

Optimism and persuasive technology: a case study

## **Optimism and persuasive technology: a case study**

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MComp in Computer Science  
The University of Bath  
April 2021

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## **Optimism and persuasive technology: a case study**

Submitted by: Alexander Ito-Low

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# Optimism and persuasive technology: a case study

## Abstract

Mental health is an established concept that has recently come to the forefront of policy makers' agendas. Despite this, however, there are individuals who do not have access to amenities to address their needs and poor mental health is a prevalent issue and increasing issue. The impact of optimism on one's mental health, coupled with the presence of persuasive technology, provides the potential to mitigate the problem of poor mental health.

Persuasive technology is becoming more sought-after because of its ability to help people adopt healthy behaviors and its ability to scale to demand. While there is research that supports the efficacy of persuasive systems in the domain of health and wellness, there have been few studies about their efficacy with health behaviors such as depression.

This project aims to add to the literature about the efficacy of systems in the health behavior domain. This project presents literature about the domain of optimism, persuasive techniques to develop persuasive systems, and state-of-the-art research and technologies in the domain of optimism.

The design and development of an application that aims to cultivate optimism is then undertaken. The approach taken is participatory design. The developed application is then evaluated to determine its efficacy. Whilst the statistical significance about the effectiveness of the application for the cultivation and maintenance of optimism is inconclusive, there remains evidence that supports the efficacy of the developed application as it is usable and has moderately positive feedback. The project is then concluded by a reflection about its success, its wider contribution to the field, its limitations, and possible directions that future research can take.

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# Acknowledgements

I would like to express gratitude to my supervisor Mr. John Benardis for his continuous support throughout this project. He has provided valuable advice and suggestions that shaped this project. I would also like to thank Dr. Simon Jones for his support with the ethical documentation. Lastly, I would like to thank all of the participants who partook in this research.

# Chapter 1

## Introduction

The concept of mental health has been around for over a century; with its earliest technical reference dating back to 1946 (Bertolote, 2008). Mental health is defined by the World Health Organisation (WHO) as the presence of wellbeing in one's life such that the individual has the capacity to realize their self-worth, is able to work productively, and is able to manage the everyday stressors of real-life (Bertolte, 2008).

Given such a definition of mental health, poor mental health is defined as the lack of wellbeing in one's life such that the individual does not have the capacity to realize their self-worth, is not able to work productively, and has trouble dealing with the everyday stressors of daily life. The problem of poor mental health has recently come to the forefront of policy makers' agendas, making it more important than ever to address.

### 1.1 Problems of poor mental health

The Global Burden of Disease (GBD) is defined as a measure that quantifies the health loss from diseases and injuries (Vos et al., 2020). The GBD is approximated by gathering and statistically analyzing data related to disease or injury from published studies, government websites, and sources such as health surveys (Vos et al., 2020). Disability-adjusted life years (DALYs) are one of the measures that approximate GBD. DALYs are calculated for a specific age range by summing the years lived with a disability with the years lost due to pre-mature mortality (Pr et al., 2003).

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According to a recent GBD report, global health has improved since the 1990s (Vos et al., 2020). However, the demographics reveal that poor mental health conditions are amongst the top 10 causes of DALYs in the age groups 10-25 years of age and 25-49 years of age. Given its presence across different demographics, poor mental health is a problem that needs to be addressed.

Poor mental health is not just a burden at the individual level, it also affects economies and whole countries. One report about the impact of mental health on the worldwide economy used 3 approaches to approximate a value for this burden: human capital costs, lost economic growth, and value of statistical life (Trautmann et al., 2016). From this study, a cumulative figure for the economic losses worldwide due to poor mental health between 2011 and 2030 are estimated at 16.3 trillion USD. As for human capital costs and the value of statistical life, these were estimated to be 2.5 billion USD and 8.5 billion USD respectively in 2010, and are estimated to double by 2030. This shows that there is a burden of mental health on the economy and this burden is likely to increase if poor mental health is not addressed.

Another reason that poor mental health is a prevalent problem in society is due to the inequality of mental health amenities worldwide. A review of the global development of mental health from 2010 to 2016 indicated that only 0.3% of the resources focused on health assistance were dedicated primarily towards mental health (Liese et al., 2019). Given that approximately 50% of the population in middle to high income countries are expected to encounter at least one obstructor to their mental health in their lives, there is a mismatch between the magnitude of the problem and how much is being invested into solving it (Trautmann et al., 2016).

Furthermore, poor mental health is made worse by the COVID-19 pandemic. A cross-sectional survey study that consisted of 7236 participants from China found that 3155 of them thought about COVID-19 for more than three hours a day which had a strong association with depression, lack of sleep, and anxiety (Generalised Anxiety Disorder) (Huang and Zhao, 2020). From this cross-sectional survey, a two-tailed test on the data collected from individuals concluded that Generalised Anxiety is significantly more common amongst individuals under the age of 35. With the COVID-19 pandemic being a period of uncertainty, this indicates that poor mental health is likely to get worse if not addressed.

Closely related to mental health is optimism. Optimism consists of two aspects: hopefulness and the belief that the individual is living in the best circumstances (Conversano et al., 2010). Optimism can be found to impact many dimensions of daily life, for example: physical health, mental health, coping with difficult situations (Conversano et al., 2010). These findings indicate that the concept of optimism is worth investigating further due to its impact on mental health.

### **1.1.1 Motivation – the use of persuasive technology**

Persuasive systems should be considered to solve the problem of poor mental health. Persuasion is defined as an approach to shift viewpoints and/or actions without the employment of coercion or deception with the intention of behavior change from the beginning of the design of the system (Fogg, 2002). A major advantage of persuasive technology is its scalability. Unlike human persuaders, technology can be made available to millions of people on demand (Fogg, 2002). This technology is not just scalable, it provides a set of techniques that can be adapted based on the context of the application that is to be developed. An example technique is reduction. Reduction aims to reduce a complex behavior into small tasks to help the user perform their target behavior (Onias-Kukkonen, 2009). These advantages of persuasive technology provide promise for it to be adopted in the context of poor mental health.

Persuasive technology is effective in the health and wellness domain. 16 years' worth of literature that examined persuasive technology through empirical evaluations were examined from 2000 to 2015. It was concluded that 92% of the 80 studies examined led to positive outcomes amongst individuals (Orji and Moffatt, 2018). Only one of the studies, however, developed and evaluated a persuasive technology in the domain of health behaviors - in particular, in mental health. This is a limitation in the field of persuasive technology as not much can yet be concluded about the efficacy of applications in the domain of health behaviors.

Literature review:

### **1.2 Project aims and contributions**

The research in this project aims to develop and evaluate a persuasive optimistic intervention system to add to the literature about the efficacy systems in the domain of health behaviors; with particular emphasis placed upon the cultivation and maintenance of a positive attitude.

The objectives needed to achieve the above aims are summarised below:

1. Define the concept of optimism and the different types of optimism.
2. Study behavioral theories that are related to the concept of optimism to understand what factors contribute to aiding and maintaining behavioral change.
3. Understand how optimism is cultivated to aid the creation of strategies to be used within the system.
4. Explore how optimism is measured in order to inform the evaluation of the completed system.

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5. Investigate existing frameworks to develop persuasive technology and look at some examples of persuasive technology systems to gain an insight into what procedures and techniques make a persuasive technology system successful.
6. Design and develop a persuasive application with the aid of stakeholders.
7. Evaluate the developed system and document its efficacy.

### 1.3 Structure of the dissertation

The structure of the dissertation is presented below:

- **Literature review:** This chapter will examine the literature about the concept of optimism. After an understanding of what optimism is, its cultivation and measurement will be studied. Attention will then be turned to persuasive system frameworks. These frameworks will be analyzed and compared to determine their effectiveness, before investigating state-of-the-art technologies and research in the domain of health behaviors. The findings in this chapter will contribute to the elicitation of requirements in the next chapter.
- **Requirements elicitation:** Equipped with knowledge from the literature review, this chapter goes on to elicit a formal set of system requirements for the proposed system based on the concept of optimism and chosen persuasive system framework.
- **Design of the system:** The set of formalized requirements are iteratively refined to produce a high-fidelity prototype of the system. This refinement is driven by stakeholder feedback.
- **Evaluation:** This chapter will present an experimental design to determine the overall efficacy of the designed system and which data will be examined to determine this efficacy.
- **Results and Discussion:** In this chapter, the results from the evaluation phase will be analyzed to determine if there are any meaningful conclusions about the efficacy of the designed system.
- **Conclusion:** This chapter will draw upon the achievements of this research and its contributions to the wider context. Directions in future research will then be advised.

## Chapter 2

# Literature and Technology Survey

This chapter will define the concept of optimism for the purposes of this project and to aid the research path taken in this project. Upon completion of this study, frameworks of persuasive systems will be studied and compared to one another to determine a suitable framework for this project. Technologies and research in this domain of mental health will be studied as well to justify this research. The findings from this chapter will contribute towards the requirements chapter, the design chapter, and the evaluation chapter.

### 2.1 Optimism

#### 2.1.1 Core concepts of optimism

Optimism is defined as a cognitive and emotional characteristic where one has the expectation of a future that one regards as socially desirable (Tiger, 1979). Optimism is viewed as an inherent trait that individuals accept or reject, but is also viewed at the level of an individual difference (Peterson, 2000). The viewpoint of optimism as a natural trait is supported by psychologists coining different terms for it: for example, the Pollyanna principle and positive denial (Matlin and Stang, 1978; Lazarus, 1983). The viewpoint of optimism as an individual trait is usually argued by psychologists with an interest in individual differences, for example, Lazarus (1983) and Tiger (1979). Amongst the viewpoints of optimism, there are two prevalent modalities for measuring optimism: dispositional optimism and explanatory style (Dobson and Dozois, 2008). These approaches will be discussed as they can help analyze optimism in a holistic manner (Peterson, 2000).

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Using the definition of optimism, optimistic individuals are classified as those that look at the positives in life, are resilient, and expect opportunities in their future (Dobson and Dozois, 2008).

Pessimists, on the other hand, cast doubts about their future and expect the worst outcomes (Dobson and Dozois, 2008). Considering these classifications will aid the analysis of the two modalities for measuring optimism.

Dispositional optimism (expectational optimism) is defined in terms of expectations (Dobson and Dozois, 2008). Using this view of optimism, optimists can be viewed as those that expect the best out of the future and expect their goals to be fulfilled, while pessimists can be viewed as those who expect the worst out of the future and expect to never fulfill their goals (Dobson and Dozois, 2008). Explanatory style is the other modality of optimism and it is conceptualized as explanations about past or current events (Dobson and Dozois, 2008). Explanations in this mode of optimism measure three dimensions of inference about oneself:

1. Internal versus external: Internal explanations are those where one believes it is one's own fault for an outcome, whilst external explanations are those where one casts the fault of the outcome on the stimuli (Dobson and Dozois, 2008). For example, "it is my fault for bad grades" would be an internal explanation, whereas "it is the fault of an injury that led to bad grades" would be an external explanation.
2. Stable versus unstable: Stable explanations do not change over a period of time, whereas an unstable explanation is one that does (Dobson and Dozois, 2008). For example, needing glasses would be a stable explanation, whilst lost motivation would be an unstable explanation as it can fluctuate over time.
3. Global versus specific: Global explanations are ones that are generalized, whilst specific explanations are those that apply to certain instances. For example, not getting into a company because of quota would be a specific explanation, not getting into any company because of a poor resume would be an example of a global explanation (Dobson and Dozois, 2008).

With all of these dimensions explained, in the face of setbacks, a pessimist can be one that uses internal, stable, and global explanations to explain current and past events. Optimists use the opposite dimensions to explain current and past events (Dobson and Dozois, 2008). Optimists will be more resilient to setbacks as they view them as temporary, whereas the pessimist will blame themselves (Dobson and Dozois, 2008). The explanatory style for positive events is the opposite of that of negative events. This presented information adds to our knowledge about how optimism can be defined in the context of this project.

### **2.1.2 Considerations about optimism**

Before optimism is defined within the context of this project, it is important to deal with certain issues concerning optimism: specifically, the abstractions of optimism and realistic optimism. There are 2 predominant abstractions of optimism: big optimism that encompasses fewer specific expectations and little optimism which has an emphasis on specific expectations (Peterson, 2000). It is important to consider these abstractions as they can vary across individuals, which can result in a different set of elicited requirements.

Optimism may have negative effects associated with it if it is too unrealistic (Peterson, 2000). For example, the underestimation of the risks of gambling could eventually lead an individual to become bankrupt. This is because the individual may think they will eventually win, hence, they continue to gamble. It is therefore worth encouraging realistic optimism (reality basis optimism) because it will not instill a false sense of hope in individuals (Peterson, 2000). The concept of realistic optimism can aid the consideration of which strategies are used to cultivate optimism in the creation of the system in this project.

For the purposes of this project, optimism will be defined as an association with a variable expectation or an outlook that relates to a desirable reality that is realistic and socially desirable. The inclusion of social desirability in the definition ensures that the definition remains ethical towards individuals and groups in society. It is also important to note that there is no reference to time within this definition of optimism. This will ensure that the definition accounts for explanatory style and expectational optimism as means to measure optimism. With these considerations, optimism has been defined for the purpose of this project.

### **2.1.3 Self-efficacy**

With optimism defined, a similar concept to be discussed is self-efficacy. Self-efficacy is defined as one's thoughts about one's capabilities to accomplish a goal (Dobson and Dozois, 2008). This predicts how much effort one will expend to accomplish one's goal (Dobson and Dozois, 2008). Self-efficacy should be considered in the scope of this project because it has the ability to predict one's efforts in the maintenance of a positive attitude. This theory is explained in terms of expectation, namely: outcome expectancy and efficacy expectation. Outcome expectancy is defined as the individual's ideas about the consequences of an undergone behavior (Bandura 1977). Efficacy expectation, on the other hand, is defined as the belief that an individual can successfully partake in the behavior in question (Bandura, 1977). Therefore, self-efficacy is seen to not only stem from beliefs about the environment, but also beliefs about oneself.

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Efficacy expectations are of importance because without them, the individual is unlikely to take any action towards their goal whatsoever (Bandura, 1977). There are four main ways to support efficacy expectations: performance accomplishments, vicarious experiences, verbal persuasion, and emotional arousal. Performance accomplishments are based upon past positive experiences of accomplishing a goal (Bandura, 1977). Vicarious experiences, on the other hand, are expectations that originate from another person's experience. Furthermore, verbal persuasion is where one is influenced to believe that they can accomplish their goal. Emotional arousal affects efficacy expectations because emotional arousal levels are said to predict one's performance (Bandura, 1977). These methods of supporting efficacy-expectations are useful to consider in the scope of this project because they can help an individual maintain their efforts towards a positive attitude.

### 2.1.4 The cultivation of Optimism

Cognitive Behavioural Therapy (CBT) is defined as a process that aims to modify an individual's unhelpful and self-destructing thoughts (Beck, 1970). In a literature review, it has been said that CBT has the ability to aid individuals to adopt more accurate perceptions about positive and negative events (Forgeard and Seligman, 2012). CBT will be looked at in more detail in order to determine if it is an appropriate method to cultivate optimism.

Within CBT, there are two cognitive techniques that are employed: the recognition of idiosyncratic thoughts and distancing (Beck, 1970). Idiosyncratic thoughts can be seen as internal thoughts that relate to oneself. In CBT these idiosyncratic thoughts are usually degrading and are the origin of one's unpleasant emotions in the face of external stimuli (Beck, 1970). An example of an idiosyncratic thought in response to upcoming exams is the thought "I will fail my exams", this could potentially result in anxiousness for the person experiencing this thought. It is therefore important that the individual recognizes these unhelpful thoughts in the wake of stimuli. The distancing aspect is where one attempts to objectify their thought. For example, referring back to the upcoming exam, I can use my past performance as a predictor to objectify my thought as well as how much revision has been done for this exam, instead of just jumping to the conclusion that I will fail. It is the combination of recognition of idiosyncratic thoughts and distancing that make up CBT.

With an understanding of how CBT works, the next question to address is the efficacy of CBT if it to be used to elicit optimism. A review of meta-analyses consisted of 269 studies of CBT for various problems including general stress and anxiety disorders (Hofmann et al., 2012). Pessimism was not specifically mentioned as a cause but it can be implied that general stress and anxiety disorders are a source of pessimism because according to dispositional optimism, the definition of pessimism involves seeing the worst in an expected future. Pessimism could be explained as the presence of idiosyncratic thoughts that focus on the worst expectations of the future.

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It was concluded from the review that CBT is particularly effective for dealing with anxiety disorders and general stress (Hofmann et al., 2012). Anxiety and general stress are common effects of having low levels of optimism. Therefore, CBT should be considered as a strategy to cultivate optimism.

### 2.1.5 The measurement of optimism

The concept of optimism has been discussed alongside the modalities of measuring optimism, self-efficacy theory, and the use of CBT for the cultivation of optimism. A more concrete analysis of how one can empirically measure optimism is required to inform the research to be undertaken in this project.

Expectational optimism and explanatory styles are two modalities of measuring optimism that have been previously discussed. It will be important to see how these measurements differ from one another and how they fare in an empirical context. Explanatory style and expectational optimism have a different focus: expectational optimism focuses on future expectation while explanatory style focuses on how past and current explanations about events predict the future (Dobson and Dozois, 2008). These two foci overlap and it is suggested that researchers consider measuring both when examining optimism and pessimism.

This project will only make use of expectational optimism as a measure. This is because expectational optimism is more in line with scholarly definitions of optimism (Peterson, 2000). The main reason why explanatory style is not chosen is because of its accuracy in an empirical context (Peterson, 2000). The internal dimension of explanatory style relates to other concepts such as self-efficacy and self-blame. Due to its correlation with other concepts, explanatory style may not be an accurate predictor of optimism in an empirical context. Thus, when measuring optimism, only expectational optimism will be used.

The Life Orientation Test-Revised (LOT-R) is a questionnaire that measures expectational optimism as well as general expectancies of optimism and pessimism. It consists of 10 items. Items within this questionnaire are scored on a five-point scale: 0 (strongly disagree) to 4 (strongly agree). It is to be noted that this scale uses a one-factor approach to analyze optimism, that is it only measures overall optimism (Scheier et al., 1994). This scale is recommended because it consists of 10 questions, the least number of items when compared to other scales (Speight et al., 2007). This means that there is less likely to be participant fatigue if the questionnaire is distributed.

To see why the LOT-R is the ideal candidate for measuring expectational optimism, we need to discuss the relationship between optimism and pessimism. It has been acknowledged that the absence of pessimism does not equate with an individual being optimistic (Peterson, 2000; Carver et al., 2010).

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This is in line with the aforementioned definition of optimism because what an individual considers desirable may not entirely lead to an absence of pessimism. It is from this understanding that it is important to consider pessimism as well as optimism to form an overall picture of one's optimism. Hence, the LOT-R should be considered to measure optimism in this project because it is a measure of the overall expectancy of one's optimism and pessimism.

The LOT-R had a predecessor, the Life Orientation Test (LOT). It however, has been questioned as to whether the effects of optimism included in this scale are dependent on other predictor variables such as neuroticism, trait anxiety and self-esteem. These dependencies were examined (Scheier et al., 1994). It was concluded that the LOT is a valid predictor of an overall frame of ones' optimism, thus is empirically grounded (Scheier et al., 1994).

However, two of the items in the original LOT did not explicitly relate to expectations about a problem, they related to the way people react to problems (Scheier et al., 1994). This meant that the LOT would correlate strongly with measures about positive re-interpretation and growth which was unwanted. In order to mitigate this unwanted correlation, the Revised Life Orientation Test (LOT-R) was devised by the removal of both of the items that caused the bias. These removed items were replaced by one positively worded item (Scheier et al., 1994). To balance the number of positive and negatively worded items, a negatively worded item was removed (Scheier et al., 1994). Scale correlations, internal consistency, and test-retest reliability were examined to ensure that the altered scale was still valid (Scheier et al., 1994). All of these remained high. Therefore, the LOT-R is a good candidate to consider when measuring expectational optimism.

Furthermore, the LOT-R is an ideal candidate to measure expectational optimism because of its findings' stability across periods of time (Scheier et al., 1994). Findings from Carver et al., (2010) mention that distress in one's life may shift from one-time point to another. Thus, measuring optimism at one point in time may not be as effective as measuring optimism across multiple time points, to get a clearer picture of a person's overall state of optimism. This makes the LOT-R is an ideal candidate for measuring expectational optimism in the context of this project because it is accurate, it is able to be administered across different time points and it is a brief scale that can capture one's overall state of optimism.

## 2.2 Design frameworks for persuasive systems

With an understanding of optimism, frameworks for the development of persuasive systems are of interest. This is because they provide insights about how to formally develop a persuasive system within the scope of this project. This section draws insights from persuasive frameworks that will not only be useful for this project but will aid system designers by detailing a framework of persuasive systems.

## Optimism and persuasive technology: a case study

The following section will describe and compare the design frameworks for persuasive systems. This comparison will result in a chosen framework for this project.

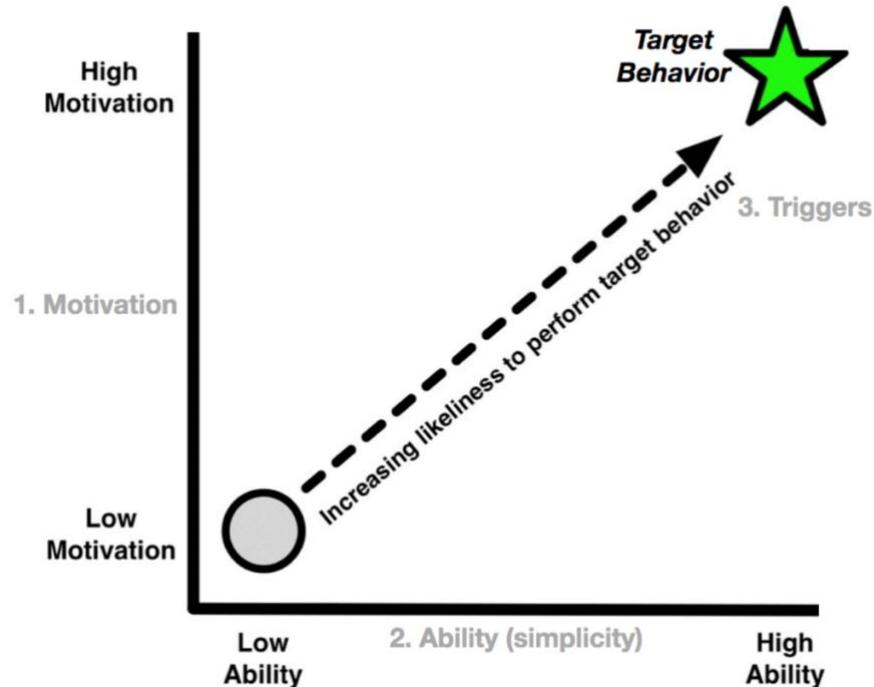


Figure 2.1: The Fogg Behavior Model has three factors: motivation, ability, and triggers (Fogg, 2009).

A methodology that aids the understanding of how to design a persuasive system is detailed in an article by Fogg (2009). This methodology is called the eight-step design process and is formed on the basis of experience and the Fogg behavior model. The Fogg behavior model includes three components that make up behavior change: motivation, ability, and triggers (Figure 2.1) as displayed above. It is a combination of all three that increases the likelihood that an individual will perform their target behavior (Fogg, 2009). The eight-step design process consists of firstly interacting with stakeholders to determine which components of the Fogg behavioral model are lacking. Once these components are identified, a system is built on top of these and the target behavior. Due to stakeholder feedback early in the design process, designers can ensure that their solutions cater to stakeholder needs (Fogg, 2009). This quality of the framework makes it a candidate to administer in this project.

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The next persuasive framework is Persuasive Systems Design (PSD). This framework consists of three steps: understand the key issues with persuasive systems, analyze the persuasion context, and design the system (Onias-Kukkonen, 2009). These steps provide designers with a comprehensive framework that will eventually lead to the creation of a system that utilizes persuasive technology.

When compared to the eight-step design process, PSD seems to be a more comprehensive theoretical framework in practice. The eight-step design process does not take issues behind persuasive systems into account, one may potentially miss some of the ethical issues associated with persuasive technology. Thus, the Persuasive System Design framework is more comprehensive from an ethical sense.

The PSD is also more comprehensive regarding the theory it builds upon. The eight-step design process was based on experience from a practitioner, whereas all of the steps within the PSD are backed up with a theoretical explanation (Fogg 2009; Onias-Kukkonen, 2009). For instance, the need to analyze the persuasive context is backed up by two points of view from scholars, while in the eight-step design process, justification is based upon experience without any theoretical background. In an empirical context, the PSD would be more appropriate because of its strong theoretical grounding. Therefore, it should be considered within this context.

Although the eight-step design process details steps that can lead to a practical implementation, it does not detail how to transform considerations into a detailed requirement specification. The PSD, on the other hand, explains design principles that can be transformed into requirements (Fogg, 2009; Onias-Kukkonen, 2009). In this specific context, a requirements specification will eventually have to be created for the proposed intervention system. A system requirements specification is not only useful for the context of the study but is also useful for maintaining and managing aspects of the application under development.

Espinoza and Baranauskas (2020) detailed a framework for the design of a persuasive system that puts an emphasis on socially aware design and stakeholder behavior. This aimed to provide more insight into how stakeholders could be incorporated into the design of the system. This framework includes the following stakeholder-oriented steps: Identify stakeholders, identify stakeholder behavior, and find ideas and suggestions based on persuasive principles. These steps include modeling stakeholders within the context of the application and analyzing their behaviors in order to detail solutions that are in line with persuasive principles (Espinoza and Baranauskas, 2020). The PSD will still be considered because the socially aware design framework lacks formalities around the way in the persuasive context is addressed, which PSD does very well.

## Optimism and persuasive technology: a case study

Although this project will utilize the PSD as the primary design framework for the development of the persuasive system, the eight-step design process and the socially aware design framework do provide elements that would be useful to incorporate into the PSD framework. The Fogg behavior model within the 8-step design process is useful because it can further justify elicited requirements. As for the socially aware design framework, it provides questions one can explore when designing a system around stakeholders. For example, questions relating to stakeholder behaviors and whether a solution meets stakeholder needs (Espinoza and Baranauskas, 2020). Therefore, PSD will be utilized along with these components from other frameworks in the context of this project.

Since PSD is utilized, it will have to be studied in further detail. There are three steps to the PSD (Figure 2.2) displayed below. These steps will be studied in more detail to inform the methodology undertaken for the creation of a persuasive system.

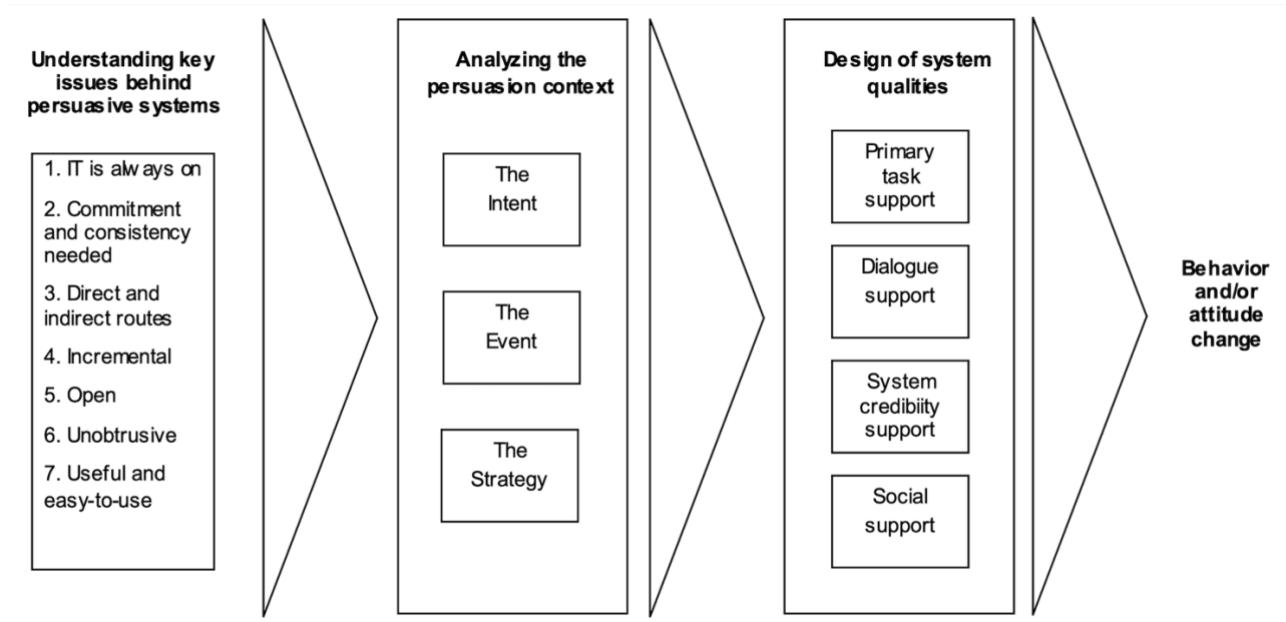


Figure 2.2: Phases in Persuasive Systems Development (Onias-Kukkonen, 2009).

