HealthyMind: A mental health solution for student wellbeing

CM50150: Interactive Communication Design

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ABSTRACT

Student wellbeing is a key aspect of studying at university. Commonly cited problems include stress, anxiety and depression, which are prevalent in young people undertaking studies [4]. Student services within universities are often put under increasing pressures to be able to address student wellbeing problems at all times of the day. Behaviour change support systems exist as one means of providing an intervention for students, which is not a clinical solution. Whilst others have previously attempted to introduce technology to combat mental health, this has been met with varying degrees of success [25]. We therefore propose 'HealthyMind' - a mobile application-based behaviour change support system which encourages students to (1) identify when their state of mind is deviating from positive patterns; (2) to allow students to combat these states of mind by engaging in gamified interventions and; (3) to direct students to the appropriate sources of help at a university.

KEYWORDS

HCI, Human Computer Interaction, Mental Health, Student Wellbeing, Participatory Design, Scenario-based Design, Interactivity

ACM Reference Format:
Marc Adlington, Kimberley Chong, Xiaowei Li, Yalin Shi, and Ewan Soubutts. 2018. HealthyMind: A mental health solution for student wellbeing: CM50150: Interactive Communication Design. In *Proceedings of Design: Team 4 (University of Bath),* Marc Adlington, Kimberley Chong, Xiaowei Li, Yalin Shi, and Ewan Soubutts . ACM, Bath, Somerset, UK, 32 pages.

1 INTRODUCTION

Human behaviour is recursive. Quite often it is possible for people to adopt negative patterns of behaviour, which can be difficult to break out of [23]. Our behaviour change support system seeks to reinforce positive behaviours related to student state of mind, which encourages them to think, act and behave in a psychologically stable frame of mind. Whilst our app does not seek to exist as a mental health intervention of the clinical kind, we aim to provide positive reinforcement for poor mental health behaviours. Our app - 'HealthyMind', allows students to gain awareness of their own psychological states, track them over time, and take actions, to change their behaviour. This behavioural change comes from a 'trigger', initiated by our app, which either encourages students to perform these formative actions on their own, or encourages them to seek support from university services, if they feel it is appropriate.

Statistics have shown that mental health disorders are becoming increasingly prevalent with one in four people in the United Kingdom, being diagnosed with anxiety and/or depression [18]. Recent studies have further revealed that mental health disorders such as anxiety and depression are prevalent in the every-day life of university students. Symptoms of these disorders may arise from traumatic episodic events, experienced prior to undertaking academic studies, or may arise whilst students are at University [4]. Further, the proliferation in use of social media, being adopted by young people in attendance of universities and colleges, has contributed to the greater presence of social anxiety and stress. It has therefore become increasingly easy for students to unrealistically compare their academic progress against their peers; heightening disorders such as anxiety.

These factors have resulted in a dramatic increase in reported cases of poor mental health for students studying in Higher Education. Whilst Beiter et al. [4] identify this reaching a record high in 2016, there has yet to be a large-scale intervention to curb this increase. Calvo et al. [5] pose a methodology for bringing together Human Computer Interaction (HCI) researchers, Psychologists and health workers to elaborate ways to reach out to those with ongoing mental health issues. They pose five 'challenge areas' where interdisciplinary collaboration between research communities, academics and technology can help to curb this 'pandemic'. These five interdisciplinary challenge areas include 'Design outcomes, Entrepreneurship, Publishing, Theoretical (Health) Frameworks and Research funding' [5].

This initiative identified areas where technology and in particular, collaboration with HCI, could generate progress towards preventing a global trend of poor mental health. This study was not focussed on student mental health issues, yet it presented that 'tools can advance or improve mental health' and that through this research, progress has already been made.

We have therefore built upon this work to present 'HealthyMind' - a digital mental health solution for students, to combat common psychological issues often found whilst studying in Higher Education, such as depression, anxiety, stress and social isolation. We aim to raise awareness of student physiological and psychological states and put students in better contact with the resources available to them. As such, a structured technological intervention can be used to aid them during intensive study periods. We acknowledge that this system is not designed to replace the role

University of Bath, April 2018, Bath, United Kingdom
2018.

of psychological therapists or University counselling services, but instead is designed with the intent of providing users of the system a source of enjoyable yet informative diversion from their studies. This may encourage them to confront any problems they may be facing. We provide prototypes, design specifications and an explication of Scenario-Based and Participatory Design sessions. Such deliverables will inform the final design type of our mobile health application.

1.1 Problem Area

With the increasing prevalence and the effects of anxiety and depression most common among university students, we aim to devise a system that changes the behaviour of university students by allowing them to become aware of their own mental health and assisting them to look for help when necessary. It would also encourage positivity for those who are diagnosed with a mental illness to curb self-harming behaviours and suicidal thoughts developed from mental distress. The system would alternatively encourage students to seek help when needed and to also provide counsellors and clinical psychologists a tool to raise awareness of a students' medical condition. Our system thus mainly targets anxiety and depression as these are the most prevalent of current mental health conditions and tries to impact stress levels in students attending Higher Education, especially in universities.

1.2 Context

Our solution exists within the context of both a mobile application and a wearable device. Our wearable device capitalises on existing sensor technology found within contemporary mobile devices to include physiological, emotional, and habitual aspects. In the event of a sudden change of physical state, the app sends a notification to users, informing them of current physical health indications, which are linked to a pre-defined mental state within the app, based on readings measured by the wearable. This is displayed to the user's smartphone and wearable device background as a dynamic image display of the user's choosing. For example, a user may choose to select a picture of a tree as one of their dynamic backgrounds within the app. The image would then change according to the data sourced from the user and interpreted by the app to reflect the neuro-physical responses being received at that time. As the app monitors changes in real-time, the imagery and prompts to the user are always changing. If the user is not displaying any overt signs of a mental health problem, then the app continues to display regular imagery; yet if the user displays symptoms of a particular mental health issue, the dynamic background animates to reinforce the calming mood. At this point, a notification is sent to the user to prompt them to engage in an activity to change their current state of mind. The user may choose to 'snooze' these notifications, but if choosing to engage in them, the app reacts to guide them through a series of steps to help them no longer experience that particular mental state. For example, a user experiencing an anxiety episode, may perform an activity in the form of a controlled breathing exercise, which the app prompts the user to follow, to bring them back to a normal resting heart rate to reduce their stress.

Our solution distinguishes itself from the other mental health applications we have explored in that it is a dynamic (and not static) intervention which is constantly running on users' devices. This approach allows users to monitor their health far more effectively than opening and closing an app and manually inputting data, so that it is possible for users to know their current mental state at a glance. An advantage of seeing an analysis of their own mental health data in real time, is that this will provide an opportunity for users to enact changes to their behaviour in real-time, providing them with the motivation to alter their behaviour, as well as a trigger to see this through, with the app's notification system.

1.3 Requirements Gathering

Functional Requirements

- *To accurately measure and detect poor mental health from users based on physiological responses.*

The American Psychiatric Association (APA) [1] has listed some symptoms for depression and anxiety in which our app bases the evaluation of mental health on. Among them, the continuum of emotion plays a big part in mood disorders including depression, and anxiety disorders. In depressive disorders, persistent sad emotions are displayed while fear is found in anxiety disorders. To measure this, research findings reported that emotions can be detected using physiological symptoms such as heartbeat, respiration rate, blood pressure, galvanic skin response (GSR) measurements and other nervous system responses [3]. This is helpful for detecting emotional distress that could be led on by anxiety and depression. This can also be adjusted with the self-report ratings of users to increase the accuracy of the app.

Thus, we seek to collect data from users related to the assessment of their mental health disorders [1] through a wearable device to track physical response measures. These include: the user's heartbeat, respiration rate, blood pressure and GSR, as well as emotional aspects, measurable with a Likert scale, and other habitual activity such as sleep, circadian cycle, physical activity and diets. The solution delivers this information to users in 'real-time', so regular changes to the dynamic wallpaper are necessary to ensure that the information being displayed is accurate and concurrent. Changes to the background and refresh rate (R) are set at around *R=5 minutes*. Through this functionality, users can self-monitor their performance thereby making changes to their mood, for a desirable outcome.

- *To notify users of a decline in their own mental health.*

Whilst mental health can vary widely, even within the space of a 24-hour period [18], it is important to notify users whenever significant changes to these states take place. Therefore, our solution tracks these relapses and graphically presents them to the users as an extended option within the app. This data can then be exported or set up to track 'danger points' in the user's day where either they, or the app notice that their mental health declines at a specific time, on a regular basis.

- *To influence decision making to encourage users to adopt a positive attitude towards their own mental health.*

To implement a change in users' behaviour, it is necessary to make them aware of the current state of their mental health and to make it relevant to their needs. As Oinas-Kukkonen describes in the Process Model of Persuasive Systems, it is necessary to analyse the

'Persuasive Context' whereby 'Personalisation' plays a key role in the effectiveness of the behaviour change implementation [20]. To ensure that we induce positive decision making, we have included a system of personalised interventions, prompted through 'push notifications' whereby a user can choose to engage in a positive and mindful intervention, when the app detects that they are experiencing a negative mental state.

- *To encourage users to act to change their poor mental state by engaging in gamified interventions within the app.*

Kukkonen and Orji et al. both describe means of gamifying persuasive health interventions [20, 21]. It is this approach which we favour in 'HealthyMind' to ensure that users engage in an enjoyable and ultimately self-fulfilling set of tasks which are repeatable and reproducible to track their recovery from poor mental health. By gamifying this information and displaying the results, we elicit 'self-monitoring informatics' as described by Orji which allow a user to monitor and adapt their behaviour to be sustainable or increasingly positive. This positive feedback loop aims to sustain the behaviour change intervention over a longer duration so that the effectiveness of the app is long-lasting. If sustainable, this is particularly beneficial for students during prolonged study periods such as exams which can typically last up to a month from preparation to sitting the exam.

Non-functional requirements

- *Visual and Tactile Aesthetics*

Whilst our behaviour change intervention primarily exists within the visual domain, it is possible to implement some tactile engagement with users through actuators in mobile devices. Haptic feedback could be leveraged in the display of information on-screen. This has been evidenced to be equally useful in the presentation of data to users in sustaining a behaviour change [2]. Aside from this, our design is visually themed to appeal to a commercial, not corporate environment, so aims to utilise a colour palette consistent with psychology (purples) and in hues akin to the pastel shades shown in the design of other apps on App stores [14]. We also expect 'cute' images and icons would appeal to our target audience of university students who are younger of age. The visual language and layout is similar to designs evidenced through other app store applications and are not limited to mental health apps. This conforms to recognisable app layouts (informed through our user evaluations), which make use of a standard alphanumeric keyboard interface to view and add data.

- *Usability*

Our intervention is designed to be easy to use for those who are experiencing poor mental health. It has been documented that large and complicated text can lead to increased anxiety [11]. Therefore the primary form factor of our app is centred on a dynamic background image on the 'lock screen' which changes according to each user's metrics. As the app is largely responsive to users in real-time, providing information visualisation, extensive technical skills are not required to make use of the app's functionality. The steepest learning curve in using our application was found to be learning when to snooze notifications and when partking in a Iconography within the app provides users greater accessibility over functions. It was considered for the app to have a 'speak-aloud' feature which would read mood data out loud to a user, if they may have visual impairments. This idea was rejected however due to concerns over privacy, as reading out loud mental health data in a public setting, was unwanted by most users. Instead, large, clear icons on both the mobile and watch iterations of the app allow for those with visual impairments to access the core functionality of the app. Whilst the watch version of the app does not allow users to import/export data, the mobile instance of our app allows this if it is synced with a PC. Regional settings (to change the defaults) including language are also able to be set for the app within a device's settings menu.

- *Performance*

Our device is highly responsive and refreshes in 'real-time' through instances of five minutes where data is recorded and interpreted and the device display is altered appropriately. This helps to ensure metrics such as speed and accuracy when monitoring data. Safety is ensured through taking discrete readings on physiometric measures through a mobile device's standard controllers. These are non-intrusive and do not pose any harm to the user. Distress is reduced through reinforcing data with calming imagery to keep users checking their data without affecting their existing mental state. As information is processed on the client-side and not through a server, there is increased reliability which does not require the use of an active internet connection. Availability is therefore continuous, allowing the user to be able to monitor themselves at any time of day, during any activity.

- *Operation*

The app aims to run in the background of a user's device, throughout a 24-hour period. Within the physical environment, the device calibrates itself according to activities a user performs. During this time, sensors within the user's device will be capitalised to take snapshots of behavioural and physiometric data to resultingly generate notifications and visual and haptic feedback to prompt users towards specific behaviours. Within the technical environment, this data can then be analysed by the user, or they can engage in a specific behaviour-change activity, which is designed to improve their mood. This enables them to respond positively to their current state of mind.

- *Security*

The app ensures security through implementing biometric authentication through a TouchID protocol before data can be downloaded from the user's device to any PC. For iOS devices, a password must be entered on the authorising PC for health data to be downloaded to that machine. Data views within the app can also be password-protected so that others cannot glance at personal data if it is being displayed with the user unaware. During an emergency, our app responds to de-activate itself to allow critical or life-saving processes to run on the device i.e. Emergency calls. Information regarding a user may for example, also be added to the Apple 'Medical ID' page which shows critical information about a person during a medical emergency. In future iteration of our solution, aside from storing data in an encrypted manner on a user's device, the output from 'HealthyMind' may also be stored on our app's own SSL-encrypted, cloud-based servers to be recovered in the event of a device malfunction or personal data loss. Due to vulnerabilities associated

with encryption, the security within our app is a tested and publicly accepted cryptographic standard - the Advanced Encryption Standard (AES) [17]. This tight regulation is to protect consumers' data amd privacy. In the event of power loss or damage to the device, the app will deactivate when set to a Low Power Mode and will record no data when the device is inactive. On restoring the device, it will continue to monitor the user's data with a gap indicating the down-time and the reasons for this, in any exported results.

