Session (Photo Evidence)
D7. View Meditation Logs (Photo Evidence)

D8. Close Application (Photo Evidence)
Appendix E: Software source code

PLEASE NOTE:

Please find attached a USB flash drive that contains a copy of the application package, including its source code and all resource files.