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Abstract:
This paper explores how augmented reality, ecotherapy and gamification technology can improve the well-being of Danish students. Through an analysis of the causes of stress, treatment of stress, target group, design and relevant technologies it was possible to begin the creation of a prototype. This application was tested and changed in several iterations with a main focus on user-centred design. The high-fidelity prototype was in the form of a mobile application that would lead the user to specific locations in nature. Meanwhile it would utilise gamification theory and eco-therapy principles to create an interactive treasure hunt. The high-fidelity prototype was tested and received positive feedback. Both in terms of usability and as a proof of concept. However, further design iterations and more testing with the target group would be required to finalise the prototype.

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1 Introduction

In Denmark an average of 430.000 people experiences symptoms of stress every day, according to Stressforeningen [1] and an approximation of 250.000 to 300.000 Danes suffer from serious stress. This is one of the most prominent problems in modern Danish society. The World Health Organisation (WHO) anticipates it to become the biggest sickness factor by 2020 [1].

A statistical analysis by Sundhedsstyrelsen and Statens Institut for Folkesundhed (SDU), states the amount of Danish people suffering from high levels of stress in 2013 was 21,3%, this number rose to an average of 25,1% in 2017. This number reflects all ages for both men and women. However, by taking a closer look at people in the age group from 16- to 24-year-olds, the numbers are drastically higher. In 2013 the number of 16- to 24-year-olds suffering from high levels of stress was 24,2%, which is almost a quarter of young Danish adults. This number increased by 7,7% in 4 years where 31,9% of young adults in Denmark suffered from high levels of stress. This is almost one third of 16- to 24-year-olds in Denmark [2].

Stress over short periods of time is not necessarily a bad thing, it can motivate an individual in certain circumstances [3]. Longer sessions of stress will begin to take a toll on the body, which can prove detrimental to an individual's well-being. Some of the common effects of stress affect the body in many ways. Such as one's body, mood, behaviour, mind and energy levels. It can cause anxiety or angry outbursts. Furthermore, it can lead to high blood pressure, hearts disease, obesity and diabetes, which can prove fatal [4].

There are a multitude of ways to deal with stress. One way is the resurfaced field of eco-therapy. This is described by Chalquist *"Eco-therapy is a method of restoring optimal health and well-being through routine exposure to an experience in the natural world"* [5].

The use of eco-therapy as a treatment for mental health problems, such as stress, predates most other treatments. Throughout the 20th century, the use of nature decreased as a therapeutic tool. Before this time, mental health institutions were often situated in lush green landscapes or gardens. However, over the last twenty years, research in this field has exponentially increased [6].

The strictest form of eco-therapy involves a trained therapist guiding a patient through an array of outdoor activities focused on reconnecting with nature. There are many forms of eco-therapy, and these will be covered in-depth in the analysis. Several researchers made significant contributions to the field of eco-therapy. These early researchers made it clear that balancing our relationship with nature has a significant impact on the human psyche. To conclude, *"people need to get outside and expose themselves to nature regularly to reach optimal health"* [7].

This project will develop and evaluate a possible solution to the growing numbers of young adults experiencing stress. Eco-therapy will play a key role in this solution. An analysis based on an initial problem statement will attempt to dive deeper into the subjects of stress, eco-therapy and other relevant subjects in order to form a final problem statement (FPS). This FPS will serve as a basis to form design requirements from and will assist in forming the core design of the solution.

1.1 Initial Problem Statement

"How can the use of media technology paired with eco-therapy help alleviate stress among young adults?"

2 Analysis

The analysis chapter will break down and explore various research relevant to our initial problem statement. Stress as a condition and its treatments will be examined. Additionally, the chapter will delve into relevant technologies and state of the art. The overall aim of this chapter is to explore the initial problem statement to a sufficient standard, that can allow a more accurate final problem statement to be formed. Furthermore, it aims to identify a base foundation from which the design chapter can build upon, to provide a possible solution to the final problem statement.

2.1 Problem Description

2.1.1 What Is Stress?

In this segment stress as a whole will be elaborated upon and a definition of stress will be made. There are already many definitions to what stress is exactly. First of all, stress is mostly a physical response, when the body feels like it is under attack and goes into "fight or flight" mode [8]. This has proven to be a useful survival tool for the human race, and it can be credited for our survival as a species. When the body thinks it is under attack, it will prepare the body for action. This process releases various chemicals into the bloodstream, e.g. adrenaline which heightens our awareness, allowing us to perform better and faster in dangerous situations. However, while this was important and especially useful in the early days of humanity, it has come to mean something else today. In modern times, the same hazards are less prevalent, and stress is linked to other more relevant dangers; *"what was once designed as a means of survival is now associated with the development of disease and illness that claims the lives of millions of people worldwide"* [7].

Stress becomes an issue as it can aid diseases by weakening the body's physiological systems which can advance the disease process and, can therefore prove fatal. It also has a multitude of other, lighter consequences that many people are feeling in their daily lives. The word stress (as a condition for humans) was first used in the book "The stress of life" by Hans Selye [7]. In modern times, the word is most often used as *"the level of tension people feel is placed on their minds and soul, by the demands of their jobs, relationships and responsibilities in their personal lives."* It is important to note that stress is not always bad, being able to work under pressure is a sought-after quality. However, constant stress can have devastating consequences. This is where the condition can become problematic.

2.1.2 What Causes Stress?

Stress is not a disease though it is sometimes mentioned as such. It can worsen an already existing disease or illness, and this is called stress related illness but stress itself is not a disease or an illness [9]. Stress is an imbalance in the state of mind of the stressed individual [9]. Furthermore, stress is different for each person, meaning that depending on the individual different things can enable stress [9]. For example, stress can be caused by carrying out a task that contradicts the persons personal values, having too large of a workload unequally divided, and given to a person whom lacks the resources to execute it properly, or simply working in a

bad or toxic environment [10]. Stress is mainly caused by the things we experience, do or things we do not do anything about. An example of this is when we have a conflict with our goals, in relation to our personal lives. E.g. when we are given opportunities and choices, if we lack abilities in our area of work, and when our values and personality traits are confronted [10].

In many cases, an excessive workload is the cause of stress in humans. They often come home after a long working day and fail to relax or rest. They, on the contrary, are still thinking more about what they have not been able to accomplish, what they need to finish, or if they have kids, they have to take care of them as well. As time passes, the individual falls victim to a downward spiral that results in less productivity and more stress [11].

It is very easy to imagine that a person who has personal problems in their family relationships, cannot fully concentrate on their work but are increasingly thinking about personal problems. These problems are then negatively reflected in the work results they provide [11].

If a person is exposed to large financial requirements (e.g. repayment of a house or car loan), their performance is under constant pressure to provide good or even better results in their work, so that they might get promoted or at least not get fired. This can have destructive effects on the overall well-being of the psyche, which in turn stresses them out [11].

2.1.3 Who Gets Stressed?

As the beginning of the Introduction states, 25,1%, one quarter of the danish population suffer from serious stress in 2017 (1). Furthermore, Denmark is consistently ranked has one of the most stressed countries in the world.

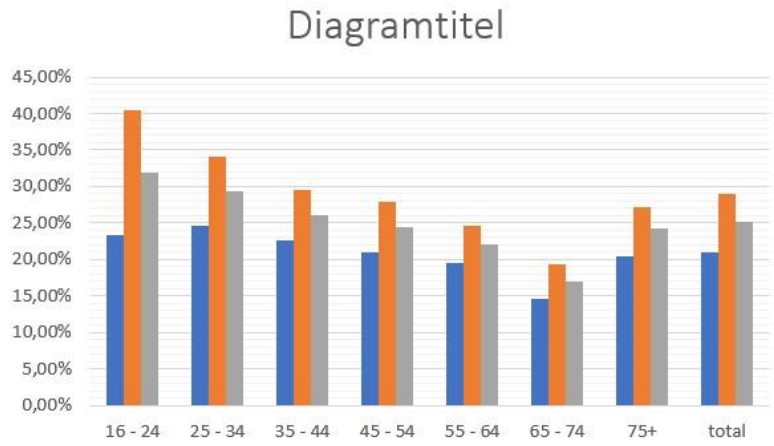


Figure 1: Demographic division of Danish citizens with high levels of stress, 2017 [2].

There are two demographics that stand out and has a far larger percentage of people who suffer from stress, compared to the other demographic groups. These are the young adults, the female population, and the most stressed demographic are young females. First, amongst young adults, almost a third had high stress levels in 2017. This is the highest percentages of all the categories. In relation to that, this number has grown from 24,3% in 2013, to 31,9% in 2017 [2].

Secondly, young adult women had the highest stress per person average of all the demographic groups, with a whole 40,5% of females aged 16- to 24-year-olds suffering from high levels of stress in 2017. This number has increased by 7,5% in four years. Compared to men in the same age range, 16- to 24-year-olds, women were 17,1% more likely to be stressed in 2017. All these numbers seem to have an upward trend for all age groups, except for the 75+ age group, which is the only age group from 2013 to 2017 that have become, overall, less stressed. Additionally, according to Forebygstress.dk and Statens Institut for Folkesundhed, 28,9% of people with a non-western background were stressed in 2010. This is 10,7% more than people with other western backgrounds and 17,6% more than people with a Danish ethnic background in 2010 [2].

Finally, it can be concluded that, almost a quarter of Danish citizens suffer from high levels of stress, and that the younger generation, overall, suffer more from stress, compared to other age groups. Also, women and people from non-western backgrounds are more likely to suffer from stress [2].

2.2 Types of Stress

There are three main recognised types of stress. These include acute stress, episodic acute stress and chronic stress. This subsection will investigate in detail each of these types.

2.2.1 Acute Stress

Acute stress is the most common form of stress that most people will have experienced at some point in their lives. It is brought on by pressures of the recent past or by the anticipated demands of the near future. The symptoms of acute stress are well known. The American Psychological Association [12] identifies these symptoms as:

- Emotional distress — some combination of anger or irritability, anxiety and depression, the three stress emotions.
- Muscular problems including tension headache, back pain, jaw pain and the muscular tensions that lead to pulled muscles and tendon and ligament problems.
- Stomach, gut and bowel problems such as heartburn, acid stomach, flatulence, diarrhoea, constipation and irritable bowel syndrome.
- Transient over-arousal leads to elevation in blood pressure, rapid heartbeat, sweaty palms, heart palpitations, dizziness, migraine headaches, cold hands or feet, shortness of breath and chest pain.

Acute stress can affect anyone. It is, however, highly treatable [12].