2 OVERVIEW OF PERSUASIVE SYSTEMS

This study suggests the use of gamification to be a motivation for behaviour change through engagement. Based on Fogg's Behaviour Model, behaviour change is comprised of motivation, ability, and trigger [13]. To make our app more fun and engaging for those faced with stress at university, our design incorporates the use of gamification as it plays a role in providing intrinsic motivation to users. According to Mitchell et al. [19], gamification can promote behaviour change and maintain the attitude towards behaviour change. Although their study did not find the cause of behaviour change being generated from intrinsic benefits, such as enjoyment or interest, it is possible behaviour change outcomes from extrinsic motivations, such as game elements, involving achievements and badges [19]. More importantly, the impact of gamification on behaviour change and maintenance is considered in our system design, such that users will remain to change behaviour and retain improvement after using the app.

In the context of gaming in mental health apps, studies have shown that gamification is beneficial because gaming is appealing to a range of audience and especially in young people [12]. Besides that, gaming is seen as an enjoyable activity which raises its engaging potential and has the potential to be effective in behaviour changing by providing opportunities for users to be immersed in the environment and allow social learning to maintain that behaviour [12]. This promotes the use of gamification in our app which is not found in most existing solutions.

2.1 Existing Persuasive Solutions

Persuasive technology plays a vital role in creating an effective mobile app, especially in the aspect of health [8]. Mobile persuasive technology enables developers to implement personalised applications. Besides detecting users behaviours, the approach of quantifying self has encouraged persuasive technology to record and collect user data in daily life, which assists the app to accomplish health interventions and inform further advice [16]. The following applications are existing solutions in the mobile app and wearable industry that strives to improve mental health.

- *What's Up*

What's Up is a mental health mobile app that indicates to users the triggers of their mental health states [10]. Useful elements of this app include an ability to share mental health data with others so that it is possible to maintain motivation towards achieving personal goals [10].

- *7 Cups*

7 Cups exists to help users speak anonymously with mental health professionals online in a similar manner to Samaritans services. The app's design centres around live-chat communication between the user and other callers to help them find someone to talk to who can assist with the user's current mood.

- *Calm*

'Calm' makes use of mindfulness interventions to guide you though a meditated session that fits around your work day. This allows users to allocate time specifically for meditation, to ensure that they do not become severely stressed.

- *Moodnotes*

Perhaps most similar to our own intervention is 'Moodnotes' which allows users to track their mood by inputting data on how they are feeling. This performs a keywords analysis which provides useful suggestions and perspectives to improve your mood.

- *Headspace*

Headspace is a meditation app that guides users step-by-step on how to to relieve stress, improve sleep quality, focus better and even increase creativity without requiring a special environment or predefined time. After signing in, the user is asked to choose one answer which best matches his or her status based on five questions. Then the app gives suggestions for meditation exercises based on the analysis of those answers. Headspace uses cute cartoon animation to explain relevant knowledge and preparations for meditation that captures users' attention. The meditation courses are presented in a timeline format, with each session lasting for ten minutes. It also shows personal progress and records as well as how many people in the world have completed the same activity. Moreover, Headspace offers special exercises such as fear and attention, as well as other different life scenarios.

- *Tide*

Tide is an app to encourage people to be mindful, peaceful and joyful with various nature sounds. It is easy for users to listen to white noise music elegantly, in order to more focus on creating, working, living and sleeping. Tide has selected seven scenes includes ocean, rain, muse, forest, cafe, library and fire. For most people, these nature sounds make people feel peaceful and help users to get into a highly focused state as soon as possible. The interface of the app is fresh, nature and without extra complicated design, it is regarded as achieving the goal of "Do not make the user to think". In addition, different greetings at different times, sentences and background pictures pushed everyday also brings a feeling of tranquillity and peace to people.

- *Prana*

Prana is the first wearable to help people breathe and sit in a healthier way which benefits for body and mind to reduce stress. This small wearable device enables users to wear on along their waistline and observes users' breathing, it has an on-device buzzer for alerts and can also send the user a text message. A notification pop-ups or the device buzzing itself to ask the user to correct their breath or posture when it detects undue stress. Besides monitoring and notifying the user, Prana has provided users with opportunity to teach them right breathing through a series of games, for example, a two minute game allows an avatar in the game to avoid hitting the wall by exhaling and inhaling properly to navigate.

Based on these existing solutions, our app incorporates the features of existing apps and wearables such that learnability of features from those existing apps and wearable devices that can be transferred into our app. Our app also incorporates new features such as being responsive to the user's physiometric measures and provide immediate feedback that provides novelty and usability to our users.

3 METHODOLOGY

We have chosen to use a Scenario Based Design and Participatory Design for our system. Proposing Scenario Based Design forms is an important part of collecting and comprehending users requirements [24]. Since requirements always change, Scenario Based Design is flexible to deal with constant changes and encourages designers to slow down their thought process and consider more about the users. Through these vivid stories, we are able to create a satisfactory system, which meets users' needs and suitably affects their behaviour.

To date, Scenario Based Design (SBD) has been widely used in the area of design [15]. Scenarios are a set of stories about the users and their activities in the product. Several advantages are provided by scenario during the process of design. Firstly, it is much more flexible and concrete than most alternative design methods. Moreover, through scenario based design, designers can consider the product from multiple angles of when the product is used [6]. Most importantly, scenario based design is one of the work-oriented methods, which means that this method initiates thinking about what the users do when they actually use the product.

During the process of design, especially for products with requirements related to interaction with people, it is a good idea to consider what actions the user will take [6]. When the stakeholders do not have a clear conception for the product, scenario-based design can provide a better understanding between designers and users. Moreover, through adopting scenario-based design, the developer is able to gather a richer understanding about the user requirements for the product. Likewise, [9] illustrates that Scenario Based Design (SBD) provides an important potential for the future stakeholders as one of the tools for participatory technologies development in the field of design. Through a clear and specific scenario, the method can increase the efficiency of communication between users and designers. Sequentially, the designer can achieve an optimal balance between the feasibility of technology and the user's requirements.

Participatory design is an approach to design where the stakeholders of the product or service are involved in the design process. This ensures the end product matches the needs and expectations of the target audience. Moreover, participatory design is argued to result in more innovative design concepts. This is predominantly due to the involvement of the population in interest throughout the design life-cycle of a computer-based system. Through observation of user needs and preferences, there is potential to learn additional information that would not necessary be discussed in an interview. Therefore, in an attempt to ensure a rigorous design, we have additionally employed the participatory approach to our design process.

3.1 Design Approaches

3.1.1 Scenario Based Design. To make our scenarios, we looked at current situations of what university students currently face and the outcomes. Following that, we decided on how the intervention may help them to change their behaviour for a better result. As studies have found that physical workouts help in improving mental health [5], the scenario of our app sets the scene of having the user to exercise and having the heartbeat have an increase triggers a notification to make sure that the student is not having a panic attack, anxious, or under stress. The storyboard shows that if the user is exercising, the option of 'snooze' appears to temporarily ignore the heartbeat increase as it is due to a physical workout and not facing a psychological symptom or under stress. However, if the user is facing a mental health issue such as dealing with stress or anxiety, resources have been provided such as breathing exercises to be carried out to calm the mood. If further help is needed, the app provides direction for the student to seek professional help from the university mental health and counselling services as well.

Due to scenario design is used to image what kinds of activities potential users perform in our product, making a set of storyboards probably benefits for designers to consider what the product can do. Moreover, in some particular situations, potential user and designers might not clear enough for the details. Scenarios are available to provide a much clear and logical versions for all of stakeholders. For our product, we have made a mass of product interfaces and storyboards, making sure every buttons in product links to a particular function. In the process of drawing storyboards and interfaces, some new ideas about how to increase the attraction for potential users have been putted forward. For example, in the homepage, a tree represents the state of mind-healthy. Users are able to directly catch the information about their healthy situation. As a result, through providing a clear and particular scenarios, more detail about user's requirements are realized. Moreover, when we try to describe our product to potential user, scenarios can help user to understand the services provided by our product.

3.1.2 Participatory Design. The participatory design approach has comprised the following two design sessions, in which the participants are presented with our scenario based designs, as well as the tools to create and design low-fidelity prototypes:

Participatory Design Session 1. The purpose of the first participatory design session is to highlight the problem area to our user group, in an effort to gather the vision and scope for the system. The design session requires the participants to undertake an individual exercise to develop their ideal wireframe design. The users then proposed their low-fidelity prototypes to the group, while providing an explanation for their product design. The information and low-fidelity prototypes gathered from the session determined the direction of our project, such that we changed our initial product design based on user suggestion.

Participatory Design Session 2. Thus, following the first design session high-fidelity prototypes were drawn. These illustrations integrate the knowledge gained during the initial design session to produce a more detailed prototype design. The scenario-based design was shown to the participants at the beginning of the session, such that the user can gather an understanding of the type of

interactions we want our system to undertake. This was then be proceeded by an interactive high-fidelity prototype, in which the user interacted with the design to provide feedback. The session concluded on a final discussion, ensuring all of the stakeholder needs and wants have been met, or any fundamental changes are aware of.

Questionnaires. Based on the feedbacks we collected from the last two design sessions, we have made some updates about our product including the homepage and user-centred design. In order to re-test our product, we made an online questionnaire to collect more information about our product from those potential users.

4 DESIGN SESSION EVALUATION

In adherence to the structure outlined in Section 3.1.2, the first participatory design session required both participants to draw wireframe designs, depicting their vision of the discussed mental health support system. The necessity of a chat system, enabling the user to contact the mental health service at the university, was found to be a commonality across both designs. Upon probing, the participants revealed the importance of said feature to derive from the need to present users with professional support, if assistance is required beyond the scope of the app.

Further, we note that the participants discussed the importance of a general advice section. The participants suggested this feature to provide individuals, who are currently experiencing depression or anxiety, with relevant information to help control and become aware of their thought process.

In addition, the participants introduced the concept of incorporating an interactive flower background wallpaper, that would "blossom based on the users daily progress" (Participant 1). This gamification technique can be described as a goal-setting strategy, enticing the user to use the app in order to feel a sense of accomplishment and achievement of growing something tangible.

Moreover, the second participatory design session gained additional design insights, and focused on the participants examining the scenario-based design and high-fidelity prototype design of our system; leading to an open discussion. The participants were content with the creative direction and cohesiveness of the project. This was due to the proposed design being found to effectively encompass the participants needs and wants for the system, as gathered in the initial participatory design session.

4.1 Prototype Design

4.1.1 Low Fidelity Prototype. For the design of the low fidelity prototype, we initially used Balsamiq Mockups for the initial wireframes of the app as seen in Figure 1. It is meant to show that the background image of the mobile device would change in real-time that reflects the user's mental health. When there is a change of mode, a push notification is generated for the user to take immediate action. Through this prototype, we hope to communicate how users would be able to receive notice of their own physiological changes that would reflect a possible change in mood.

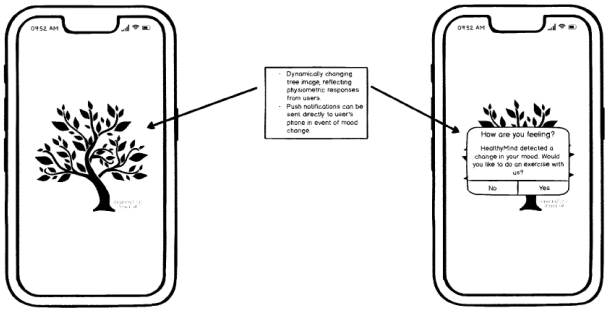


Figure 1: Low Fidelity Prototype

4.1.2 High Fidelity Prototype (Appendix H). After our first participatory design session, the high fidelity prototype was made with Axure RP and hosted on Axure Share[1].

Even though the first evaluation of the design was conducted to have features that provides a chat system with professional help and general advice, there is limited support in which the app can provide as it is not staffed by professionals. However, we would be able to direct the users towards the university's counselling and mental health service. This allows them to get in touch with the appropriate support through a phone call, live chat, message, or other online resources as shown in Figure 2. Besides that, the app analyses the data collected and give a general advice on whether a user should seek professional help immediately.

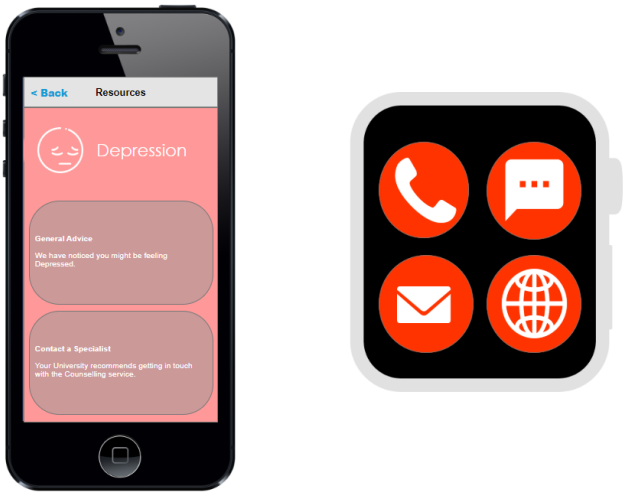


Figure 2: High Fidelity Prototype

Further functionality is added into the high fidelity prototype that reflects the initial requirements gathered. As emotions play a big part of differentiating depression and anxiety, self-reported ratings are added with six primary emotions. Quantitative and qualitative data of the psychological metrics were also reflected in the high fidelity prototype that allows users to understand their

[1] Link to prototype on Axure Share: https://q9ijlx.axshare.com/

mental health better before seeking help. To accommodate for users' anonymity , privacy, and security, no identification of the users are made compared to how usual apps in the industry implements a "My Account" feature. Settings is also added in the high fidelity prototype addressing the need of adjusting when recording of data is allowed or discontinued based on the requirements found in the first Participatory Design.

4.2 Analytical Rationale

To adjust our design through each iteration we reasoned we would iterate our final design three times. Three stages were decided upon as this provided us with a suitable number of iterations to perform any major refinements given our timescale and also followed the same number of iterations in Chittaro's study [8]. To ensure consistency, we conducted user scenario-based and participatory design sessions within each iteration. This provided empirically-driven means of evaluating our design changes at each stage.