The first step in PSD is addressing the issues with persuasive technology. It is important for designers to analyze these issues as they address system features, users of the system, and persuasive strategies to consider, before the implementation of the system. A list of these issues is presented briefly below:

## Optimism and persuasive technology: a case study

- 1) Persuasive technology is never neutral. This means that the user's goals towards their behaviors could change (Onias-Kukkonen, 2009). It is therefore important to make an adaptive system that takes into consideration individual change.
- 2) People like their views about the world to be organized and consistent (Onias-Kukkonen, 2009). Therefore, the persuasive system should support commitments as this is likely to persuade the user.
- 3) Direct and indirect routes are key persuasion strategies. This point emphasizes the importance of understanding stakeholder groups. The stakeholder group will determine what type of route is taken when delivering messages to the user (Onias-Kukkonen, 2009). For example, if a user does not like to evaluate things in-depth, messages linked to associations or stereotypes can be employed.
- 4) Persuasion is often incremental. This means that instead of aiming to persuade the user in one setting with one message, the system should take small incremental steps to persuade the user towards their target behavior (Onias-Kukkonen, 2009).
- 5) Persuasion through persuasive systems should always be open. This is important from an ethical sense because if content in a persuasive system is ungrounded, this would mean that the system would be deceptive which is something designers should avoid when designing persuasive systems (Onias-Kukkonen, 2009).
- 6) Persuasive systems should aim at unobtrusiveness. If the designer considers this, they can determine an appropriate time to send persuasive prompts to users (Onias-Kukkonen, 2009). This will result in the persuasive prompt being more effective.
- 7) Persuasive systems should aim at both being useful and easy to use. This tells the designer that they should design the system such that it brings positive experiences to the user when using the system to increase the chance of user acceptance of the application (Onias-Kukkonen, 2009). For example, these could include accessibility and ease of use.

The second step in PSD is to analyze the persuasive context. It is advised that designers have an understanding of this because, without a proper understanding of the persuasive context, it becomes challenging to effectively persuade the user (Oinas-Kukkonen and Harjumaa, 2009). Within the analysis of the persuasive context, the following needs to be addressed: the persuasive intent, the persuasive event, and the persuasive strategy. These will now be examined individually.

## Optimism and persuasive technology: a case study

The persuasive intent makes the designer consider questions surrounding the purpose of persuasion. Within this, the persuader needs to be identified. This could either be: the creator of the application, the distributor of the application, or the person adopting the behavior qualities (Oinas-Kukkonen and Harjumaa, 2009). The next question to ask within persuasive intent is what the change type is. This is categorized into changing a behavior or attitude or both. This will determine the strategies to be employed by the designer and provide information about how to evaluate the persuasive system.

Using this project as an example, the persuader is the very person using the technology; this type of technology can be referred to as autogenous (Onias-Kukkonen, 2009). It is recommended that such technologies focus on the user experience such that the user would want to continue to use the application (Onias-Kukkonen, 2009). Answering the next question, the type of change would be an attitude change because optimism is an attitude that one possesses.

According to the article, an attitude change is one where the user's evaluation of some aspect of their lives has been altered (Onias-Kukkonen, 2009). To measure this, an evaluation of the user's attitude would need to be conducted at multiple time points to determine if there is an attitude change. This example further emphasizes the importance of persuasive intent by showing its usefulness in the requirements elicitation and evaluation of persuasive systems.

Following this, the persuasive event informs the designer about the use context which further helps with ideas about which persuasive features should be in the system (Oinas-Kukkonen and Harjumaa, 2009). The article recommends that designers consider features to implement based on the problem domain and understanding of the user group; especially their goals and their views towards them. For example, using this project again, optimism is something that one may want to reinforce, therefore a system can be designed to guide the user through tasks such that they can practice their target attitude with ease. As for what information constitutes as relevant, this is heavily reliant on interaction with stakeholders. Using the understanding of the persuasive event, designers can obtain ideas about which features to include in their design that meet stakeholder needs.

The third and final part of analyzing the persuasive context is to look at the persuasive strategy (Oinas-Kukkonen and Harjumaa, 2009). This is very similar to the analysis of the persuasive event as it is also heavily reliant on stakeholder interaction. However, it differs from the persuasive event as it focuses more on how stakeholders analyze persuasive messages. This analysis relies on whether users prefer to evaluate messages in-depth or whether they like to analyze messages by cues and associations. Depending on how users interpret messages, this will determine if the direct route or the indirect route is used. It is important to note that these two routes can be combined when designing a persuasive system.

## Optimism and persuasive technology: a case study

The final step of the framework is to design system qualities (Oinas-Kukkonen and Harjumaa, 2009). Although in the first two steps, system qualities were found, these need to be explained in precise terms to formulate a software requirements specification. A software requirements specification includes non-functional requirements that are system qualities and functional requirements that relate to system behavior. This is useful because it gives the designers a document that is easily interpreted by a software engineer to implement the system. In the article, example requirements are presented alongside explanations of the system qualities. These system qualities will be useful to examine in the context of this project. This will ensure that the elements of persuasion within the design of the system are realized and the system will be ready to implement.

## 2.3 Technology and research review

We have thus far studied optimism to gain a greater understanding of the problem domain. We have also compared different frameworks for the development of persuasive technology to inform the structure of this project. It would be useful to examine technologies and research in the domain of health and wellbeing as well. This is because technology in this domain can inform the requirements and design elicitation of the system. Research can indicate where this project lies in the domain.

### 2.3.1 Persuasive mobile apps in the domain of mental health

Mobile applications are one technology that use persuasion, especially in the domain of mental health. A systematic review was conducted on 80 applications in the health and wellness domain that used persuasive strategies to aid behavior change (Oyebode et al., 2020). This study aimed to analyze the persuasive features present in applications across their respective domains. 20 of the applications studied were in the domain of emotional and mental health. To determine which persuasive strategies were employed by the applications, three experts collectively utilized the PSD and Cialdini's six Principles of persuasion. It was concluded that the most employed strategies in the emotional and mental health domain were personalization, surface credibility, and liking (Oyebode et al., 2020). Given that the analyzed applications were the 20 most popular in their domain, this informs this project because it emphasizes that these features are worth investigating further in the requirements section of this project.

The design of mobile applications in the domain of mental health can be useful when trying to visualize persuasive strategies as system designs. An example of such an application is Bloom. Bloom is an app specializing in video CBT to help people improve their mental health.

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Although it was created for use in the domain of psychology, it still offers visuals that can be attributed to persuasive techniques. Using Figure 2.3a (below) as an example, it utilizes praise, tunneling, and self-monitoring. Self-monitoring is illustrated with a graph detailing the user's emotion level, praise is visualized by the "Well done" message on the screen, tunneling is visualized as the progress bar on the screen, and liking is shown through visually colorful images. Figures 2.3b and 2.3c (below) display other persuasive techniques such as reminders and authority. This indicates that it is useful for designers to study other applications to ideate designs of their own. Another conclusion is that it would be useful to include visuals next to persuasive techniques in this project to ensure that researchers can understand how persuasive features can be translated into system designs.

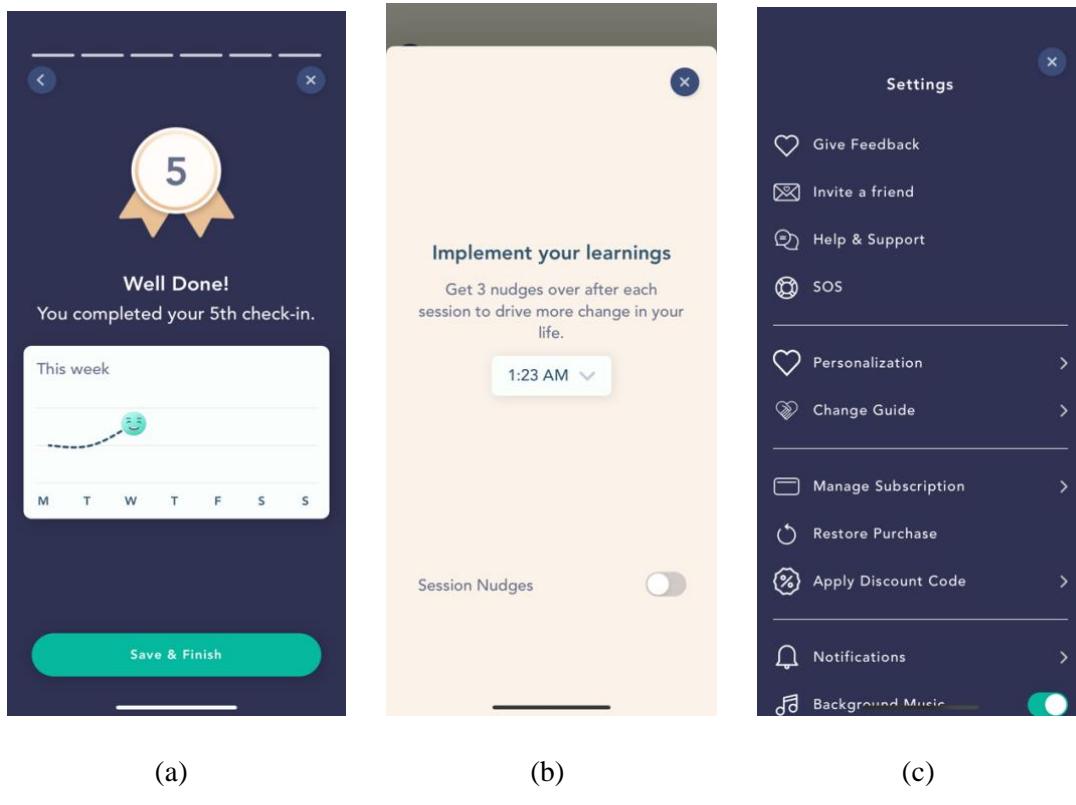


Figure 2.3: (a) Praise, tunneling, and self-monitoring, (b) Reminders, (c) Authority (Bloom, 2021).

Research into the design of persuasive mobile applications to promote positivity is still ongoing. In this light, the description of the design process of a mobile application to cultivate positive mental health care was studied (Nkwo, 2019). This research made use of PSD and interactions with stakeholders to elicit requirements. The system described in Nkwo (2019) has similar aims to the research aims in this project; in that, it can add to the literature about whether optimism applications that utilize persuasive technology have high efficacy. This research is still ongoing, so

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only brief descriptions provided. Therefore, it remains questionable if this research makes use of theoretical frameworks, such as the theory of self-efficacy or if definitions relating to positivity inform the design of the application as these are not included in the paper. This paper indicates that the design and evaluation of optimism applications using persuasive technology are still of research interest.

### 2.3.2 iCBT systems

Internet-based cognitive-behavioral therapy (iCBT) is defined as a persuasive system with the intent to reduce anxiety that comprises of three parts of therapy: therapeutic content, technological features, and interactions between the user and the system (Radomski et al., 2019). This technology has been known to use persuasive strategies. As such, it will be discussed as it too can inform this research into persuasive features to consider in the design of the system. It can also support the need to undergo this research.

A cross-sectional review was conducted to gather literature about iCBT in order to document system design features used and to hypothesize about how the components could alter an anxiety state (Radomski et al., 2019). A total of 63 documents were included in this review. The documents detailed 15 iCBT programs and the PSD model was used to extract system features. The use context of the system and the delivery of the application were documented using the Institute of Medicine model (IOM). It can be concluded for this study that primary task support is a commonly employed feature in iCBT systems as well as dialogue support and system credibility. It is suggested that PSD feature combinations complement one another and are different, thus PSD features should not be isolated and more features do not equate to a better system (Radomski et al., 2019).

The technologies considered thus far can inform designers about which PSD features to include in systems based on empirical evidence and how to go about the design of systems. However, little is known about the design process around the implemented features in the applications in the domain of optimism. This informs the validity of research as this project will build a persuasive system from the ground up and thus will document the design and evaluation of a persuasive application to add to the literature.

## 2.4 Summary

In this chapter, the concept of optimism, different design frameworks, technologies in the domain of mental health, and research in the domain of mental health have been examined in order to gain clarity on how to proceed with this project.

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In section 2.1, the domain of optimism was critically studied. From this, it was possible to gather how researchers in the field of psychology define optimism, how optimism is measured, and how optimism is cultivated. This has informed how optimism will be approached within this project.

Optimism is an association with a variable expectation or an outlook that relates to a desirable reality that is realistic and socially desirable within this project. In addition, it is worth exploring CBT techniques as well as methods of increasing self-efficacy when looking at ways to encourage an optimistic attitude. This is because CBT poses a strategy for one to challenge their way of thinking. Self-efficacy on the other hand can motivate one towards maintaining one's attitude.

Furthermore, the literature examined in section 2.1.5 has aided the investigation of considerations about optimism and how one can empirically measure optimism. It is important to understand that optimism is subjective towards individuals as illustrated in the definition and that the definition of optimism accounts for explanatory style and dispositional optimism. It is therefore the researcher's obligation to determine which one of these measures is to be used in their project. For this project, it was decided to only focus on dispositional optimism, as it exhibits empirical accuracy. The LOT-R was the chosen scale for measuring dispositional optimism because of its many benefits: efficiency, stability over time, and taking the dependency of pessimism into account as well.

The study of persuasive frameworks in section 2.2 yielded a formal procedure to elicit requirements for a persuasive system. The eight-step design model, PSD, and the Socially aware design framework were examined. Due to its formalism and its comprehensiveness, this project will make use of PSD to develop and design the persuasive system. The Fogg behavior model within the eight-step design process will be utilized to complement claims supporting requirements related to persuasive strategies and the decision of a technology platform to build the application upon. The socially aware design framework provides the insight that the investigation of stakeholder behavior is important when designing a system to suit their needs. All this information provides a formal framework to use in the design of a persuasive system within this project.

Technologies and research in the domain of mental health were examined in section 2.3. From the investigation of technologies, the common persuasive system features utilized in emotional and mental health applications have been provided. The examination of technologies has also provided designers with ideas about how to translate persuasive features into system designs. The study of the research about the design of persuasive systems in the domain of mental health has informed the direction that this project will take. Apart from considering the efficacy of an application in the domain of mental health, this project should also detail the design process of the application.

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The findings from this chapter will contribute towards the formal elicitation of system requirements in chapter three. The requirements in chapter 3 and some of the findings from this chapter will provide the necessary foundation to build the design of the system in chapter 4. The findings of the measurement of optimism will aid the evaluation phase of the system in chapter 5.

## Chapter 3

# Requirements

In the last chapter, a literature review was conducted to gain a sound understanding of the domain of optimism, current methodologies for the development of persuasive systems, state-of-the-art research, and persuasive systems in the domain of mental health. This chapter will take the findings from the literature review along with feedback from stakeholders and develop formal requirements for the development of the system.

### 3.1 Findings from the literature review

The findings from the literature review provided a theoretical basis for requirements that a system in the domain of optimism should possess. It is worth noting, however, that these findings alone are not sufficient for the creation of requirements. The reason for this is because if this system is to be used by the general public, it will need to meet their needs. It is therefore worth re-visiting the key findings from the literature review and then seeing how these align with stakeholder needs.

This project defines optimism as an association with a variable expectation or an outlook that relates to a desirable reality that is realistic and socially desirable. The stance of optimism presented in the definition accounts for optimism as an inherent trait and from the viewpoint of an individual difference. From the last chapter, CBT has been shown to be an effective method for maintaining optimism (Hofmann et al., 2012). CBT consists of many exercises that deal with different areas of thought (Branch and Willson, 2012). Therefore, it will be important to question stakeholders about which strategies they currently use to cultivate optimism and which aspects of their lives make them feel optimistic. This will aid the construction of CBT activities that benefit stakeholders.

## Optimism and persuasive technology: a case study

Alongside CBT, activities that increase one's self-efficacy should be examined. From the last chapter, self-efficacy was defined as one's thoughts and capabilities to accomplish a goal (Dobson and Dozois, 2008). It was also discussed that self-efficacy comprises of two parts: outcome expectancy that relates to one's thoughts about the external environment and efficacy expectation that relates to one's thoughts about oneself (Bandura, 1977). The consideration of activities that encourage self-efficacy stem from the belief that if one has confidence in one's ability to cultivate a positive attitude, one will expend effort when trying to change one's attitude. This belief relates to the efficacy expectation component of self-efficacy. It is therefore necessary to determine if stakeholders associate confidence with optimism and which aspects of efficacy expectation stakeholders use to maintain an optimistic attitude.

With the consideration of which activities to examine in the system covered, the methodology of the development of a persuasive system is revisited. In the last chapter, it was decided that this project will primarily use PSD to construct the system as it is a comprehensive way to elicit persuasive features of a system. PSD comprises of firstly understanding the key issues behind persuasive systems, analyzing the persuasion context, and lastly designing system qualities (Onias-Kukkonen, 2009).

Although the steps for PSD have been examined in the last chapter, it will be useful to incorporate stakeholder interaction into its three steps. Stakeholder interaction is used to determine which persuasive features are incorporated in the system. Thus, the next section will discuss stakeholders.

## 3.2 Requirements elicitation

### 3.2.1 Stakeholder engagement

The first chapter of this paper provides an indicator about which stakeholders could benefit most from an application that cultivates optimism. In the first chapter, the global burden of disease is described as a measure to estimate health loss from diseases and injuries and this was measured in disability-adjusted life years (DALYs) (Vos et al., 2020). It was found that poor mental health conditions are amongst the top 10 causes of DALYs amongst the demographics of ages 10-25 and ages 25-49. Also, Poor mental health could increase due to the uncertainties of the COVID-19 pandemic as indicated by Huang and Zhao (2020). Given that individuals within this population are the majority of the workforce in society, these demographic groups could benefit most from a system that aims to help them to maintain their optimistic attitudes. Therefore, within the scope of this project, a subsample of the population of ages 18 to 25 ( $N = 7$ ) will be sampled.

### **3.2.2 Ethical procedures regarding stakeholders**

Ethical procedures heavily influenced stakeholder sampling and the creation of questions to be asked of stakeholders. Research in this domain potentially involves sensitive topics that could have a negative effect on participants if they are affected by poor mental health. In response to this, a 12-point ethics form and an Ethical Implications of Research Activity form (ERIA) – 1 form was completed for all the research conducted in this project before all of the participants were involved in the study. The 12-point ethics form can be found in Appendix A1. To mitigate the effect of the potential recruitment of a participant from a vulnerable group, a screening questionnaire (Appendix A2) was created and attached to the introductory communication about the study. This ensured that the research conducted met the ethical standards required by the University of Bath.

When approaching the design of questions to be asked of participants that covered the subject of optimism, the number of negatively worded items was reduced to ensure that the questions asked were ethical. Furthermore, participant consent was gathered before participants took part in the project research - this consent form covered all the research undertaken that involved stakeholders. A sample consent form for the study can be found in Appendix A3.

Interviews were primarily used to elicit requirements. Interviews were chosen because they are good for understanding users and exploring issues they may have (Rogers, Sharp and Preece, 2011). This characteristic of interviews relates to the aspects that were extracted from the socially aware design framework, namely: understanding stakeholder behavior and exploring stakeholder needs. When user needs are understood, one can ensure that the system they are building adds to the current value possessed by users. Therefore, in this project, an interview consisting of seven participants was constructed to elicit requirements. Due to the sensitive nature of this study, the anonymized participant interview transcripts are not included in this project, instead, overall findings of the interviews will be presented in the next section.

### **3.2.3 Interview questions**

The questions to be asked of participants were structured around the current behaviors of participants when it came to the subject of optimism, stakeholder thoughts about optimism, and factors that would help stakeholders maintain their optimistic attitudes. The questions, their purpose, and stakeholder responses are detailed below.

**Question one:** When you hear the word optimism, what comes to mind?

The purpose of this question was to understand how the participant viewed optimism.

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All the participants viewed optimism in relation to positivity. A few participants elaborated on this. They provided some interesting views on optimism, mentioning “confidence”, “resilient emotionally” and “thinking that something will go better in the future”. The statement about confidence is linked to self-efficacy because self-efficacy is about the internal belief that one is able to successfully accomplish a behavior. Emotional resilience can also be linked to self-efficacy because emotional arousal affects efficacy expectation. The last statement links to the definition of optimism given in this project.

### **Question two:** What makes you feel optimistic?

This question was posed to briefly find out which factors positively affected optimism levels and whether specific expectations (small optimism) or more general expectations (big optimism) make the individual more optimistic.

Responses were in the categories of past performance, interaction with positive people, and enjoyable activities that are separate from day-to-day work. These findings indicate that performance accomplishments, receiving positive stimulus, and taking time out of the day are important for participants to retain their optimistic outlook. This indicates that it is little optimism which is focused upon when individuals expect optimistic situations to occur.

### **Question three:** When faced with an unexpected situation, does this affect your levels of optimism, and how so?

This question is added to indicate if the stakeholder tends towards the optimist viewpoint of expectational optimism or the pessimistic viewpoint of expectational optimism.

Four of the seven participants attributed this unexpected situation to a negative scenario, and as a result, they expected that it would deplete their optimism levels. The remaining three participants had different rationalist perspectives about this. One of the participants, although attributing the unexpected situation to a negative scenario, mentioned that if they were in a more positive mindset before the unexpected situation, they would be able to recover their optimism. Another participant did not attribute the unexpected situation to a positive scenario or a negative scenario, but if it had been encountered or not encountered. The final participant attributed the unexpected situation with both a positive scenario and a negative one. These findings suggest that three of the participants tend towards positive thinking patterns, while the other participants can greatly benefit from cultivating a positive attitude.

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**Question four:** When you are optimistic, are there any factors that decrease your optimism?

This question was asked to determine which aspects of CBT/Self-efficacy should be focused on.

Four of the participants associated their decline in optimism with uncertainties about the future and changes, while two participants attributed this to comparison with others and viewing other people's behaviors. The final participant attributed their decline of optimism with rejection and loss. Although there are conflicts in what decreases a participant's optimism, it is important that there needs to be an element of improving optimism by addressing unknown situations in the system to be developed. To account for the view of comparison with others, this application should not use competition between users as a persuasive strategy to cultivate optimism. Regarding the rejection aspect, there needs to be a feature that builds up a person's confidence such that they can deal with rejection.

**Question five:** How do these factors affect your lifestyle?

Four of the participants stated that this decrease in optimism made them more unmotivated and they tended to procrastinate because of fear of the unknown or being demoralized. An interesting comment from one participant was that "it depends how much weight you put into these thoughts". The findings indicate that a decrease in optimism decreases a positive outlook about the future and may also relate to a decline in self-efficacy. This further supports the need for the system to build up a participant's self-efficacy and to ensure that the application gets participants to think more rationally about the future such that they don't fear it.

**Question six:** What are some of the strategies that you employ to increase/maintain your optimism?

This question was asked because it would help gain an idea about the current practices that could be contributed by the system to be ubiquitous for users.

The comments elicited by this question are as follows:

- "I remind myself what my goals are".
- "I try to suppress the negativity".
- "Attach positive things to the feeling".
- "Exercises that calm the mind".
- "Asking what is the worst thing that can happen".

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This indicates that focusing on one's future performance achievements can help regain focus and the motivation to continue with one's tasks. Also, suppression of negativity by questioning negative thoughts about future happenings can be beneficial to participants if they logically restructure their thoughts. If they adhere to this, they could potentially see things from a brighter perspective. Therefore, the system should support goal-setting and should support a CBT exercise that covers negative thoughts.

### **Question 7:** How do these strategies change your thought process?

This question was asked to see what aspects participants felt were altered by engaging in their strategies for maintaining optimism.

Participants indicated that when they adopted the strategies in question 6, there was a shift in their outlook. This included: re-evaluating the current situation, more motivation, and focusing on the present. These findings indicate that strategies that are used to maintain optimism are important to engage in on a regular basis because of their effects on one's outlook on a situation. It was mentioned by participants that if there was a greater emphasis put on optimism, there would be more risk involved. This is because if one does not take incremental steps towards being more optimistic, one could potentially feel worse off than before because of trying to change too many things at once. Therefore, it will be important that the application to be developed takes this into consideration.

### **Question 8:** Out of the strategies mentioned, which would you recommend to a person struggling to maintain optimism?

This question tried to get an idea about strategies that could be expanded to the general population.

Participants had conflicting views about this point. Comments about strategies ranged from long term to others that cater towards different people. These findings highlight that the system should include activities that are tailored towards the needs of individuals and these activities should be incremental towards the user's goals.

### **Question 9:** What are the characteristics of the strategy mentioned?

This question was asked to gain more idea about what these activities consist of to aid the search for grounded strategies.

Participant viewpoints included the following: some form of visualizing negative thoughts, something that is scheduled regularly, something that alters the way they approach their thoughts. This indicates that it would be beneficial for participants to be walked through their thoughts such that they can rationalize them.

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Another insight is that this application should aim at scheduling activities to maintain or cultivate optimism in a non-intrusive way that supports the participant's journey towards optimism.

**Question 10:** What characteristics would you like to see in an optimism technique?

Explanation: This question is used to further see how the application can support users in maintaining or cultivating an optimistic attitude.

Participant views covered the following:

- long-term strategies
- non-time-consuming strategies
- strategies that account for occupational wellbeing
- strategies that account for fluctuations in the user's mentality
- strategies that provide reminders and are simple
- strategies that provide a letdown strategy

These findings provided multiple viewpoints about how findings relate to prior views raised in the interview. Perhaps one of the most important findings from this is that the application needs to provide a letdown strategy. In accounting for this, the application will ethically reveal its bias and will reduce the disappointment of users. Other important findings include convenient reminders, and activities that do not require too much cognition.

All these findings coupled with PSD and observations helped with the formation of a software requirements specification (SRS). The following section will deal with the main persuasive features of this system alongside decisions on suitable activities for the application.

### 3.3 Software Requirements Specification

The findings from stakeholders thus far showed conflicting viewpoints - this can have a great impact on how the final system turns out. Below are illustrated some problematic cases where just focusing on stakeholder needs and forgetting about the literature could lead to systems that are not in line with overall findings.

## Optimism and persuasive technology: a case study

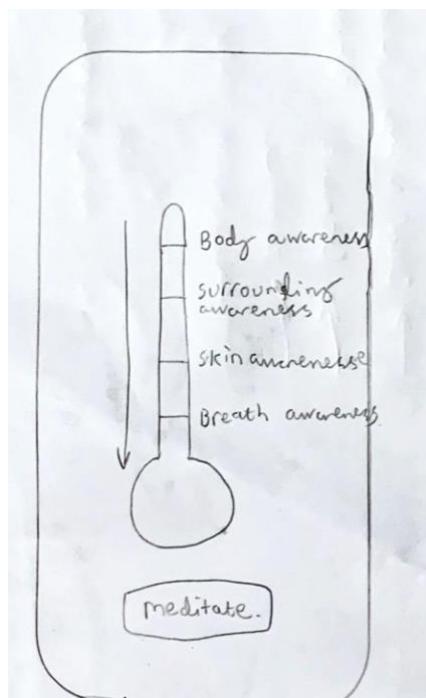


Figure 3.1: Mindfulness application idea.

The first example of this is Figure 3.1 (above). Figure 3.1 took the perspectives from users that they wanted a system that would give them time out of their day and the opportunity to rationalize their thoughts. The designer of this system may have seen that mindfulness met these requirements, therefore they designed a mindfulness system. Returning to the literature, it can be observed that this system was incorrectly designed because there is no literature presented in this project that states that mindfulness is a good strategy for cultivating optimism. It may be that mindfulness does help, but it is important to reference grounded strategies of optimism. Figure 3.2 (below) is another example of what not to do. It is based on a storyboard that walks the user through the use of the system.

## Optimism and persuasive technology: a case study

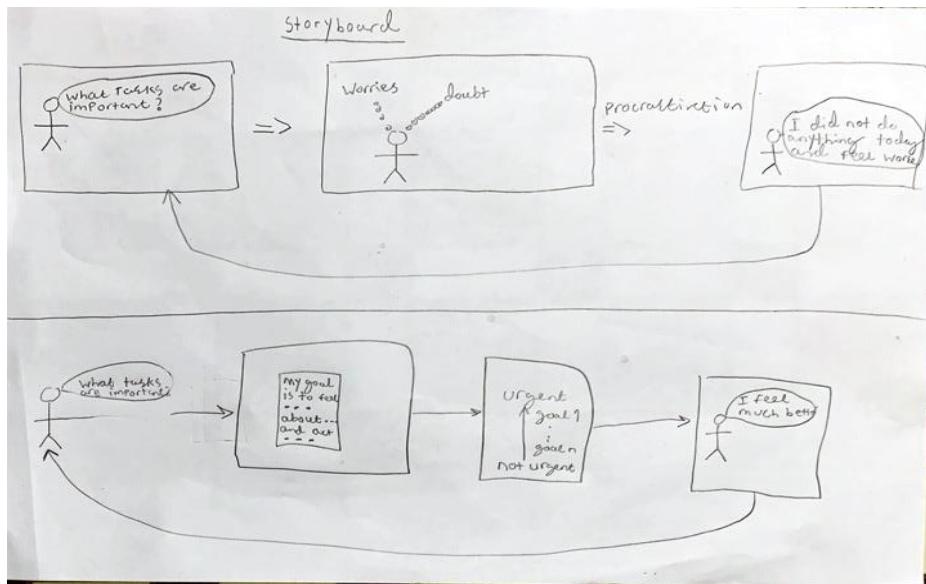


Figure 3.2: A storyboard of a prioritization system.