2.2.2 Episodic Acute Stress

Episodic acute stress is the phenomenon of experiencing acute stress frequently. People who suffer from this usually have taken on more than they can handle. They are always in a rush but struggle to be on time. The symptoms of episodic acute stress are no different from that of acute stress. The major difference, however, is that the symptoms seem relentless to the inflicted. Another form of episodic acute stress comes from continuous worry. People who have a pessimistic view on life. They will anticipate a catastrophic finale to most situation that they are presented with. Victims of this form of episodic acute stress tend to be more anxious and depressed, rather than angry and hostile. Treatment for this form of stress requires external intervention, often from a professional and can take many months. Sufferers can be highly stubborn towards change and will only be persistent in their treatment if they are promised relief from their symptoms [12].

2.2.3 Chronic Stress

Chronic stress is the most severe of the three forms. It is long term severe stress that can originate from many different variables. For example, being trapped in a violent relationship, poverty, traumatic experiences from childhood, etc. can all lead to chronic stress. Sufferers of chronic stress do not see an end to a miserable situation. They see only interminable demands that cannot be met, and they usually give up hope of ever finding a solution to their situation. One of the severe outcomes of chronic stress is the victims tend to acclimatise to the symptoms; it becomes normal. This means that an individual can live their lives unaware of the severity of their situation. Chronic stress leads to fatalities by the means of suicide, violence, heart failure, stroke and sometimes cancer. Due to the long-term attrition of both the physical and mental state of the individual, long term medical and behavioural treatment and stress management are usually required for a recovery [12].

2.3 Stress Management and Prevention

This section deals with management and prevention of stress. Stress is a part of life that everyone experiences and is healthy to some degree but can as mentioned have negative effects on mental and physical health if not managed correctly. Managing stress is an advantageous way to prevent stress. The section also functions as a segue from our initial problem statement to our final problem statement. Since this project has a limited scope, it will not be able to test whether a prototype relieves stress or not, therefore the focus will be shifted to preventing stress through strategies and techniques explained above and below this section.

2.3.1 Managing Stress

The first step to successfully manage unhealthy stress levels is to identify the stressors. Stressors are everything in life that contributes to the amount of stress one experiences. Common stressors include Relationships with family, a spouse, colleagues or others or excessive workloads. Simply put, if the demands of life are higher than the resources available,

an unbalance is present, and this will lead to unhealthy stress levels. To prevent this unbalance, stress prevention techniques can be applied [13].

Firstly, a person must identify the demands they face in everyday life, this can be done through the creation of a stress journal. Every time the person identifies a stressor, it will be noted in the journal. The identification of issues in and of itself has beneficial properties. It becomes easier to identify how often a certain stressor is present and how the person usually deals with it. Through this process it can become clear which stressors the subject needs to address, in order to prevent them from causing further damage. The theory of the four A's can be applied to address stressors. One can either try to change the situation by: Avoiding or altering the stressor. If the stressor cannot be changed, one can try to change their reaction by: Adapting to or accepting the stressor [13]. Avoiding the stressor can mean avoiding interaction with certain individuals, avoiding stressful situations like going grocery shopping or driving at peak times. However, some stressors cannot be avoided, and they should be dealt with accordingly. Altering the stressor can mean that instead of letting feelings bottle up, the stressed individual should practice expressing themselves and their opinions regarding a certain subject, it could also mean improving their time management. Adapting to a stressor is the altering of one's reaction to the situation. Having a positive outlook even when one is stressed can have a huge impact, relying on communication within close relationships is one way to achieve this [13]. Accepting the stressor when it cannot be changed is another way to cope with stress. For example, if one is facing a difficult situation it should be perceived as an opportunity for personal growth. Additionally, there are many other ways to prevent and manage stress like food, sleep and exercise, these will be discussed below.

2.3.2 Food

Nowadays, obesity is a worldwide health problem that affects over 500 million people on Earth. Obesity can lead to chronic medical problems such as, type 2 diabetes and cardiovascular diseases. The central nervous system is being researched in this context. Human brain functions can be scanned with the help of neuroimaging techniques. Food cues (hunger induced by seeing or smelling food) and stress are the two main natural factors that have an impact on eating manners. Exposure to one's favourite food cues in a stressful scenario encourages the activation of the brain's motivation-reward region [14].

Food can greatly reduce stress levels. Everybody has their own comfort food, e.g. a bowl of oatmeal boosts serotonin levels. Serotonin is a chemical that calms the brain. Some foods bring the levels of cortisol and adrenaline down. Cortisol and adrenaline are stress hormones and, in excess, are not good for the body and will take a toll on one's body over a period of time. A healthy stress diet is a good way to cope with stress, boost your immune system and lower your blood pressure [15].

Carbohydrates are good for producing high levels of serotonin. Eating complex carbohydrates that take longer to digest are considered beneficial, as they remain in the body for a longer period of time. Good carbohydrates include pastas, whole-grain breads or breakfast cereals, for example, oatmeal [15]. Simple carbohydrates such as sodas or sweets cause rapid boosts to serotonin levels. This is not considered healthy as they do not last [15].

Oranges are known for their high content of Vitamin C, that helps with strengthening the immune system. Reportedly, people who took some form of Vitamin C before a stressful task, experienced their blood pressure and levels of cortisol return to normal faster [15].

Green leafy vegetables such as spinach, microgreen, kale and more, contain folate, that produces dopamine which causes the brain to calm down. Consuming folate helps easing the symptoms of depression. A study from the University of Otago showed that university students who eat more fruits and vegetables are often happier, calmer and more energetic [16].

2.3.3 Sleep

Sleep can help a person deal with everyday stress easier, according to the Sleep Disorders Health Centre [17]. According to a study by US. Department of Health and Human Services, if teenagers do not get enough sleep it can lead to the teenager feeling stressed along with other symptoms
[18].

Lawyers are known to have a stressful work environment, where the work hours are often several hours above the average. The New Zealand Law Society asked Dr. Raymonde Jean, who is a director of sleep medicine and associate director of critical care at St Luke's-Roosevelt Hospital Center in New York City, for ways to reduce or prevent stress. She answered that sleep reduces stress levels and that sleeping better will help you live better.

2.3.4 Exercise

Regular exercise and sport activity are important elements in all psychical and body diseases. Nothing is more important for a human being than a regular moving exercise, it has a great impact on stress prevention. "Regular and systematic exercise, it is our main anti-stress program!" according to M.Safarin. It is very important in the beginning to find motivation and happiness in the exercises people are doing. People should not perceive it as a must or "lesser evil" when trying to implement exercise in their lives.

M.Safarin described, that working out or having exercises with friends or people we like is more interesting, and people enjoy it even more. It helps people's mind when they enjoy their time with acquaintances, and they do not think about things that may stress them. One of the most important things that people usually forget, is that they do any kind of exercises for themselves, so they should keep it the most comfortable for them and not to race with others. They should start easy and adjust difficulty, exercise for a longer time or add more weights as the time advances [19].

2.4 Forms of Stress Treatment

The following section addresses treatment targeting individuals already affected by stress. there are many ways of alleviating stress, all with different methods, approaches and procedures. Some of which include, aromatherapy, eating healthily, cultivating supporting relationships [20]. This section will therefore explore some of these types of treatments and argue for the choice of ecotherapy in our design.

2.4.1 Eco-therapy

Eco-therapy has been briefly explained in (section 1) The project will focus on eco-therapy as the primary treatment for stress, as it provides an opportunity to combine several forms of stress treatments together in a way that will be beneficial for the project. eco-therapy is an umbrella term referring to physical and psychological healing using nature. As mentioned in the introduction, there are many forms of eco-therapy. These include but are not limited to,

- Wilderness therapy,
- Eco-art therapy,
- Adventure therapy, • Animal-assisted therapy and,
- Horticultural therapy [21].

Wilderness therapy includes taking time out of your daily routine to embark on an excursion into the wilderness. This usually is done for a period of two weeks or more to realise the effects of such treatment. It is commonly done without phones or technology to maximise natural immersion. This treatment, for safety reasons, is assisted by a wilderness professional and is a common program for troubled youths [22].

Eco-art therapy is the marriage of traditional eco-therapy with art therapy. Activities of this form include expressing oneself through artistic endeavours such as: painting, drawing, modelling. Doing such activities in the presence of nature has shown to reduce not just stress levels, but, levels of depression and anxiety [23].

Adventure therapy is closely related to wilderness therapy. It involves getting out into nature, usually a remote area, and participating in activities like rock climbing, kayaking and other adventure activities. It has been shown to be especially effective for treating people with community integration problems [24].

Animal assisted eco-therapy is the act of bonding with animals such as, dogs, horses, etc. It is usually led by an experienced therapist [24].

Horticultural eco-therapy involves a variety of activities from gardening to growing and harvesting your own food. This form of eco-therapy is not strictly limited to nature. Sessions may take place in allotments within the city or community gardens [24].

Eco-therapy in its most basic form is the reconnection to nature to helps a multitude of mental and physical problems. It is the reminder that we as humans are holistically part of the ecosystem rather than separate. And, this reconnection is vital for overall health, including stress relief.

2.4.2 Physical Activity

Stress today tends to be produced cognitively, rather than physically. Millennia ago, life-threatening attacks were of great concern to our early ancestors. When such an attack occurs, the body enters a state of fight-or-flee. This response causes the body to shut down many non-

vital functions in order for the body to reach peak performance when reacting to the threat. An example of a nonvital function is digestion, this is why many stress sufferers acquire gastrointestinal problems. The main issue today is the fact that the brain cannot distinguish between a life-threatening situation and an everyday problem, such as, deadlines or bills. As these stressors tend to be long term or repetitious and the fact that we do not actually fight or flee causes stress hormones to remain in the body. Scientific studies have concluded that physical activity can greatly help in dissipating stress hormones in the body as it replicates the fight or flight response. Furthermore, while the fight or flight response has shown to tax the immune system through preparing the body for physical warfare. Studies have shown that low to moderate exercise can strengthen the immune system [25].

Physical activity also produces endorphins, which act as a natural pain killer and can help to decrease tension and fatigue, as well as, to improve sleep, self-esteem, concentration, alertness, moods, and cognitive functioning. Exercise of low to moderate intensity makes you feel energised, healthy and stimulates anti-anxiety effects [26].