- *Iteration 1 (Appendix B and C):* Within our first iteration we generated a prototype based on Scenarios which were analysed during a scenario-based design session. It was then collectively decided what the core features of our system would be and a short design specification was devised - namely, the link to a dynamic background on the user's device, the physiometric measures taken by the device to determine the user's mood, a set of intervention options for different moods i.e. stress as well as links to specific mental health services at a University. Taking these four core features as a starting point, we were able to construct our first low-fidelity prototypes.
- *Iteration 2 (Appendix D):* Our second iteration was largely based on the first Participatory Design session we conducted. To this end, our user feedback was analysed and we reflected upon commentary and metrics observed, which could inform our next iteration. From asking questions centred on how the system was perceived by our participants to the extent which they believed it affected their behaviour in the desired manner, this allowed us to make rationed judgements as to the degree of changes we wished to make before the next iteration and the type of changes they wished to see.
- *Iteration 3 (Appendix H):* The final iteration of our prototype saw implementation using Axure to create a High-Fidelity model of the system. This version of the system followed our second, 'Evaluative' Participatory Design session with our users and identified further changes, based on our original designs and subsequent feedback, which we incorporated into this version. Our analysis performed from the second iteration of our designs built on the existing measures we had used and honed these further, for the final version of our system. Our Future Work section addresses the challenges of only performing two iterations within a complex system such as ours as well as our interest in continuing to refine our prototype to better affect behaviour, so that our application could change behaviour consistently over a longer duration.

This forms the analytical basis from which we approached the analysis and refinement of prototypes from each design session. We also performed empirical qualitative measures, with our users during each session, which ensured that our engagement with our users was recorded suitably and could be easily translated into system refinements.

4.3 Empirical Rationale

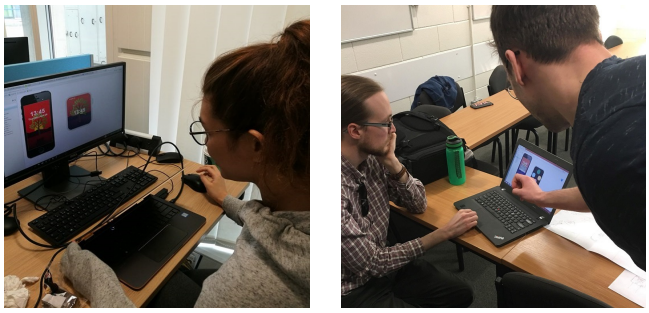
To ensure that our designs were created in a logical and sensible manner, it was necessary to test our system's effectiveness with users through our design sessions. We observed their interactions with our prototypes and final designs through direct observation of their gestures and comments. In this manner we qualitatively assessed our prototypes to judge their effectiveness within the context of a behaviour change support system. Verbal feedback from users included:

"*I enjoy that users can easily swipe between prompts and windows on a device. The way each icon is centred around a central is also presented nicely and makes me think about the options available to me. This is nice if I was stressed.*" (Participant, 1).

"*It's useful that the notifications are not demanding and they don't seem intrusive to me. Having the calming background behind these doesn't make me feel like I have to do something right away. If I was anxious, this would be a help. I don't know if it would make me change my behaviour altogether, but it would certainly make me consider my options.*" (Participant, 2).

"*It comes across as a very well designed visual system, but I might need more direct feedback about how my mood can be changed from knowing things like my heart rate etc. I like what you've done from what you showed us originally, to what it is now. I'm sure I'd download it on the app store!*" (Participant, 1).

The photos shown below detail the common areas on the device which our participants frequently gestured to. We assume that this 'pointing' modality observed in our design sessions would overlay to gestures observable on a mobile device. Considering this, the two photos detailed below, indicate the most commonly indicated screens, which users may interact with most frequently.



(a) Participant 1 Immersed. **(b) Participant 2 Immersed.**

Figure 3: High-Fidelity Design Review.

4.4 Discussion

We have presented the analytical and empirical validation through which we evaluated our system both within our design sessions and following these, during each iteration and refinement of our prototype. From following a means of collecting qualitative data,

we have surveyed users' opinions, problems and needs through each iteration of our designs.

We discovered two themes which were identifiable from the data collected during these sessions. Firstly, we noted that our participants gestured towards interactions with the physiometric data which the app displayed. Whilst this is an essential aspect of the design of our system, it is not essential to the behaviour change. Therefore, we recommend making the physiometric information less central to the interactions within the app and more discrete within its design. Secondly, we noted that users struggled to form a mental model [22] of how the physiometric data collected by our app translated into a representation of their mood. Therefore, we recommend making this more apparent to users in future iterations of our system either through a 'swipe-through' guide on first opening the app, or by introducing a 'Help' feature within the system [7].

5 EVALUATION OF DESIGNS AND METHODS

We generated a rich picture at the beginning of our design process to drive the direction of our initial participatory design session. This technique enabled us to identify the internal and external stakeholders that encompass our app, and to develop a broad understanding of their respective pain points and user needs.

Scenario based design was then conducted, to describe possible scenarios applied to describe possible scenarios, basic functions of the app and how it works, which helped us hold a conceptual overview for this system. Then, two participatory design sessions were adopted to generate user opinions and suggestions. According to our brainstorms and views from participants, we produced a series of prototype designs. Complete and close-to-reality features provided great help to our evaluation session. In the following content, we evaluated from two aspect, analytical evaluation and empirical evaluation.

5.1 Analytical Evaluation

A cognitive walkthrough was adopted in our analytical evaluation. As questionnaires are usually multiple-choice questions, it is difficult for application designers to receive effective feedback from users, so we chose qualitative interviews to conduct drills. Two volunteers from University of Bath were invited to participate in our walkthroughs, in which we presented the prototypes of the app through a Axure link, enabling participants to simulate real operations. To avoid bias, we recruited participants who were previously not involved in the participatory designs. Furthermore, participants were briefly informed of the application's purpose at the beginning, "This is an app which cares about the mental health of university students, assuming you are anxious and have an increasing heart rate, both smart watch and mobile phone will alert you of the abnormal change". Then participants interacted with the app by themselves according to the scenario we have provided to them. As a result, Participant 1 (P1) indicated that the specific cause of the anomaly is clear and helps him to obtain direct help based on different situations. Participant 2 (P2) noted that the most attractive and interesting design is the colour of the tree that would change according to the mood, she also believed that the monitoring of the heartbeat may play an important role in an emergency situation, such as in the event of the heartbeat stopping. Both participants considered it helpful to seek assistance online. As for whether the application is easy to use, we received positive answers, emphasizing that all features were clear, simple to understand and easy to find.

5.2 Empirical Evaluation

Empirical research is one of the methods to collect knowledge through direct or indirect observation. Compared with analytical evaluation, empirical evaluation may be able to get better answers for those who cannot be studied in lab, especially in the area of social sciences and education. In order to collect more information about the user's feelings and requirements, we have conducted a set of interviews with our users. Since the target users of our product are university students, all of interviewees are students at the University of Bath. Moreover, in order to get better empirical evidence, the questions during interviews have been defined clearly. At the beginning of the interview, a clear description about what tasks the participants did during each interview were provided by each of our group members to know the interaction users would have with the app.

In creating our designs, we sought to encapsulate a behaviour change at the centre of our design principles. Taking Fogg's behavioural model [**?**] as a starting point, we began by considering which element of our design should best capture and display behaviour. In the same way that human behaviour has been evidenced to reinforce its own bad habits, we sought to exemplify our technology as inducing good habits in people [23]. To do this, we decided that the 'home' screen, featuring our dynamic background and changing central image, should be representative of the 'trigger' element of Fogg's model. This is analogous to a human looking into a mirror and perhaps visually seeing what behaviour they are currently experiencing. Our app therefore, provides this trigger through a combination of the dynamic background and push notification which prompts the user to complete a game, based on a detectable change in mood. Table 1 identifies the starting behaviours as described by our users and evidenced in Section 4.3 and shows how their behaviour was affected by our system.

	Initial Behaviour	**Changed Behaviour**
Likehood of seeking mental health support	Never sought out a mental health service at Uni	Willing to engage with our controlled interventions in-app
Frequency of Using Mobile Devices	Users would frequently use their phones for social media.	Were keen to reduce their device consumption to reduce own anxiety.
Engagement with Mobile Health/Games	Rarely used mobile devices for gaming.	Haven't used Mobile Health games before, but liked the form factors of ours.

Table 1: Efficacy of mental health behaviour change.

5.2.1 Qualitative Evaluation. We invited four university students who were interested in our HealthyMind application, one of

them had previously participated in the analytical evaluation. Three of them were experiencing different aspects of stress or anxiety, one was undertaking pressure from coursework, one felt depressed because of low academic grades, another one was worried about his relationship. Hence, participants can be considered as our target audience and allow them inspect our system in light of distinct situations. Considering that each individual experiment only required less than ten minutes, and in order to avoid interference, we looked for two empty classrooms to prevent someone from disruption during the session. We defined four independent variables in term of four states that HealthyMind mainly aimed at: (1) Doing exercise; (2) Stressed by academics; (3) Feeling depressed; (4) Undertaking anxiety. We tried to let participants to complete the entire evaluation process by themselves, avoided answering enquiries to figure out users' true experience feelings. At the end of each individual experiment, we offered a questionnaire to enable them rate experiences by 5 Likert scales and conducted face-to-face interviews.

After collecting the questionnaires from four participants (Appendix F) , we observed they all thought they could find the app as a solution to the problem, while one did not know whether the solution was useful or not. As for the satisfaction about the interface, we received both 'Agree' and 'Strongly Agree' responses. This indicated that our app may be effective for behaviour change.

Participant 1 indicated that it is helpful to involve the 'Workout' state when there is a push notification, which can prevent users from being regarded as mentally unhealthy due to the rapid heartbeat. The user's choice to cancel future notifications and allow continued monitoring after exercise is useful, but he believed that we should allow users to choose the amount of 'snooze' time, since sometimes the user may only exercise for half an hour.

Participant 2 was struggling with her assignments, she had five deadlines within a week and made her feel breathless. She noted that the general advice provided on the app will help her to alleviate her anxiety. At the same time, she could save much time by using the app to seek help instead of going to a clinic to make an appointment, which can be annoying due to long waiting times. She said she will only consider face-to-face consultations if she cannot overcome anxiety by herself. Moreover, she had mindfulness exercises before, and she liked our idea that we put functions of monitoring, giving advices and mindfulness exercises all in one app.

Participant 3 felt depressed because he received a low grade in his last assignment. He thought he had done his best and felt disappointed by the result. He believed that the diversified solutions we provided could truly helped him to relieve stress. He particularly liked the breathing exercise section, and could feel better after following the instructions. Indoor physical exercises was also a good option, as he is introverted and does not like to seek help because of psychological problems, as a result, it is an excellent solution to solve his anxiety through indoor exercises.

Participant 4 was worried about her social relationships with her friends and boyfriend. She felt that the general advice on the app would not work for her, but she could get effective stress relief from breath training. Since she could record her mood both before and after training, she thought it would rate the intensity of anxiety, which would encourage her to try and make herself more relaxed.

5.2.2 Quantitative evaluation. Excluding those four interviewees who had took part in our product design, we have interviewed 15 university students through online questionnaires. One of the reasons why we needed more interviewees lies in the fact that it would be better for us to get more information about the potential users and it was easier for us to make a quantitative analysis. We showed them our prototype so that they could anticipate what kinds of activities they could do through our product. According to the result collected from the questionnaires (Appendix F), most of our potential users felt they did not take long to learn how to use the app, which means the app was easy to use. Regarding relevant solutions, interviewees presented that they probably were able to find similar products from the current market but it might take some effort. Moreover, the responses reflected functions in our product were clearly demonstrated so efficiency was guaranteed. As for whether the options provided by our app could correctly match user's states such as the emotions available for reporting current state, some of them believed it could not correctly match, but most of them trusted the app would be able to reflect accurately their states and requirements. As for the visual aspect of the app, most of them found our app visually appealing.

6 CONCLUSION

We have presented 'HealthyMind' - a means of allowing students to track their own mental health, based on physiological measures interpreted and displayed through a mobile device.

The scenarios we initially conceived paved the way for the structure and delivery of our participatory design sessions. During the first Participatory Design session, we intentionally showed the participants our 'Rich Picture' (Appendix A); limiting their knowledge of our system, to ensure the initial concepts were not influenced by our perception of the system. We decided to present our scenarios to users during the second evaluative Participatory Design session. This allowed us to demonstrate how our intentions for the application intersected with the wants and needs of each user. At this stage, we presented our refinements to the participants to gather qualitative feedback which helped inform the final iteration of our design. This demonstrates how both our Scenario-based and Participatory Design sessions contributed to the development of our final solution. We were able to provide trade-offs with our user's requirements to produce a final design that met our own specification for a behaviour-change support system as well as incorporated users' wants, validating the effectiveness of our design sessions.

From our study, we have identified the constraints of our prototype designs. Due to it being a prototype, the full functionality of our final model was not available to our participants which caused some disappointment. Behaviour change in our users were also not observed due to it being a short study with limited functionality. Within the scope of our project surrounding mental health, collecting personal data from our users and rigorous testing is needed for ethical issues such as user's privacy and intrusiveness. As our participants for the design sessions have not reported having any mental health problems, there may be conflicting opinions on the design of our system with students who are clinically diagnosed.

Thus, some of the features need to be removed or altered, as well as having the possibility to add new features to accommodate users who are facing mental health issues. Additionally, the scope of our work focus on having a wearable device to take measures and track user records. Within a physical device, this would become an inconvenience if the user is not in contact with the wearable when the device is charging or when the user has to take it off for different activities i.e. sleeping. Also, the scope of our work assumes that the wearable device can interpret certain less measurable human variables, such as apathy, which are important for mental health assessment and which are currently limited at the time of design.