### 3.3.1 PSD framework with stakeholder considerations

This project aims to create a persuasive system that helps users to cultivate or maintain optimism. Using the Fogg behavioral model, and the finding that users would want to use the system regularly, it was decided that this system take the form of a mobile phone application as it will make it easier to provide triggers to the user to remind them to use the system and will also support their ability to use the application (Fogg, 2009).

The findings from the literature and the interviews with stakeholders thus far could result in confusion for the researcher. To resolve this, findings aligned with stakeholder views and literature will be included in an SRS. With an SRS all of the system requirements are laid out.

Before some of the requirements in the SRS are detailed, it would be useful to address the key needs of the users from the interview and see how these fit in with the framework of the PSD. As discussed previously, all persuasive systems must address the seven postulates. These, coupled with stakeholder viewpoints, form a solid foundation for the creation of a persuasive system.

The first postulate is that information technology is never neutral. This corresponds to the stakeholder viewpoint that the system should account for shifts in a user's mood such that relevant and beneficial information is shown to them.

## Optimism and persuasive technology: a case study

The second postulate is that commitment and consistency are needed. This aligns with the viewpoint of the need for reminder functionality. This is because, with reminders, the user may feel more inclined to continue with their intended behavior because they feel tied to a commitment.

The third postulate is the need to determine which modality of persuasion is taken: the direct route or indirect route. From the interviews with stakeholders, it can be implied that users would prefer the indirect route of persuasion. This can be found from the viewpoint that some of the users in the sampled population enjoy things that give them a break from their day as well as the finding that the system should not be too time consuming and cognitively taxing.

The fourth postulate is persuasion should be incremental. This aligns with the finding from the interview that the shift to optimism should not be so different from that of people's daily lives such that they have a difficult time adopting the behavior. Instead, the shift towards optimism should be gradual and at the user's pace.

The fifth postulate is persuasion through persuasive systems should always be open. This postulate was indirectly mentioned in the interview as the idea that the system should offer a letdown strategy for its users. This is because if the user was convinced that the system would grant them an optimistic outlook and it did not deliver, this would be unethical.

The sixth postulate is persuasion should aim at unobtrusiveness. In the second postulate, the reminder functionality was mentioned by stakeholders. However, reminders at unwanted times can cause annoyance and can hamper the persuasion brought out by the persuasive message. The findings from question 9 of the interview account for this postulate.

The seventh and final postulate is that the system should aim at being both useful and easy to use. This considers the view that the system should provide simplicity for the user and should be trustworthy.

The analysis of seven postulates and how they relate to stakeholder viewpoints builds the foundation for the system requirements.

In the second step of PSD, the persuasive context with respect to stakeholders has to be analyzed, namely: which tasks are relevant to user needs. Previously, it has been revealed from the literature review that both CBT and self-efficacy activities have been beneficial to incorporate into the system. From participant viewpoints, it was discovered that the sub-sampled population attribute their decline of optimism to uncertainties about the future and rejection. The strategies to encourage optimism, therefore, should focus on dealing with negative thoughts about the future, while the strategies that aim at improving self-efficacy should focus on motivating the user and goal-setting.

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To acknowledge the need for negative thoughts, an activity called “immediate thoughts” is used. This activity helps one logically restructure any negative thought that one may have by walking them through their thought and having them re-evaluate the possible scenarios arising from that thought (Selva, n.d.). This activity focuses on small optimism because it considers specific scenarios and thought cases. Regarding the goal-setting activity, a strategy called “three things” was chosen as a potential activity. In this activity, the user lists three things in the past that they accomplished, how those accomplishments made them feel, goals for the future, and how accomplishing their goals would make them feel (Chowdhury, 2021).

A metaphor is defined as an expression that describes an object by comparing it to another object and it is an important tool that one can use when approaching the indirect route of persuasive messaging. In the domain of advertising, it has been shown that indirect metaphorical persuasion has the ability to elicit positive conclusions about a brand (McQuarrie and Phillips, 2005). However, unlike in marketing, the metaphors employed here should not aim to deceive or coerce the user. Metaphors should instead aim to elicit a positive user experience when the user is using the application and to enable easier analysis of a message. Metaphors are therefore used in this way within this project.

For the third step of PSD, system qualities have to be decided. These are the formal non-functional requirements of the system. They cover the support of the user’s primary interactions when using the system (primary task support), offering feedback to the user (dialogue support), and being credible.

### 3.4 Formal requirements

Before the qualities of the system are discussed, it is essential to define a key for the requirements to determine their importance. This importance is detailed by the usage of “must”, “should”, and “could”. “Must” indicates high priority requirements that if left out could significantly diminish the quality of the product. “Should” indicates medium to high priority requirements that creators should adhere to when developing the system. Researchers should make every effort to include these in the system. “Could” indicates low priority requirements that can be included if one would like them in the system, but there is little-to-no effect on the final product if these are left out.

#### Primary task support requirements

The application should aim to reduce the user’s effort towards becoming more optimistic (reduction) (Onias-kukkonen, 2009).

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Referring to the fourth postulate of persuasive systems, if the complex behavior of optimism is reduced to simpler behaviors, this will make it easier for users to engage with the application which could aid the user in their journey towards an optimistic attitude (Onias-Kukkonen, 2009). Therefore, this should be included in the system.

The application should guide the users through the process of the cultivation or maintenance of an optimistic attitude by making the application a process where the user works through the immediate thought activity and the goal-setting activity every time they use the application (tunneling) (Onias-Kukkonen, 2009). Tunneling is considered because it gives the user more of an opportunity to be persuaded as they are working through a process, potentially bringing them towards a more optimistic attitude (Onias-Kukkonen, 2009).

The application should provide tailored activities for users (tailoring) (Onias-Kukkonen, 2009). A system that includes tailoring is one that provides information that is relevant to the needs of its users (Onias-Kukkonen, 2009). Such systems have the potential to be more persuasive. In the context of this project, the tailoring should be applied to determining which activities users should engage in based on how they are feeling at the time of using the application.

The application should offer personalized content to its users (personalization) (Onias-Kukkonen, 2009). This is very similar to tailoring as it is content-focused, however, one difference here is that personalized content appeals to the individuals of the application (Onias-Kukkonen, 2009). An example of this would be to present information such as the individual's name to the user if they log into their account. Personalization should therefore be considered as a system requirement because it can appeal to the user at a personal level, driving the persuasive effect it has on users.

The application should allow the user to track their mood (self-monitoring) (Onias-Kukkonen, 2009). Self-monitoring is of interest because monitoring a user's mood can support their journey towards optimism as optimism is said to be associated with a better mood (Peterson, 2000).

### **Dialogue support requirements**

The application should offer praise through words or images as users work towards a positive attitude (Onias-Kukkonen, 2009). With praise, it is implied that the user will be more likely open to persuasion (Onias-Kukkonen, 2009). The goal of this application is to help the user shift their attitude to an optimistic one, therefore, to support their journey, this strategy of persuasion is favored.

The application should remind users to return to the application to continue their journey towards a more optimistic attitude (Onias-Kukkonen, 2009). With reference to the second postulate of persuasive systems, this would support commitment to the system and it also supports the user's need to regularly interact with the application.

## Optimism and persuasive technology: a case study

This persuasive strategy is hence added as a non-functional requirement.

### Credibility requirements

The application must be credible (Onias-Kukkonen, 2009). This requirement would ensure that the system elicited trust in the user. As mental health is a very sensitive topic to some, individuals may be wary when using such systems to better their mental health. It is therefore essential that this application takes into consideration trustworthiness, expertise, and surface credibility (Onias-Kukkonen, 2009).

### Functional requirements

Functional requirements are requirements that have an element of system behavior associated with them. The main functional requirements are listed below.

1. The application must allow the user to log in using a username and password. In doing so, this will ensure that the user's inputted data is secure from unauthorized parties. Source: Lit (Onias-Kukkonen, 2009).
2. The application must provide the user with a disclaimer saying: "This application aims to elicit optimistic behavior, therefore it should not act as a replacement for clinical practices or clinical practitioners." Source: Lit (Onias-Kukkonen, 2009).
3. The application must use the immediate thought exercise to help users cultivate optimism. Sources: Literature (Selva, n.d.) and interview.
4. The user should be asked two questions to determine which activities will benefit them. Source: Literature (Onias-Kukkonen, 2009).
5. The questions that users are asked should link to the appropriate activity if the user gives an answer to the question that is considered pessimistic/having low confidence. Source: observation by the researcher.
6. The questions users are asked should be created based on the new general self-efficacy scale and the LOT-R scale. Source: observation by the researcher.

It is worth elaborating on the last functional requirement. The purposes of the LOT-R and the self-efficacy scale are to measure one's optimism and self-efficacy respectively. These are the evaluative outcomes of this study. It therefore would be indicative that a user could benefit from an optimism boost if they answered negatively to a constructed question about the LOT-R. The same observation can be said about the question related to the new-general self-efficacy scale. From this observation, two questions should be asked of users to determine if they need to engage in the optimism activity, the self-efficacy activity, or both. The final requirements for the system are detailed in Appendix B.

### **Security and data storage**

The proposed application will store user data such as passwords and usernames on the user's local device (shared preferences). This may raise a question about the secure storage of data because in the case that the user's device is compromised, any data stored on the user's device is unsafe. This includes any data entered into the application. For the purposes of this project, only the usability and the effectiveness of the application are to be studied. As a result, no data will be stored by the application at this phase of development. An information form will be issued to participants in the evaluation study to detail which data will be collected from participants. Explicit consent about the collection of such data will also take place before the evaluation study proceeds. If this application were to be developed for commercial context or further prototyped, the storage of user data along with informed consent about its storage would have to be addressed as high priority requirements.

## **3.5 Summary**

This chapter introduced findings from the literature review to aid the elicitation of requirements. Stakeholders were then approached to determine their needs. Once the stakeholder needs were gathered, the framework of PSD was applied to form non-functional and functional requirements. The persuasive features found spanned three categories: primary task support, dialogue support, and system credibility. The functional requirements described the tasks to cultivate optimism and that these tasks would be streamlined such that the user works through them to work towards optimism. In the next chapter, the found requirements are taken from the SRS and converted into a concrete application design.

## Chapter 4

# Design

In the previous chapter, literature and stakeholders were consulted to establish an initial set of non-functional and functional requirements for the system. These requirements were established into a formal document called a software requirements specification (SRS). With the SRS, one can start to develop a system. In this chapter, the SRS will be transformed into a set of designs for the application.

### 4.1 Design methodology

When one tries to go from a requirements specification to a set of designs, there can be differences in delivery. This could be to do with how people perceive the written requirements. The researcher interprets these requirements as they see fit and transforms them into a design.

This research will make use of participatory design to drive the design process. Participatory design is defined as research that is comprised of stakeholder interaction, requirement elicitation, and prototyping, where the researcher iteratively alters the design of the system based on user feedback (Spinuzzi, 2005). In this chapter, prototyping of the user interface (UI) will be covered. Participatory design is used to prototype the UI because it involves the target population which can result in a design that has been validated by users. It has also been indicated that participatory design is a technique that is lacking in persuasive system design research (Orji and Moffatt, 2018). Therefore, in the design phase, this project will focus on the iterative creation of designs for the application.

One technique of participatory design is rapid prototyping. After a prototype has been developed, it is shared with users for their feedback. The resulting feedback is then fed back into another iteration of the design (IDEO.org, n.d.).

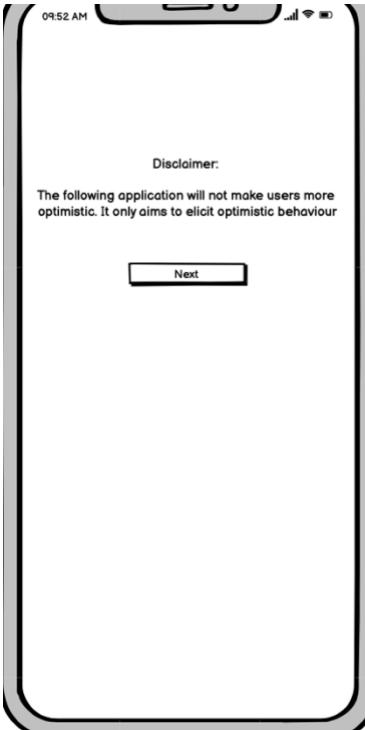
## Optimism and persuasive technology: a case study

This was chosen as the means to iteratively design the application because of the quick delivery of feedback from stakeholders early in the design process. Rapid prototyping also ensures that ideas can quickly be tested with respect to stakeholders.

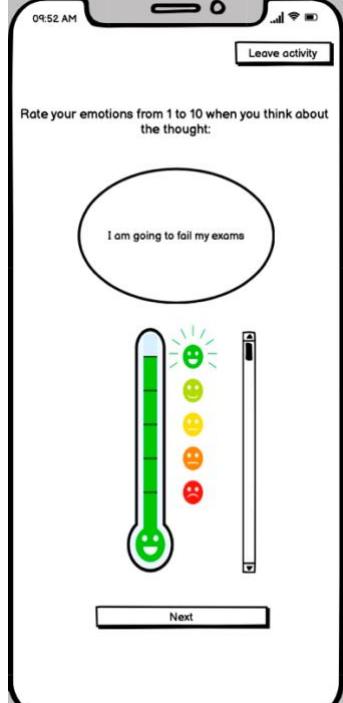
### 4.2 First iteration of the design

The first design of the system was based on the requirement that the system would tunnel the activities for the users to work through a process. This meant that the user would be guided through the relevant tasks in the application depending on how they answered the constructed questions about their optimism and self-efficacy. This prototype was a wireframe that was designed using Balsamiq. Below are some of the prototyped screens of the first iteration along with the persuasive features they support (Table 4.1). A full design of the first prototype can be viewed in Appendix C1.

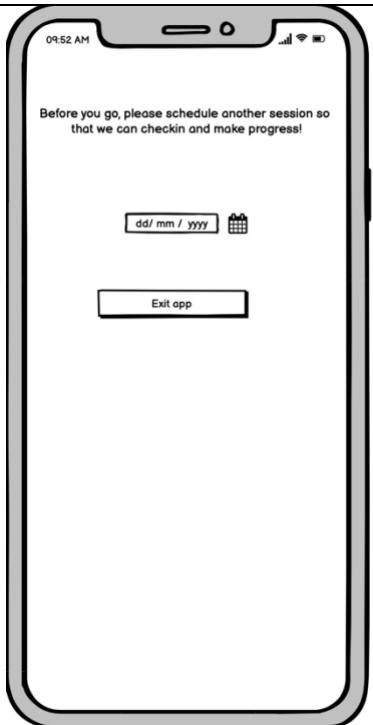
Table 4.1: Prototypes accompanied by an implementation of persuasive features.

Screenshot of prototype	Persuasive feature used
 A wireframe of a smartphone screen. At the top, there is a status bar with the time '09:52 AM' and signal strength indicators. The main screen displays a 'Disclaimer' message: 'The following application will not make users more optimistic. It only aims to elicit optimistic behaviour'. Below the text is a small rectangular button labeled 'Next'.	Disclaimer screen presented to the user when they first open the application supports surface credibility.

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 A smartphone screen displaying a user interface for an optimism exercise. The top status bar shows the time as 09:52 AM and signal strength. A "Leave activity" button is at the top right. The main content area asks, "Question 1: Do you agree with the following: 'I usually expect good things to happen to me'". Below this is a row of two radio buttons labeled "Yes" and "No". At the bottom is a "Next" button.	<p>The first question of the optimism exercise directs user to the appropriate activity, supporting tailoring.</p>
 A smartphone screen displaying an emotion rating screen. The top status bar shows the time as 09:52 AM and signal strength. A "Leave activity" button is at the top right. The main content area says, "Rate your emotions from 1 to 10 when you think about the thought:" followed by a thought bubble containing the text "I am going to fail my exams". Below this is a vertical thermometer-like scale with a green滑块 (slide) pointing towards the top. The scale has six colored faces (green, yellow, orange, red) corresponding to different emotional states. At the bottom is a "Next" button.	<p>Emotion rating screen for immediate thoughts supports liking and visual metaphors (Artist (09910190, n.d.).</p>

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 A smartphone screen prompting the user to "Before you go, please schedule another session so that we can checkin and make progress!". It includes a date input field labeled "dd/ mm / yyyy" and a calendar icon, along with an "Exit app" button.	This screen allows the user to schedule a reminder to use the application again.
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## Optimism and persuasive technology: a case study

### 4.2.1 Stakeholder feedback for the first iteration

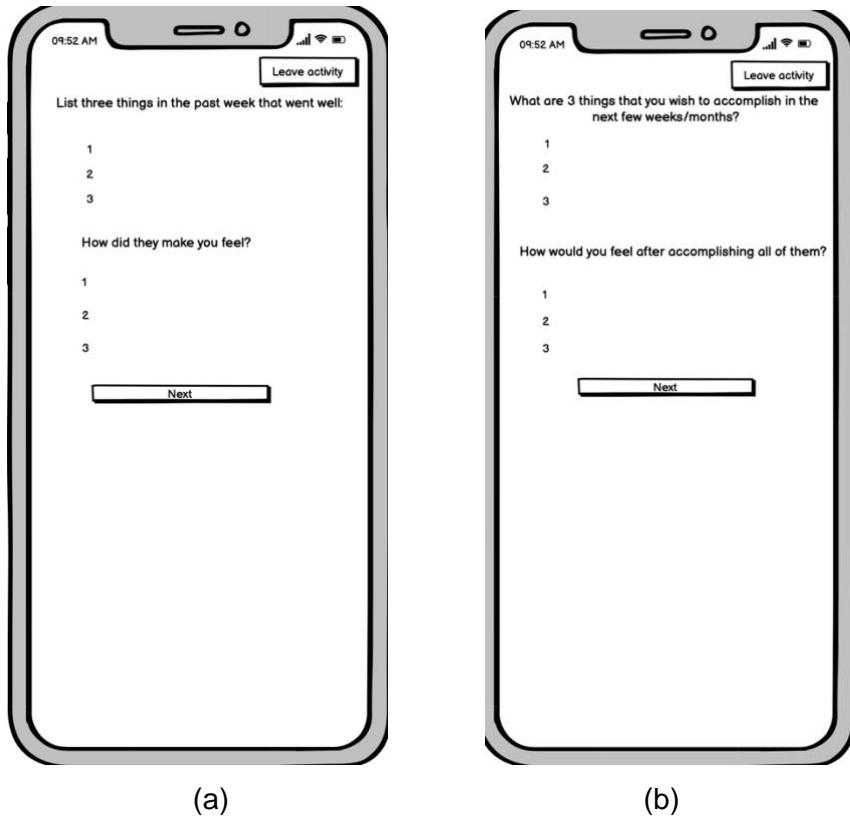


Figure 4.1: (a) First screen of the goal-setting task, (b) Second screen of the goal-setting task.

A focus group was conducted with the same participants from the interviews in the previous chapter. Results of the first focus group can be viewed in Appendix D1. Some comments about the improvement of the system were made:

- “Add a survey or multiple-choice questions to gauge how the user is feeling at a given point in time.”
- “Possibly replace the thermometer with just faces.”
- “More imagery and improve the UI.”
- “The goal-setting task is too tedious” (Figures 4.1a 4.1b above).
- “Brief descriptions about the activities could be provided.”
- “Add some color to the application.”

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- “Instead of listing a date for when the user last had a negative thought, have the user choose from a set of pre-determined options.”

These comments indicate that pictorial metaphors work to a certain extent. In the case of the thermometer screen, the faces worked because users may have found it easier to associate faces with emotions as opposed to the secondary coupling of the thermometer with emotions. In the case of adding a survey to determine how the user is feeling, this could change the binary measurement to an emotion that is measured every time that the user completes their activities. This would ensure that the user can view their overall mood in the graph and this captures the overall view of one’s optimism.

Regarding the comments about the color scheme, as well as the images used in the application, these are important to balance because images need to be of relevance to the tasks that the user engages in, also the color scheme can provide a sense of identity to the application. In the next iteration, it will be important to add a background color to the application.

In the next design iteration of the application, the goal-setting task will be replaced to ensure that the application does not contain too much text for the user. This is because if the interface is too textual, it will be tedious to work through for the user and could reduce the application’s persuasive intent. Therefore, new tasks for the improvement of self-efficacy need to be researched.

This feedback led to the creation of a second design of the interface.

### 4.3 Second iteration of the design

One significant change in this iteration was the choice to discard the goal-setting activity in exchange for the user to decide to engage in a self-affirmation activity or a role model activity (Figure 4.2a below). The self-affirmation activity involves the user typing one kind thing about themselves, while the role model activity involves naming a role model and then typing what the role model would say to improve the user’s confidence. Self-affirmation has been used to oppose negative thoughts, increase self-esteem and motivate one’s self (Catherine Moore, 2021). Alternatively, users may prefer to persuade themselves by selecting an external figure to persuade them (Chowdhury, 2021). The SRS from the previous chapter was therefore adapted to fit the new tasks and their procedure screens.

## Optimism and persuasive technology: a case study

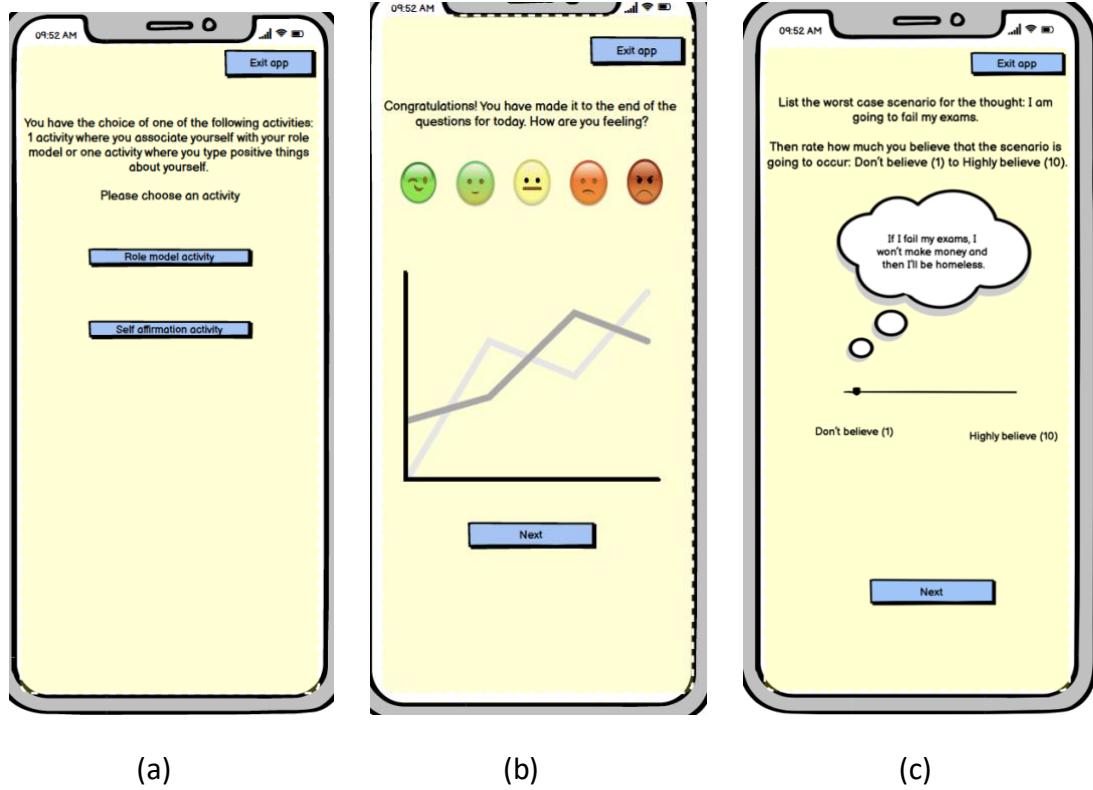


Figure 4.2: (a) Replaced goal-setting, (b) replaced self-monitoring, (c) ovals have been replaced with thought bubbles to provide more liking (pngfind, n.d.).

The other changes to the user interface were made in response to the stakeholder feedback from the first focus group. Namely, the addition of a survey at the end to gauge how the user was feeling as seen in Figure 4.2b (above), the replacement of the thermometer for emotions emojis, the replacement of the date setting feature for a choice of pre-configured time periods, the brief description of activities, the change of ovals to thought clouds and the addition of the background color (Figure 4.2c above). A full version of the second design is included in Appendix C2.

### 4.3.1 Stakeholder feedback for the second iteration

A second focus group was conducted to determine the stakeholder acceptance of the application. The findings from the second focus group can be viewed in Appendix D2. The findings were generally positive. The stakeholders liked the addition of the new activities and that they could choose between them. This is because some of the stakeholders stated that they did not follow the role model route when trying to build their self-efficacy. Stakeholders were also queried about the level of the emotions displayed in the emotion gauging stages of the application. The stakeholders liked that the application had five levels for the final recording of emotion. For the emotion scales in the immediate thought activity, participants liked

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this but stated that a list of secondary emotions could pop up when the user clicked on a primary emotion.

#### **4.4 Third iteration of the design**

A concern raised by stakeholders towards this iteration of the application was its lack of character and the interface visuals. There was a need to make the application more visually appealing for users. Theoretically, the possible reason why the application may have not been preferable for participants is because of the visceral design of the system. The human brain is suggested to comprise of three distinct levels: the visceral level that is responsible for processing immediate happenings in the real world, the behavioral level that processes the control of behavior, and the reflective level that involves the processing of scrutinization (Norman, 2004). With these three levels of the human brain covered, the third iteration of this application should be designed to evoke positive emotions from the user when they use the application through accounting for Norman's 3 levels of design. Namely, the look of the application (visceral design), the usability of the application (behavioral design), and the value of the application (reflective design) (Norman, 2004; Rogers, Sharp and Preece, 2011).

To design at the visceral level, inspiration had to be provoked based on which images and color schemes were used. Mood boarding greatly helped at this level of design. Mood boarding is defined as a qualitative research tool that can validate design concepts (Cassidy, 2011). This process is iterative where the items in the mood board are created and updated based on internal observation or through the interaction with stakeholders usually in the early phases of system design. The mood board in this project was designed using internal judgment because the design decisions could be linked back to the findings of the interview in the previous chapter. The mood board was also used at the later phase of design because it accounted for visceral design. Therefore, this approach was taken to decide on a color scheme and get ideas about which pictorial elements were present in the third iteration.

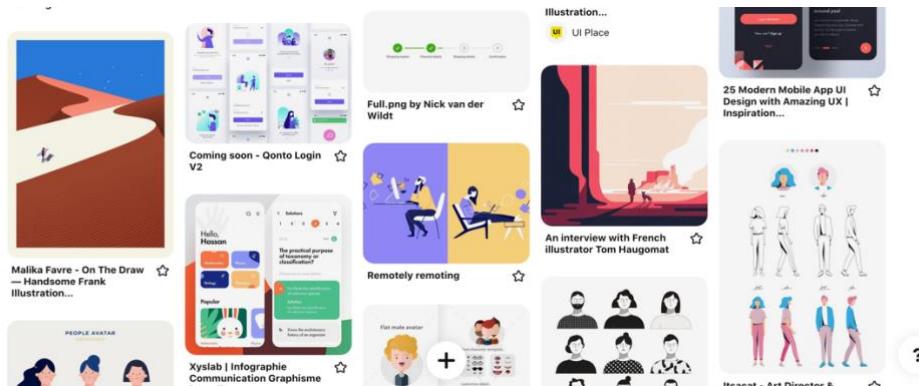


Figure 4.3: Part of the created mood board.

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The created mood board, partly shown above in Figure 4.3 focused on imagery and the color scheme of the application. The imagery in the mood board included visual metaphors similar to the thought bubble used in the second iteration. From this construction of the mood board, it was observed that visual metaphors relating to textual titles or descriptions present in the application would be useful. This was because the findings from the requirements chapter indicate that a visual metaphor would increase the visual appeal of the application whilst providing semantic meaning to the user. An example of a relevant metaphor would be the addition of a dartboard with an arrow in the center next to the text "SMART targets". When the user sees the target, they would potentially associate the bullseye with a SMART target. Therefore, more visual metaphors that have a relation to the accompanying descriptive text should be included in the third iteration of this application.