2.4.3 Psychotherapy

Psychotherapy is a procedure of nursing people with psychological disorders and often also stress, by using verbal and mental methods. A trained psychotherapist helps patients solve their problems, which can be both, general and specific. Even though there are several techniques and strategies that a therapist can use, most of them include creating a therapeutic relationship/bond, debating, and working towards successfully resolving problematic thoughts and behaviours. Psychotherapy is not only people laying down while interviewed/listened to by the therapist. There are several methods that therapists use. Methods can differ from patient to patient, from therapist to therapist and from problem to problem [27].

Psychoanalytic therapy uses the principles of the analysis of transference, dream interpretation and free association. The idea behind it is to discover any unconscious thoughts, feelings and lost memories that might have influenced patient's behaviour. This technique was discovered by Sigmund Freud.

behavioural therapy uses conditioning to determine problematic behaviours. It was put in use when behaviourism was prominent. It uses classical conditioning, operant conditioning and social learning to discover and change problematic behaviour.

Cognitive theory means that therapists focuses on how thoughts influence patient's normal behaviour and functioning. It is based on an idea that our thoughts have a major influence on one's mental health state. As an example, if one sees and looks for negative things only, he is more likely to have a pessimistic view and grumpier mood. The goal is to find cognitive distortions and replace them with positive thoughts.

Humanistic therapy is a client-centred type of therapy, where the therapist shows unconditional positive regard to the client. It is widely used nowadays as well. This approach in psychotherapy helps people in improving their potential. This approach also emphasizes the importance of self-exploration, free will and self-actualization.

Cognitive-behavioural therapy is commonly used in treating mental problems such as depression, anxiety, phobias and addictions. This therapy is a combination of cognitive and behavioural principles and tries to change the bad and negative thoughts and behaviours.

Depending on the problem, therapy method, therapist and patient, different formats are used. We currently know 4 formats:

- Individual therapy
- Couples therapy
- Family therapy
- Group therapy

2.4.4 Puzzle Solving

Another way of reducing stress is puzzle solving. When thinking of stress, most people would not immediately imagine puzzles, but be more inclined to imagine any form of relaxing activity. But puzzle solving e.g. a jigsaw puzzle has been shown to reduce stress, and that the more your brain is involved, the less stressed you feel, as it can give the stressed person a sense of fulfilment and accomplishment when finishing a puzzle [28]. This is also why games are considered stress relieving, even violent video games have shown to alleviate stress, and that many uses video games as a coping method for stress recovery purposes. cooperative games in particular are beneficial because players can comfort and empower friends, create positive feelings among players and thereby both build resilience to and relief, stress. Essentially, any game or puzzle that you can enjoy will provide an escape from the daily stress and will be a stress reliever [29]. In short, escaping your daily life, be it work or school, escaping to something that you can control, will result in a rewarding conclusion that greatly helps not only relieving stress, but also to manage it.

2.4.5 Interacting with Friends

In 2010. a study over 308.000 participants [30], that shows an active social life can improve the user's life more than exercise can [31]. It does not mean the exercise should be excluded from the user, since that would have consequences on their health. This is due to how someone can relieve stress by talking to a friend or a specialist (2.4.3) where they are allowed to talk about their day or problems. That is more for the short terms stress, like at the end of a long day, stress can be reduced by talking to a friend [31].

The human brain releases endorphins that relieve stress or pain in other cases, when they are spending their time with good friends. a study from oxford in 2016, found out that people with a large social life had a higher pain tolerance that those with fewer friends or less fulfilling relationships
[32].

2.4.6 Music Therapy

Listening to music changes the activities in many brain regions, including the most important structures of emotional centres. The ability of music to interact with these brain structures is proof that music has an impact on human emotions. The emotional centre of brain structures is closely connected to people's immune system, which means that music provides people with beneficial effects on the physical and mental health of people [33].

In year 2012, after 26 small trials with a total 1369 participant, the results show that listening to music, singing or playing music may have beneficial effect in reducing stress, anxiety and helps people with heart and blood problems [34]. Based on the evaluation from the research of Harinek et al. [35] relaxing music is an effective tool for relaxation, stress reduction and anxiety.

2.4.7 Mindfulness

Mindfulness used as therapy for stress is a relatively new phenomenon in the western world, but across eastern cultures, forms of mindfulness has been used for centuries. Yoga and meditation for example are centred around dealing with everyday challenges as well as stress relevance. In 1979 Dr. Krbat-Zinn founded the Mindfulness-Based Stress Reduction- (MBSR)-lab at University of Massachusetts (UMASS). Here DR. Krbat-Zinn does research on how mindfulness can assist an individual, over an 8-week intense mindfulness program, to better and more effectively use their innate resources and abilities to respond to stress, pain and illness [36]. This being said, some argue what the true meaning of mindfulness is, while some say that this is the true meaning of the word, others believe that this is not true, as mindfulness at its core is "The quality or state of being conscious or aware of something." according to the Oxford dictionary [37].

2.4.8 Overview of Treatments

After researching different treatment options, it will be decided in this conclusion which methods complement each other and can be combined into a potentially suitable solution to the IPS. It will also eliminate certain treatments that will not compliment the final prototype.

Firstly, Psychotherapy will be ruled out. The reason for this is simply because one cannot safely work in this field without the relevant knowledge, experience or education. Secondly, after researching mindfulness, it can take up to eight weeks to realise the stress relieving benefits. Taking this into consideration, it would be too long term to test accurately. Finally, it was chosen to rule out music therapy as it is in direct conflict with the immersion aspect of eco-therapy.

Additionally, this project will attempt to combine this with low intensity physical activity, for example, walking in nature. Furthermore, puzzle solving will be used not just as a stress reducing technique but also, as a method of gamification. Interaction with friends can also be combined by having the prototype involve group activities.

2.5 Target Group

In this segment an outline of the target group will be made, to make sure that the product can help the target group as effectively as possible. This will be done in order to further understand the target group and their needs. This will be done by first looking at the demographics of the group, then why they are stressed, and finally a conclusion.

The target group will consist of people living in Denmark, as these are the people the statistical data is based on, also they are available for testing. As mentioned in the Introduction, Danmarks Statistik have uncovered that the age group from 16 to 24 made up 31,9% of all individuals experiencing serious stress symptoms. Therefore, it makes sense that this project should focus on that demographic.

Another important aspect to look at is that Danish children are half as much out in nature every day during the summer-season compared to their grandparents when they were children, according to a study made by Danmarks Naturfredningsforening [38]. This number could be an indication that people are less aware of rules in nature and therefore might not think to go into nature when they get older as a way do de-stress. This is a big difference, especially when considering the fact that the young adults of today's generation are so much more stressed, compared to previous generations. Furthermore, people seem to be bad at identifying stress, but also how to judge stress from serious stress. According to Google trends, there has been a 25% increase in google searches of the word stress since 2004 to today in Denmark. People are looking up symptoms of stress, and forms of dealing with stress at an increased rate compared to before, which indicates that people are not aware or taught enough about the subject. Stress has grown way more compared to the searches and the levels of stress in Danish society, but the attention of education on the subject seem to be stale [39].

Finally, it is important to stress the fact that anyone can be affected by stress in the sense that it takes different amounts of exposure to stressful environments to become stressed for different people. Stress can come from four main points; work, everyday life, the mind and private life [10]. Furthermore, Danish people without jobs are more stressed, but they also make up less of the total population compared to students. in a study from 2017 made by Dansk Magisterforening 45% of students in Denmark answered that they could often not overcome the tasks they had to do. Furthermore, just under 49% of students often felt stressed or nervous during their semester and this number increases to around 90% during the exam period [40]. Finally, one third of students felt angry when they did not have influence on what was happening (2).

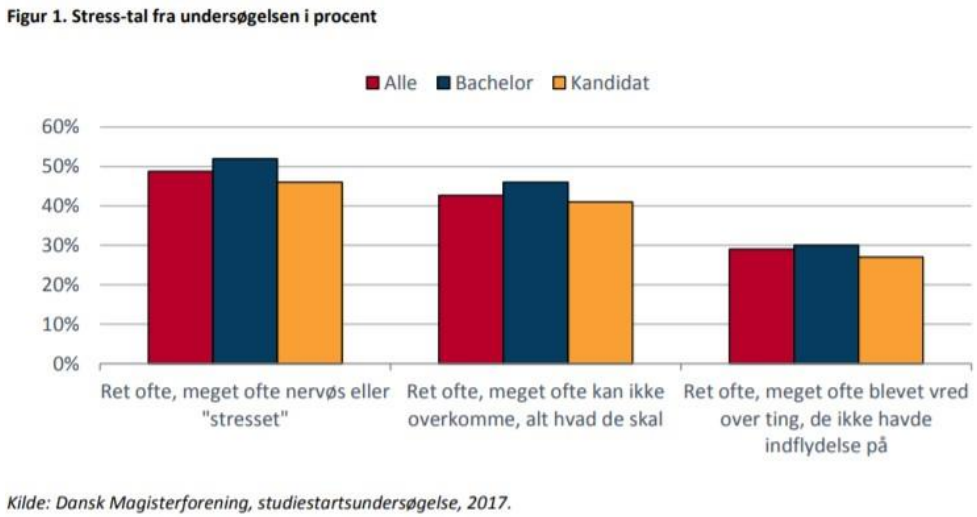


Figure 2: Stress of Danish students [40].

One of the reasons why this age group is more stressed than other age groups, could be due to the fact that expectations from society are increasing [41]. Every study demands higher grades than they did the past five years, while the amount of educations with no grade-requirement has fallen. The grades that the government expect students and applicants to have to continue their education, is set too high for them. With these facts in mind, the students will go into two scenarios, one where they overwork themselves to get good grades or the second scenario where they do the minimum work for a passing grade. The path of overworking themselves can lead to episodic acute stress (2.2.2) and the minimum work effort may lead to chronic stress (2.2.3).

From the information gathered in the analysis above a target group can be made. The target group is students that are young adults in the age range 16-24, who live in Denmark.

2.6 Relevant Technologies

This chapter will take a look at the technologies available to consumers today, as well as technologies and developmental tools that can be used in relation to the problem of stress in Danish society. Since the target group has been established in the previous section, the technologies most relevant to said target group will be explored in depth. However, this does not imply that these technologies do not serve a larger market. The overall ambition of this section will be to discover what type of technology could serve as the basis of the project and satisfy the target group's needs.

2.6.1 Smartphones

Smartphones are phones with advanced operation system which allows users to install, use, and manage other applications. Operation systems that differs from classic cell phones are iOS, Android, Windows Phone, Windows Mobile, Bada, Blackberry, MeeGo and Symbian [42]. Over

six billion of people have a smartphone [43], which nowadays can be compared to a desktop computer, which means that smartphones are not only used for sending SMS and calling [42].