6.1 Future Work

During the design phase of our study, no more than three iterations of the prototype were conducted and so, this limited the range of alternatives for the design of our app. Future work may explore different designs of the app such as changing the colour of the tree instead of the background image on the home screen. Our evaluation approaches have also not considered quantitative measures for assessing usability or performance of carrying out tasks. Further work with measurements of time taken to complete a task helped us to assess the ease of use of our design.

Although our study may be useful for university students to take care of their mental health and to seek help from university services, future studies might further explore the development of mental health devices that can be aware of the context and surroundings of the user. These devices could provide accurate measurements of the variables involved in mental health for valid assessments for therapists to refer to. As our current functionality of the app focuses solely on services provided by a universities, we suggest future work to integrate services outside of university for users' comfort and sharing of personal information for privacy, convenience and accessibility.

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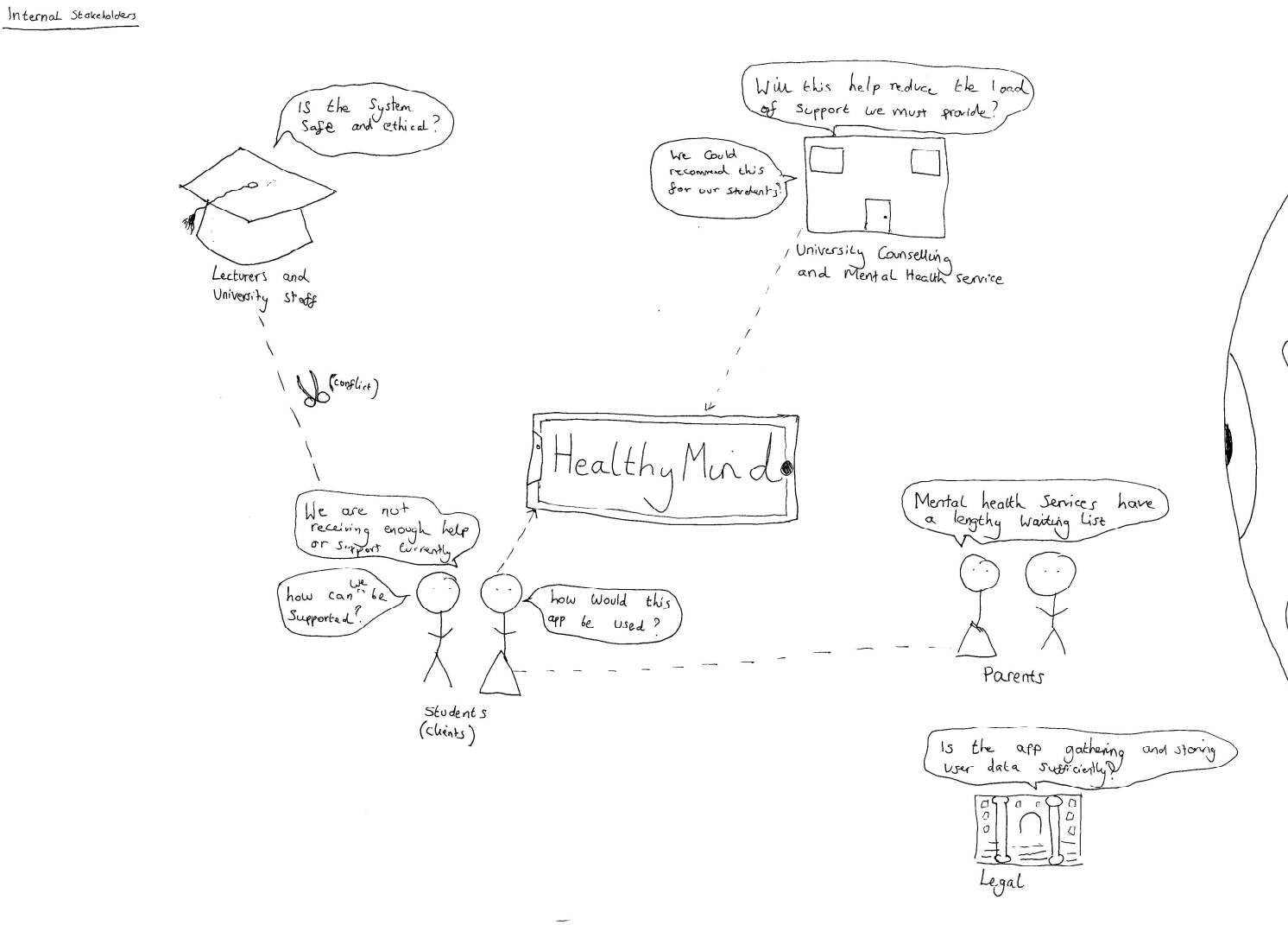
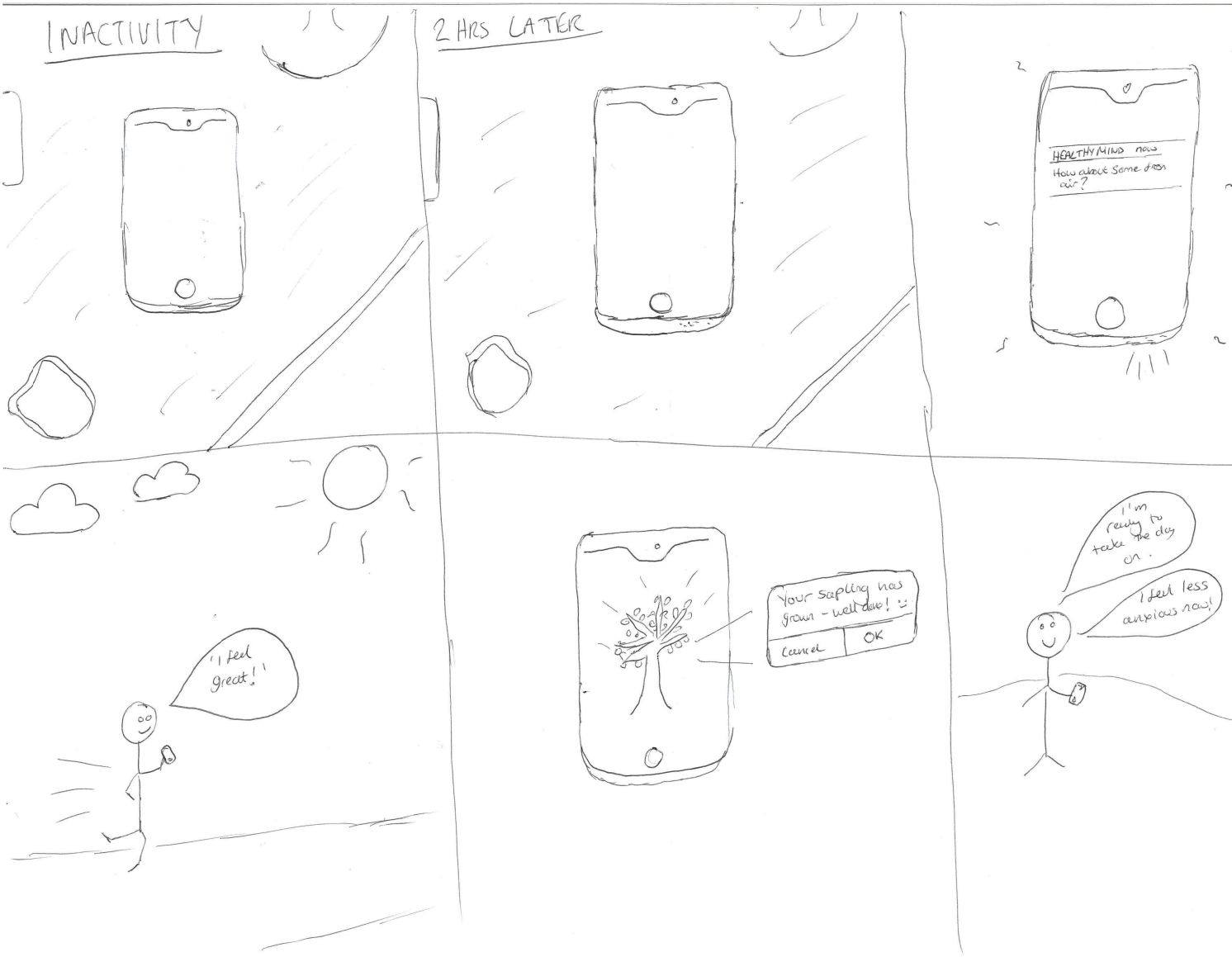
A APPENDICES

Appendix A



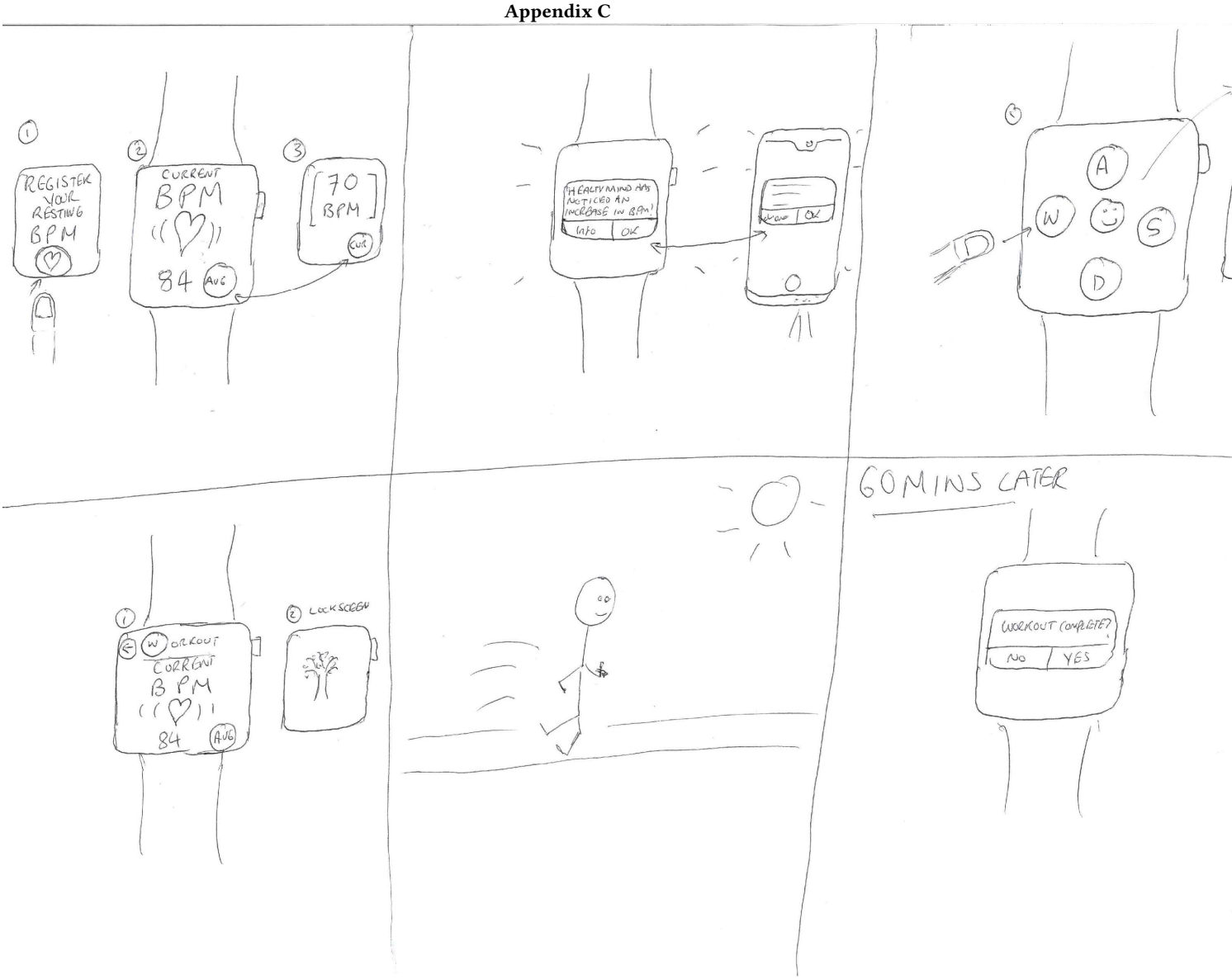
Appendix A: A rich picture to identify our users and stakeholders.

Appendix B



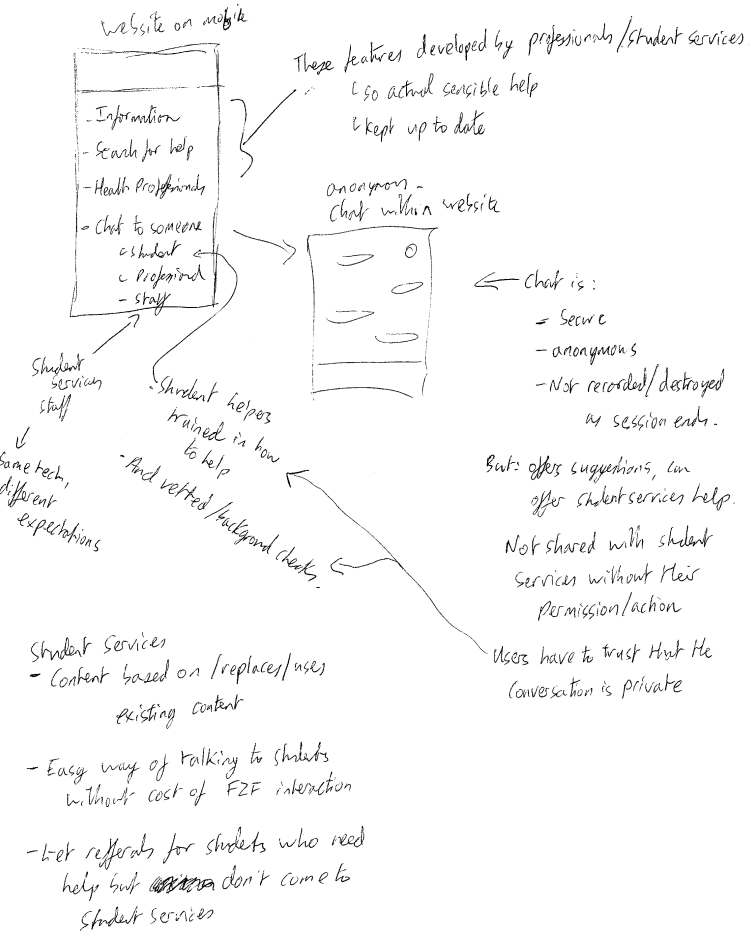
Appendix B: First draft scenario of how users will use HealthyMind on smartphone.