The findings from the mood board with respect to colors concluded that a purple color scheme would be favorable for the third iteration of the application. Purple has been qualitatively described to represent spirituality and has been referred to as a cool color that is relaxing and is often present in hedonic products that give the user joy (Kolenda, n.d.). As a result, the primary color of the application was purple (B39DDB) and the secondary color of the application was chosen to be purple as well (C5CAE9). The visceral elements of the application were then accounted for.

To aid the design of the third iteration of the application, the formalisms of design needed to be investigated. The material design specification has been created by Google to support the design, usability, and the accessibility of iOS, Android, and Flutter applications (Google, n.d.). It was noted that users may potentially associate the application interface with Google's interface which could elevate the level of trust in the application as well as the ubiquity of the application because Google search and many other services are prominent in society. This would ensure that behavioral design and reflective design were accounted for. The material design specification was therefore relied upon for the design of the third iteration.

Another alteration in this prototype was to add SMART target setting after the reframing thoughts activity. This activity was added because it meets the need for a task that aims to help the users set realistic goals. Once a goal is set, this would hopefully encourage the user to work towards their performative accomplishments (Mead). The SMART target will be based around the best-case scenario for the user in the immediate thoughts exercise. This would ensure that regardless of being in a negative state after the immediate thought activity, the user could still set a goal for themselves that could shift their negative thoughts. This requirement of this activity was therefore added to the SRS.

Other design changes in this iteration included the addition of a login and sign-in screen for the user, a dashboard to store the main content of the application, a "heart" graphic in the menu to indicate progress towards the end of the optimism activities. Some further alterations worth discussing are the addition of

## Optimism and persuasive technology: a case study

trustworthiness elements in the application. In the main menu, there was a button added called “Seek help”. This button was added to ensure that if the user needs to contact a professional organization regarding their mental health they can do so. Also, sources for the activities used in the application were added. This addition ensured that users were reassured that the ideation of these activities was grounded. The third iteration has assured that the application design thus far has taken usability, stakeholder needs, and the requirements specification into account. Some of the design changes can be viewed in Figure 4.4 below. The full designs of the third iteration are provided in Appendix C3.

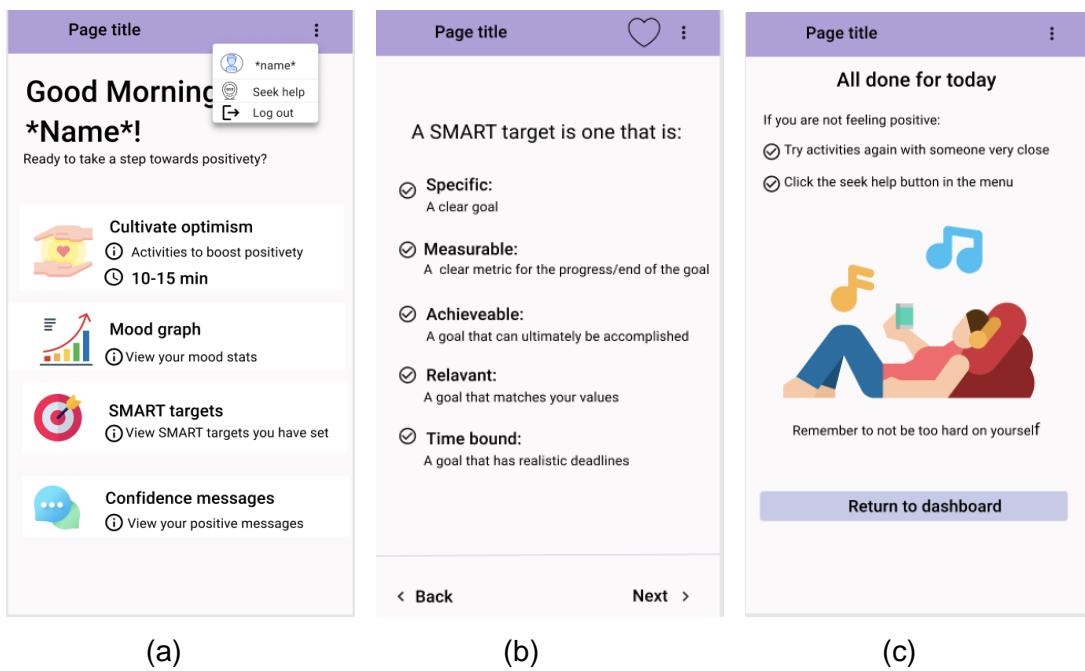


Figure 4.4: (a) Dashboard screen, (b) SMART target information screen, (c) Praise screen (flaticon, n.d.).

This third iteration was designed in Figma: an online design platform. As a result, it could be turned into a navigationally functional application. For practitioners and researchers with time constraints, it is beneficial to use wireframing tools such as Figma to prototype the application because these tools can bring a partially functional prototype to the hands of the users quickly. This third iteration was not tested by users because it will be tested in the evaluation chapter.

## 4.5 Summary

This chapter has taken the SRS and has transformed it into a set of designs that are ready to be developed. The design process took the approach of participatory design and used rapid prototyping to iterate through application designs. The first and second iterations focused mainly on the functional aspects of the application. The third iteration took a more formal approach to design based on Norman's three levels of design. In the third iteration, mood boarding was used as a strategy to gather inspiration about what color scheme could be included in the application as well as imagery. More pictorial elements were added to the third iteration because they provided semantic meaning to the text and could add more interaction to the application. Furthermore, the color purple was chosen for the color scheme of this application because it conceptually satisfied the needs of the user population. This consideration, along with Google's material design specification and the addition of elements that further promote trustworthiness, provided an interface that was ready for development.

The design procedure used in this chapter can be applied by researchers and practitioners alike. It is worth noting though that design depending on the context will alter which strategies work for designers. Nevertheless, some prototyping techniques have been explained in depth that can prove useful for implementations. Since Figma was used to prototype this application, the partial development of the application is complete. The next chapter will describe the methodology taken to perform an evaluation of the wireframed design of this application.

## Chapter 5

# Evaluation

This chapter will outline the experimental procedures undertaken to evaluate the efficacy and the usability of the persuasive optimistic intervention app. The purpose of the experiment and its scope will be discussed. This will lead to the formulation of the aims of the experiment as well as research questions. This chapter will then discuss the experimental design and the hypotheses to be examined within the experiment.

### 5.1 Scope of the experiment

Thus far, a high-fidelity prototype of the persuasive optimistic intervention app has been designed using the PSD framework alongside participatory design that incorporated elements from CBT and activities that encourage self-efficacy. The intention of this project was to develop a system that adds to the literature about the efficacy of persuasive systems in the domain of health behaviors towards the improvement of mental health. As such, an experiment that determines the effectiveness of the optimistic intervention application is required. In chapter 4, the design procedure for the application was covered. It remains to be answered if this prototype is usable by the intended population. It would also be useful to gain feedback about the application designed to further determine if it could be adopted in a wider context. Therefore, a usability test and a way to measure the feedback of the application should be included within the experiment. The results from these measures will provide an indicator of the efficacy of the application.

The scope of the experiment will consider the persuasive elements and the perceived usability of the high-fidelity prototype of the application developed in chapter 4. As this prototype was developed in Figma, the user is not able to interact with all the elements of the application. This means that interactions, such as data movement and data authentication will not be covered by the experiment. Interactions with the system on the user side will be simulated by the user, while

## Optimism and persuasive technology: a case study

interactions such as the reminders will be covered by the researcher. This type of experimental design is known as Wizard of Oz (Rogers, Sharp and Preece, 2011). It allows for the system to be evaluated without having a fully functioning system.

### 5.2 Aims of the experiment

The aims of the experiment in this project are as follows:

1. **To measure the effectiveness of the application**

The effectiveness of the application is one of the main aims of this project. The results will determine if this application was effective in helping the user cultivate or maintain a positive attitude, thus adding to the literature about persuasive systems in the domain of healthy behaviors.

2. **To measure the usability of the application**

The application usability measure can capture user satisfaction, effectiveness, and the efficacy of the designed application. This will provide an indication of how well the application is designed for the user group and how it is accepted by the user group.

3. **To receive feedback about the application**

Feedback about the application is of importance. This is because it can serve as an indicator that supports the efficacy of the application. Within feedback, the dimension of whether the application is recommended to a wider audience is of interest because it can serve as an indicator of the quality of the application from the user group's perspective.

### 5.3 Construction of research questions

Using the findings from chapter 2, the measurement of the effectiveness of the application can be predicted by analysis of the user's optimism level. Self-efficacy is also to be examined because it will be used as a predictor to determine how confident the user is that they can achieve their goals. These two predictors will determine how effective the application is in supporting the user towards a more positive attitude. In chapter 2, the temporal element of optimism was briefly discussed. This temporal element will be accounted for in the experiment by the creation of research questions that span a period of time for the measurement of optimism and self-efficacy respectively.

This led to the creation of the following research questions:

- **RQ1:** How does a user's optimism shift over the period of a week when using the application?

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- **RQ2:** How does the user's self-efficacy shift over the period of a week when using the application?

As for the usability of the application and its feedback, the following research questions will be investigated:

- **RQ3:** How do the participants rate the usability of the designed application?
- **RQ4:** Would participants recommend the system to others?

## **5.4 Methodology and design of the experiment**

A field study was chosen as the experimental setup because it provided a sense of realism for the evaluation of the application. Realism is preferable in this evaluation because the purpose of this research is to determine how effective the application is within its context of use. If a controlled study were to be conducted, the captured context of use would be poor because it would be tightly controlled (Rogers, Sharp and Preece, 2011).

### **5.4.1 Participant selection and ethical considerations**

The participants chosen for this experiment were the same group of sampled participants from prior chapters: a sampled population ( $N = 7$ ) of adults in the age group 18-25. It was initially thought that since this group contributed greatly to the design of the system, it would be appropriate to determine the effectiveness of the application and its usability in the hands of these users.

However, this sampled population poses a risk to the experiment because participants evaluating the application may have preconceived biases about the application as they have been exposed to its design and how it will work.

In addition, one of the participants involved in the requirements elicitation and the design of the application was unable to take part in the experiment, therefore another individual in the demographic group was recruited. This limited the effects of knowledge bias but should be discussed as a limitation of the experiment.

As for the ethics in this experiment, an information sheet was issued to participants. It detailed the experimental procedure and what data would be taken from participants. As mentioned in chapter 3, all the research in this study has undergone investigation to ensure it has met ethical standards and the consent form covers all the studies that involve stakeholders, therefore, only an information sheet and an initial communication had to be distributed to participants. These can be viewed in Appendix E1 and Appendix E2 respectively.

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### **5.4.2 Measurement of the effectiveness of the application**

It remains to be answered how the posed research questions will be measured. This section will describe how each of the research questions can be quantitatively measured.

#### **RQ1: Measurement of optimism**

To investigate RQ1, the Life Orientation Test-Revised (LOT-R) will be distributed to participants before and after using the application for a period of a week. In chapter 2, the LOT-R was found to be an exceptional empirical scale that could accurately capture one's overall optimism at a point in time. Comparing two LOT-R results can help ascertain how a participant's optimism level has shifted over time (Appendix E3).

#### **RQ2: Measurement of self-efficacy**

To investigate RQ2, the New General Self-Efficacy (NGSE) scale will be distributed to participants before and after using the application for a period of a week. The NGSE scale consists of eight items that are scored on a five-point Likert scale from strongly disagree to strongly agree. The scale is appropriate for use because it can be widely adopted to suit different tasks, it has been shown to be theoretically grounded, and is internally consistent and stable over time. (Appendix E4).

#### **RQ3: Measurement of usability**

To investigate RQ3, the usability of the application needs to be analyzed. The System Usability Scale (SUS) provides a valid and high-level overview of the subjective usability (Brooke, 2013). This scale is comprised of 10 statements that are scored on a 5-point Likert scale from strongly disagree to strongly agree (Brooke, 2013). Statements within the SUS are arranged in an alternating fashion such that a positively worded statement is followed by a negatively worded statement. Responses from this scale are then converted into a score that gives an indicative figure of the usability of the system. (Appendix E5).

#### **RQ4: Measurement of recommendation**

To investigate RQ4, a subjective question that asked users if they would recommend the application to other individuals was used at the very bottom of the SUS. This specific question was chosen because it can estimate a quantitative value of how much a user would recommend the application to another person, ranked from 0 to 10.

Having introduced the measures of the experiment, the following independent and dependent variables are to be examined.

### Independent variables

- Period of time (number of days using the system)

### Dependent variables

- Raw LOT-R score (before and after the period of a week)
- Raw NGSE score (before and after the period of a week)
- Usability score from the SUS (only used after the period of a week)
- Level of recommendation asked after the SUS questions (only used after the period of a week)

#### 5.4.3 Experimental setup

This experiment will take place on the user's laptop. It has been designed such that the application will be distributed to the participant for a period of a week. This experiment will adhere to a within-participant design as all the participants will have to engage with all of the tasks within the experiment. The experiment is split into three stages over the course of a week: day one, days two to six, and day seven. These stages are outlined below:

##### 1. Pre-day one

The effectiveness of the application is one of the main aims of this project. The results will determine if this application was effective in helping the user cultivate or maintain a positive attitude, thus adding to the literature about persuasive systems in the domain of healthy behaviors.

##### 2. Day one

The application usability measure can capture user satisfaction, effectiveness, and the efficacy of the designed application. This will provide an indication of how well the application is designed for the user group and how it is accepted by the user group.

##### 3. Days two to six

Feedback about the application is of importance. This is because it can serve as an indicator that supports the efficacy of the application. Within feedback, the dimension of whether the application is recommended to a wider audience is of interest because it can serve as an indicator of the quality of the application from the user group's perspective.

##### 4. Days seven

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Participants will need to complete the LOT-R scale, the NGSE, and the SUS followed by the additional question about the value of the application.

On completion of the experiment, participants will then be sent a debrief thanking them for their participation. This debrief can be viewed in Appendix E6.

### 5.4.4 Threats to validity

The threats to the internal and external validity of this experimental procedure need to be addressed.

#### Confounding variables

Due to the nature of the field study, there will be confounding variables in the experiment. Not all of them can be controlled, for example, the external factors that affect one's life. However, the variables with respect to the application and its usage can and will be controlled in the experiment:

- **Device used:** The mobile phone simulator on Figma will display the application on the same device for all participants regardless of their physical computer.
- **Instruction sheet:** All of the participants will receive the same instructions on how to conduct the experiment.
- **Briefing and debriefing:** All of the participants will receive the same email communications regarding the experiment.
- **Number of days interacting with the application:** All of the participants will be subject to the same amount of app usage time.

One limitation with this experiment is that it cannot control external variables such as the events of a participant's life at the particular time of testing. This will pose a limitation to the validity of the results gathered about the changes in optimism and self-efficacy that a participant experiences over the period of a week, therefore, this will be discussed further in the limitations section of the experiment in the next chapter.

#### Participant fatigue

Another risk posed in this research is that the quality of participant responses may decline over the series of surveys. In this research, participants will complete these in their own time so short questionnaires were chosen intentionally to mitigate participant fatigue. It is estimated that it will take 15 minutes to work through the exercises in the application to minimize participant fatigue.

#### Training effects and misunderstanding instructions

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Participants will not have any experience when they receive the application, and their unfamiliarity with it may affect the quality of the results. A pilot study ( $N = 1$ ) was conducted to determine if the participants would need to be trained to use the app and if the instructions were clear enough. The conclusion from this pilot study indicated that there was no training needed. To account for instances in which a participant would experience difficulty, contact details were provided so that participants could ask about anything they were unsure of.

### **Self-selection bias**

One threat to the external validity of this experiment is that the participants were selected through non-probabilistic sampling which may result in participants with certain traits taking part in the experiment. This will then bias the results. The screening questionnaire distributed to participants ensured that this was reduced by determining if a participant was biased towards wanting to be more optimistic before being involved in the research.

### **Social desirability bias**

Another threat in the domain of participant selection is that there is the possibility that the participants for this experiment will not answer questions because they are eager to please. It is therefore important to express to participants that honest responses are valuable for the validity of the experiment.

### **Participant communication**

There is a possibility that participant communication can have an influence on the results obtained, therefore, affecting both the external and internal validity of the experiment. This threat is dealt with by BCCing emails to participants, so that they are unaware of the other participants in this study.

### **Participant dropout**

In this research, participants are given the opportunity to drop out of the experiment. Indeed, one participant was unable to take part in the evaluation phase of this project, potentially having an effect on the overall results. It is important to acknowledge participant dropout as a limitation of the experiment.

### **Hawthorne effect**

The final risk to be addressed is the Hawthorne effect: that participants knowing they are being observed, could alter their behavior, having an effect on the internal validity of the experiment. This experiment takes place over a longer period of time (longitudinal study); hence it deals with the threat by reducing participant's feelings that they are being observed.

## 5.5 Hypotheses

With the discussion of formal measurements and the experiment design, hypotheses about the research questions can be formulated.

**H1:** Participant LOT-R scores will be significantly higher after using the application compared to the period before using the application.

**H2:** Participant self-efficacy scores will be significantly higher after using the application compared to the period before using the application.

**H3:** The average of the SUS score will be beyond the standard average of the SUS score (a mean greater than 68).

**H4:** The average response to the recommendation question posed will be beyond 5.

In response to the formulated hypotheses, the null hypotheses for this experiment are as follows:

**NH1:** There is no difference between the LOT-R score before and after using the application.

**NH2:** There is no difference between the self-efficacy score before and after using the application.

There is no hypothesis for RQ3 and RQ4 because the hypothesis is not about statistical differences.

## 5.6 Summary

This chapter has discussed an experiment to determine the effectiveness and the efficacy of the designed application. With the aims of this research discussed, the foundations were laid for the methodology and the design of the experiment. This design included the measurements and the procedures of the experiment. There were threats to the internal and external validity of the gathered results. These threats were addressed and mitigated. The main hypotheses of the experiment were then listed along with the null hypotheses.

## Chapter 6

# Results

The previous chapter described an experimental procedure to investigate the effectiveness of the designed application, the usability of its interface, and to receive feedback about it. This chapter will analyze the collected results of the study and will present the main findings to address the posed research questions and hypotheses that were formulated in the previous chapter.

### 6.1 Analysis of results

All the participants ( $N = 7$ ) successfully completed the experiment with little to no difficulty encountered. Minor difficulties arose because participants were not familiar with how to run the prototype on the Figma website. A screenshot of the location of the button to launch the prototype was sent to participants to ease this difficulty. Participants did not use the daily reminder function either as they were confident in their own ability to remind themselves to use the application, therefore, trust was placed in the stakeholders to be truthful in the experiment.

The investigations that involved the changes in optimism and self-efficacy used a paired t-test. A paired t-test was appropriate for these investigations because, within the experiment, there were two means corresponding to two-time intervals for each participant. The investigations that dealt with the perceived usability and the feedback about the application made use of descriptive statistics as only the averages of the data are needed.

#### 6.1.1 H1: Increases in optimism

The pre-app usage and post-app usage LOT-R scores were calculated for each of the participants. The LOT-R scores are split into three: scores of 0 to 13 indicate a high level of pessimism, scores of 14 to 18 indicate moderate optimism, and scores

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of 19 to 24 indicate a high level of optimism (Celestine, 14th March 2021). Using these distinctions and in Table 6.1 below it is observed that three of the participants started from a high level of pessimism, while three of the participants were initially measured to have a moderate level of optimism. Only one participant initially exhibited a high level of optimism. After the period of using the application, only one of the participants did not observe any changes to their optimism level. Furthermore, three participants managed to attain a higher level of optimism. Whether these changes are a coincidence or not, needs to be examined.

Table 6.1: Participant optimism levels before and after the period of a week.

Participant number	Baseline LOT-score of 24	Post application usage LOT-R score out of 24
1	9	18
2	9	15
3	8	9
4	15	19
5	19	23
6	16	16
7	17	18

A paired t-test was applied to the set of LOT-R scores to determine if there was any significant increase between the pre-app usage scores and post-app usage scores. It is conveyed below in Figure 6.1 and Table 6.2 that there indeed was a significant increase between the pre-app usage ( $M = 13.286$ ,  $SD = 4.499$ ,  $SE = 1.700$ ) and the post-app usage ( $M = 16.857$ ,  $SD = 4.298$ ,  $SE = 1.625$ ) LOT-R scores where  $t(7) = -2.946$  and  $p = 0.013$  – lower than the 0.05 significance level. It is concluded that the null hypothesis  $NH_1$  is rejected and this provides a greater certainty that  $H_1$  is supported.

Table 6.2: Quantitative significant difference for the change of optimism.

Paired Samples T-Test

		t	df	p	
LOT-R score pre	-	LOT-R score post	-2.946	6	0.013

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## Descriptives Plot

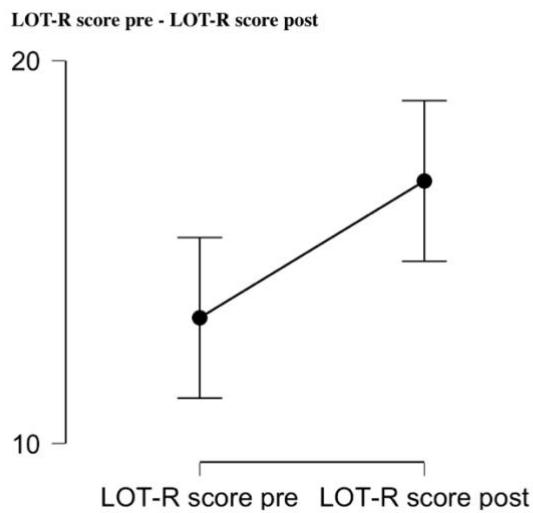


Figure 6.1: Visualization of the significance in the change of optimism.

### 6.1.2 H2: Increases in self-efficacy

Table 6.3: Participant self-efficacy levels before and after the period of a week.

Participant number	Base level self-efficacy score out of 5	Post application usage self-efficacy score out of 5
1	3.5	4
2	3.375	4
3	3.625	4
4	4.375	5
5	4.375	4.625
6	2.5	3.625
7	3.5	4.125

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Table 6.4: Quantitative significant difference for the change of self-efficacy.

Paired Samples T-Test

		t	df	p
NGSE score pre	-	NGSE score post	-5.632	6 < .001

The next hypothesis to be examined is whether there is a significant increase in NGSE scores between the pre-app usage scores and the post-app usage scores. Table 6.3 (above) indicates that there is an increase in NGSE scores for all the participants post-app usage. Similar to the analysis of H1, to determine if there is a significant increase in NGSE scores, a paired t-test was applied to the dataset. The results in Figure 6.2 below, and Table 6.4 above show that there was an increase between participant pre-app usage ( $M = 3.607$ ,  $SD = 0.643$ ,  $SE = 0.243$ ) and the post-app usage ( $M = 4.196$ ,  $SD = 0.461$ ,  $SE = 0.174$ ) NGSE scores where  $t(7) = -5.632$  and  $p < .001$ , again lower than the 0.05 significance level. Therefore, the null hypothesis NH2 is rejected and there is convincing evidence that H2 is supported.

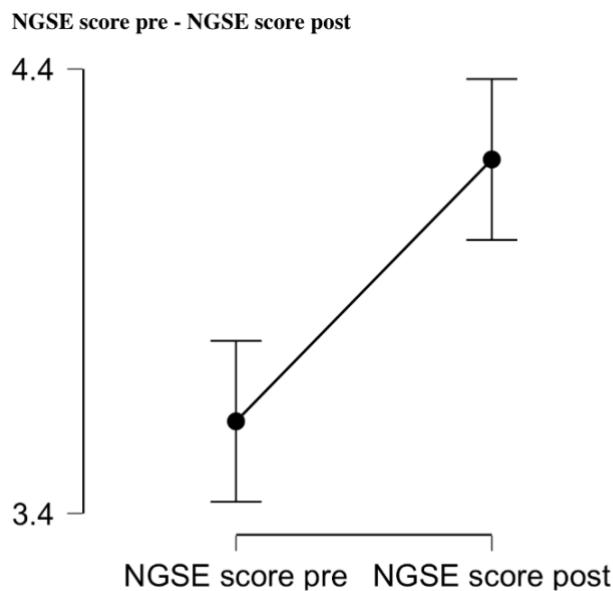


Figure 6.2: Visualization of the significance in the change of self-efficacy.

Given that there is evidence that supports H1 and H2, this suggests that the application is effective to a certain extent in helping the sampled population cultivate or maintain a positive attitude.

### 6.1.3 H3: Usability of the application

As discussed in the last chapter, the SUS was used to quantitatively measure the subjective usability of the application. The SUS scores were calculated for each participant and averaged. The average usability of the system amongst the sampled population was 83.214 ( $SD = 10.177$ ). Table 6.5 highlights this information and Figure 6.3 visualizes the data. Both are displayed below. The recorded mean of its usability is above the average SUS score (68), hence there is evidence that H3 is supported. H3 can be supported further by comparing this designed system with other optimism intervention systems to determine where this application stands in terms of its usability. For now, however, the SUS will suffice.

Table 6.5: Quantitative descriptor of the sampled population's SUS scores

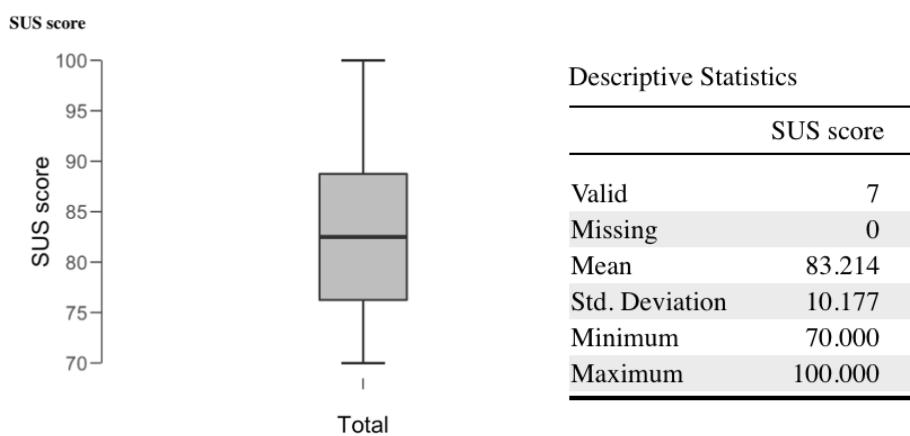


Figure 6.3: Visualization of the characteristics of the sampled population SUS scores.

This result indicates that the design of the application is suited towards the sampled population in terms of satisfaction, enjoyment, and efficacy.

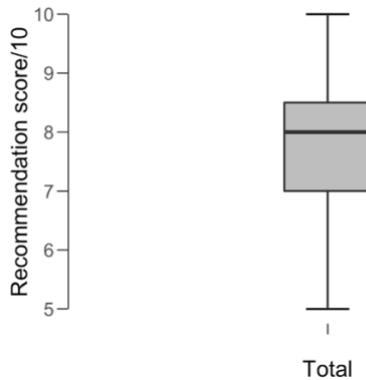
### 6.1.4 H4: Recommendation of the application

The final hypothesis to examine is how much one would recommend the application to others. The previous chapter mentioned that this would be examined by adding a follow-up question at the end of the SUS that asked the user how much they would recommend the application to another person on a scale of 10. The average score for this question amongst the participant group was 7.714 ( $SD = 1.704$ ). The results can be observed in Table 6.6 and Figure 6.4 below. The average responses to the question were above 5, therefore providing evidence that H4 is supported. The analyzed metric provides a very brief measure of how much one is willing to

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recommend the system to a wider audience.

Table 6.6: Quantitative descriptor of the sampled population's recommendation scores.



Recommendation score/10	
Valid	7
Missing	1
Mean	7.714
Std. Deviation	1.704
Minimum	5.000
Maximum	10.000

Figure 6.4: Visualization of the sampled population recommendation scores.

## 6.2 Limitations of the study

Whilst measures were taken to mitigate the threats to the validity of the experiment, there were still limitations that need to be discussed alongside how future evaluation studies can overcome them.

### Participant selection

As mentioned in the prior chapter, participants from this experiment were non-probabilistically sampled. Although this threat to validity was mitigated in the previous chapter through the use of a screening questionnaire, the chosen participants still may have exhibited certain characteristics when compared to participants chosen through probabilistic sampling, for example, knowledge bias as discussed in the previous chapter. The results of this experiment are therefore prone to being less generalizable across the age range (18-25). Future studies that involve the evaluation of persuasive systems should ideally include a general population in the evaluation phase as this will increase the external validity of the results obtained.

### Honesty within the experiment

This experiment relied on participant honesty. Dishonesty may have arisen because there was no continuous communication with participants. Therefore, participant usage of the application was not monitored and the application usage may have been falsified. Future evaluation studies should take every measure to avoid participant dishonesty in longitudinal studies. One possible pathway to avoid

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participant dishonesty in future experiments would be to use a fully functional application that keeps logs about when the user has used the application.

Implicit observation without human intervention would mitigate the risk of the Hawthorne effect as well.