Smartphones are personal, and the user should expect a level of privacy to be met. People do not need to share their phones with anyone, they can customise the smartphone according to their needs or tastes. Communication on the device belongs only to the owner of that phone. In turn, they should not have to worry about somebody eavesdropping on their conversations [44].

The biggest smartphone companies are trying to enlarge RAM, improve processors and increase the resolution of displays. This is, in part, due to mobile gaming being a dynamically growing area. As the demand for mobile games grows, if developers wish to remain in a competitive market, so must the computing power of the devices[45]. For instance, the figure (3) shows two searching phrases: blue = Android games, red = Android apps.

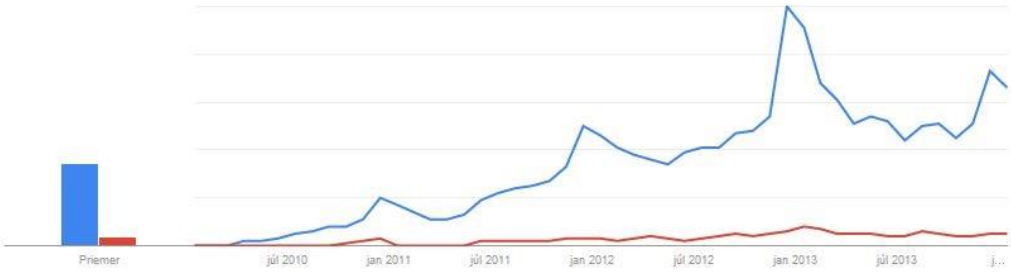


Figure 3: Comparison between searching games and apps [45].

An advantage of common mobile games is the fact that people almost always have their mobile phones with them. In that case, they can play games anywhere at any time, even, thanks to waterproof smartphones, in a bath. Mobile games are relatively basic, they contain more small levels, which user can pass through in few minutes. On the other hand, more advanced games - 3D games from the greatest game companies, are being made for smartphones that can be compared in quality to that of computer games [45].

in Denmark, more than 88% of every household has a smartphone according to Danmark's Statistik [46]. It is possible to look into what device they have, what Operating system (OS) they use and what version of it. It can be used to find out what technology is available for and popular with the user.

To find out what devices that are used most in Denmark, a tour over to DevieAtlas can tell what devices are the most popular in Denmark. The most popular smartphone in Denmark in 2019 starts with the iPhone 5S, being the oldest with the iPhone operating system (iOS) and all the way up to iPhone X as the newest edition. Samsung on the other hand starts at Samsung Galaxy S7 as the oldest, and the newest one being the Samsung Galaxy S9. More precise number can be found in the figure (4).



Country	Position	Phone model	Share
Denmark	1	iPhone 6	11.71%
Denmark	2	iPhone 7	9.54%
Denmark	3	iPhone SE	5.85%
Denmark	4	iPhone 6S	5.72%
Denmark	5	iPhone 8	4.71%
Denmark	6	iPhone X	4.58%
Denmark	7	Samsung Galaxy S7 Edge	2.92%
Denmark	8	Samsung Galaxy S7	1.97%
Denmark	9	Samsung Galaxy S8	1.97%
Denmark	10	iPhone 5S	1.90%
Denmark	11	iPhone 7 Plus	1.78%
Denmark	12	Samsung Galaxy S9	1.08%

Figure 4: Most popular smartphones in Denmark,2019 [47].

2.6.2 Virtual Reality

Virtual reality (VR) has been around since the 1970's. The technology has been pursued since the end of the second world war, since armies wanted to train pilots and later tank operators and captains in the control of the related vehicles without putting the operators at risk. VR technology saw an exponential increase in usability and performance following the emergence of high-speed computers developed during the 1980's [48]. Today, VR is readily available to the consumer market and top shelf VR headsets are priced comparable to that of a new smartphone [49].

The goal for VR technology remains the same since the emergence of the technology, to immerse the user in a virtual environment that will simulate some situation, be it driving, playing a game or doing surgery. Studies show that VR can evoke real emotions because it gives the user a sense of presence in the virtual environment, this combined with techniques used in film making or game development to evoke emotions gives VR a great opportunity to be immersive [50] and [51]. This immersion is currently used in various applications spanning several categories. These include military, sport, mental health, medical training and education. These are all more or less related to learning a certain skill or train existing skills [52]. VR is mostly recognized as a tool for entertainment, this can be seen when doing a search

for most popular applications on the website WEARVR.com, the world's leading independent VR application store [53].

Apple have their own augmented reality (AR) developer kit called ARKit [54]. This kit is only for the iOS and it requires an iOS device with iOS 11 and an A9 processor or later to run it. That means the oldest device that an AR application can run on is the iPhone 6s, 6s plus or SE. Every model after that can run AR applications. For virtual reality (VR), Apple themselves have not made a developer kit for the iOS, but Google have. Google's VR uses Unity where they have made a kit called "Google VR" [55]. This kit supports iPhone 5 and upward with running iOS 8 or higher.

Android on the other hand, is using the same method as iPhone with Google VR. To use VR on Android, the device needed to have android 4.4, known as "KitKat" and it needed a holder like the google cardboard [56]. To give an idea how old the android smartphone can be, KitKat is used on the Samsung Galaxy S4, which was released 2013. AR for Android requires android 8.0, called Oreo which was introduced with the Samsung Galaxy S7 [57]. For development, it is possible to use Unity with an asset called "ARCore SDK" [58].

VR could help facilitate stress treatment, but there are a few difficulties related to VR. First of all, not many people own a VR headset and therefore it might be difficult to reach the people in need of the treatment. Secondly, with a focus on eco-therapy for the prototype, VR might hinder some of the positive effects of being in nature like sight, hearing, real world immersion and presence.

2.6.3 Augmented Reality

Augmented Reality (AR) is the overlaying of virtual elements in a real environment. This can be done in various ways, through head mounted displays (HMD) or through your smartphone's camera. The virtual elements in an AR system must respond to the user (this is usually the response to the user's movements) to be true augmented reality. This means that 3D compositing in motion pictures is excluded. Lastly true AR requires the virtual overlay to interact with the real-world environment.

Another type of unique technical implication that AR can have is different affordances. Which is why it can have a whole other applied use, to motivate people to go outside. However, as AR still is not explicitly defined, and its definitions have had different versions over time. Here are 3 simple "listings" that defines AR in a simple way [59]:

- Combines real and virtual
- Is interactive in real time
- Is registered in three dimensions

For this project, handheld AR devices will be focused on, because of the aforementioned ubiquity of cell phones in (2.6.1) and because most other AR devices are either under development, or are still created for corporate use, or to further research. The problem with AR right now, compared to VR, is its technological requirements that are even higher, e.g. the

tracking of the user must have a much higher accuracy, and wider input [60]. AR will, as VR, increase immersion and can bolster the enjoyment and motivation of the experience. It was originally researched and developed for similar reason as VR - it can prove useful for, amongst other things, designing and assembling areas in corporate or military settings [60].

AR can still be considered uncharted territory, with a very small amount of people actually owning an AR device. It is still, however, recognised for having potential future use. Furthermore, today's most modern phones already have AR capabilities, and as long as they are on the newest update and version, it should work. It has potential to facilitate stress treatments and is well coupled with physical activity and eco-therapy, as all of these requires the users to move around outside. It is for this reason that it has been chosen to work with AR, as well as its possibilities to be combined with other stress alleviation measurements.

2.6.4 Global Positioning System

A common practice when using AR, is to use the global positioning system (GPS) for cleaner interaction between real life and virtual objects [61]. The GPS work on phones by receiving data from four or more of the 28 satellites that is only used for geo-location [62]. Since this data is using radio waves, it is slow and use a lot of power. There is another GPS system for phones called "Assisted global positioning system" or, AGPS. This system is using the phone's signal by pinging the cell towers to give the location to your phone carrier. This data is more precise, down to 50 meters in real time, but for this to work, the phone needs an active data plan.

2.7 Gamification

The following section will explain how gamification can be utilised to improve the user experience when using interactive systems, and how it can be used to facilitate stress prevention. Since this project will focus on having users interact with a prototype that could help prevent stress, it is important to explore theories that could help increase engagement with the prototype. Gamification is a theory that relies on using game design elements to increase user engagement and therefore important to this project.

The term "gamification" was coined in 2008 in the book *The Gameful World: Approaches, Issues, Applications* [63]. Gamification is in short using game-design elements like points, score, levels, rewards and game-design principles like *"easy to learn, hard to master"* & *"more rewards than punishment"* [64] in a non-gaming context. The reason for doing this is to increase the user's overall engagement with the system. Gamification can improve ease-of-use, flow, physical exercise, extrinsic motivation, learning and more when utilized in the design of a system. A few examples of gamification that are regarded as successful implementation of the method is Pokémon Go [65] and Nike+ [66]. Both have been complimented in their ability to motivate people to exercise more [67] and [68]. A relevant term to also have in mind when creating our software will be gamification, that has been trending in the last couple of years.

Gamification can turn something non-gaming related into actual games or something that is similar. Hamari et al defines it as "*a process of enhancing services with (motivational) affordances in order to invoke gameful experiences and further behavioral outcomes*" [69]. In simple terms, it is taking gaming elements into something non-gaming related. It is used to

increase user engagement, social interaction, and overall motivation for users. E.g. the system could have a competitive function implemented, as a form of scoreboard that could put users against each other, this way motivating users to compete with each other, using the system more often. This can, however work against the intended and reduce the amount of intrinsic motivation, making the user more interested in the game for the game's sake, and not because the user wants to reduce stress. For our software, it needs to be in a balanced amount, not losing the focus of eco-therapy but also incentivise the user to keep playing.

Gamification can be used to facilitate the treatment of stress by making the user more engaged in the use of our prototype, keeping the user motivated and rewarding the user for their engagement, for this reason making it relevant to our project.

2.8 Interaction Design

This section intends to cover theories of interaction design that will be relevant to this project. These theories will be later used in the design chapter and implemented in the prototype. They will be focused on Don Norman and his design principles as well as the four interaction types, Gestalt principles and UI/UX.

2.8.1 Don Norman's Interaction Design Principles

When designing user-centred applications, there is no getting around Don Norman. Norman is especially known for his book The Design of Everyday Things. In his book he analyses the design of everyday objects and extrapolates what makes a design especially user friendly. This is boiled down to a few catchwords that explain the design principles that one should stick to when designing for the user. Norman talks about affordance, feedback, consistency, mapping, visibility and constraints [70] and [71].