Appendix C

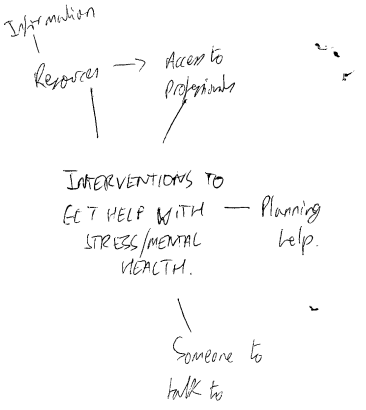


Appendix C: Second draft scenario of how users will use HealthyMind on wearable device.

Appendix D

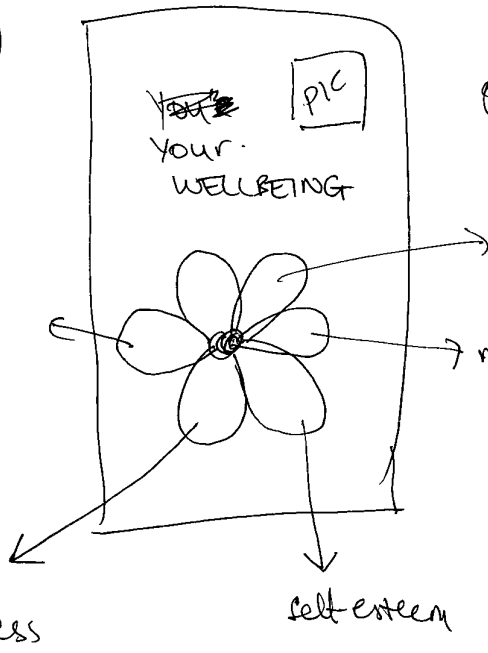


Student Services
- Content based on /replaces/uses existing content
- Easy way of talking to students without cost of F2F interaction
- Get referrals for students who need help but don't come to Student Services



17/4/18.

(1)



On the petals have different elements that can influence one's mental health. (clickable links)

Should have an online community/forum including self-help guides and CBT treatments (online).

(2) To keep information anonymous, no photo of ~~one~~ self or full name or app.
- ~~they~~ can pick ~~a~~ username ~~they~~ and only interact w/ others online

(3)
- Online forum so that there's a community where people can share their experiences w/ depression/anxiety etc
- Provides online counselling ~~for~~ or perhaps start the process to be on counselling waitlist on the app as it takes a few weeks.
- Maybe an option for ~~a~~ online and in person counselling.
- Forms & questionnaires (GAD-7 & PHQ 9 for example for depression/anxiety) ~~to track~~ so you can look back on progress.

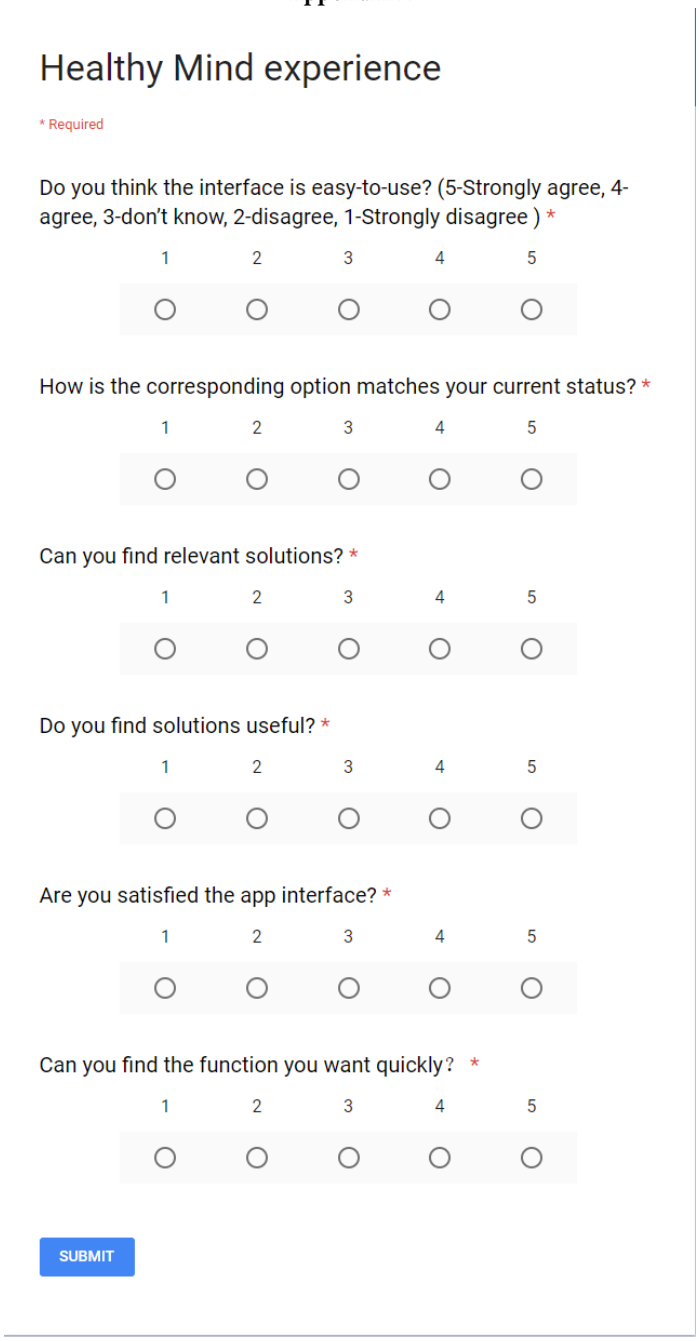
(4)

- As ~~there~~ the student's data is stored on an app on their phone, tracking own progress can be a motivator that isn't easily accessible when you go via student services as they keep them in files.

- ~~Easy access when~~ potentially can be used to other services (GP)

Appendix D: Notes from the first Participatory Design session.

Appendix E



Healthy Mind experience

* Required

Do you think the interface is easy-to-use? (5-Strongly agree, 4-agree, 3-don't know, 2-disagree, 1-Strongly disagree) *

1 2 3 4 5

How is the corresponding option matches your current status? *

1 2 3 4 5

Can you find relevant solutions? *

1 2 3 4 5

Do you find solutions useful? *

1 2 3 4 5

Are you satisfied the app interface? *

1 2 3 4 5

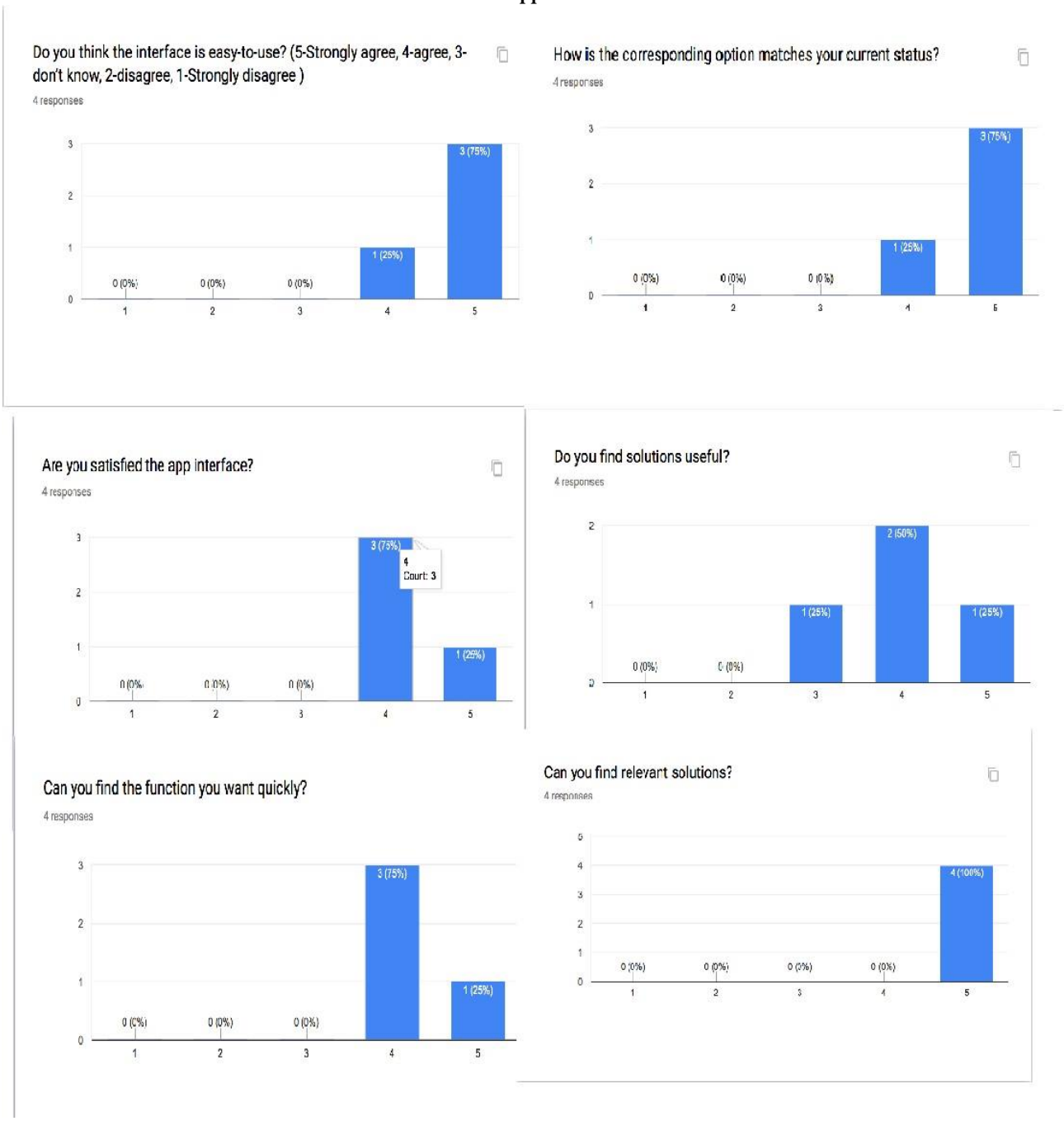
Can you find the function you want quickly? *

1 2 3 4 5

SUBMIT

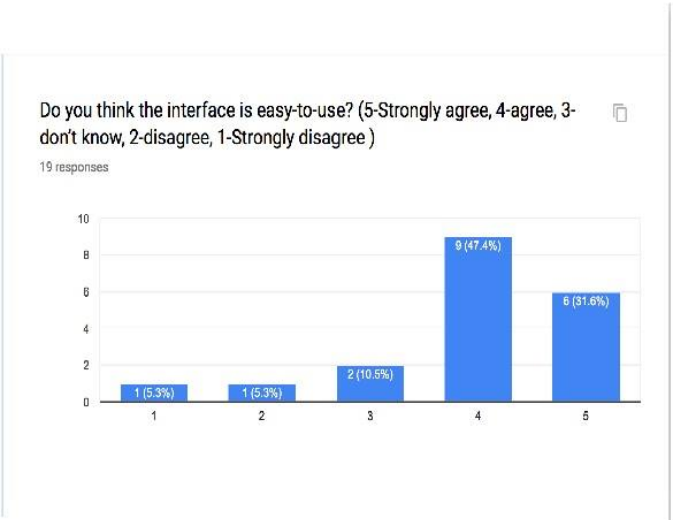
Appendix E: Empirical evaluation questionnaire

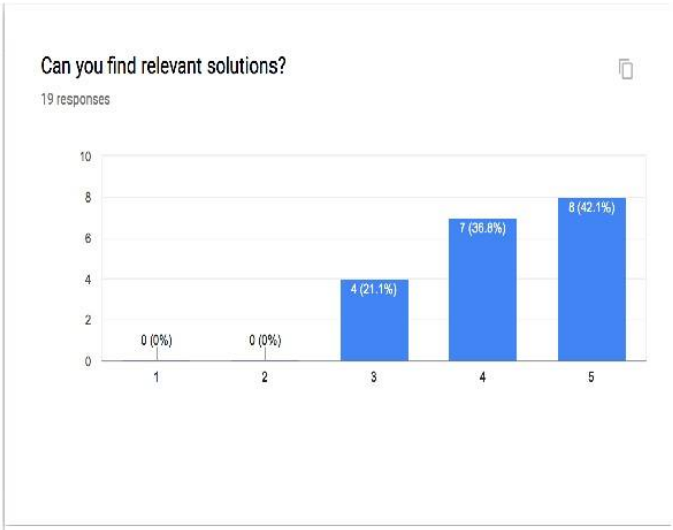
Appendix F

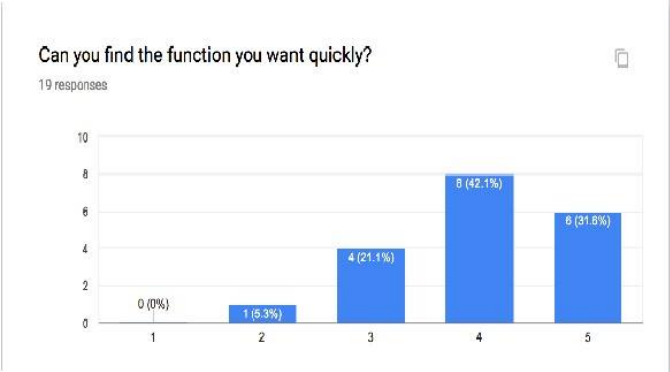


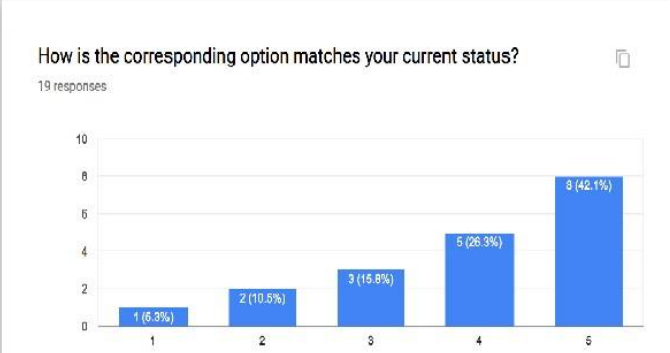
Appendix F: Empirical evaluation questionnaire results