### **Participant dropout**

One of the participants in the experiment dropped out. Although a replacement was found, this could have had an effect on the results obtained as the replacement may have had different traits compared to the participant who dropped out. Future studies should therefore try to limit this occurrence.

### **Control over external variables**

Although an effort was taken to reduce confounding variables, due to the field study nature of this experiment, there was little that could be done to mitigate the effect of external confounding variables. This poses a threat to the internal validity of the hypotheses that investigated the changes of optimism and self-efficacy because they may have been affected by external factors. One such confounding variable is the user's circumstances during the course of the experiment. For example, before using the application, the participant may have been anxious about exams, whereas, when the second measure of LOT-R and NGSE scales was made, the participant may have finished with their exams. Hence, increases in optimism and in self-efficacy may have been attributed to their exams as opposed to the application.

If future studies were to be conducted, they would have to be more rigorous, possibly with normalization of measurements with respect to a baseline variable to account for the time of the experiment, or by designing a controlled experiment to provide further support for the hypotheses.

### **Duration of the study**

This study took place over a week and had the user interact with the application for a period of five days, due to time constraints. Considering the individual nature of optimism as introduced in chapter 2, different people may require different periods of time to change their level of optimism. This implies that multiple readings over a longer period of time about one's optimism and self-efficacy could result in more robust readings of any changes. Future researchers investigating measurements over time are therefore advised to collect more than two readings over a longer period.

### **The realism of the application**

This application used the Wizard of Oz approach to emulate a completed application, which meant that the realism of the experiment was affected because

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participants were not interacting with the final product. This may have affected the results of the usability of the application because participants could not fully experience it. If a future study were conducted with this system, it would be fully coded and then distributed to reflect a more accurate measure of its usability.

### 6.3 Implications of the findings

Whilst there is evidence that favors the effectiveness of the application in helping people to maintain and cultivate optimism over the period of five days as indicated by H1 and H2, NH1 and NH2 should not be ruled out as not statistically significant because of the limitations of the study. Nor should the application be considered effective across the whole population due to the narrow sample of participants. If statistical significance were to be determined, a more robust experimental procedure involving a larger sample population would have to be carried out.

The most promising statistic from this experiment with respect to the sampled population was the usability of the application. The results from the SUS provide convincing evidence that H3 is indeed supported. There was no comparison with another application in this study, thus, there was no need for the formulation of a null hypothesis. As for the feedback regarding the application, an indicative figure was calculated based on the one question asked and this provided evidence to accept H4. Though a brief measure, the implications of H4 support the conjecture that the app has a moderate to high level of efficacy associated with it.

While it cannot be concluded that the application is effective in the cultivation and the maintenance of optimism, despite supporting evidence within the sampled population, it can be concluded that the application is usable and it has a moderate efficacy because participants would recommend it to other individuals. This finding indicates that the developed application was successful in meeting the needs of the intended population, providing evidence that the formal design of a persuasive system in the domain of health behaviors in this particular instance was successful.

### 6.4 Summary

This chapter reported and analyzed the results of the experiment. Despite minor difficulties with the evaluation, all the experimental hypotheses were successfully analyzed. All the results provided evidence that the developed application has a moderate to high efficacy to an extent, this laid the foundation that the formal design of a persuasive system in the domain of health behaviors in the instance of optimism was successful. The next chapter will re-iterate and assess how well the objectives in the introductory chapter were met. It will then discuss how the findings in this chapter can impact the state of research of persuasive systems in this domain and the directions that future research can take in this domain.

## Chapter 7

# Conclusions

With the analysis of the evaluation in the previous chapter completed, this chapter will conclude the project by firstly examining its achievements with relation to the objectives set in the introductory chapter. This chapter then discusses the contributions of this project to the field. Attention is then drawn to the limitations of the project and the possible directions that future research can take beyond its scope.

### 7.1 Achievements of objectives

This project addressed the lack of examination of the efficacy of persuasive systems in the domain of health behaviors by the development and evaluation of a persuasive optimistic intervention system. It is believed that this research will contribute to the literature about the efficacy of systems in the domain of health behaviors and will provide more information about the formal design and development of a persuasive system. This section will re-iterate the objectives of the project and examine how well these objectives have been met.

This project comprised the overarching aim of the development and evaluation of a persuasive system in the domain of health behaviors; with particular emphasis placed upon the cultivation and maintenance of a positive attitude. In chapter 1, the following objectives to achieve these aims was devised:

1. Define the concept of optimism and the different types of optimism.

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2. Study behavioral theories that are related to the concept of optimism to understand what factors contribute to aiding and maintaining behavioral change.
3. Understand how optimism is cultivated to aid the creation of strategies to be used within the system.
4. Explore how optimism is measured to inform the evaluation of the completed system.
5. Investigate existing frameworks to develop persuasive technology and look at some examples of persuasive technology systems to gain an insight into what procedures and techniques make a persuasive technology system successful.
6. Design and develop a persuasive application with the aid of stakeholders.
7. Evaluate the developed system and document its efficacy.

To accomplish the first objective, literature in the domain of psychology was relied upon to gain an accurate understanding of optimism and the terminologies used to discuss and measure it. Optimism for the purposes of this research was defined as an association with a variable expectation or an outlook that relates to a desirable reality that is realistic and socially desirable. It was found that there are two modalities that measure optimism: dispositional optimism and explanatory style optimism (Dobson and Dozois, 2008). Equally important to consider within optimism was the concept of pessimism it was discovered that there may exist traces of pessimism in optimistic individuals (Peterson, 2000). Big optimism and little optimism provided a vocabulary to express the specificity of optimism, while reality bias optimism was found to be an objective and realistic viewpoint of optimism. The first objective was met.

The second objective was approached by the consideration of the concept of self-efficacy. This concept was found to indeed be a behavioral theory that met the requirement of being closely related to optimism. The factors within self-efficacy that were found to maintain behavioral change were one's internal beliefs about the maintenance of a behavior (efficacy expectation) (Bandura, 1977). Within efficacy expectation, there were four ways to support it: performance accomplishments, vicarious experiences, verbal persuasion, and emotional arousal (Bandura, 1977). This knowledge ensured that the system would consider self-efficacy to support the change towards a more positive attitude.

The third objective was met with success by the examination of Cognitive Behavioural Therapy (CBT) as a means of supporting the cultivation of optimism. CBT comprises of activities that firstly face internal thoughts (idiosyncratic thoughts) and then objectify those thoughts (distancing) (Beck, 1970). This approach has found to be a method to objectify positive and negative thoughts, and it is suggested

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that it is an effective strategy for dealing with low optimism (Hofmann et al., 2012).

The fourth objective involved the analyzes of the modalities of measuring optimism. As this was an empirical setting, it was decided to measure optimism by estimating one's dispositional optimism because explanatory style corresponds to other concepts outside of optimism which meant that it had a dubious internal consistency (Peterson, 2000). LOT-R was found to be a suitable instrument to estimate dispositional optimism because of its many favorable traits such as its high internal reliability, high test-retest reliability, and length (Scheier, Carver and Bridges, 1994; Speight et al., 2007).

Literature about techniques for the development of persuasive systems as well as literature relating to the current technologies and research to develop technologies in the domain of mental health were examined to meet objective five. Through the comparison of different persuasive frameworks, it was decided to predominately design the system through the use of Persuasive System Design (PSD) due to its strong theoretical grounding and comprehensive requirement listings (Oinas-Kukkonen and Harjumaa, 2009). The study of current technology and research about persuasive systems in the domain of mental health provided common persuasive features to investigate, but the literature offers little evidence about the procedures and techniques that make a persuasive system successful.

Objective five was eventually fully accomplished alongside objectives six and seven. Through the target demographic of stakeholders, requirements about the system were elicited, non-functional requirements were formally documented, and a wireframe of the system was designed with the help of the material design specification (Google, n.d.). Despite the use of a wireframe, the evaluation of the application's efficacy and usability were able to take place. While the null hypothesis regarding the efficacy cannot be rejected at this stage, possibly the most significant finding was that of the usability and the feedback given about the application. These statistics revealed that the designed application was usable by the intended population and the application received moderately encouraging feedback suggesting the application would be recommended to another user. All these findings together reveal that the application contains some efficacy. This indicates that participatory design and formal design procedures make a persuasive technology system successful.

## 7.2 Summary of contributions

Apart from meeting the research aims and objectives, this project provides the following contributions to the domain of persuasive technology research.

- This research has added to the current evidence pool that supports the need for formal persuasive frameworks to develop persuasive systems that exhibit

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moderate to high efficacy amongst a demographic.

- Whilst PSD is a tool for the development of system features that support the effectiveness of a system, this project suggests that formal design techniques and stakeholder interaction throughout the system lifecycle are important to consider because they provide evidence that the designed system is suitable for the needs of the target demographic, is usable by the target demographic, whilst being theoretically grounded.
- This research provides practitioners and researchers with a framework to develop and evaluate an optimistic intervention system coupled with the use of persuasive technology.
- This project can be extended past a framework for optimistic intervention systems and generalized for the design and development of persuasive systems in general. Using the steps taken in this paper, formal steps in the development of a persuasive system can be listed as follows:
  1. Understand the domain of the behavior change that is of interest.
  2. Gain an understanding of the behavioral theories that underpin the intended behavioral change.
  3. Choose a persuasive framework by comparing persuasive frameworks and choosing an appropriate one that suits the researcher or practitioner's requirements.
  4. Involve stakeholders to gain an understanding of their needs, such that these needs can be translated into system features depending on the chosen persuasive framework and the knowledge of the behavioral change.
  5. Choose a suitable design strategy. It is up to the researcher or practitioner how many iterations are made but stakeholders should be involved in every iteration.
  6. Transform designs into code.
  7. Evaluate the code.

The procedures in this project used the waterfall approach to develop the persuasive system. The above framework could perhaps be adapted to suit an agile methodology by having steps four, five, and six incrementally build-up system features.

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Steps one to three should be sequential because they will ensure that the researcher or practitioner is equipped with the domain knowledge and persuasive strategies before undertaking the development of the system.

### 7.3 Project limitations

The main limitations of this project lay within the evaluation section. Due to a small and narrow sample of participants, evidence of the efficacy of the application needs to be explored with a wider population to produce more conclusive results. Furthermore, a more robust study needs to be performed to gain more concrete evidence about the app as there were external effects to the field study performed which may have skewed results.

Another limitation with this project is that the developed system was a high-fidelity wireframe as opposed to a fully coded application. This meant that the realism of the application usage was possibly affected. Further studies need to be conducted on the fully functional system for more conclusive results as well. More limitations related to the experiment are discussed in section 6.4.

In the requirements elicitation section, it is possible that not all the stakeholder needs have been met regarding their needs. This research tried to provide a balanced approach towards stakeholder needs and the elicited requirements of the system but may have inadvertently left some of the stakeholder needs out. If this research was to be continued, an approach to systematically balance stakeholder needs would be applied.

The final limitation of this project is that the design of the application was confined to look like a Google application because of the use of the material design specification. If this research were to be continued, alternative designs would be studied to enable the application to be differentiated.

### 7.4 Future directions

Having covered the limitations of this research, attention is turned to possible directions for future research.

**More research about the efficacy of persuasive systems in the domain of health behaviors:** More research is needed to provide more evidence of their efficacy. This statement applies specifically to the efficacy of persuasive optimistic intervention systems.

**More evidence to support the use of persuasive system frameworks coupled with participatory design and formal design techniques:** More research is needed to determine this is actually a useful approach by comparing a persuasive system

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developed with a persuasive system design framework utilizing design techniques that are not from a formal specification and without stakeholder interaction versus another system developed with a persuasive system design framework coupled with stakeholder interaction and formal design techniques.

**Determine the length of an attitude adoption:** Little attention was paid to how long a shift in attitude would remain once it has been acquired. Future research can explore this further.

**Creation of an optimism intervention system using Social Support:** Within this project, the chosen persuasive features from the PSD did not include social support. Further research can explore its usage in a persuasive optimistic intervention system and how it affects the efficacy of the system compared to another PSD without social support.

## 7.5 Closing remarks

This research intended to add to the literature about the efficacy of applications using persuasive technology to address issues in the health behavior domain. From the literature, a formal persuasive framework and knowledge about the domain of optimism provided direction to design and develop a system. Interaction with stakeholders served as an indicator that the system would meet user needs. This assumption was tested in a field study. Whilst the results gathered about the efficacy of the developed application suggest further research, evidence from the experiment provides some support for the efficacy of this system.

Furthermore, the formal design procedures taken to develop this system were found to be applicable to other persuasive systems of a similar nature. This resulted in a generalized framework that can be of use to practitioners and researchers, although more evidence is required to support this.

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## **Appendix A**

### **Ethical documentation for research**

**Please refer to the next page for the 12-point ethics form**

## A1 12-point ethics checklist

 UNIVERSITY OF <b>BATH</b>	<b>Department of Computer Science</b> 12-Point Ethics Checklist for UG and MSc Projects
Student	— Alexander Ito - Low Year 3
Academic Year or Project Title	
Supervisor	— Dr. John Benardis

*Does your project involve people for the collection of data other than you and your supervisor(s)?*

**YES / NO**

If the answer to the previous question is YES, you need to answer the following questions, otherwise you can ignore them.

This document describes the 12 issues that need to be considered carefully before students or staff involve other people ('participants' or 'volunteers') for the collection of information as part of their project or research. Replace the text beneath each question with a statement of how you address the issue in your project.

1. *Will you prepare a Participant Information Sheet for volunteers?*

**YES / NO**

Participants will be sent a digital information sheet with all of the necessary information: information about what the study will involve, and the sender's contact information. This will be sent together with a consent form.

2. *Will the participants be informed that they could withdraw at any time?*

**YES / NO**

All participants will be given the ability to withdraw at any time throughout the study. This will be made clear in the information form. Participant data will be erased if the participant withdraws from the study.

Figure A1: 12-point ethics form questions 1 to 2.

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3. ***Will there be any intentional deception of the participants?*** YES / NO  
All intentions of the study will be made clear before the study. There will be disclaimers in the study stating that the product will not make them more positive. Not attempt to cure. Its use as a supplementary tool.
4. ***Will participants be de-briefed?*** YES / NO  
Participants will be sent an a debrief document after the study has taken place. This will remind them about the nature of the study and how they can receive the conclusions for the study if they are interested. Contact details will be included as part of the debrief.
5. ***Will participants voluntarily give informed consent?*** YES / NO  
Participants will be issued a consent form and before taking part, they must complete it. The consent form is attached alongside the information sheet. This consent form includes participant signatures to ensure that they agreed to the terms of the studies being issued.
6. ***Will the participants be exposed to any risks greater than those encountered in their normal work life (e.g., through the use of non-standard equipment)?*** YES / NO  
Participants have been informed that this study may involve sensitive elements (especially questions). These questions are not meant to be thought provoking hence their risk is not greater than the risks encountered in everyday life.
7. ***Will you be offering any incentive to the participants?*** YES / NO  
No incentives have been used only voluntary participation. Participants will be thanked for their voluntary participation.
8. ***Will you be in a position of authority or influence over any of your participants?*** YES / NO  
All participants will be treated as equals and will have the right to express their views at any time within the study. I will only act as a questioner in the research studies. Hence, the position of authority does not pressurise participants to take part in, remain in, any experiment.

Figure A2: 12-point ethics form questions 3 to 8.

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9. ***Will any of your participants be under the age of 16?*** YES / NO

All participants will be over the age of 16. This will be ensured through a pre-screening questionnaire.

10. ***Will any of your participants have an impairment that will limit Their understanding or communication?*** YES / NO

A screening questionnaire will be issued to participants to ensure that participants with impairments are not included within the study.

11. ***Will the participants be informed of your contact details?*** YES / NO

I have enclosed my email address within the information sheet and the consent forms

12. ***Will you have a data management plan for all recorded data?*** YES / NO

Personal data is anything which could be used to identify a person, or which can be related to an identifiable person. All personal data (hard copy and/or soft copy) should be anonymized (with the exception of consent forms) and stored securely on university servers (not the cloud).

I have a data management plan in place. It has been attached within the ethics forms I have submitted. A summary of which has been given below:

Due to the collection of sensitive data within this project that associates with another person. Participants will be allocated a number in order to anonymise them. Data related to this code will be stored on a secure file on the bath.h file system for the duration of this project with participant consent. This will ensure that data is backed up and protected. If the data does need to move off of the bath.h file system, it will be stored on a password protected system. All of the data will be deleted upon the acquisition of the degree.

Figure A3: 12-point ethics form questions nine to 12.

## A2 Screening questionnaire

### Screening Questionnaire

Thank you for your interest in this research. In order to ensure that ethics are taken into consideration, **Please answer the following questions based on your knowledge**

- |  | <b>Yes</b>               | <b>No</b>                |
|--|--------------------------|--------------------------|
| 1. I am in the age group 18- 25 years old?   | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. I do not have an impairment that limits my understanding/communication  | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. I have not been diagnosed with or am suffering from any mental health problems such as depression, general anxiety disorder or a stress disorder. | <input type="checkbox"/> | <input type="checkbox"/> |
| 4. I would like to develop coping strategies around pessimistic thoughts.  | <input type="checkbox"/> | <input type="checkbox"/> |
| 5. Please select a value from 1 to 5 by checking a box to the following:<br>I would like to adopt a more positive outlook for my life                |                          |                          |

1.      2.      3.      4.      5.  
Strongly disagree              Strongly agree

### **Signatures (Can be digitally signed)**

---

Name of participant [IN BLOCK LETTERS]

Signature

---

Date

## A3 Participant consent form

### Participation in study consent form

Please answer the following questions based on your knowledge

**Do you confirm that you:**

- have filled out the screening questionnaire to the best of your knowledge?

Yes  No

**Have you:**

- I have been provided with information explaining what participation in this project involves ?

- had the opportunity to ask questions and discuss this study ?

- received satisfactory answers to all the questions you asked ?

- received enough information about the study for you to make a decision about your participation ?

**Do you understand:**

That you are free to withdraw from the study and free to withdraw your data prior to anonymisation

- at any time

- without having to give a reason for withdrawing?

**Are you alright with:**

- Being Audio recorded

- Me taking notes of what you are saying

**Do you acknowledge:**

- that summarised results of the anonymised studies will be presented

In my dissertation

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- that your transcripts of my anonymised notes during studies may be  
quoted in the dissertation
- that your data will be stored on the University of Baths' H drive until the  
acquisition of the degree
- that your data will be shared with my supervisor, Mr. John Benardis.

### **I hereby fully consent to my participation in this study**

I understand the nature and the purpose of the procedures involved in this study. These have been communicated with me on the information sheet accompanying this form.

I understand and acknowledge that the investigation is designed to promote scientific knowledge and that the researcher from the University of Bath will use the data I provide for no purpose other than research.

I understand that the data I provide will be kept **confidential** and that on completion of this interview, my transcript will be anonymized by removing all links between my name or other identifying information and my study data. This will be done by the **30<sup>th</sup> of April 2021**, and before the presentation or publication of my data.

I understand and am aware about how my data will be stored and agree for my anonymized data to be stored on the University of Baths' file storage system.

I understand that my consent forms will be stored in a separate folder to my anonymized data on the University of Baths' file storage system

I am aware that all of my data and my consent forms will be deleted upon the researcher getting his degree.

I understand that the researcher will only **share** my anonymized data with his supervisor: Mr John Benardis

If you agree will all of the above, please sign below:

### **Signatures (Can be digitally signed)**

---

Name of participant [IN BLOCK LETTERS]

Signature

---

Date

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---

Name of researcher [IN CAPITALS]

Signature

---

Date

## Appendix B

### SRS

Please refer to the below key for the source of the requirements:

Lit: Literature

I: Interviewing stakeholders

O: Observation by researcher

The key below details the priority of the elicited requirements:

“Must” – High priority requirements

“Should” – Medium to high priority requirements

“Could” – Nice to have features that are low priority requirements

#### Functional requirements

#### **Hardware requirements:**

1. The application must be able to run on a mobile device. Source: Lit (Fogg, 2009) and I.
2. The application should run on android phones. Source: Lit (Fogg, 2009) and I.
3. The application should run on IOS phones. Source: Lit (Fogg, 2009) and I.
4. The application could run on tablets. Source: Lit (Fogg, 2009) and O

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### **General features:**

1. The application must allow the user to log in using a username and password. Sources: O and I.
2. The application should offer password retrieval. Source: O.
3. The application must support the sign-up for an account. Source: O.
4. The application must handle incorrect login credentials by displaying an error message to the user. Source: O.
5. The application should support the deletion of a user's account. Source: O.
6. The application should allow the user to stay logged into their account if they do not close their application. Source: O.
7. The application must provide the user with a disclaimer saying: "This application aims to elicit optimistic behavior, therefore it should not act as a replacement for clinical practices or clinical practitioners". Source: Lit (Onias-Kukkonen, 2009).
8. The application should use shared preferences to store usernames and passwords. Source: O.

### **Choices for the strategies to aid the maintenance of optimism:**

1. The application must try to promote optimism through grounded strategies. Sources: Lit (Onias-Kukkonen, 2009) and I.
2. The application should promote optimism through the use of Cognitive Behavioural Therapy (CBT). Source: Lit (Forgeard and Seligman, 2012).
3. The application should include activities that encourage self-efficacy. Source: Lit (Bandura, 1977).
4. The cumulative duration of the chosen activities should be at most 20 minutes. Source: O.
5. The user should be asked questions to determine which activities will benefit them. Source: Lit (Onias-Kukkonen, 2009).
6. The questions that users are asked should link to the appropriate activity if the user gives an answer to the question that is considered pessimistic/having low confidence. Source: O.

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7. The questions users are asked should be created based on the new general self-efficacy scale and the LOT-R scale. Source: O.

### **Specific strategies used in this application:**

1. The application must use the immediate thought exercise to help users cultivate optimism. Sources: Lit (Selva, n.d.) and I.
2. The application must use SMART targets to help with self-efficacy. Sources: Lit (Mead, n.d.) and I.
3. The application should give users the choice of self-affirmation or role model inspiration to help self-efficacy. Sources: Lit (Catherine Moore, 2021; Chowdhury, 2021) and I.

### **Immediate thought exercise screen first page:**

1. The title of the activity must be displayed. Source: O.
2. The application should enable the user to choose when they last had a negative thought from a set of options. Source: Lit (Selva, n.d.).

### **Immediate thought exercise screen second page:**

1. The application must allow the user to input their negative thought into a text field  
Source: Lit (Selva, n.d.).
2. The user must be able to choose a value on a scale to determine how much they believe their negative thought. Source: Lit (Selva, n.d.).
3. The scale should have accompanying labels attached to it. Source: O.

### **Immediate thought exercise screen third page:**

1. The negative thought from the second page of the exercise should be displayed to the user. Source: O.
2. Below the displayed negative thought, the user must be able to choose from a list of options how the thought makes them feel. Source: Lit (Selva, n.d.).

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### **Immediate thought exercise screen fourth page:**

1. The application must allow the user to input the worst-case scenario for their negative thought into a text box. Sources: Source: Lit (Selva, n.d.).
2. The user must be able to choose a value on a scale to determine how much they think the negative scenario will happen. Sources: Source: Lit (Selva, n.d.).
3. The scale should have accompanying labels attached to it. Source: O and I

### **Immediate thought exercise screen fifth page:**

1. The application must allow the user to input the best-case scenario for their negative thought into a text box. Sources: Source: Lit (Selva, n.d.).
2. The user must be able to choose a value on a scale to determine how much they think the negative scenario will happen. Sources: Source: Lit (Selva, n.d.).
3. The scale should have accompanying labels attached to it. Source: O.

### **Immediate thought exercise screen sixth page:**

1. The application must ask the user where their beliefs lie regarding the 2 scenarios. Sources: Source: Lit (Selva, n.d.).
2. The user must be able to choose a value on a scale to determine how much they think the negative scenario will happen. Source: Lit (Selva, n.d.).
3. The scale should have accompanying labels attached to it. Source: O.

### **SMART Target first page:**

1. The concept of what a SMART target is should be explained to the user. Source: O.

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### **SMART Target second page:**

1. The user's best-case scenario for the negative thought must be displayed. Source: O.
2. Below the best-case scenario, the user must be able to type their SMART target to achieve the best-case scenario. Source: O.
3. On completion, the data of the user's SMART target should be sent to the SMART target page in the dashboard. Source: O.

### **Task 2 first page:**

1. The user should be able to choose between the self-affirmation exercise or the role model inspiration exercise. Source: Lit (Onias-Kukkonen, 2009).
2. Information should be provided for both of the options. Source: O.

### **Self-affirmation exercise first page:**

1. The user must be able to type 1 kind thing about themselves. Source: Lit (Catherine Moore, 2021).
2. The thing the user types about themselves should be sent to the positive messages page in the dashboard. Source: O.

### **Role model activity first page:**

1. The user should be able to type in a role model who they look up to. Source: Lit (Catherine Moore, 2021).

### **Role model activity second page:**

1. The user should see their role model's name. Source: O.
2. The user must be asked what their role model would say to them to boost their confidence. Source: Lit (Chowdhury, 2021).
3. Below, the user must be able to type in what they think their role model would say to them to boost confidence. Source: Lit (Chowdhury, 2021).
4. This should be sent to the positive messages page in the dashboard. Source: O.

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### **Feeling evaluation screen:**

1. Emotion options must be displayed to the user. Source O.
2. The user should be able to evaluate how they are feeling by being able to choose an option of the displayed emotions. Sources: O and I.
3. This should be sent to the mood graph. Sources: O, I and Lit (Onias-Kukkonen, 2009).
4. The user should then view a notification that indicates that they have completed their activities for the day. Source: O.

### **Finish screen:**

1. Upon clicking finish, the user should be given the option to schedule a reminder. Sources: I and Lit (Onias-Kukkonen, 2009).
  - 1.1 The reminder screen should contain options for how far in advance they would like to schedule their reminder. Sources: I and Lit (Onias-Kukkonen, 2009).
2. Upon completion the user should be directed to the dashboard. Source: O.

### **Features that are present throughout the whole application:**

1. Some of the text and text boxes should be decorated by imagery. Sources: Lit (Onias-Kukkonen, 2009) and I.
2. When the user is working through their optimism activities, there should be a progress indicator that details how far through the exercises an individual is. Source: Lit (Onias-Kukkonen, 2009).
3. There should be at least 1 screen that encourages the user by displaying an image that encourages the user to continue working through the activities. Source: O, Lit (Onias-Kukkonen, 2009), and I.
  - 3.1 These screens should have a written message below them. Source: O, Lit (Onias-Kukkonen, 2009), and I.

**Navigation layouts:**

1. The application should have its content displayed in the main dashboard.  
Source: O.
  - 1.1 Within the main dashboard, there should be a card that when clicked enables the user to go through the optimism activities. Source: O.
    - 1.1.1 On all of the optimism activity pages, there must be some form of next button. Source: O.
    - 1.1.2 On all of the optimism activity pages there must a back button for the user to navigate through the optimism activities. Source: O.
    - 1.1.3 Within the optimism activity pages, there should be a menu bar.  
Source: O.
    - 1.1.4 The menu bar should include the items of the main bar in the dashboard. Source: O.
    - 1.1.5 In addition, this menu bar should include a return to menu option.  
Source: O.
  - 1.2 Within the main dashboard, there should be a card where when clicked enables the user can view a graph of their mood. Source: O.
    - 1.2.1 This mood graph should be altered every time the participant lists down how they are feeling at the end of the optimism activities.  
Sources: O and Lit (Onias-Kukkonen, 2009).
  - 1.3 Within the main dashboard, there should be a card where when clicked enables the user to view the smart targets that they have set from the optimism activities. Source: O.
    - 1.3.1 The user should be able to delete a SMART Target. Source: O.
    - 1.3.2 The user should be able to edit a SMART Target. Source: O.
    - 1.3.3 There must be a menu bar on the viewing screen that enables back navigation. Source: O.
    - 1.3.4 The menu bar on the viewing screen should include a return to the menu option. Source: O.

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- 1.3.5 When clicked, the user should be returned to the dashboard. Source: O.
- 1.3.6 The menu bar in the SMART target screen should include all the functionality from the menu bar on the main screen. Source: O.
- 1.4 Within the main dashboard, there should be a card that when clicked, enables the user to view positive messages that they have set for themselves from the optimism activities. Source: O.
  - 1.4.1 The user should be able to delete positive messages. Source: O.
  - 1.4.2 The user should be able to edit positive messages. Source: O.
  - 1.4.3 The menu bar on the viewing screen should include a back button. Source: O.
  - 1.4.4 The menu bar on the viewing screen should include all the functionality from the menu bar on the main screen. Source: O.
- 1.5 The main dashboard must include a menu bar. Source: O.
  - 1.5.1 This menu bar should include a profile icon of the user. Source: Lit (Onias-Kukkonen, 2009).
  - 1.5.2 Alongside the profile icon of the user, the name of the user should be provided. Source: Lit (Onias-Kukkonen, 2009).
  - 1.5.3 This menu bar should include an option for the user to view the sources of the chosen optimism activities. Source: Lit (Onias-Kukkonen, 2009).
  - 1.5.4 This menu bar must include an option for the user to logout. Source: O.
  - 1.5.5 This menu bar must provide a seek help option. Source: O and Lit: (Onias-Kukkonen, 2009)
- 1.6 The main dashboard menu bar should have functionality. Source: O.
  - 1.6.1 When the user's name is clicked, the user could go to a profile page where they could edit their account. Source: O.