Affordance: Affordance refers to clues in an object that hint at how the user should use them. For smartphone applications, this is closely related to icons, these can represent some action, like a letter symbol represents your e-mail or a house will represent going back to the default page of an application. Having strong affordances is crucial when introducing the user to a new application, this will affect how likely they are to use it or return after the initial attempt. On the other hand, if the user opens the application and does not know how to get around, they might close it down and delete it without wasting their time [70] and [71].

Feedback: When a user interacts with some graphical element in an application, opens a menu or otherwise does something inside the application, it is important that appropriate feedback is given. Taking a picture inside an application might make a camera sound and make the screen flash white for a second. This will let the user know that their action has been performed. Good feedback will always improve the user experience [70] and [71].

Consistency: Consistency is somewhat self-explanatory; it means that when you offer some form of interaction, the layout, colour or other remains the same for this type of interaction throughout the application [70] and [71]. When designing for mobile, one can partly rely on Google's Material Design Guidelines (android) [72] or Apple's Human Interaction guidelines

(iOS) [73]. These guidelines will help during the design process by verifying that the design is consistent with current design practices.

Mapping: When creating an application, it is important to consider mapping. Mapping refers to the relationship between controls (Icons, menus, other graphical elements) and their effect on the state of the application. It should be as obvious as possible for the user what their actions will do when using the application [70] and [71].

Visibility: Simply put, visibility refers to the relationship between highly visible functions, and the user's likelihood to use that function. The higher the visibility, the more likely the user is to interact with the function, and on the contrary, the less visible a function is, the less likely the user is to interact with it. This can be utilized to guide the user through the application in a certain way [70] and [71].

Constraints: Another way of guiding the user is to constrain the possibilities the user has on any given page of an application. If you overwhelm the user with possibilities, it is more likely than not, that they will use the application in a way not intended by the designer. Therefore, it is important to only show the possible elements that would increase the users experience with the application [70] and [71].

2.8.2 Gestalt Principles

The term Gestalt means 'unified whole'. This is the overall theme of the Gestalt principles, which state that humans will tend to see groups of information before they see the individual parts. There are six Gestalt principles related to design. These are:

- Similarity,
- Continuation,
- Closure,
- Proximity,
- Figure/Ground and,
- Symmetry and order.

Similarity is the phenomenon that humans see visually similar things as the same object. For example, in figure (5) the shapes are perceived as one, while the letter c stands out as different.

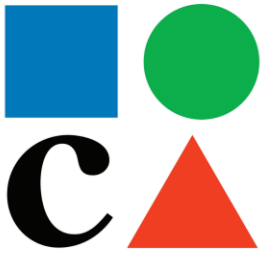


Figure 5: Gestalt principle of similarity.

Continuation is the principle where the eyes are guided along a path within the design, often leading towards a secondary element of the composition. This is seen in figure (6), where the line leads the eyes through the letter H to the secondary element, in this case, the leaf.



Figure 6: Gestalt principle of continuation.

Closure allows the viewer to fill in blank spaces in a design. It works where an object is incomplete or if an element's interior space is not fully closed. A great example of this is the World Wildlife Fund logo as seen in figure (7).



Figure 7: Gestalt principle of closure.

Proximity or grouping is the close arrangement of objects to show their connection to each other. These grouped objects will be perceived as a single whole, even though they are separate elements. This can be seen in figure (8), Adobe applications are grouped together and separate from other groups such as Microsoft Office.



Figure 8: Gestalt principle of proximity.

Figure/ground describes the tendency of the eye to separate objects from the background of a composition. The human brain wants to separate the foreground image from the background and perceive them as two different elements. As seen in figure (9), the eyes see the fork and the wine bottles as two separate objects within the composition.

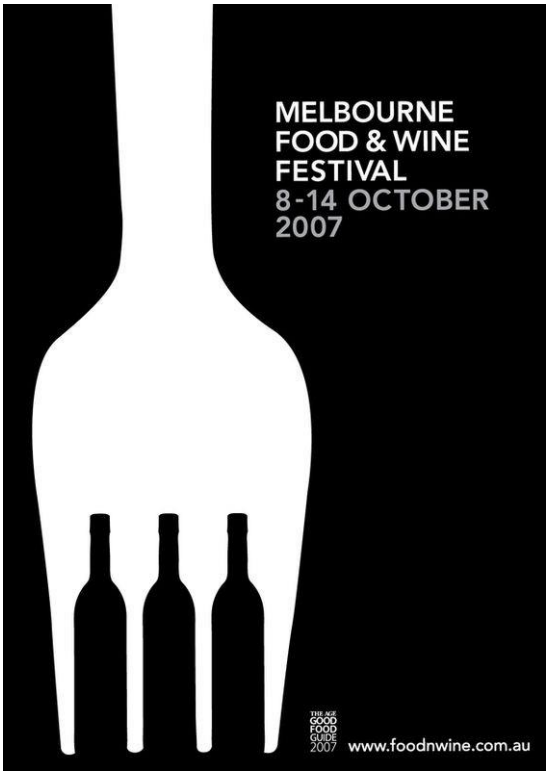


Figure 9: Gestalt principle of figure/ground.

The symmetry principle states that symmetrical elements within a design are perceived as a whole. This can be done through symmetry or ordering elements within a composition. If this principle is ignored the design can leave the viewer trying to figure out what is wrong or missing in the design. In figure (10), there is good use of symmetry and balances the design to create a simple yet attractive composition.



Figure 10: Gestalt principle of symmetry.

2.8.3 Seven States of Action

The seven stages of action can be split up into two parts, namely the gulf of execution and the gulf of evaluation. The gulf of execution and gulf of evaluation is the distance between users and the physical system interface, and how users get there.

The gulf of execution, meaning how users do certain things, and if they can figure it out, and is all about user discoverability. Likewise, is the gulf of evaluation the distance from the physical system interface to the user, what kind of feedback they are getting. Do they know what happened and why after a certain execution has happened?

This is important, because it is relevant to know how best to bridge the gulfs, making it easier for users to achieve their goal with the application they are using, and reduce their cognitive effort here [74]. This can happen through making interfaces that match users' psychological characteristics, and make the user learn how to plan and create goals and create action sequences [74].

They are the two parts of Norman's 7 stages of action, between the goals and the world.

- Goal forming
- Intention forming
- Planning of actions
- Execution of those actions
- Perceiving the worlds state
- Interpreting the worlds state
- Evaluating the result

As an example, let's say one wants a chair that supports his back. After the goal is formed, he next plans which new chair to buy, and afterwards executes that plan, buying the chair. He now sees the chair, and then understands that it supports his back while sitting it. He evaluates it and sees that he can now sit down for a longer period of time without getting back pain. This is very relevant for every kind of design and can be used as a check list to make sure to bridge the gulfs with as few issues as possible.

2.8.4 Usability Goals

For the user to have a great experience using any program, they need to be efficient, effective and to such a satisfactory degree that users will not seek elsewhere for their goal. Quite simply, if a product of any kind is not usable, the UX will be bad, and then users will leave. It is therefore necessary to look into the goals of the users, so the product does become usable. Here, are six usability goals that helps make sure that the users get the best experience possible: goals [75]:

- Effectiveness
- Efficiency
- safety/errors
- Utility
- Learnability
- Memorability

Effectiveness means how good the overall system is at what it does, whereas efficiency refers to the time the job takes, and the likelihood of mistakes. Safety means how safe the system is for users, and Utility measures all the functionality that the system holds. At last learnability means how easy the system is to learn, and, once learned, how easy it is to recall is the memorability.

2.8.5 Types of Interfaces

This section deals with various types of interfaces related to the creation of the project prototype. The section aims to uncover which interface theory might be useful during the design process. Mobile/Smartphones augmented, and virtual reality interfaces are covered in depth in sections (2.6.1), (2.6.2) and (2.6.3).

Multimedia interface: A multimedia interface incorporates different media within the same application. This could be animations, text and video for example. The goal with doing this, is to convey information in an easily understandable way, that encourages the user to explore the application by clicking on the animations or graphical elements within the application. It is also worth noting that the incorporation of multiple media will help facilitate quick access to information. To give an example of this, we can imagine an application that provides clues to a puzzle, these clues might be presented as text, a video or an animation [74].

Touch interfaces: The touch or multi-touch interface is useful when working with applications where the user is encouraged to zoom, turn or otherwise interact with a graphical element like a 3D model. Since the technology is very widespread it also helps the learnability for new users, if used in accordance with existing paradigm for touch interfaces [74].

2.8.6 Colour theory

Colour theory means how and what colours are getting picked for the product. It is about creating harmony between buttons, background and images to give the user a better experience [76]. In 1666, Sir Isaac Newton made the colour wheel from a passage of light through a prism and translated that intro a circle of segments. The colour wheel has changed over time with its colour for each segment, but more or less remain the same and in 2011, Bleicher stated that the wheel could be categorized into three main types of colours. The types of colours are following:

- Primary colours
- Secondary colours
- Tertiary colours

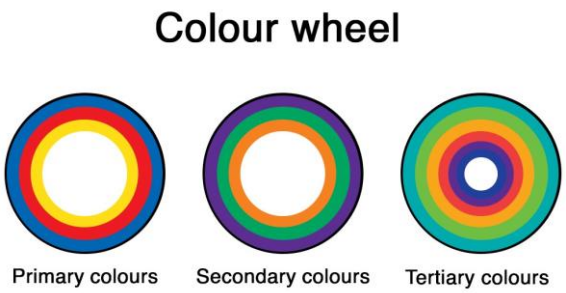


Figure 11: colour wheel.

Primary colours are the basic colours that cannot be broken down into any simple colours, and these colours are yellow, red and blue. The secondary colours are a combination of two from the primary colours to make a new colour, such as orange, green and purple. Lastly, the tertiary colours are created, by mixing a primary colour and a secondary colour together.

To figure out which selections of colours create most harmony, Bleicher also create five main colours schemes that allow the designers to make harmony in their designs. These schemes are as followed:

- Monochromatic
- Analogous
- Complementary
- Split-Complementary or Compound
- Triadic

Monochromatic scheme is where one colour is selected and then adding black or white to get different shades or tones of the selected colour. A scheme like this is commonly used in minimal design because it becomes less distracting when there is one hue.

Analogous scheme is where colours are next to each other in the colour wheel. It could be either secondary or primary colour as the main colour and then the tertiary colours next to them. This scheme can be found in the nature, e.g. leaves from a tree change colour depending on the season.