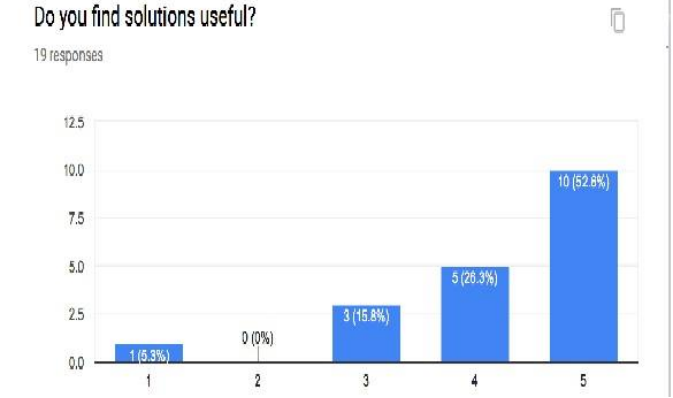
Appendix G

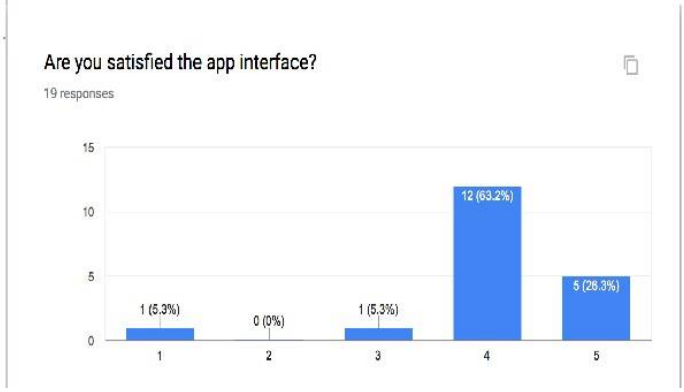






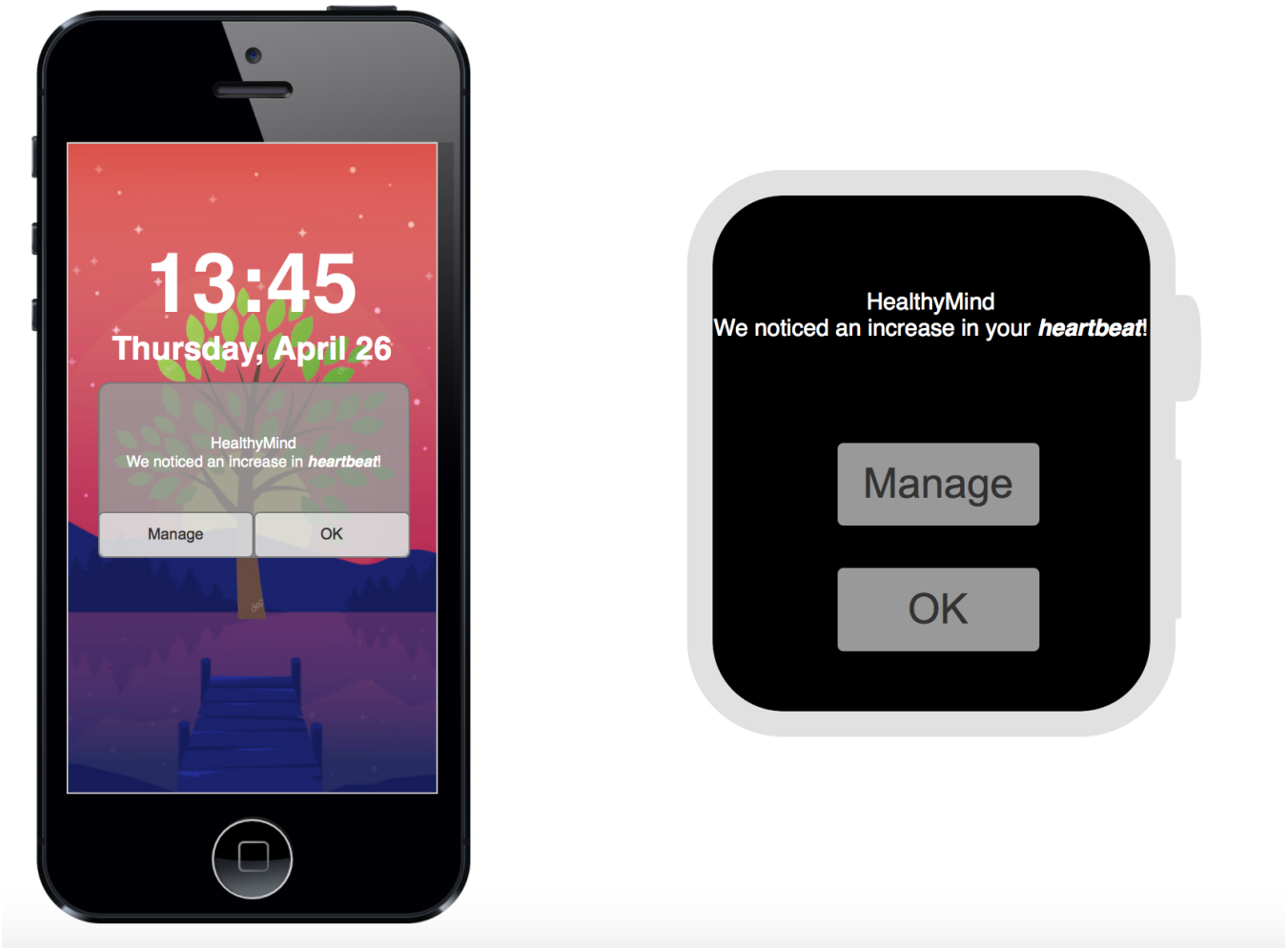




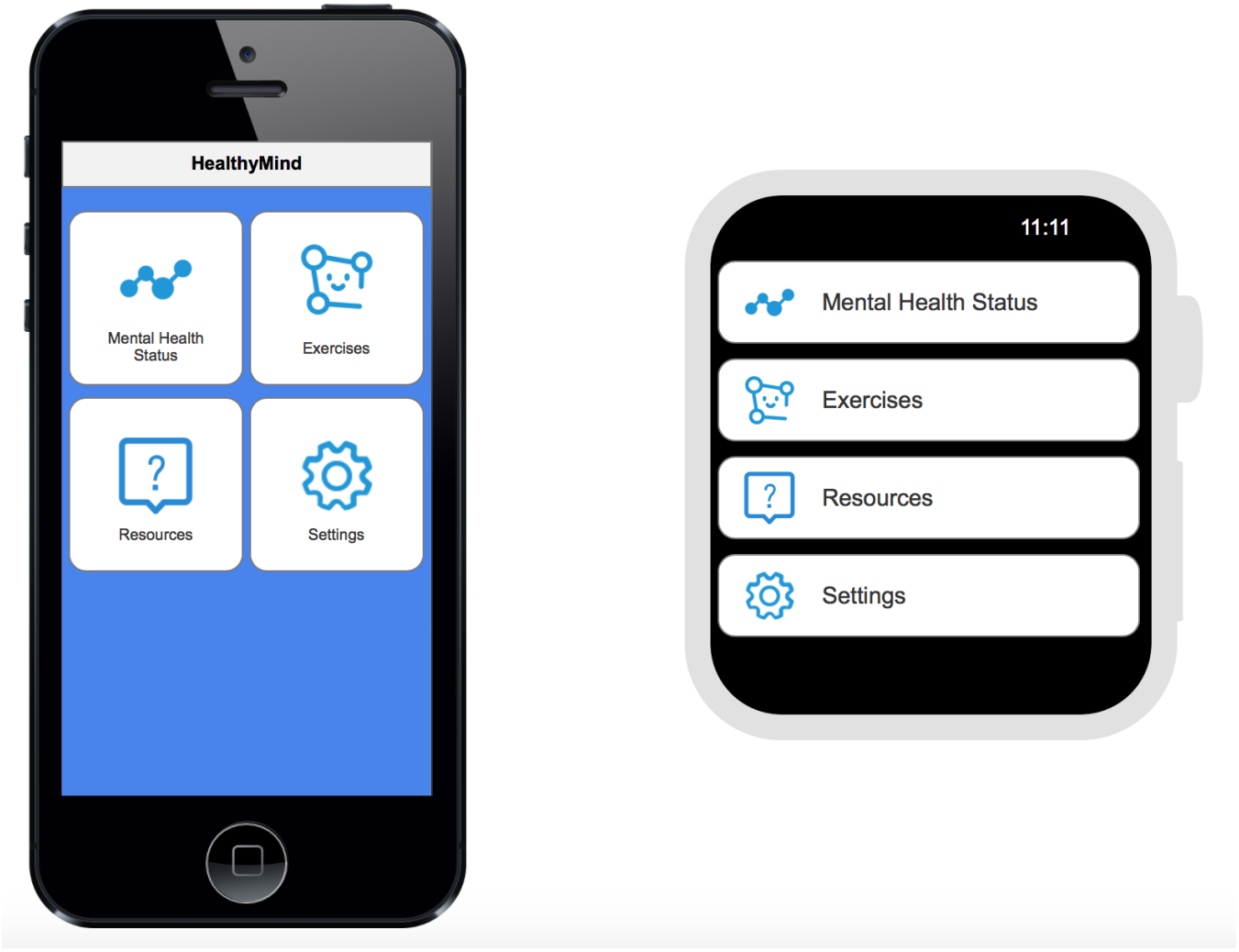


Appendix G: Quantitative questionnaires results

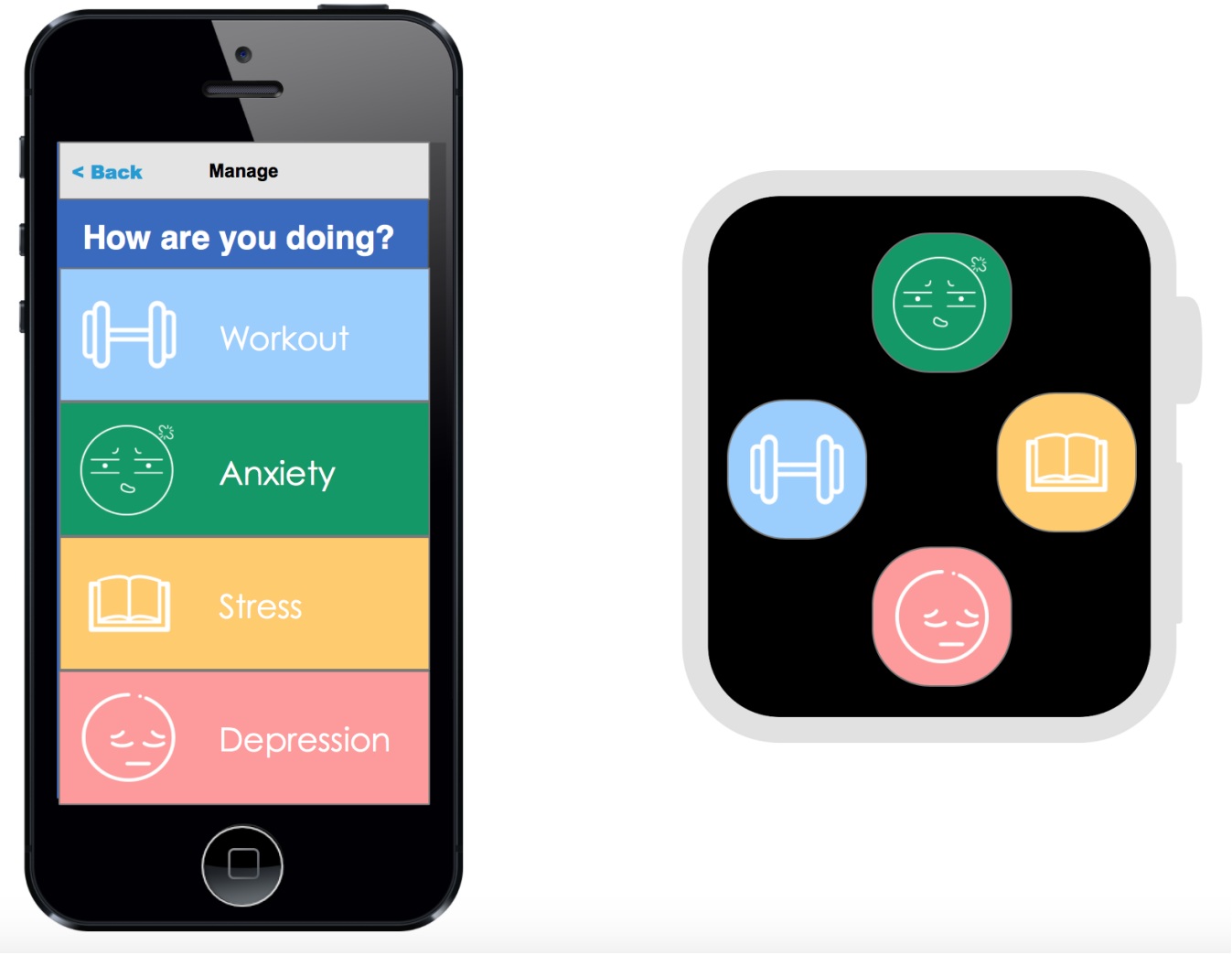
Appendix H



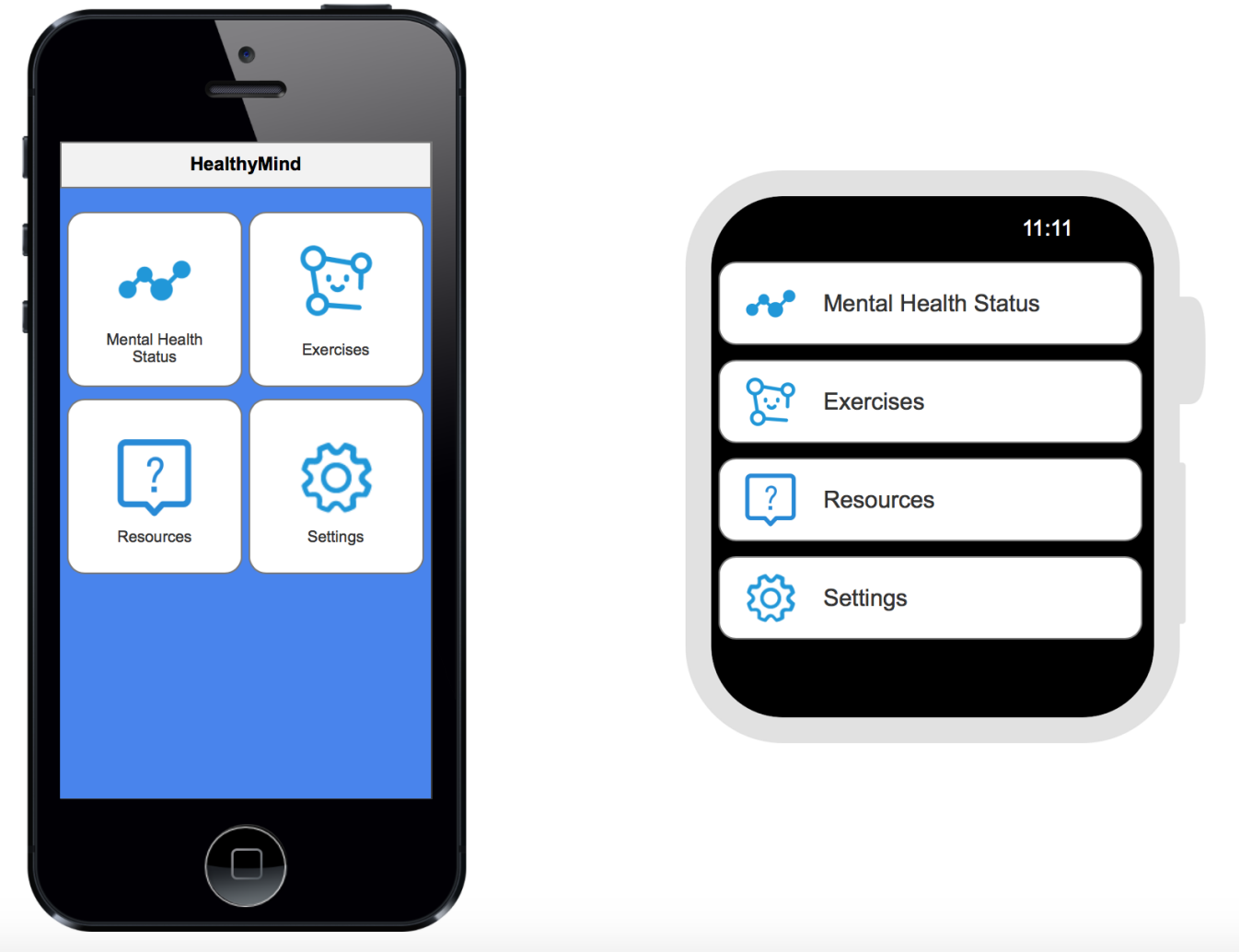
Notification Page


HealthyMind
Mental Health Status
Exercises
Resources
Settings
11:11
Mental Health Status
Exercises
Resources
Settings