## Optimism and Pessimism: a case study

- 1.6.2 When the user clicks on the view sources of chosen optimism activities, they should be navigated to a page with the sources of all of the sources of the optimism activates alongside their titles.  
Source: O.
- 1.6.3 When the user clicks on log out, the system should log the user out of the application. Source: O.
- 1.6.4 When the user clicks on seek help, the user should be navigated to the contacts of the NHS and Samaritans. Source: O.

### **Non-functional requirements:**

1. The application should offer support for the user to work towards a more positive attitude. Source: (Onias-Kukkonen, 2009) and I.
  - 1.1 The application should aim to reduce the user's effort towards becoming more optimistic. Source: Lit (Onias-Kukkonen, 2009).
  - 1.2 The application should guide the users through the process of engaging with the optimism activities to cultivate/maintain an optimistic attitude. Source: Lit (Onias-Kukkonen, 2009).
  - 1.3 The application should provide tailored activities for users. Sources: Lit (Onias-Kukkonen, 2009).
  - 1.4 The application should offer personalized content to its users.  
Source: Lit (Onias-Kukkonen, 2009).
  - 1.5 The application should allow the user to track their mood.  
Sources: Lit (Onias- Kukkonen, 2009) and I.
2. The application should provide system feedback to its users. Sources: Lit (Onias- Kukkonen, 2009) and I
  - 2.1 The application should offer praise by words or images to the users as they are working towards a positive attitude. Sources: Lit (Onias- Kukkonen, 2009) and I.
  - 2.2 The application should remind users to return to the application to continue their journey towards a more optimistic attitude. Sources: Lit (Onias- Kukkonen, 2009) and I.
  - 2.3 The application should include visual metaphors that appeal to users.  
Sources Lit (Onias-Kukkonen, 2009) and I.

## Optimism and Pessimism: a case study

3. The application should be credible. Sources: Lit (Onias-Kukkonen, 2009) and I.
  - 3.1 The application should provide information about the source of the optimism exercises. Source: Lit (Onias-Kukkonen, 2009).
  - 3.2 The application should provide unbiased and truthful information that it may not work. Source: Lit (Onias-Kukkonen, 2009).
  - 3.3 The application should only contain relevant information for helping the user cultivate optimism. Source: Lit (Onias-Kukkonen, 2009).
  - 3.4 The system should quote authority such as the NHS and Samaritans if a user is feeling very negative. Source: Lit (Onias-Kukkonen, 2009).
4. The application in this project must not store any user data if it is in a non-finished state. Source: O.
5. If any data is stored by the application or the application is enhanced, it must comply with all of the GDPR regulations. Source Lit (bcs, 2019).

## Appendix C

### Design evidence

#### C1 First iteration design evidence

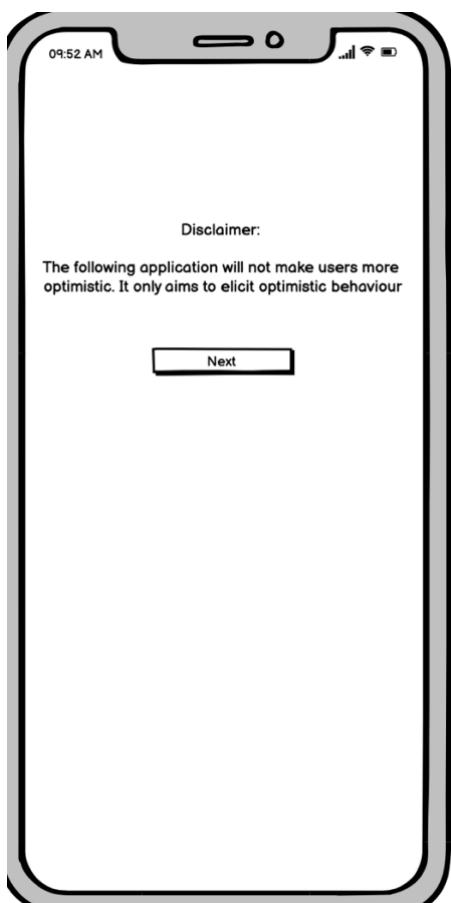


Figure C1: Disclaimer screen.

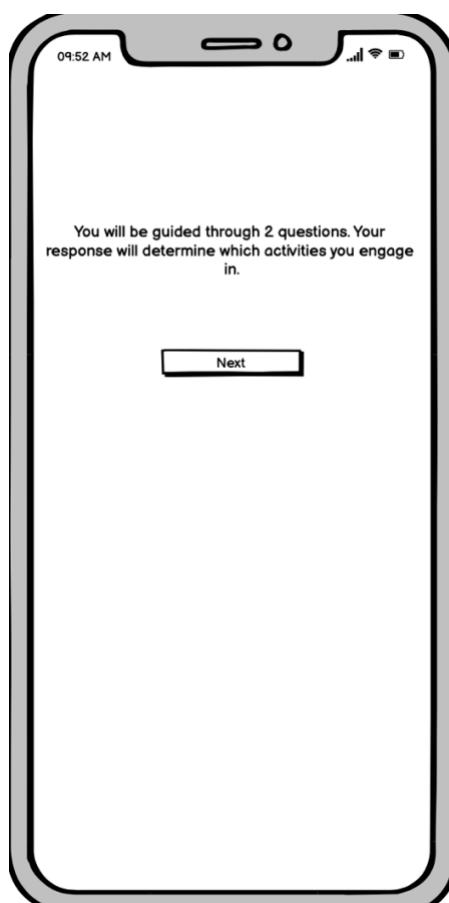


Figure C2: Basic information screen.

## Optimism and Pessimism: a case study

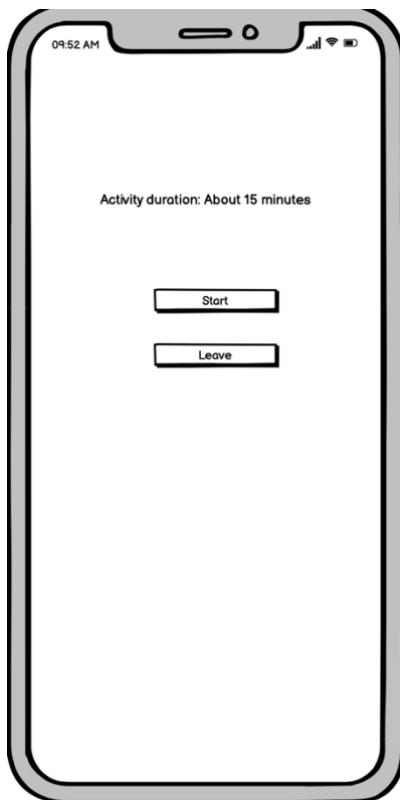


Figure C3: Dashboard.

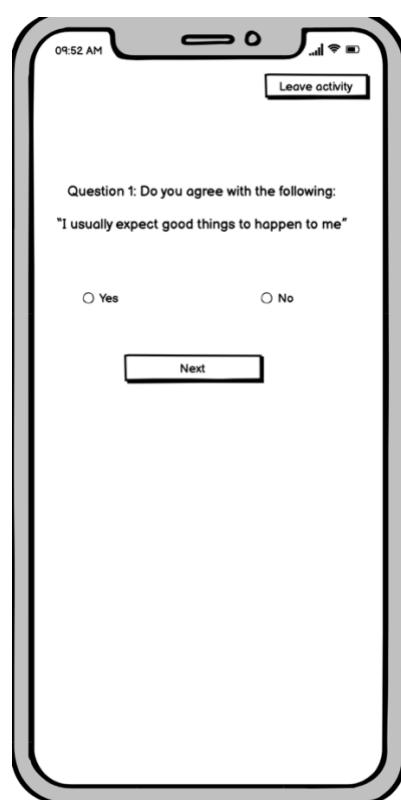


Figure C4: Optimism question.

## Optimism and Pessimism: a case study

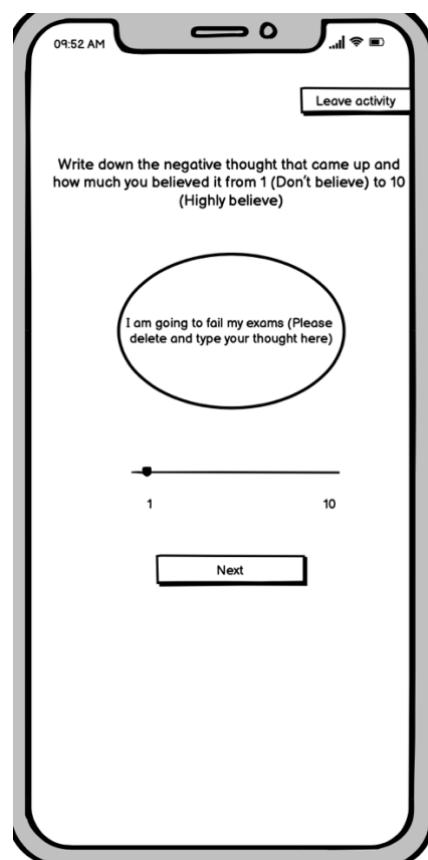
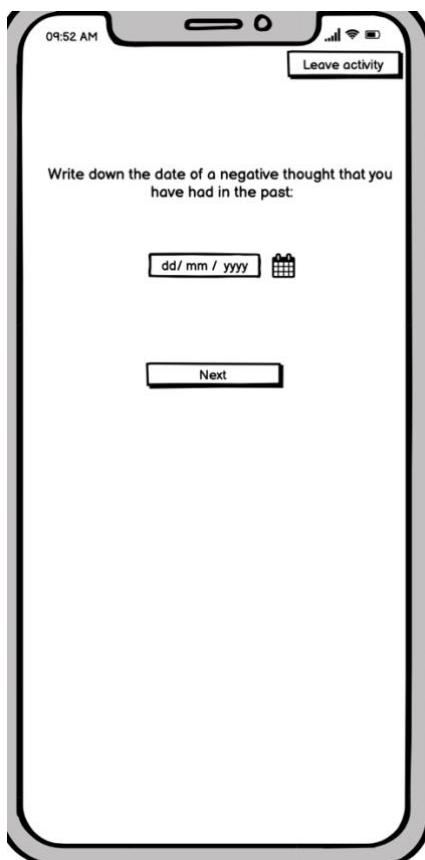


Figure C5: Date of last negative thought. Figure C6: Negative thought screen

## Optimism and Pessimism: a case study

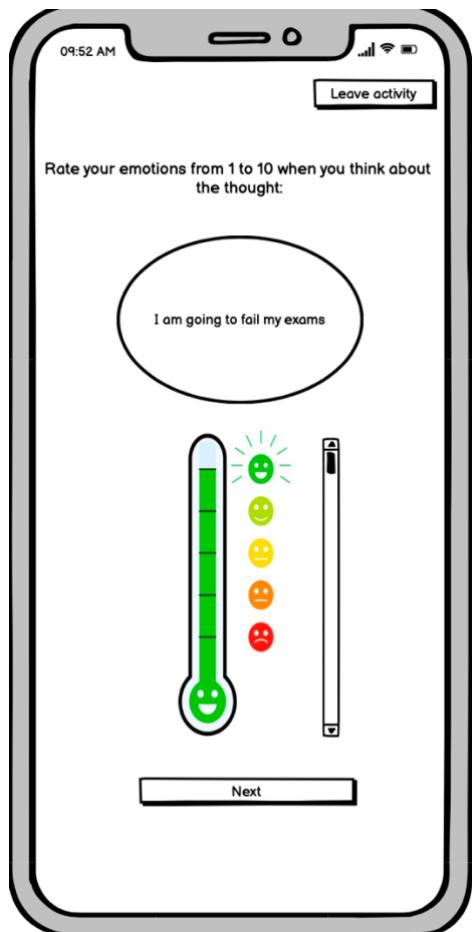


Figure C7: Negative emotion measure.

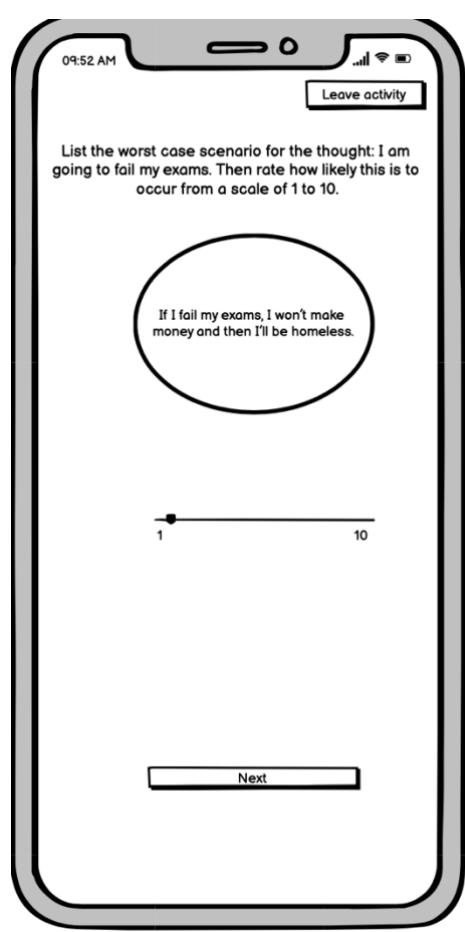


Figure C8: Negative scenario screen.

## Optimism and Pessimism: a case study

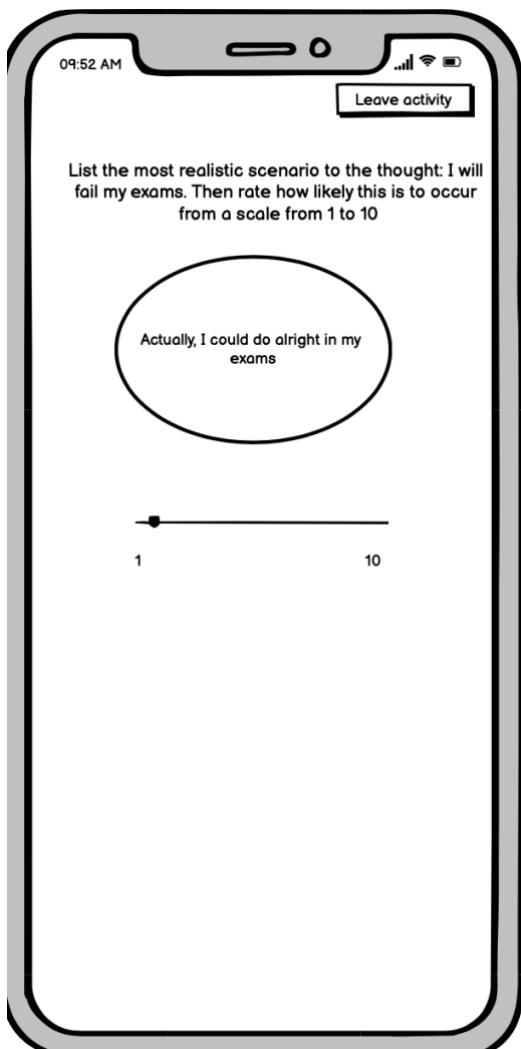


Figure C9: Realistic thought screen.

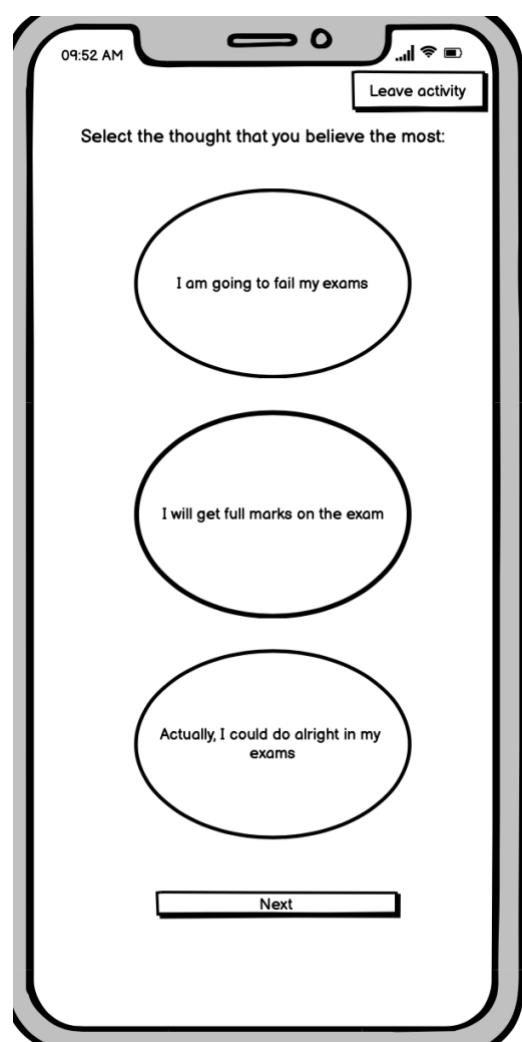


Figure C10: Choose thought screen.

## Optimism and Pessimism: a case study

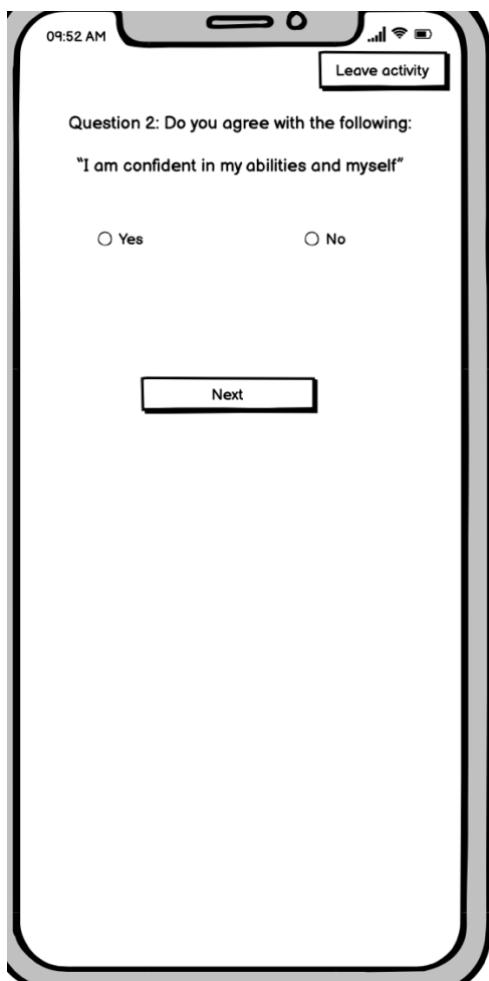


Figure C11: Second question screen.

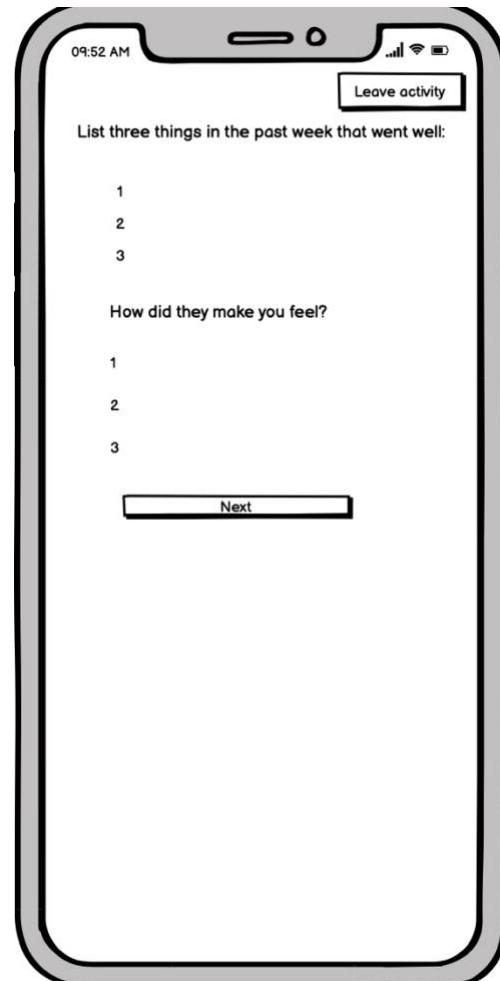


Figure C12: Goal-setting task first screen.

## Optimism and Pessimism: a case study

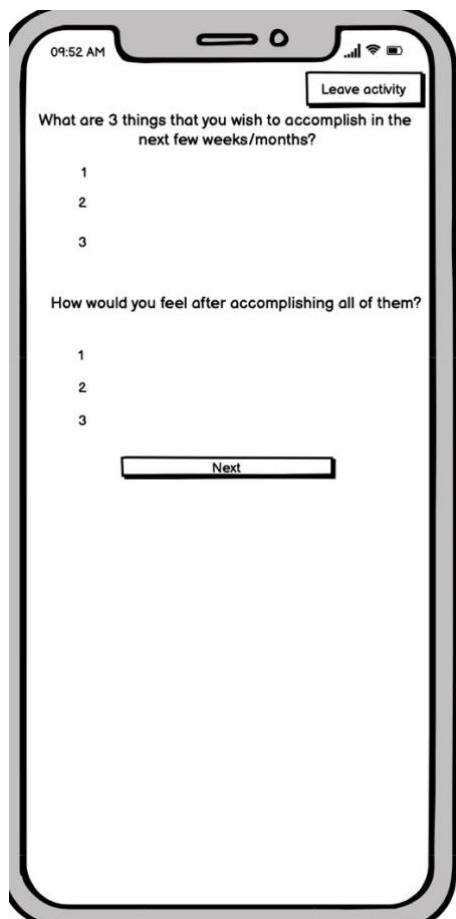


Figure C13: Goal-setting task screen two

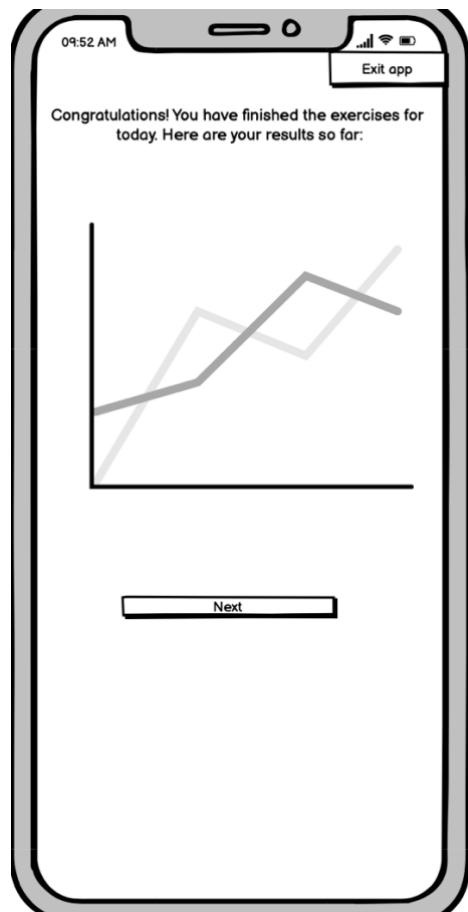


Figure C14: Praise Screen.

## Optimism and Pessimism: a case study

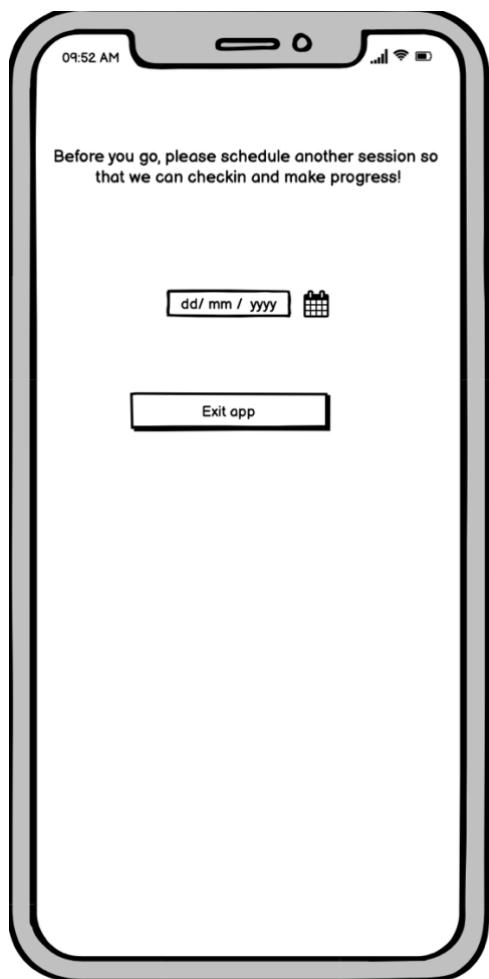


Figure C15: Reminder screen.

## Optimism and Pessimism: a case study

### C2 Second iteration design evidence

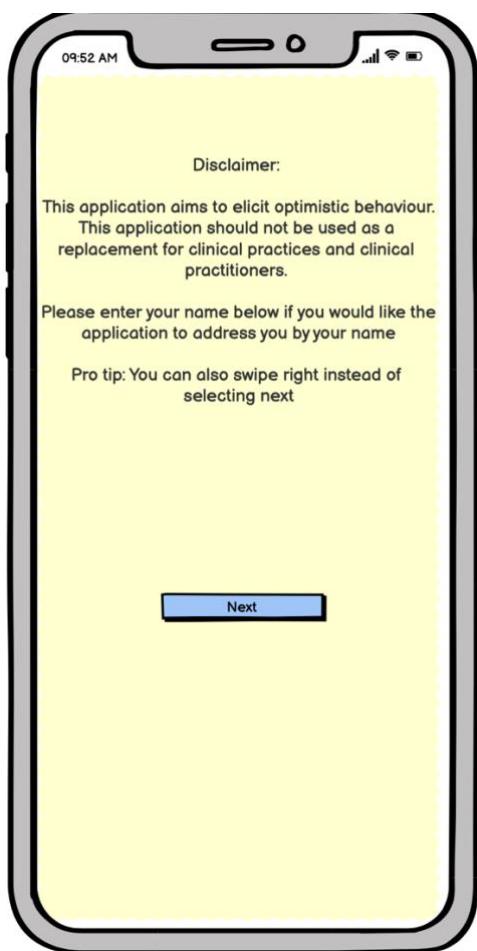


Figure C15: Disclaimer screen.

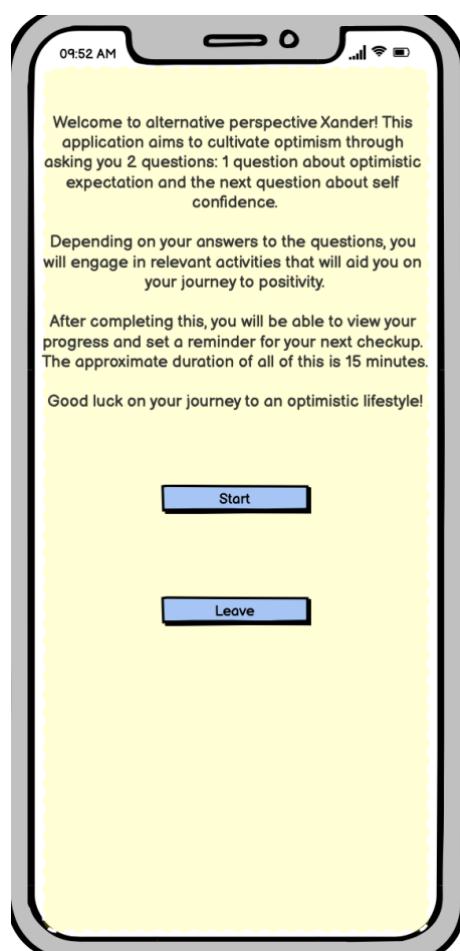


Figure C16: Information screen.

## Optimism and Pessimism: a case study

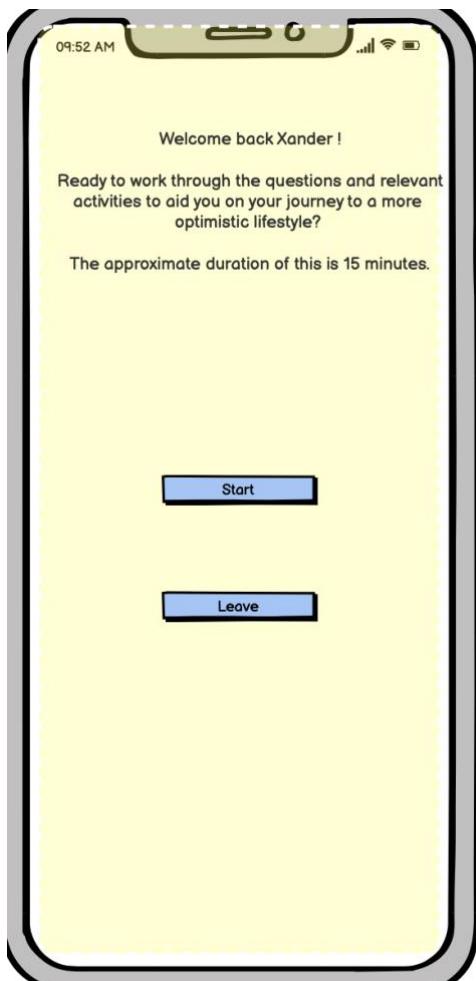


Figure C17: Information screen.