Complementary schemes, also known as opposite colour scheme due to how the scheme is working. For this one, a colour is chosen and then the opposite of that colour is picked as well, to make a contrast between them.

Split-Complementary is a combination of complementary and analogous scheme and is used to soften the impact of the complementary scheme. It can in some situations become too bold or harsh for the viewer's eye and might ruin their experience.

Triadic scheme is where three colours are picked with equal distance between each other. A way to find the colours is to make an equilateral triangle and place it in on the wheel. Each corner of the triangle will touch a colour that is 120°from each other. This scheme is used a lot in art, since it can deliver a pleasing visual result compared to using complementary schemes.

A good technique to utilize these schemes could be the 60-30-10 rule [77]. This technique is simple and bring balance to the composition. The colours will be combined in proportion of 60%, 30% and 10%. The 60% will go to the dominant hue, 30% for the secondary colour and 10% for the accent colour. This make it more pleasant for the human eye and make it easier for the designer to make user interface, when they know the proportions.

2.9 State of The Art

The intention of this section is to evaluate other programs or apps related to the theme of the project and decide which elements of apps and programs could be used in our prototype. This chapter will assist us as an inspiration for the design chapter and design requirements that will be used in final design.

Previously done research on Stress Management and Prevention (2.3), forms of Stress Treatment (2.4), Target Group (2.5), Relevant Technology (2.6), Gamification (2.7) and Interaction Design (2.8) in previous sections, assisted us to make conclusions on what kinds of apps we should consider while choosing the right way to set the app up.

Exploring already existing apps such as Headspace, Geocaching, Pokémon Go, Sketchfab, Fenn Treasure and puzzle games, it is important to find more information for further research and development of the prototype, the layout of the prototype and which techniques involved while designing a treasure hunt might be.

2.9.1 Headspace

The Headspace application gives people the opportunity to utilise the benefits of meditation anywhere and anytime [78]. It is available for Apple iOS and Android devices and the app can be purchased in the App Store, Google Play or Amazon.com [79]. Headspace contains voice guided meditations, pleasant animations explaining concepts, a user-friendly interface which is customisable and more. The app is being used by millions of users and in more than 190

countries [78]. The full library of content contains approximately 365 meditations and new ones are being developed [79]. Since it is best to repeat exercises daily, the app gives the users a chance to set up reminders in the Calendar for exercises. The app is free and includes the first 10 sessions, after that, it is required to upgrade which costs almost 6 euros per a month and it gives users the right to choose lectures they like or to create their own lectures [80].

Headspace's design is easy on the eyes, since it's an uncluttered interface that greets the user. The app uses pastel colours, which means that colours are bright, but also less saturated. Colours are minimalistic and mostly in monochromatic scale, in combination with complementary colours. More specifically, background colours are white, shades of blue and low saturated shades of yellow and orange. As contrast colours were used shades with strong saturation of orange, turquoise, yellow, brown and grey colours.

The app uses an easy to read font with a combination of regular and bold letters. There is no unnecessary text and the text is not cluttered. During the meditation lectures, the only text visible is the name of the session and the timer. Meditations are voice guided and they are all in English and it means basic knowledge or understanding of the language is necessary to attend meditation lectures.

All pictures in the app and all buttons except the bottom bar buttons have rounded corners, which makes the overall design look even more user-friendly and calming. Characters that appear in the app always pop up, with higher saturation and contrast. These creatures are simple and possess a friendly look, fulfilling the task to sooth the user.

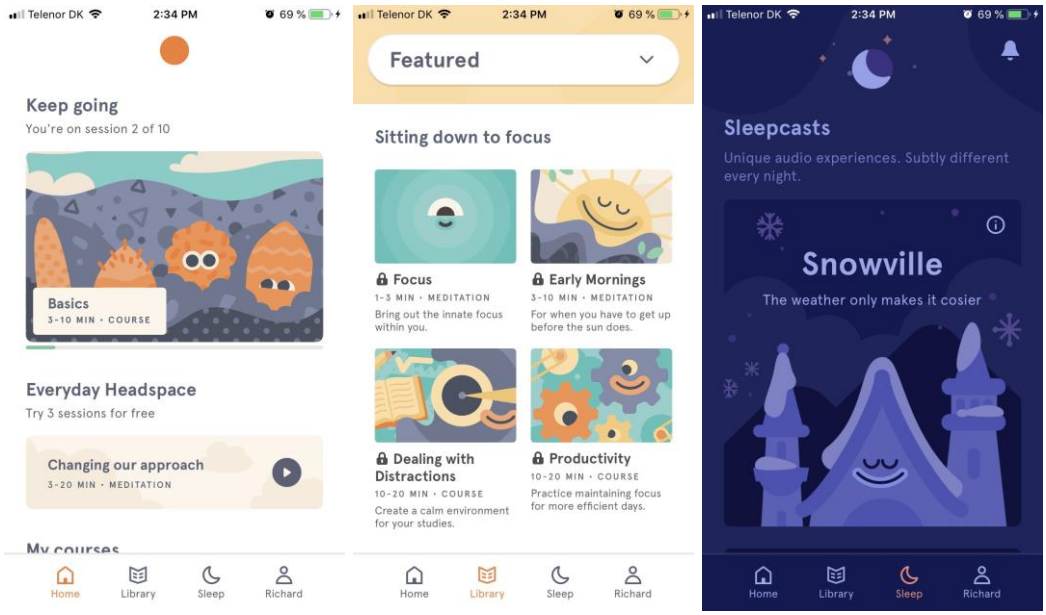


Figure 12: Headspace interface.

2.9.2 Geocaching

Geocaching is an app used all over the world to help exploring new things, places and adventures. This project's prototype will also focus on exploring new things, places and going out and spending time in the nature. Thus, giving good basis to base our app on. It is a family-friendly app that helps families get together and explore their surroundings whether they are at home, or on a vacation in a different country or city. For example, there is 1762 Geocaches around Aalborg. The whole idea of Geocaching works on the idea of users creating caches, hideouts for their treasures, providing riddles or navigations to help other users find it. When a user finds a cache, there is a logbook where users sign their names or usernames. There is also a stash of different things, where you can leave a personal belonging of your own and trade it for a different thing. Some "professional" Geocachers have their own badges that they leave in the stashes. Owners of caches declare how difficult it is to find the cache, how big it is and what the terrain to finding the cache is like. When a cache found, Geocachers have the opportunity to rate and comment on how long it took you, how difficult it was and how big it was [81] and [82].

The Geocaching team made a study on their product, where they recruited 14 Geocachers from the United Kingdom, out of which 10 were males and 4 females ranging between 20-60 years of age. Some Geocachers went Geocaching with their children, giving the researchers an additional viewpoint. Participants' experience with Geocaching differed substantially, some having several years of experience from before and some being very new to the activity. The researchers' aim for the study was exploratory, and to gain more knowledge from the participants on issues the users might have while using the app. Participants were also given £40.00 vouchers for participating in the study [83].

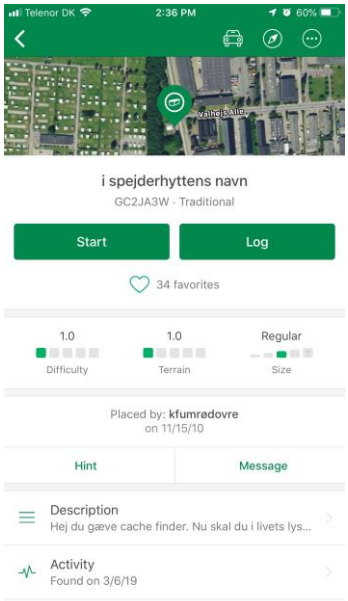


Figure 13: Geocaching Cache Interface.

Some of the results show that sometimes, it was not the intention of the user to go out Geocaching but saw an opportunity and decided to find a cache. One example was a participant visiting a friend, while friend went inside of his house to grab something, the participant decided to spend the time looking for a cache, he found a cache and returned back in 10 minutes. Geocaching revolves around other activities, where people seize the opportunity to go look for a cache. Another finding was that regular users check the Geocaching website regularly also turning on e-mail notifications to be notified if a new cache has been made locally around their house, work, or places they visit on regular basis [83].

The app itself has a nice, clean design with minimalistic elements. Its main element is green colour that appears to represent earth and correlation to earth elements as grass, trees, etc. After downloading, it asks for an account creation or log in. After logging in, the app gives a small intro on how the app works and how to use and navigate through it. When in-app, the layout has 5 buttons on the bottom bar that offer navigation to: Your profile, messages, map, lists and more.

2.9.3 Pokémon Go

Pokémon Go is a mobile game based on GPS location and augmented reality technology. Pokémon Go was launched in 2016 and it soon became the most popular game in the history of USA, with more than 25 million users in a week after releasing the game. The game's most important feature is the mobility that the game encourages and AR technology. Users are required to move in addition to hunt and collect Pokémon or to fight other users [84].

Tim Althoff et al. [85] have done a research on Pokémon Go based on a physical activity while playing. The results show that Pokémon Go leads people to increase their daily physical activity over a period of 30 days. For instance, users increased their daily activity by 1473 steps on average in a day. Another important fact to mention is, that the game increased physical activity to both men and women, of all ages and all weights. They also found, that the combination of game play and physical activity helps to reach activity-poor people [85].

AR games like Pokémon Go helps people to get in touch with other users, many games provide users with online communities and communication in those communities. Players of Pokémon Go are forming groups all over the world and are meeting in public places. In this point of view, Pokémon Go is beneficial game to meet and interact with people. Playing the same game can help starting a new conversation with other people outside on the street and/or build stronger relationships. On the other hand, players of this game look immersed into their devices, which can be also very dangerous [86].

After starting the Pokémon Go game a map with a user's character are displayed. Player can rotate and zoom in and out the map, but the character only moves when the user is moving himself. Then the hunt on Pokémons can begin.

Catching Pokémons is very exciting, since it is happening in AR. By walking around, the user can see on the map a Pokémon creature and after clicking on it, the map changes on a camera view and user has to press the grass on a screen. After that, a Pokémon appears somewhere on the screen, but most likely the user has to turn around and find the Pokémon, then throw a Pokéball on it and wait. Based on a rarity of a certain Pokémon that user tries to catch, can happen that Pokémon escapes from the Pokéball, but if not, they luckily get a Pokémon to their

collection. This helps encourage the user to explore and move around more. This along with achievements and bonuses that players get when walking a certain amounts of distance help encourage longer walks and activities outside.