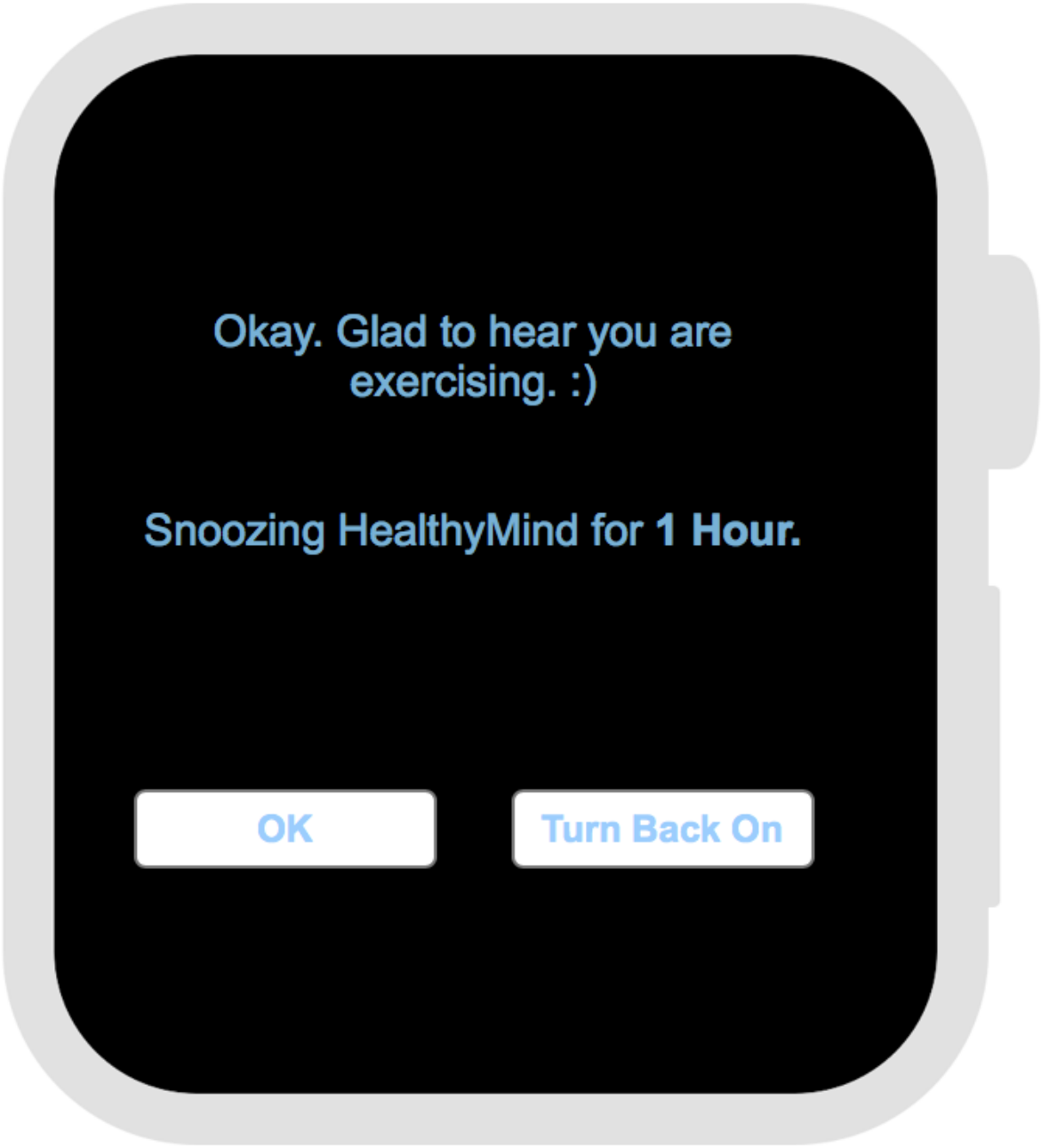
Land Page


< Back
Manage
How are you doing?
Workout
Anxiety
Stress
Depression

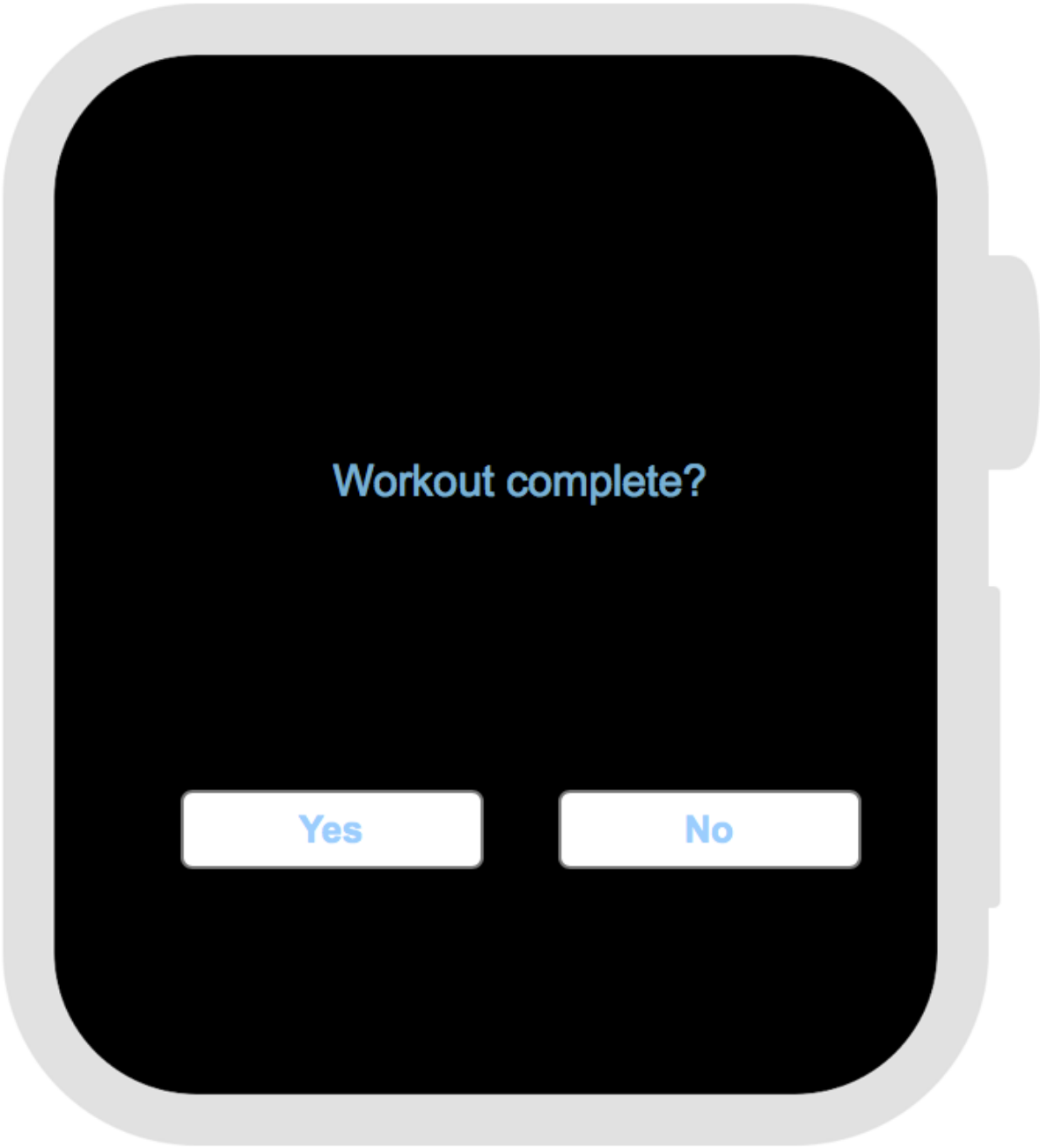
Manage Page



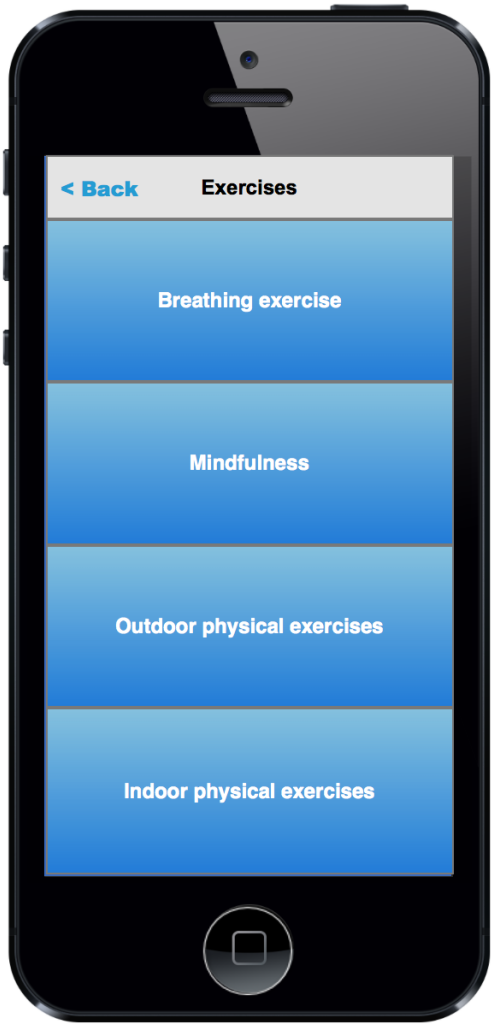
Landing Page

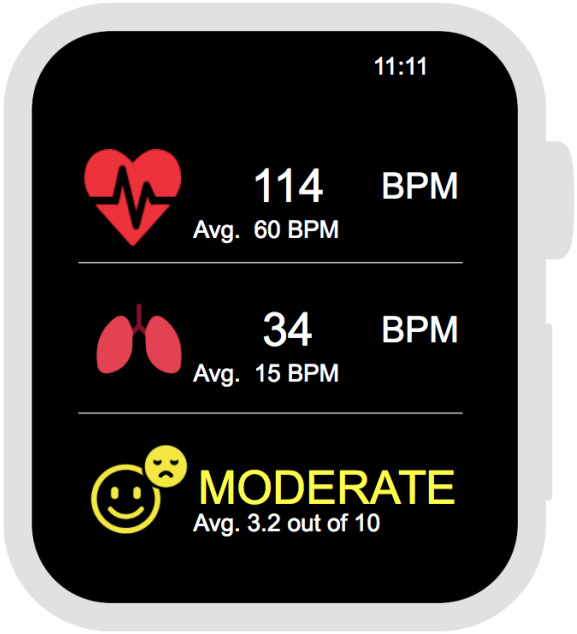


Exercise status Page1

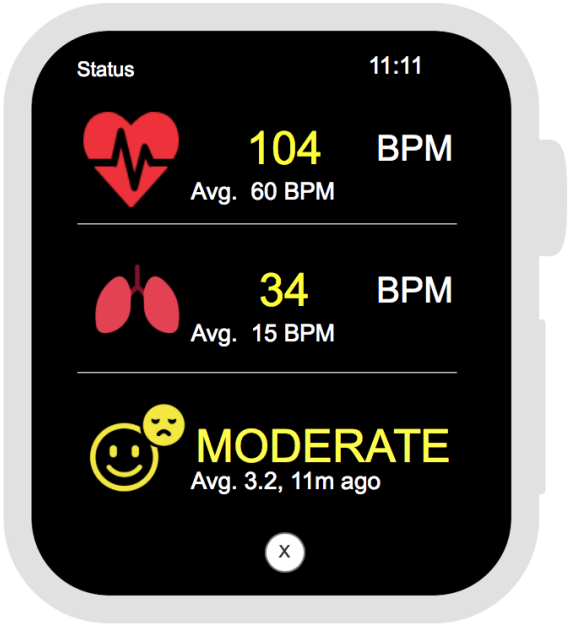


Exercise status Page2



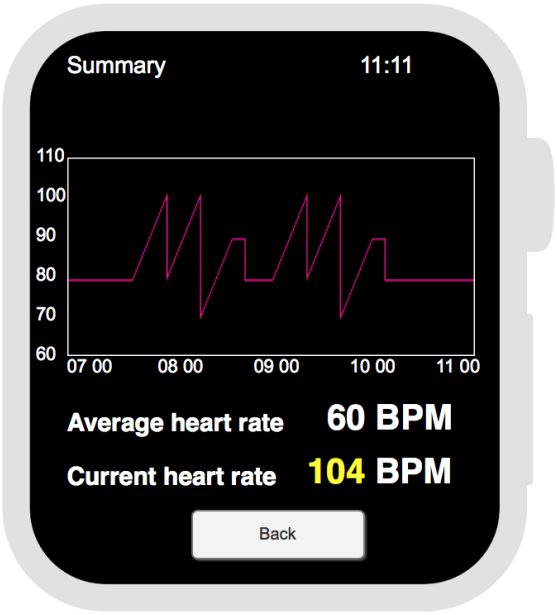


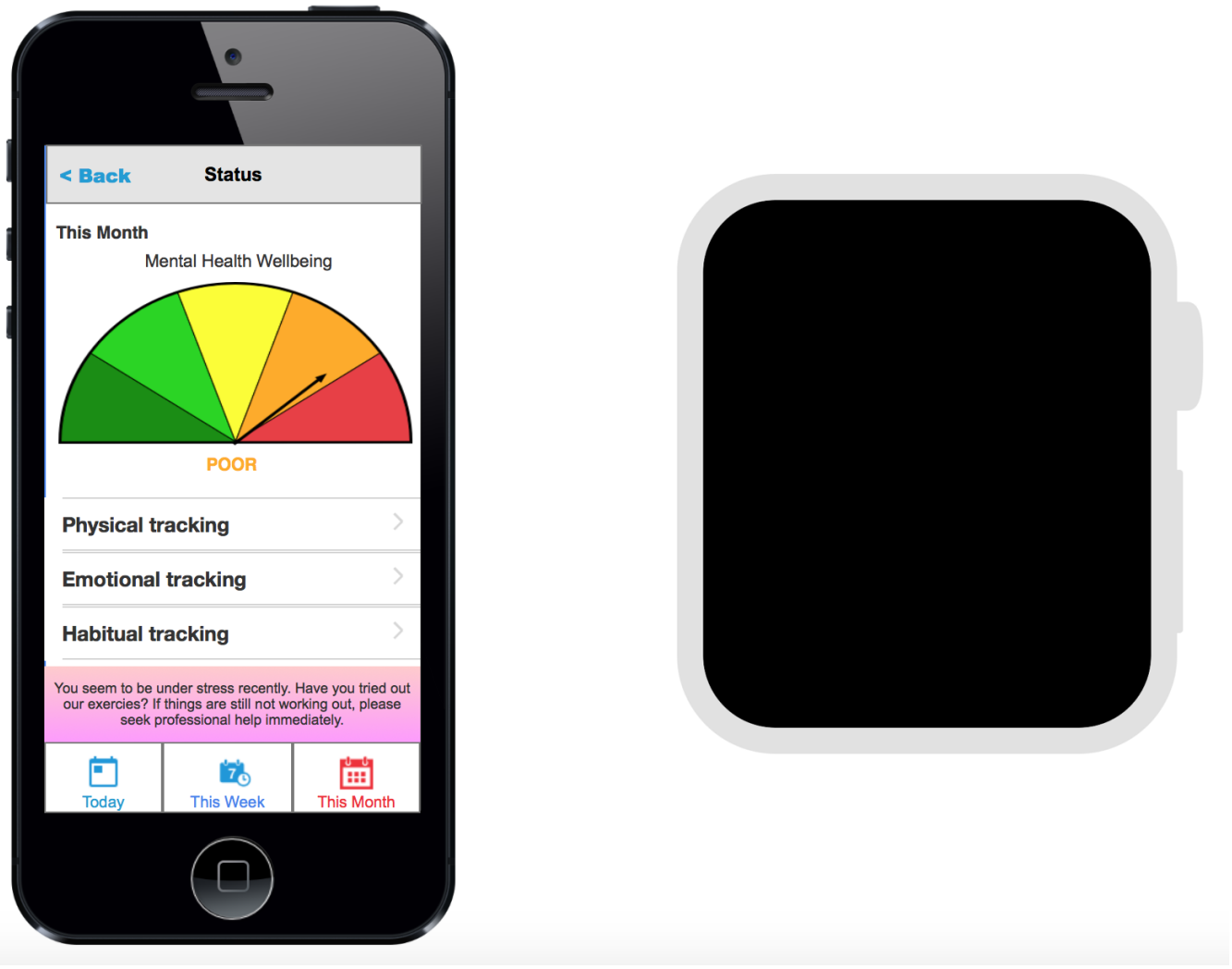
Training Page



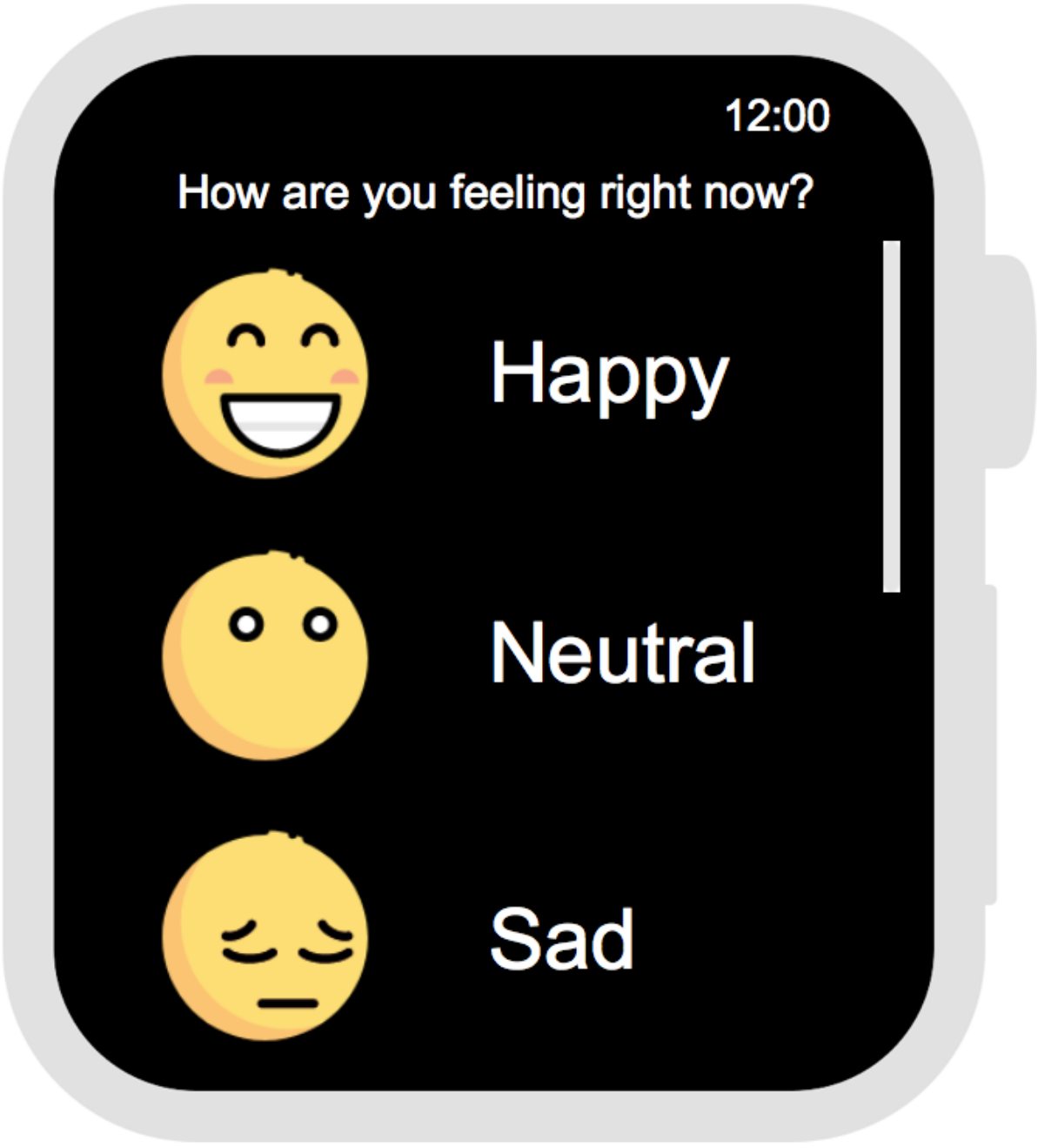
Breath Training Page 1


< Back
Breathing Exercise
Breathe
ANXIETY
breathe in
CHIBIRD


Summary
11:11
110
100
90
80
70
60
07 00
08 00
09 00
10 00
11 00
Average heart rate
60 BPM
Current heart rate
104 BPM
Back


< Back
Status
This Month
Mental Health Wellbeing
POOR
Physical tracking
Emotional tracking
Habitual tracking
You seem to be under stress recently. Have you tried out our exercies? If things are still not working out, please seek professional help immediately.
Today
This Week
This Month

Status Page



Emotion Page

Appendix I

UNIVERSITY OF BATH

Department of Computer Science

GROUP COURSEWORK
Submission Cover Sheet

Please fill in both columns in BLOCK CAPITALS and post into the appropriate Coursework Submission Box outside the Department Office.

How to present your work
1. Bind all pages of your assignment (including this submission sheet) so that all pages can be read by the marker without having to loosen or undo the binding. Ensure that the binding you use is secure. Missing pages cannot be marked.
2. If you are required to submit part of the work on a disk, place the disk in a sealed envelope and bind the envelope into the submission.

Keep a copy of your assignment and disk. The original is held by the Department for scrutiny by External Examiners.