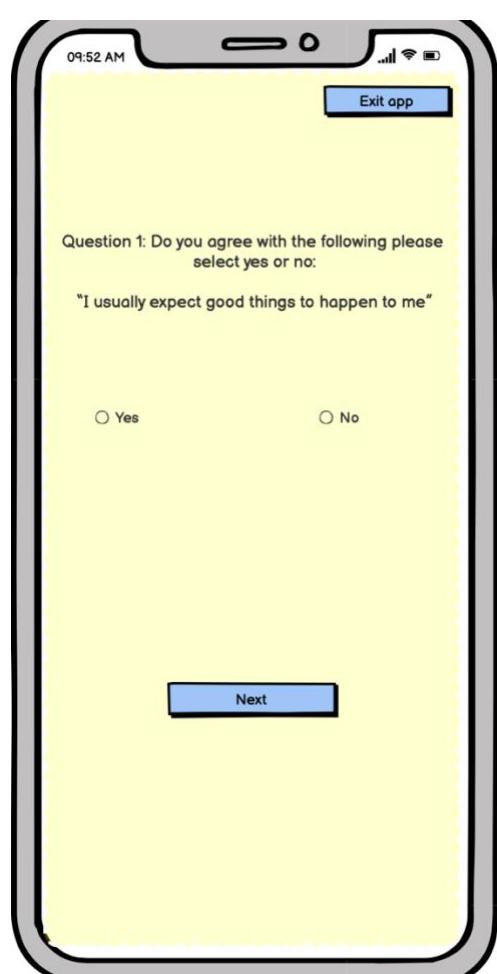


Figure C18: Optimism question.

## Optimism and Pessimism: a case study



Figure C19: Pre-defined date of negative thought.

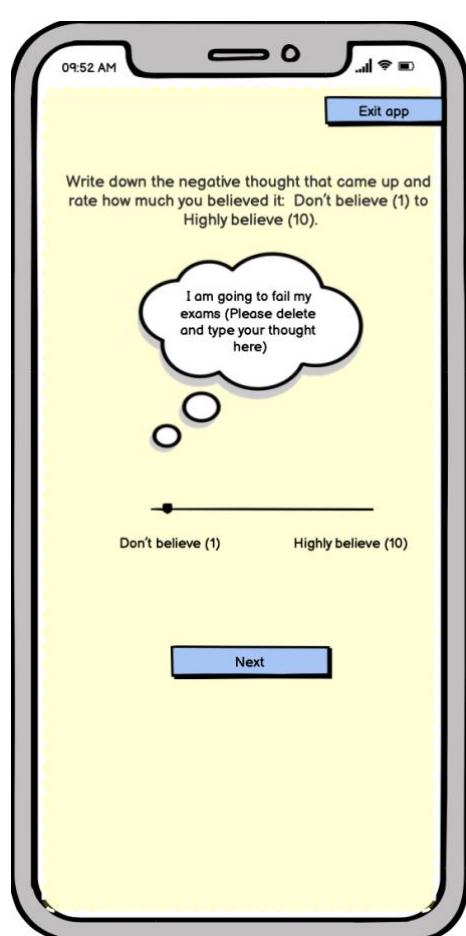


Figure C20: Negative thought screen.

## Optimism and Pessimism: a case study



Figure C21: Negative emotion screen.  
screen.

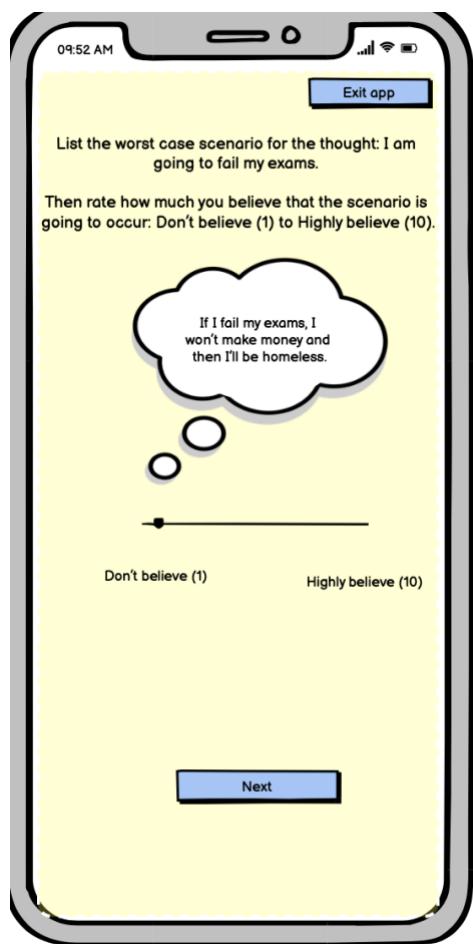


Figure C22: Worst case scenario  
screen.

## Optimism and Pessimism: a case study

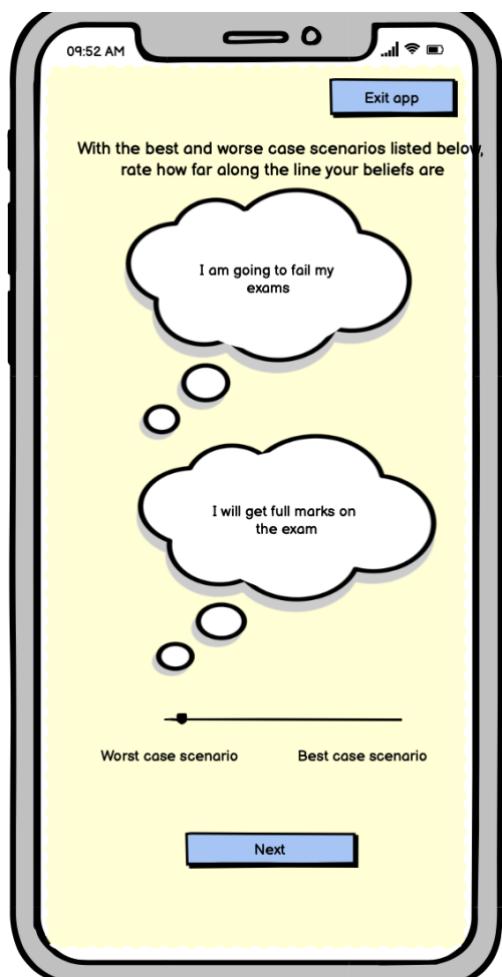


Figure C23: Realistic thought screen.

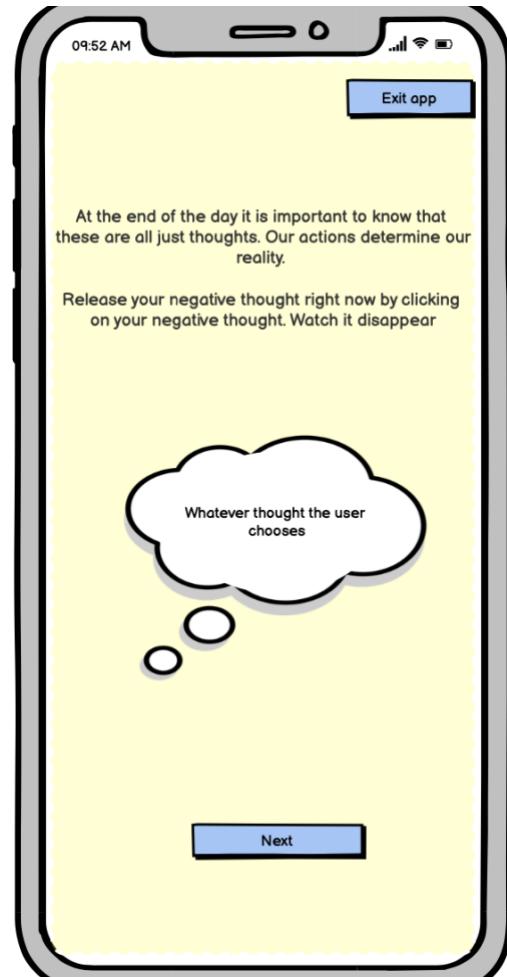


Figure C24: Inspiration screen.

## Optimism and Pessimism: a case study

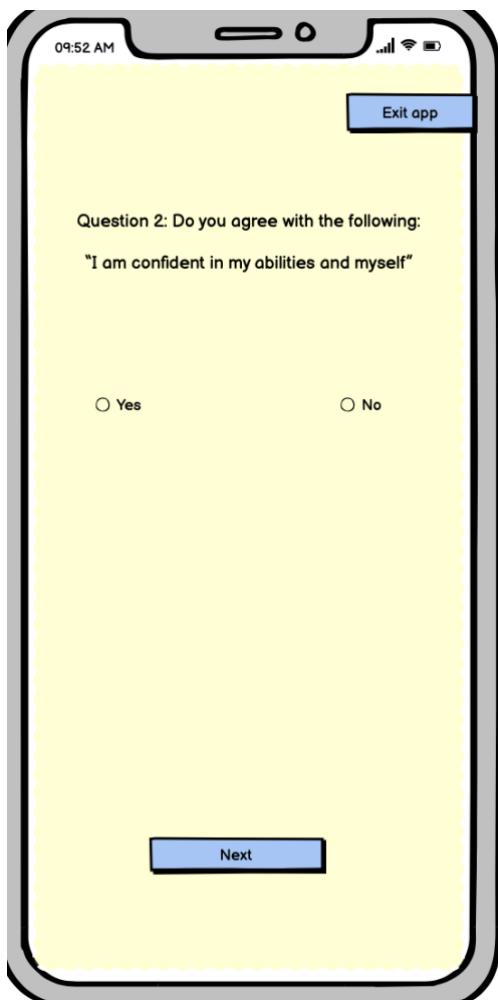


Figure C25: Self-efficacy question

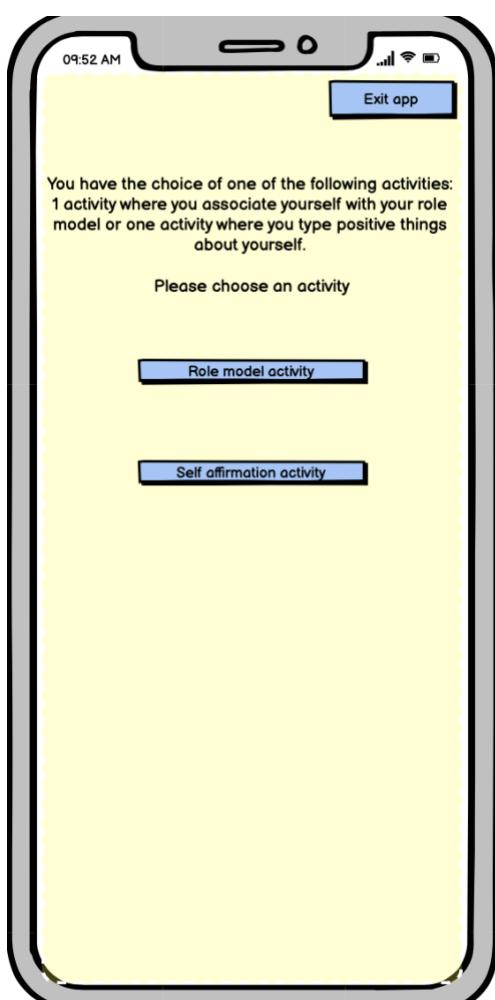


Figure C26: Tailored content screen.

## Optimism and Pessimism: a case study

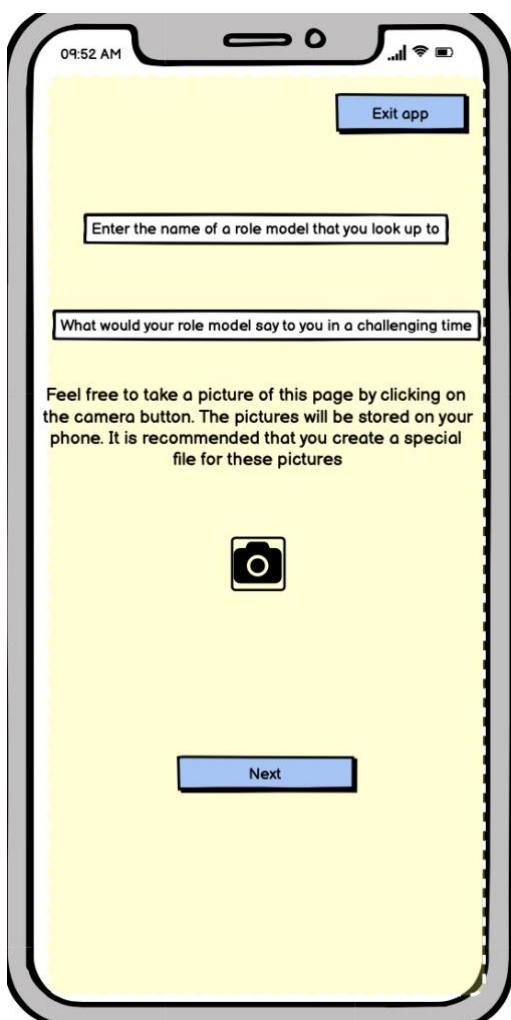


Figure C27: Role model activity screen.

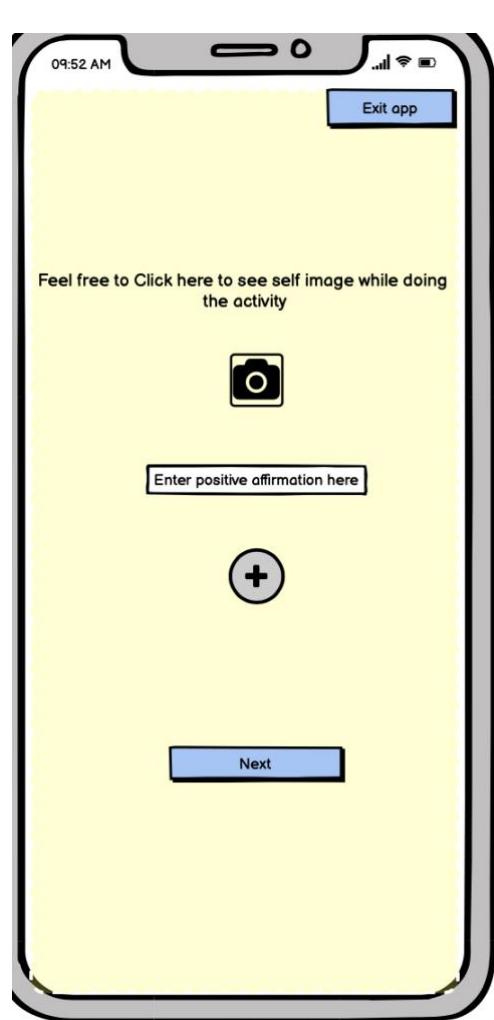


Figure C28: Self-affirmation screen.

## Optimism and Pessimism: a case study

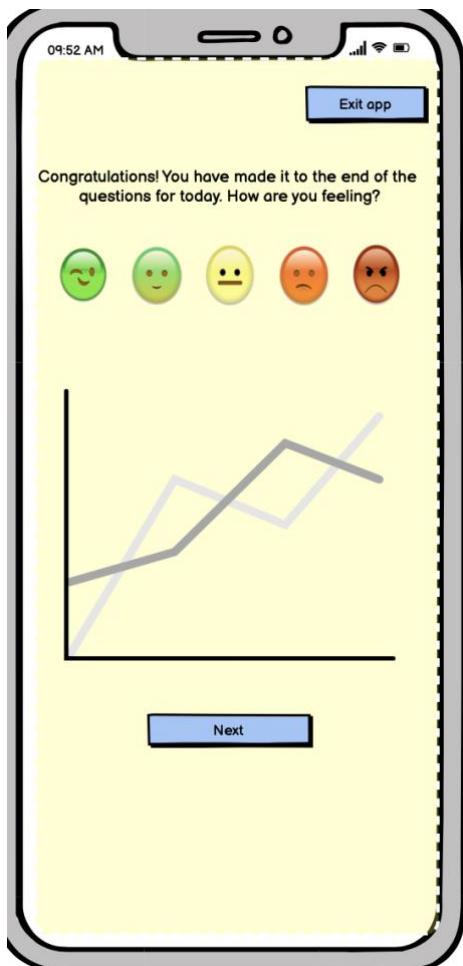


Figure C29: Praise screen.

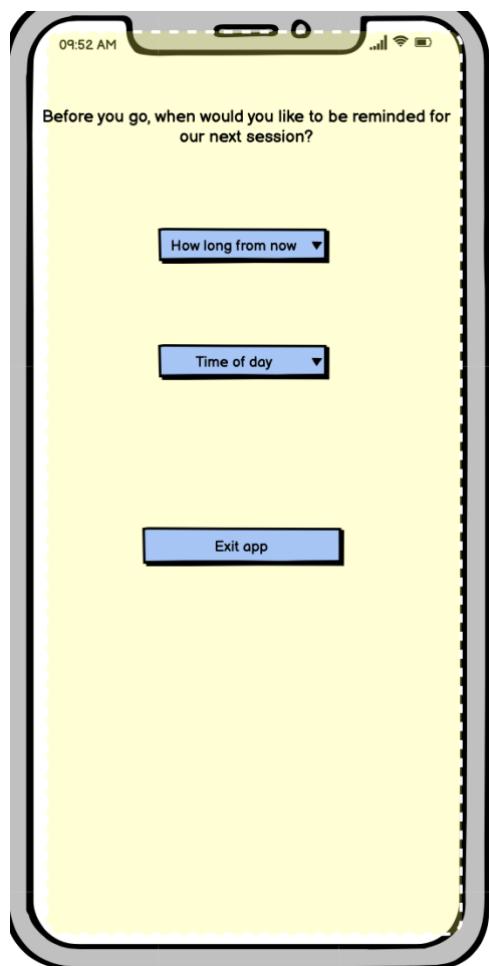


Figure C30: Reminder screen.

Optimism and Pessimism: a case study

### C3 Third iteration design evidence.

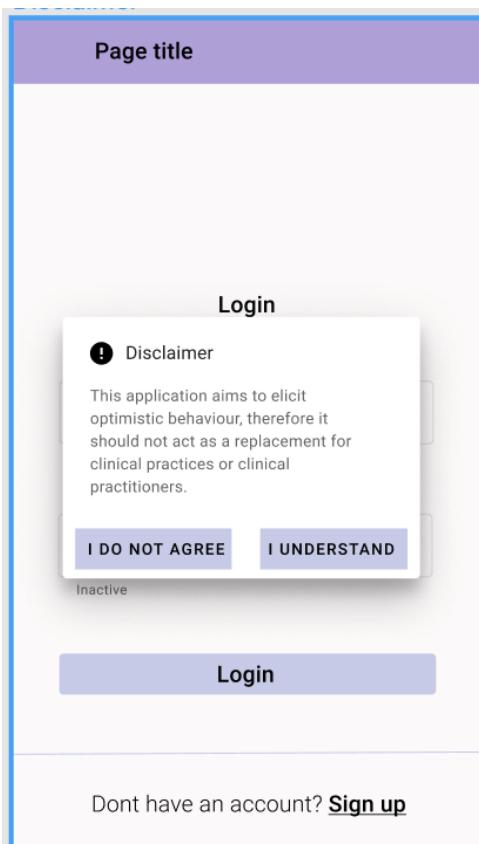


Figure C31: Disclaimer screen.

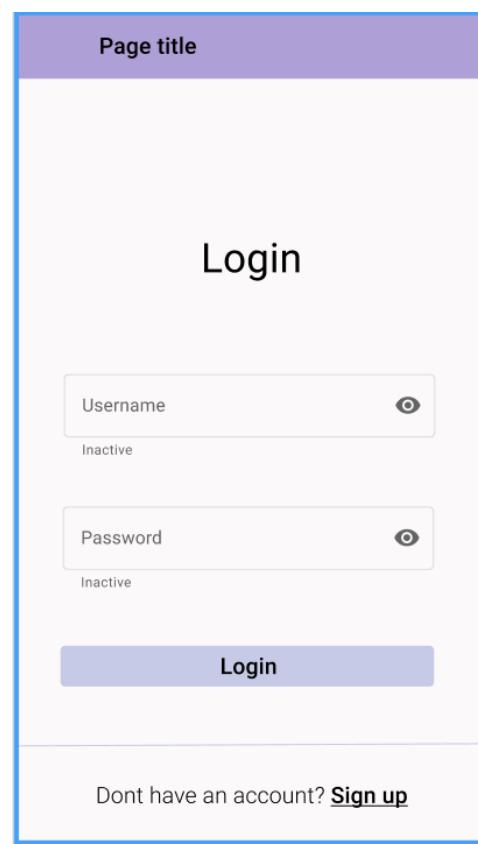


Figure C32: Login screen.

## Optimism and Pessimism: a case study

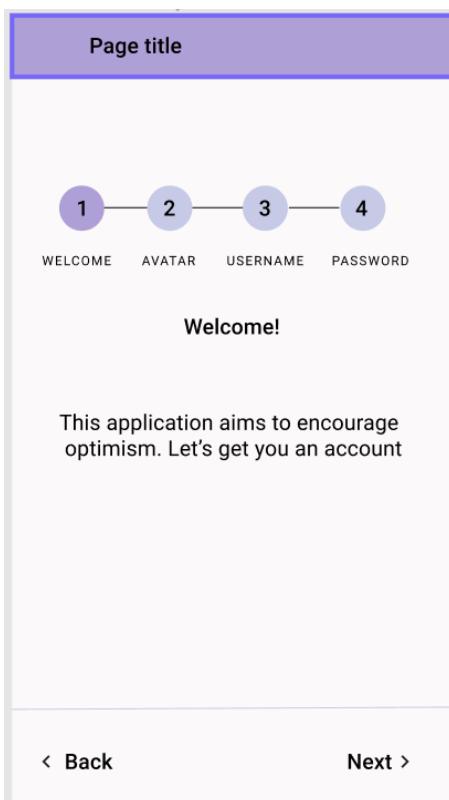


Figure C33: Sign up step one.

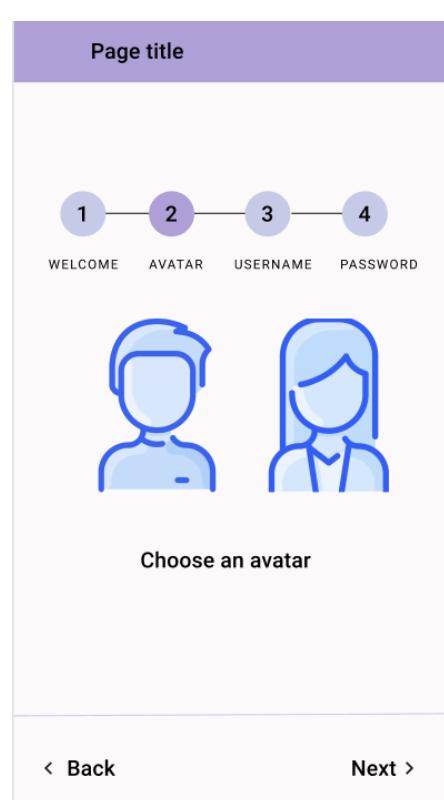


Figure C34: Sign up step two.

## Optimism and Pessimism: a case study

Page title

1 — 2 — 3 — 4

WELCOME AVATAR USERNAME PASSWORD

What would you like to be called?

Username

Inactive

< Back Next >

This figure shows the third step of a four-step sign-up process. The top navigation bar is purple with the text 'Page title'. Below it is a horizontal progress bar consisting of four blue circles numbered 1 through 4. Underneath the progress bar are the step names: 'WELCOME', 'AVATAR', 'USERNAME', and 'PASSWORD'. A question 'What would you like to be called?' is displayed above a text input field labeled 'Username' with a placeholder 'Inactive'. At the bottom are back and next buttons.

Figure C35: Sign up step three.

Page title

1 — 2 — 3 — 4

WELCOME AVATAR USERNAME PASSWORD

Almost there!  
please create and confirm a password

Password

Inactive

Confirm password

Inactive

< Back Finish >

This figure shows the fourth step of the sign-up process. The top navigation bar is purple with the text 'Page title'. Below it is a horizontal progress bar consisting of four blue circles numbered 1 through 4. A message 'Almost there! please create and confirm a password' is centered above two text input fields. The first field is labeled 'Password' with a placeholder 'Inactive' and the second is labeled 'Confirm password' with a placeholder 'Inactive'. At the bottom are back and finish buttons.

Figure C36: Sign up step four.

## Optimism and Pessimism: a case study

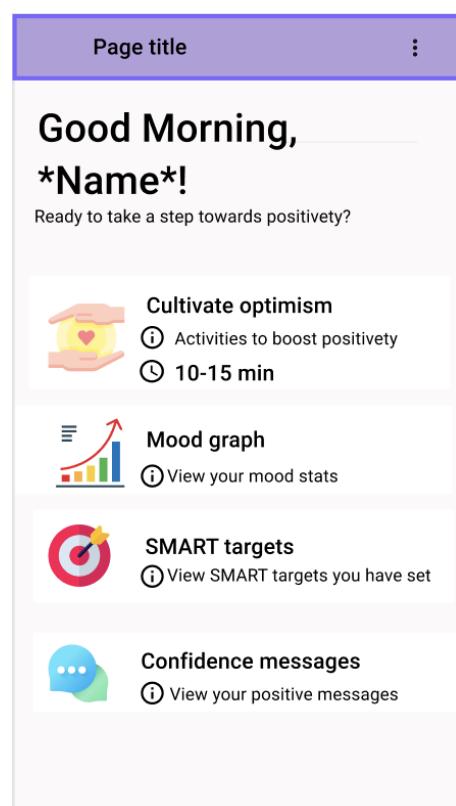
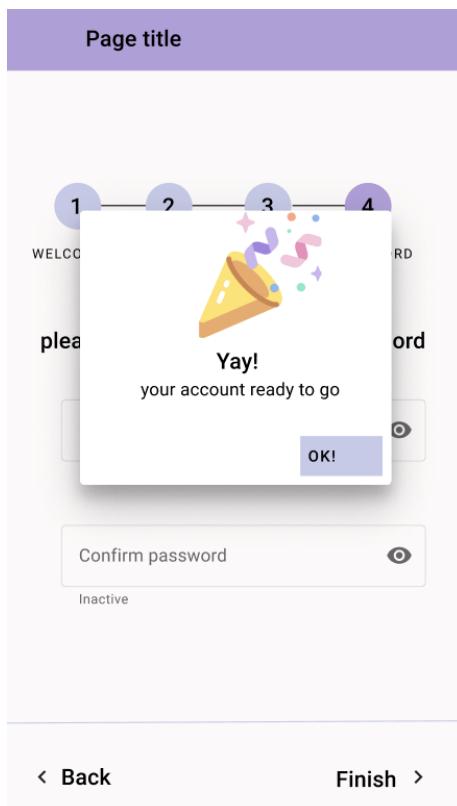


Figure C37: Successful account creation. Figure C38: Dashboard.

## Optimism and Pessimism: a case study

Page title :

**Good Morning \*Name\***

Ready to take a step towards positivity?

 **Cultivate optimism**  
 ⓘ Activities to boost positivity  
 ⏳ 10-15 min

 **Mood graph**  
 ⓘ View your mood stats

 **SMART targets**  
 ⓘ View SMART targets you have set

 **Confidence messages**  
 ⓘ View your positive messages

 \*name\*  
 Seek help  
 Log out

Page title :

**Positive growth starts with you**

A customised program for you

Recorded SMART Goals

Recorded inspirational messages

Recorded emotion log

Verified activities

 Source of the activities

< Back      Start >

Figure C39: Menu tab.

Figure C40: Optimism app first screen.

## Optimism and Pessimism: a case study

Page title  :

**Do you agree with the following:**

"I usually expect good things to happen to me"

Yes  
 No

< Back      Next >

Figure C41: Optimism question.

Page title :

**Sources for the activites:**

**Reframing thoughts is adapted from:**  
<https://rb.gy/hcxu4q>

**SMART goal setting is adapted from:**  
<https://rb.gy/edn3nm>

**Self-affirmation is adapted from:**  
<https://rb.gy/pe1csp>

**Role model inspiration is adapted from:**  
<https://rb.gy/jh7mmx>

< Back

Figure C42: Sources screen.

## Optimism and Pessimism: a case study

Page title

**How much do you believe this thought?**

1 (Don't believe) to 10 (Strongly believe)

Don't believe

Strongly believe

< Back

Next >

Figure C43: Negative thought screen.