Figure 14: Pokémon Go interface.

2.9.4 Puzzle games

Solving puzzles improves IQ, encountering a problem and logically and reasonably trying to figure out a way to solve it helps train your brain. Puzzles require the use of one's general knowledge, memory, logic, problem solving skills and more. Thus, gamifying puzzles is a good way to get in touch with a bigger number of users. Following examples of games are all puzzle games examples showing different aspects and types of puzzles.

PC games such as Klondike, backgammon, chess, and many more are PC remakes of actual board games that require thinking and problem-solving. Microsoft was the first to provide PC users with games without having to pay any extra fees for downloading them. The games that they had built into their Operating Systems' were games such as Klondike, Minesweeper, Pinball and more. The definition of a puzzle is, a game, toy or a problem designed to test one's ingenuity or knowledge. Therefore, games that are testing one's knowledge or logic are puzzle games. Tetris for example, players has to strategically place and turn falling objects so that they fit in the holes left out previously. If a player manages to fill all holes in a row, the row disappears, and player gets score and more time to play.

Some puzzle games are dynamic. Setting the difficulty according to players' skills and continuously increasing the level of puzzles requiring more dexterity and quicker responses or finding more clever ways to solve complex solutions. Depending on the difficulty and the individual, some tend to give up if the difficulty gets too difficult for them to solve the puzzle, but some persist and do their best to complete it [87].

A study has suggested that playing puzzle video games such as ”Angry Birds”, ”Bejeweled II”, etc. with minimal interfaces, short-term commitments but also high and easy accessibility tend to liven up player’s mood, assist in relaxation but also prevent anxieties. Puzzle games are often a source of triggering positive emotions. One let down is, that these games are designed to provide a short-term entertainment, often not getting people to play the game for a long time as it might get repetitive [87].

2.9.5 Fenn Treasure

Fenn Treasure is located in Yellowstone National Park, in the Rocky Mountains. It is a treasure hidden by the art dealer and author Forrest Fenn. Fenn made the treasure because he is an adrenaline junkie who wanted to give people some hope, and his treasure hunt has attracted many thrill seekers. Supposedly, the treasure is worth over a million dollars and people have gotten close to the treasure, some as close as 60m, but no one has ever found the treasure. There are 9 clues, which have supposedly been solved, but not in the right order. This proves how many people decided to go on a hunt, and how many people this treasure hunt has gotten to go outside [88].

4 people have been reported to have died while on a hunt for the Fenn Treasure. Police of New Mexico have tried to stop the hunt by pressuring Fenn into ending it. Fenn said *”No one knows where that treasure chest is, but me”*, followed with, *”If I die tomorrow, the knowledge of that location goes in the coffin with me”*. [88].

Supposedly, the box is a Romanesque box and when full, it weighs around 40 pounds. The location of the box is unknown, but Fenn’s book - The Thrill of the Chase, gives information in riddles on how to find it. Fenn gets several emails a day from treasure hunters asking him for more clues, to which he refuses to reply [89].

2.9.6 State of the Art conclusion

Having looked at different possible aspects for our prototype, Geocaching and Headspace will help establish a base for a good User Interface. Researching different treasure hunts, it has discovered that people, among other things, are driven by curiosity. The Headspace app focuses on humans’ well-being in general, but stress treatment is one big category there. Drawing inspiration from the Headspace, one of the biggest emphases should be given to colours and fonts that act calming to users. Puzzles might be a good addition to our prototype, while giving information and hints about the treasure, also sparks curiosity in the hunter and makes them think of all the possible solutions for the riddle or puzzle. The prototype can combine puzzles into AR technology, and based on the research on Pokémon Go, the prototype could be able to increase people’s physical activity.

2.10 SWOT Analysis

The SWOT analysis will be focused on Geocaching (2.9.2). While there are many apps that revolve around our topic of stress management and treasure/scavenger hunting, Geocaching is the most relevant concept-wise, thus this SWOT analysis will be focused on it.

SWOT analysis is used to analyse a product with an identical theme or idea to figure out its

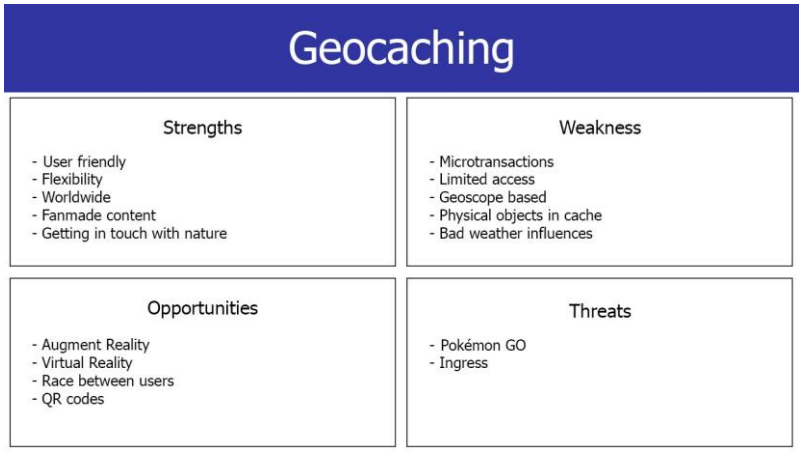


Figure 15: SWOT analysis of Geocaching.

strengths, weakness', opportunities and threats. This information can aid the design process, the strengths can be reused, and the weaknesses rethought.

A strength of the Geocaching application is its user-friendly interface. An interface that is easy to understand and use is a must have in any application. With that said, Geocaching delivers an easy and simple solution for content creation. It approaches this by allowing the users to setup their own routes through coordinates, riddles or clues.

A weakness of the application is its limited access and micro-transactions. Limited access is referring to that most of the content is hidden behind a paywall, which means that the user has limited free content. Micro-transactions are reserved for premium memberships. The user has to pay monthly to gain access to the locked content.

The future development of Geocaching could offer the option of Augmented Reality integration. Or, the addition of Virtual Reality for a more versatile approach to cache hideouts and hints. Adding some sort of a competitive element could also be implemented, this could bolster motivation through competitiveness. The addition of QR codes could also be a possibility, if a user came to a certain location, they could scan a QR code and get a new set of coordinates and riddles to advance in their hunt.

Potential Threats of Geocaching are for example Pokémon Go and Ingress. Pokémon go offers the same thrill and excitement of finding a Pokémon as finding a cache, but also offers an AR experience when catching a particular Pokémon. Although the apps focus on different aspects of "hunting". Ingress was made by the same developers as Pokémon Go, but without the idea of catching creatures or finding caches. All of these apps us GPS and location tracking as their main feature. Other attributes can be found in figure (15).

3 Final Problem Statement

The project's initial problem statement was as follows:

"How can the use of media technology paired with eco-therapy help alleviate stress among young adults"

Through the research and analysis, a definition of types of stress was made, as well as which kinds of treatments and management are available. Stress was originally not a bad thing but has in a modern society become a larger issue, as humans no longer need the fight or flight instinct. There are quite a few treatments for stress, e.g. eco-therapy in which the user is subjected to nature has been shown to have many beneficial effects on people who experience high levels of stress. In eco-therapy, users are going on an excursion into the wilderness and enjoys the surroundings and a break from their busy daily lives (2.4.1).

The analysis of the target group found that Danish citizens between the age of 16 and 24 are less frequently in nature compared to the previous generations when they were the same age (2.5). Therefore, puzzle solving and gamification combined with eco-therapy and stories could encourage and motivate students to go outside while treating their stress.

Various relevant media technologies that were capable of facilitating these stress treatments were also looked into. VR is shown to be increasingly accessible for everyday users, and the AR technologies for smartphones becoming more prominent. Furthermore, smartphones are owned by nearly everyone in the target group which makes it a suitable medium to design a prototype for.

Different types of Interaction Design principles and theories were looked into and these will be utilised in the design process of the prototype. Don Normans design principles and seven stages of action were discussed and described to better bridge the gulf of evaluation and execution. Furthermore, aspects of interaction design were elaborated upon including Gestalt principles.

Looking back at the State of the Art research (2.9), it was discovered that popular stress management apps utilize a minimalistic, clean design, some relying on voice guidance and some calm the user through well-designed colour palettes. Furthermore, the fonts used are easy to read and calming for the user. When going through the design process, the information held in the State of The Art chapter will be drawn upon to create the best possible design.

The research in the analysis points toward the fact, that a location-based eco-therapy application could be beneficial at reducing and preventing stress. But since it is beyond the scope of this project to test whether or not it does prevent or reduce stress, it has been chosen to focus this project on creating an application that is able to relax the user using the strategies and techniques that were discussed in (2.3) and (2.4). Therefore, the project will focus on testing for usability instead of alleviating stress, as that would require intricate testing over a long period of time, which, again, is not feasible. With this research and analysis in mind, the following final problem statement was chosen:

"How can a location-based mobile interface, relying on eco-therapy theory, gamification, and augmented reality, create relaxing walking experiences on behalf of Danish students between the age of 16 and 24 by guiding them to specific locations in nature?"

3.1 Design Requirements

Through our analysis we've found a list of requirements that the prototype should consist of. There are both functional and non-functional requirements and they are as follows:

Non-functional requirements:

- Must be able to run on a smartphone
- Must use AR technologies
- Must use GPS location for various functionality
- Must be able to identify the current GPS location of the user
- Spawn a 3D model at a specific GPS location
- Will be written Unity C#
- Nature inspired colour palette
- Must use touch interface
- Must use Don Norman and Gestalt principles Functional requirements:
- Puzzles/riddles should not be too difficult
- Puzzles through gamification
- Encourage user to go outdoors
- Encourage user to not use phone much
- Navigation should be easy and intuitive
- Encourage user to low intensity exercise
- User should be able to compare results with friends
- Scoring system must be implemented
- User should be informed of length and difficulty of hunt before starting.

4 Methods

In this section an overview of the methods used in the Design, Implementation and evaluation chapters will be made. This will be done in order to give insight into the methodical approach for the report, as well as which theories and methods will be used in the following sections.

4.1 Design methods

This section will go over the Methods and theory used in the design section and understand what is needed in order to design the best user centred prototype.