☐ Retain for sample Mark:	
for office use **Date received:**	
Confirmation of Hand-in **This section will be retained by the Department Office as proof of hand-in**	
Declaration *I certify that I have read and understood the entry in the Department of Computer Science Student Handbook on Cheating and Plagiarism and that all material in this assignment is my own work, except where I have indicated with appropriate references. I agree that, in line with Regulation 15.3(e), if requested I will submit an electronic copy of this work for submission to a Plagiarism Detection Service for quality assurance purposes.*	
GROUP NAME TEAM 4	GROUP NAME TEAM 4
Member Name 1 EWAN SOUBUTTS CONTRIBUTION : 23 % Signature	Member Name 1 EWAN SOUBUTTS CONTRIBUTION: 23 % Signature
Member Name 2 Marc ADLINGTON CONTRIBUTION: 23% Signature	Member Name 2 MARC ADLINGTON CONTRIBUTION: 23% Signature
Member Name 3 XIAOWEI LI Contribution: 13% Signature XIAOWEI LI	Member Name 3 XIAOWEI LI Contribution: 13% Signature XIAOWEI LI
Member Name 4 YALIN SHI CONTRIBUTION: 18% Signature YALIN SHI	Member Name 4 YALIN SHI CONTRIBUTION: 18% Signature YALIN SHI
Member Name 5 KIMBERLEY CHONG CONTRIBUTION: 23% Signature	Member Name 5 KIMBERLEY CHONG CONTRIBUTION: 23% Signature
Member Name 6 Signature	Member Name 6 Signature
Member Name 7 Signature	Member Name 7 Signature
Member Name 8 Signature	Member Name 8 Signature
UNIT CODE CMS01S0	UNIT CODE CMS01S0
UNIT TITLE INTERACTIVE COMMUNICATION DESIGN	UNIT TITLE INTERACTIVE COMMUNICATION DESIGN
DEADLINE DATE & TIME 26/04/18 18:00	DEADLINE DATE & TIME 26/04/18 18:00
COURSEWORK PART (if applicable) TASK1 (80%)	COURSEWORK PART (if applicable) TASK 1 (80%)

Appendix I: Submission Requirements: Group Coursework contributions.