Page title  :

“Negative thought here”

When you think about this thought,  
how do you feel?

- Sad 
- Angry 
- Scared 
- Other 

Figure C44: Negative emotion screen.

## Optimism and Pessimism: a case study

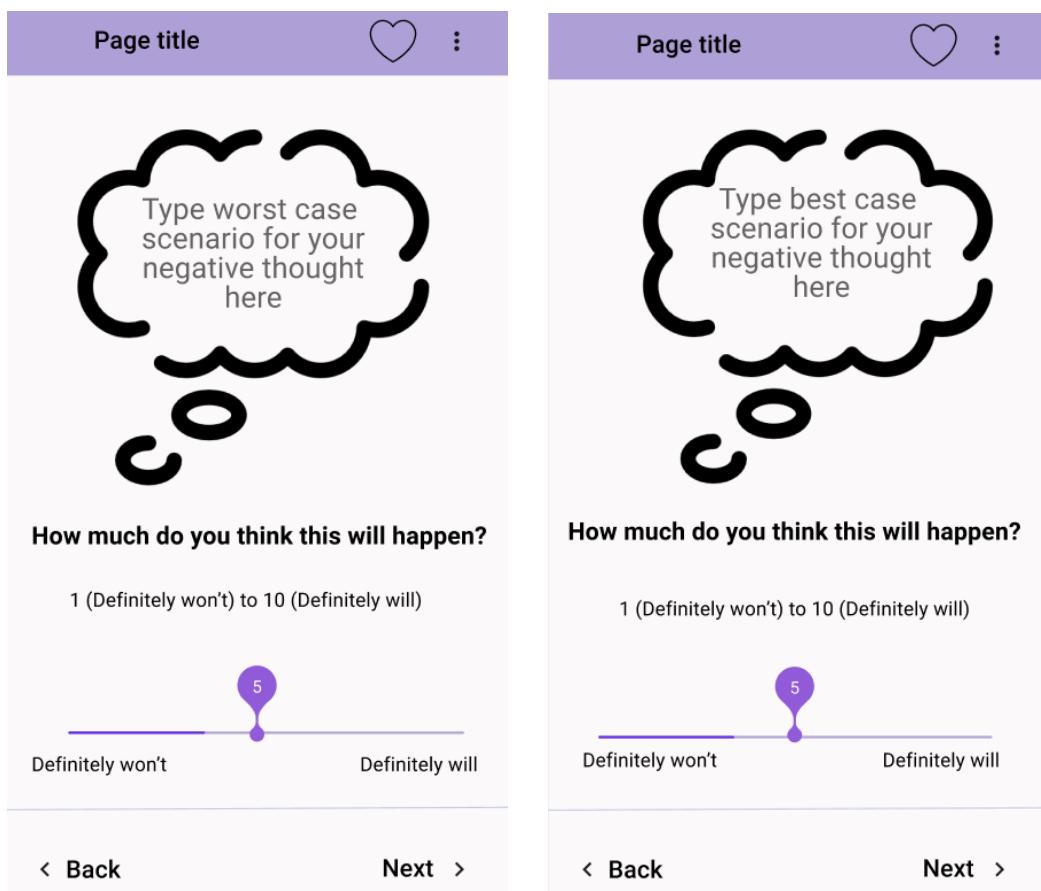


Figure C45: Worst case scenario screen. Figure C46: Best case scenario screen.

## Optimism and Pessimism: a case study

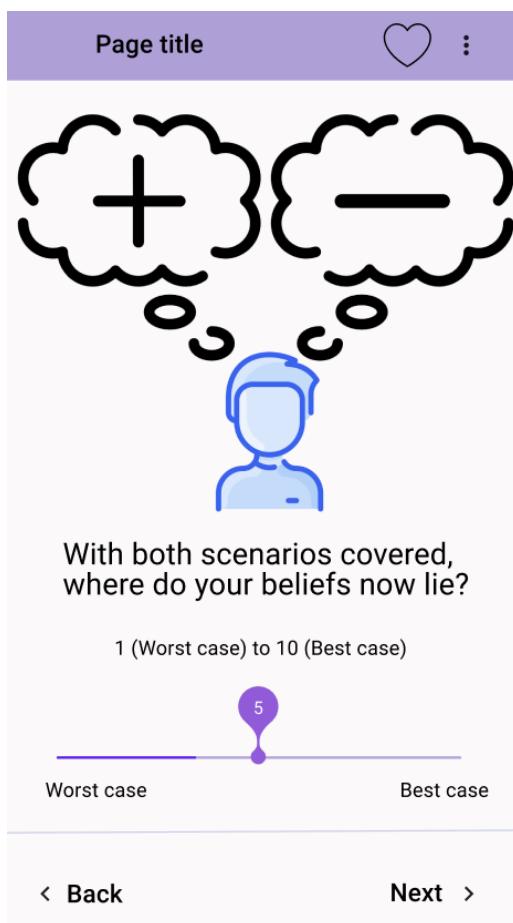


Figure C47: Objectify thought screen.

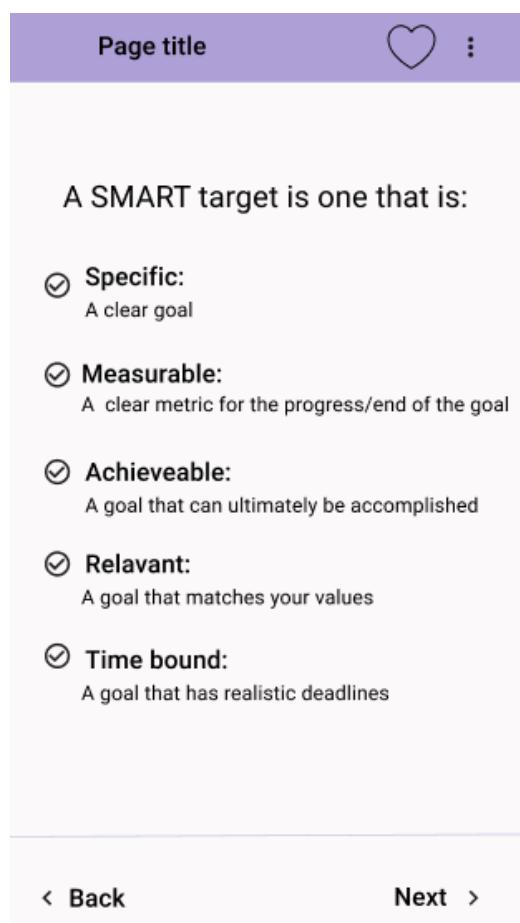


Figure C48: SMART target information screen.

## Optimism and Pessimism: a case study



Figure C49: SMART target activity screen. Figure C50: SMART target activity screen.

## Optimism and Pessimism: a case study

The image consists of two side-by-side screenshots of a mobile application interface.

**Left Screenshot (Self-efficacy question screen):**

- Header:** "Page title" with a heart icon and three dots.
- Text:** "Do you agree with the following:"
- Text:** "I am confident in my abilities and in myself"
- Buttons:** Two radio buttons: one selected (filled) labeled "Yes" and one unselected (outline) labeled "No".
- Navigation:** "< Back" and "Next >" buttons at the bottom.

**Right Screenshot (Activity decision screen):**

- Header:** "Page title" with a heart icon and three dots.
- Text:** "Choose an activity:"
- Activity 1:** Icon of a circle with diagonal lines, text: "In this task you will write 1 good thing about yourself", and an info icon (i).
- Activity 2:** Icon of a person with a starburst, text: "In this task you will list a role-model who you admire and then write what they would say to you to boost your confidence", and an info icon (i).
- Activity 3:** Icon of a person with a speech bubble, text: "Role model inspiration", and an info icon (i).
- Navigation:** "< Back" button at the bottom.

Figure C51: Self-efficacy question screen. Figure C52: Activity decision screen.

## Optimism and Pessimism: a case study

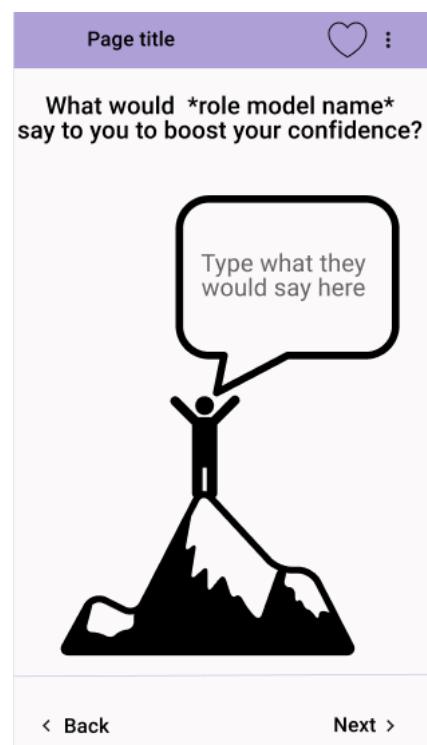


Figure C53: Role model activity screen one. Figure C54: Role model activity screen two.

## Optimism and Pessimism: a case study

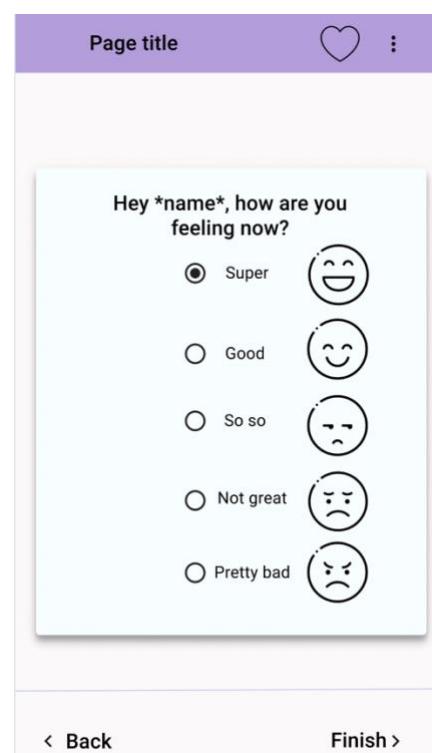
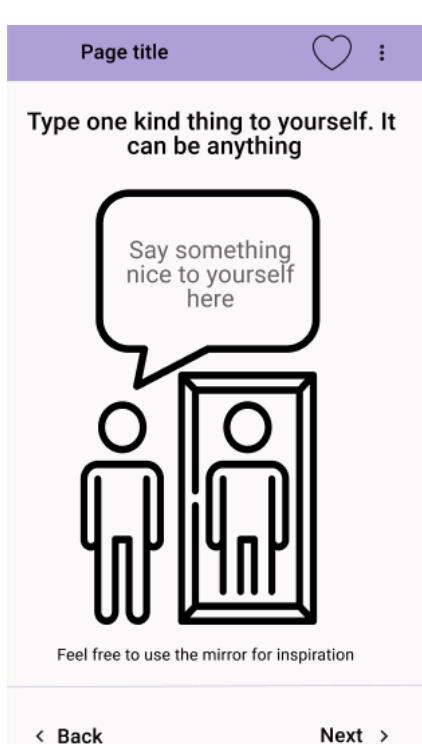


Figure C55: Self-affirmation activity screen. Figure C56: Emotion gauge screen.

## Optimism and Pessimism: a case study

Page title ::

### All done for today

If you are not feeling positive:

- Try activities again with someone very close
- Click the seek help button in the menu



Remember to not be too hard on yourself

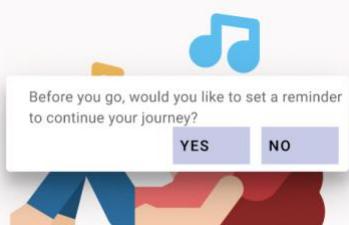
[Return to dashboard](#)

Page title ::

### All done for today

If you are not feeling positive:

- 
- 



Before you go, would you like to set a reminder to continue your journey?

[YES](#) [NO](#)

Remember to not be too hard on yourself

[Return to dashboard](#)

Figure C57: Activity completion praise screen. Figure C58: Set reminder option.

## Optimism and Pessimism: a case study

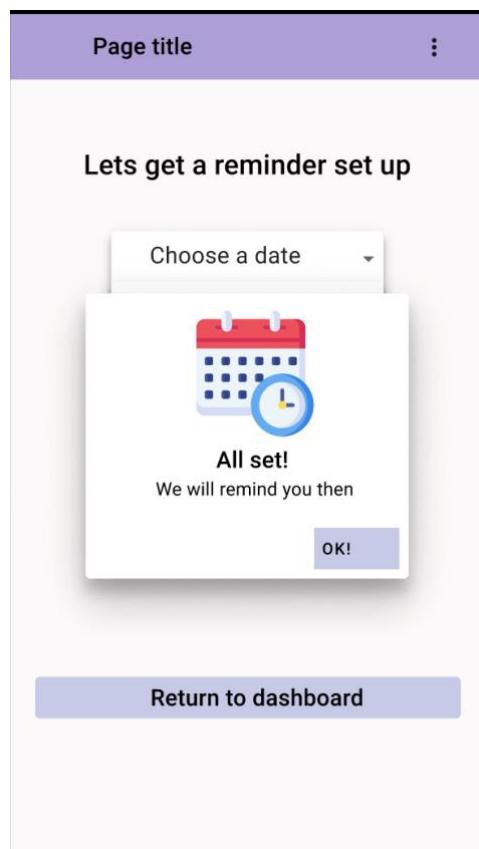
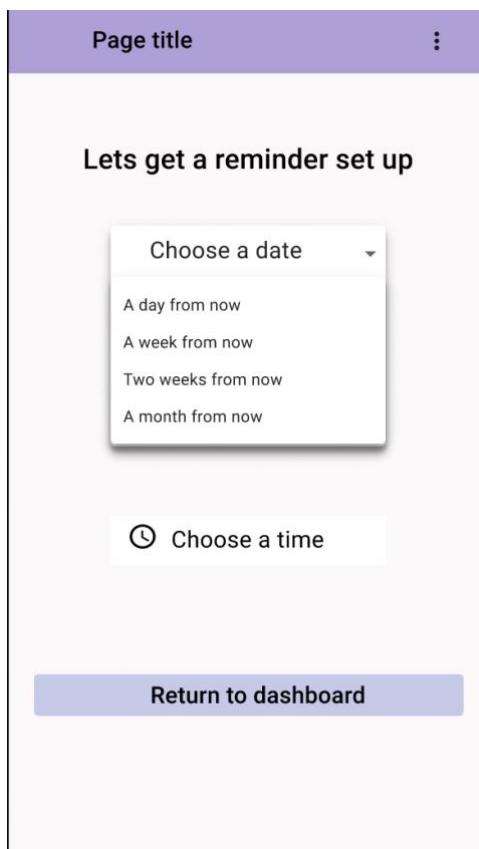


Figure C59: Reminder schedule screen.

Figure C58: Reminder confirmation screen.

## Appendix D

# Focus group feedback evidence

### D1 First focus group results:

Participant feedback about the first prototype of the optimism application:

- “Add a survey or multiple-choice questions to gauge how the user is feeling at a given moment in time.”
- “Perhaps add a progress tracker that includes a streak function/trophy when the user makes progress.”
- “Possibly replace the thermometer with just faces.”
- “Add more imagery and improve the User Interface.”
- “Brief descriptions about the activities could be provided.”
- “Activity names could be added, but this depends if the name is meaningful.”
- “Instead of listing a date for when a user last had a negative thought, have the user choose from a set of pre-determined options.”
- “Add some color to the application.”
- “Add options for the user about how far in advance they would like to set the reminder to re-engage with the application.”
- “The goal-setting task is too tedious.”

## D2 Second focus group results:

Participant feedback about the first prototype of the optimism application:

- “Some users may not have role models; therefore, the addition of the other task is suitable.”
- “I think these tasks work well because they provide choices for the users.”
- “These new tasks are not tedious for the user and they are short. I think that this works well.”
- “I like the use of emojis, they are used well.”
- “I think that the lower levels of emotions for the points where emotion is measured because people’s emotions are not exact at times.”
- “The emojis could extend to the deeper level if the user wanted a more in-depth look at their emotions.”
- “There could be a progress bar that informs the user how far they are through the optimism activities they are. This needs to be interpretable and easy to understand.”
- “There should be some login activity to personalize the application for the user.”
- “The additions of the pictures are good, it would be great if more pictures and visuals are added to the application. I feel the color scheme could be changed too.”
- “The interface still appears bland, you could improve by looking at the designs of other systems and adding more imagery.”

## Appendix E

# Experiment evidence

### E1 Email about the experiment

#### Email to participants:

Hi everyone, I hope you are well. I have finished with the development of my high-fidelity prototype and would like to commence the evaluation phase as my dissertation is deadline is approaching. I realise that this may take some time away from your days, but am really appreciative of your valuable input.

The purposes of this evaluation are to determine the usability of the system developed and how useful it is in helping individuals to cultivate optimistic attitudes.

Upon reading the information sheet and the information below, if you are interested, please fill and return the study questionnaire and the pre-screening questionnaires. These will replace the prior consent that you have given as these encapsulate all of my research.

This will run for a period of 7 days. Please find a brief description about what is involved:

You can choose to start the evaluation at any time, but it must be completed by Monday the 9<sup>th</sup> of May latest.

When filling out the scales, please remember to be as honest as possible

#### Day 1: Initial scales:

Please fill out the day 1 LOT-R and new General Self efficacy scales provided.

## Optimism and Pessimism: a case study

These will be used to estimate your baseline positivity levels.

### Day 2-day 6: Using the high fidelity prototype:

You will be sent an email inviting you to view the high-fidelity prototype. This will be from Figma and will have my name (Xander Ito-Low) in the subject. Please follow this link and create an account for Figma. You will then be able to view the design screen. Please click on the play button to the left of the share button. (Please check the attached image for visualisation).

When using the app, the sign-up text, the login button, the optimism activity button, the back button, the source of the activities button, the dropdown menu, the popup text buttons, and the forward and back buttons are clickable. All of the other elements of this application are unclickable.

When navigating through the application, please try to go through it as if you were using the application. For example, where it says list a positive thought, try to think of a positive thought. Feel free to use a pen and paper if you wish.

For the reminder screen, please send me an email about when you would like your reminder to be set. For the purposes of this research, you will set your reminder everyday but you can alter the time that you are reminded. After you have finished you can close your browser window.

Please log back in and use the app for days 2-6

On the 7<sup>th</sup> day, please fill out the day 7 LOT-R, the new General self-efficacy scale and the System usability scale. (There is no need to set a participant ID as I will set these as numerical values). The LOT-R questionnaire will measure the changed positivity level and the SUS will measure your thoughts about the usability of the created system.

Please then send the Scales from the first day and the 7<sup>th</sup> day to this email.

If you need assistance, please don't hesitate to email me. More information about my research is provided in the information sheet.

Thank you. Regards,  
Xander

## E2 Information about the experiment

### Evaluation information sheet for the project:

#### Project title

Optimism and persuasive technology: a case study

#### Goal of the project

My name is Alexander Ito-Low. My Bath email is ail24@bath.ac.uk. Persuasive technology is defined as a system designed to persuade people without the use of coercion or deception.

The aims of this project are to design, code and evaluate a persuasive application that aims to help individuals manage their optimism through the use of activities (For example, a breathing exercise). In order to design this system, something called participatory design has to be done. Participatory design is defined as when the designer gets ideas from talking with participants. This will lead to designs which will then be wireframed. At the end, to determine the success (Usability and usefulness) of the application, an evaluation is needed to be carried out.

**Disclaimer:** The application in question will not by any means be guaranteed to make the user more optimistic, it only aims to develop one's optimism. The application being designed is not a clinical application in any way.

#### Goal of this empirical evaluation

An empirical evaluation is a study aimed at getting results from an experiment. The results I am aiming to collect are: the usefulness and usability of the application I have wireframed.

#### What is involved? This study will run from Monday the 5<sup>th</sup> of May to Monday the 12<sup>th</sup> of May

This empirical evaluation will take place over the period of a week. Below I outline the activities to be completed: Before the test period, I will brief you about how to use the wire frame by organising a meeting. Further correspondence regarding this will be sent to you.

#### Day 1:

You will be asked to fill out Revised Life Orientation Test (LOT-R) and the New General Self efficacy scale. This process will take no longer than 35 minutes. You can take a break in-between the questionnaires, it is your choice when you choose to fill these out on the first day of the evaluation.

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### Days 2-6:

On these days' you will use the wireframed application (please find the link to view it in the email once you have filled out the consent form and the screening questionnaire). The screen navigation is working, however some options such as checking your daily statistics does not work (More Information about active buttons is in the email). Radio buttons and typing in negative thoughts does not work, so when navigating through the activities, please feel free to go through the activities on a piece of paper.

The reminder system will be emulated. To set a reminder, please send me an email with the date and time that you would like to use the system and I will email you with a reminder on that day.

The process will last around 15 minutes.

### Day 7:

On the last day, you will fill out the Revised Life Orientation Test (LOT-R), the New General Self efficacy scale and the System Usability Scale (SUS). These will be used in the analysis of the results for my dissertation. All of these questionnaires can be completed anytime on the 7th day.

Please send all of your responses (scales on day 1 and day 7) to my email (ail24@bath.ac.uk)

### Compensation

Your participation is highly appreciated. No compensation will be provided.

### Withdrawal policy

You can withdraw from the evaluation at any time by informing me before the evaluation has taken place, during the evaluation or after the evaluation has taken place.

### Data and ethical considerations:

The data collected will be the initial questionnaires and the final questionnaires. These are already anonymised. I will fill in your participant ID for you so there is no need to fill that out if you are asked to do so in the surveys.

## Optimism and Pessimism: a case study

The anonymised surveys and results from the surveys will be uploaded to the secure H drive on the university of baths' file storage system.

The data will only be shared with my supervisor (Mr John Bernardis, [I.Bernardis@bath.ac.uk](mailto:I.Bernardis@bath.ac.uk)) with consent until I acquire my degree, by then all of the data will be deleted. Combined findings from this evaluation will be analysed.

These findings, with participant consent, will be published in my thesis. These survey results will be kept until the acquisition of my degree. After this, all of the records on the H file of these results will be deleted.

Participants have the right to request for their data at any time. Participants also have the rights to request that their data can be removed at any time before the evaluation section of my thesis is written up. With such requests, I will comply.

### Contacting me

If you wish to get in contact with me with any questions, please do not hesitate. My Bath email is [ail24@bath.ac.uk](mailto:ail24@bath.ac.uk)

### Further concerns

If at any point you have any concerns to your own health or welfare, you can contact these services:

- If it is an immediate concern call security on 01225 385349 or email [security-office@bath.ac.uk](mailto:security-office@bath.ac.uk) -- Security will be able to contact Student Services if needed.
  - The Wellbeing Service can be contacted by email on [wellbeingservice@bath.ac.uk](mailto:wellbeingservice@bath.ac.uk) and operates every day throughout the holiday period
  - Health advice is available from the NHS 111 Service
  - Confidential emotional phone support is available 24/7 from Samaritans: 116 123
-

### E3 LOT-R Scale

Instrument Title: Life Orientation Test-Revised (LOT-R)  
Instrument Author: Carver, C. S.  
Cite instrument as: Carver, C. S. . (2013) . Life Orientation Test-Revised  
(LOT-R) . Measurement Instrument Database for the  
Social Science. Retrieved from [www.midss.ie](http://www.midss.ie)



## Optimism and Pessimism: a case study

### LOT-R

Please be as honest and accurate as you can throughout. Try not to let your response to one statement influence your responses to other statements. There are no "correct" or "incorrect" answers. Answer according to your own feelings, rather than how you think "most people" would answer.

A = I agree a lot

B = I agree a little

C = I neither agree nor disagree

D = I DISagree a little

E = I DISagree a lot

1. In uncertain times, I usually expect the best.
- [2. It's easy for me to relax.]
3. If something can go wrong for me, it will.
4. I'm always optimistic about my future.
- [5. I enjoy my friends a lot.]
- [6. It's important for me to keep busy.]
7. I hardly ever expect things to go my way.
- [8. I don't get upset too easily.]
9. I rarely count on good things happening to me.
10. Overall, I expect more good things to happen to me than bad.

Note:

Items 2, 5, 6, and 8 are fillers. Responses to "scored" items are to be coded so that high values imply optimism. Researchers who are interested in testing the potential difference between affirmation of optimism and disaffirmation of pessimism should compute separate subtotals of the relevant items.

Figure E1: LOT-R Scale Carver, C. S. . (2013) . Life Orientation Test-Revised

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**E4 NGSE scale**

**Please refer to the next page.**

## Optimism and Pessimism: a case study

### New General Self-Efficacy Scale

*This survey accompanies a measure in the SPARQTools.org [Measuring Mobility toolkit](#), which provides practitioners curated instruments for assessing mobility from poverty and tools for selecting the most appropriate measures for their programs. To get a copy of this document in your preferred format, go to "File" and then "Download as" in the toolbar menu.*

**Age:** Adult

**Duration:** < 3 minutes

**Reading Level:** 6th-8th grade

**Number of items:** 8

**Answer Format:** 1 = strongly disagree; 2 = disagree; 3 = neither agree nor disagree; 4 = agree; 5 = strongly agree.

#### **Scoring:**

To calculate the total score for each participant, take the average rating of the items by adding respondents' answers to each item and dividing this sum by the total number of items (8).

#### **Sources:**

Chen, G., Gully, S. M., & Eden, D. (2001). Validation of a new general self-efficacy scale. *Organizational research methods*, 4(1), 62-83.

## Optimism and Pessimism: a case study

**Instructions:** Participants are told that (a) general self-efficacy relates to "one's estimate of one's overall ability to perform successfully in a wide variety of achievement situations, or to how confident one is that she or he can perform effectively across different tasks and situations," and (b) self-esteem relates to "the overall affective evaluation of one's own worth, value, or importance, or to how one feels about oneself as a person."

**Instructions:** Please circle your answer below.

1. I will be able to achieve most of the goals that I set for myself.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
----------------------	----------	-------------------------------	-------	----------------

2. When facing difficult tasks, I am certain that I will accomplish them.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
----------------------	----------	-------------------------------	-------	----------------

3. In general, I think that I can obtain outcomes that are important to me.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
----------------------	----------	-------------------------------	-------	----------------

4. I believe I can succeed at most any endeavor to which I set my mind.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
----------------------	----------	-------------------------------	-------	----------------

5. I will be able to successfully overcome many challenges.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
----------------------	----------	-------------------------------	-------	----------------

## Optimism and Pessimism: a case study

6. I am confident that I can perform effectively on many different tasks.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
----------------------	----------	-------------------------------	-------	----------------

7. Compared to other people, I can do most tasks very well.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
----------------------	----------	-------------------------------	-------	----------------

8. Even when things are tough, I can perform quite well.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
----------------------	----------	-------------------------------	-------	----------------

Figure E2: NGCSE Scale (Chen, Gully and Eden, 2001)

Optimism and Pessimism: a case study

## E5 SUS with recommendation question at the end

### System Usability Scale (SUS)

This is a standard questionnaire that measures the overall usability of a system. Please select the answer that best expresses how you feel about each statement after using the application.

	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree
1. I think I would like to use this application frequently.	<input type="checkbox"/>				
2. I found the application unnecessarily complex.	<input type="checkbox"/>				
3. I thought the application was easy to use.	<input type="checkbox"/>				
4. I think that I would need the support of a technical person to be able to use this system.	<input type="checkbox"/>				
5. I found the various functions in this tool were well integrated.	<input type="checkbox"/>				
6. I thought there was too much inconsistency in this application.	<input type="checkbox"/>				
7. I would imagine that most people would learn to use this application very quickly.	<input type="checkbox"/>				
8. I found the application very cumbersome to use.	<input type="checkbox"/>				
9. I felt very confident using the application.	<input type="checkbox"/>				
10. I needed to learn a lot of things before I could get going with the application.	<input type="checkbox"/>				

How likely are you to recommend this application to others? (please check the box)

Not at all likely 0    1    2    3    4    5    6    7    8    9    10 Extremely likely

Figure E3: SUS with recommendation question at the end (Brooke, 2013).

Optimism and Pessimism: a case study

## E6 Participant debrief

### Debriefing Sheet for empirical evaluation:

Thank you for partaking in the evaluation.

To be reminded, the final goal of this project is to create a persuasive mobile phone application that aims to help the user manage their optimism through the use of optimism exercises (for example breathing exercises).

The results from this evaluation will be collated and analysed to determine how successful my application was (its usefulness and usability).

This concludes my research on the matter of optimism.

Once again, thank you for participating in this research.

If you have any further questions or comments, please contact my project supervisor: Dr. John Benardis at [I.Benardis@bath.ac.uk](mailto:I.Benardis@bath.ac.uk)

Regards,

Alexander Ito-Low

## **Impact due to COVID-19**

The impact brought about COVID-19 meant that there was more difficulty encountered when trying to find stakeholders for my project. The circumstances brought about by COVID-19 also made it challenging to distribute technology to novice users, hence more thought had to be put into the design of experimental procedures, and the ethical procedures surrounding this project.