4.1.1 UI and UX Theory

In the analysis, some brief mentions of interface design for users and experience has been talked about. A quick run through of why it is important for this project and has become a focus point in our report will be outlined. A good user interface is for the most time also a good user experience. To make a good user interface it needs to be easy to use and have a simple approach for the target group. It must be easy to read and navigate. These things are also what makes it a good user experience. This can be achieved by including some of the theory that has been gone over earlier in the report. The combination of the gestalt principles, Don Norman's theories(section 2.8.1) and colour theory(section 2.8.6) can enable the user to have a pleasant experience while using the product or app. In relation to the project this is an important aspect especially since it can influence the amount of relaxation the user experiences.

4.1.2 Design brainstorm

To create the initial design, all group members created paper prototypes on the basis of a brainstorm of design ideas. These design ideas were then evaluated upon the various possibilities for design while including the design principles described in the Interaction Design (2.8) chapter. The design ideas are available in the sketchbook folder.

4.2 Implementation methods

In this section the implementations methods will be explained. These methods will be used in the creation of the prototype iterations.

4.2.1 Scrum Method

For the implementation chapter, the group will use elements of the agile work method Scrum. The Scrum method can be used to divide the workload of the implementation into sprints so that a project goal can be reached in time. This is traditionally done by having a product owner that declares what is needed to be done and what is the most important to get done first. Then,

a scrum master who is a capable person within the specific field, whom has a good idea of how long each task will take, will divide the tasks into weekly and daily sprints. The implementer will then do the work and together with their scrum master, they will have daily assessment meetings, sometimes multiple times a day, in order to keep the scrum-master up to date.

In the end the product will be shown to the investors and hopefully they will be happy with the progress of the product. In our case Scrum will be used as a way for all members in the group to get some programming done. The scrum-master will be one of the group members and this person will divide specific tasks out to other group members. Each morning and before leaving for the day the scrum-master will be updated on the progress of project and hand out additional tasks.

4.2.2 ARKit and AR Core

As the clues, riddles and puzzles should be presented to the user through Augmented Reality in some shape or form, it is relevant to look at software packages that helps developers use AR on their smartphones. Let's first look at Apple's software first, a software development kit (SDK), the so-called ARKit, that runs on all Apple's iPhones and iPads using iOS 11 or later. (2.6.3). The ARKit is a pre-coded package that combines device tracking, camera capture, scene processing, and in general makes building an AR experience much simpler. Developers can then use the package to create AR in their apps without having to code it themselves.

Just like Apple made the ARKit, Google also made a similar SDK called AR Core that can be used for developers on android devices. This, just like the ARKit is an SDK that can prove vital for implementing AR in the final prototype.

4.2.3 GPS on Phones

As written in the analysis (section 2.6.4), there are two systems on the phone that can get the location. Normally for this matter, both systems should be turned on, so the phone can pick whatever is best for itself. That way the phone can select the system best suited for the given location. For instance, the GPS is better when the user is out of reach for a cell tower, like in the mountains or wilderness. But when the user is in a city, the AGPS is better, since it is in reach or one or more cell towers.

4.2.4 Unity, C# and Object-Oriented Programming

Unity is a real-time game-engine that will be utilized to develop the prototype. Unity facilitates the creation of 2D and 3D environments, in which the prototype will be build. 3D assets will be created in a separate 3D creation software such as Maya and Blender. These assets can then be imported into the Unity engine.

The programming can be done in C# which is a native language to Unity. C# is an object-oriented programming language, which means the functionality is based around objects containing data within the code. C# should help create a modern and simple code that easily

can be improved through iterative user testing. Unity also supports the use of the GPS which will be used to approximate both the location of the user, and game elements in real-time.

4.2.5 Evaluation methods

Throughout the project, data will be gathered by testing. Gathering information from the testers is vital for further development and iterations of the prototype, with the aim of getting as much reliable data as possible to further work on the prototype. Usability tests will be run in order to gather useful data.

4.2.6 Low-fidelity and high-fidelity

Testing will be done in several ways, using both Low-fidelity and High-fidelity prototyping. Low-fidelity prototyping using paper-form sketches implemented into a pop app to add some interactivity, to try and get the general idea out to the tester, using a very-early stage of the prototype. Moreover, participants will be asked to fill out a questionnaire answering question about their initial usage of the prototype. This method will help gather quantitative and some qualitative data regarding participants' thoughts about the prototype and its usability.

Through the low-fidelity testing, the user can help with the design, so it is more catered to them. This is known as user centred design and will be used for the high-fidelity sample. The goal of the expert interview is to get feedback on the use of eco-therapy and to find out if there is more that could be done to improve this or other aspects.

The second test will be another low-fidelity test but with updated graphics and further design changes. For this test the goal is to get feedback on the improved changes from both the expert interview and the first test as well as to test the usability.

The high-fidelity prototype will be done in later stages of the process with a close-to-done or done prototype using the changes from the feedback from the other tests. It will be on a phone in form of an app with more intractable features than the Low-fidelity prototype that only had some clickable buttons. The goal is to get feedback on the concept and experience as well as feedback on the usability of application itself [74].

Using the iterative testing method, testing will be repeatedly done at each stage of the project and changed according to feedback to limit the dis-functionality and issues of the prototype in its final form [90]. In this project the design of the product will change after each test until the final test depending on the feedback received from the test participants. This means that each test has a new version with the updated design and content. There will be three tests in total.

4.2.7 Convenience sampling

Convenience sampling is a form of non-probability sampling which, in this case, means that everyone does not have an equal chance of being tested on, but only people that happened to be around while we were testing. It was decided to use convenience sampling because it made it easier to find participants for the test and it is a fairly simple approach that could still keep a certain level of quality. A downside of using convenience sampling is that the bias of the participants is high, and that sampling can have a lot of error in regard to finding

representatives of the target group [91]. That being said, the goal is still to test on danish students in the age range 16-24, as they are the general target group. In the end, they are the intended user-base, but they will be selected using convenience sampling.

4.2.8 Expert interview

An expert interview is a form of qualitative data collection and is most often used to get a professional opinion of a subject or an evaluation of a product. An expert interview can also be used to gain knowledge on an unfamiliar subject. In this regard expert interviews are good, but the potential downside of using an expert interview is that they may be old school while a product is trying to be innovative. Another aspect could be that the questions asked are biased and thereby rendering the information useless. It had been agreed that we should have an interview with an expert. This interview will be with a psychologist and the purpose of the interview is to find out whether or not the product is utilizing eco-therapy to a good enough extend.

4.2.9 Data analysis

Mixed methods will be used to analyse the iterative test data. Both the qualitative method via the expert interview, and quantitative methods through questionnaires for the test participants. It should be noted however, that the questionnaires gather both quantitative data e.g. Likert scale data and qualitative data in the form of comments from the test participants. This means that the weaknesses of each of the methods, if used alone, can be decreased. One of the best features about mixed methods is the possibility to allow triangulation, using several methods to cast a broader light on the evaluation of the application. However, using mixed methods, one needs to be cautious as the amount of quantitative data often outweighs the amount of qualitative data [92].

5 Design

The aim of this project is to develop a high-fidelity prototype for a mobile application to give the user a relaxing experience by utilising eco-therapy and augmented reality. This chapter will be based on the findings from the analysis. It aims to build a solution to our final problem statement through the design chapter. This chapter will start off by going through the structure of the application and the pages with-in it. Then it will outline the design choices made to start building the application.

5.1 Structure

The main purpose of the application is to help users take a relaxing walk through nature by supplying different treasure hunts, as it allows combining eco-therapy and gamification. Treasure hunts also allows us to point users towards specific locations and areas. One such treasure hunt, from when the user starts the application until the end of the hunt, can be seen as a flowchart in figure (16) from start to finish.

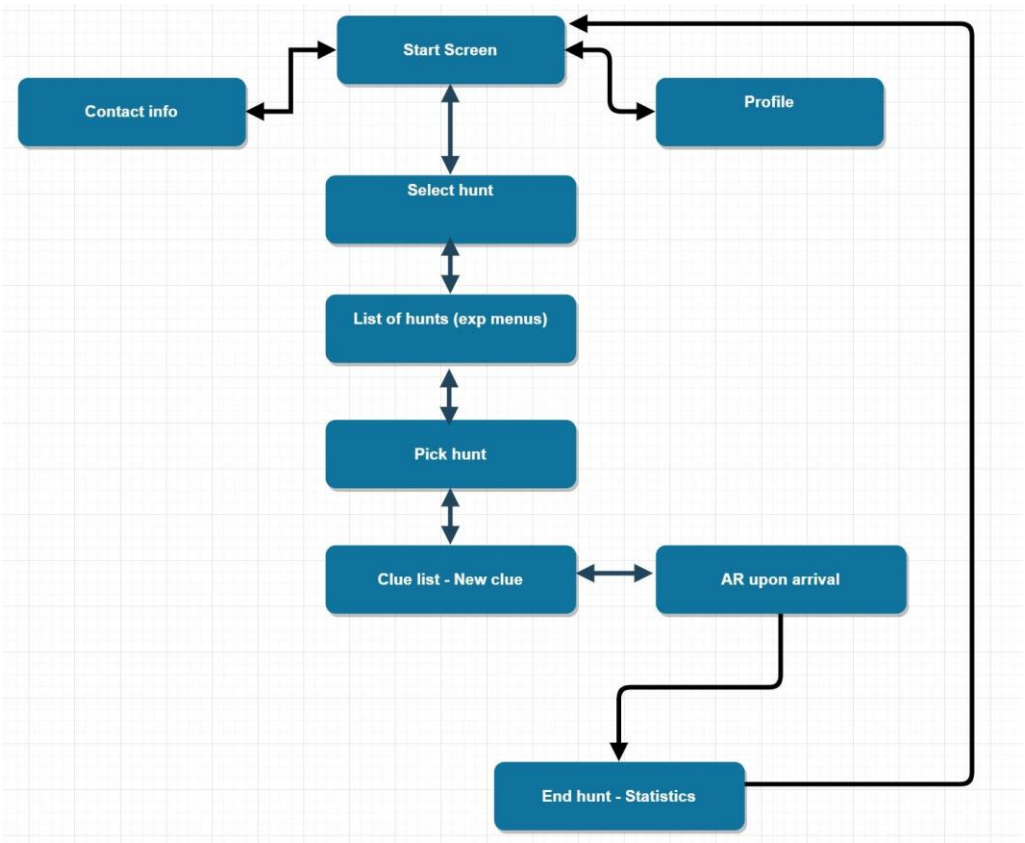


Figure 16: Flowchart for an example of a user starting the app until the end of a treasure hunt.

Once the user starts the app, they will be able to choose a hunt. When they have selected a hunt, they will be presented with the first clue. This clue will be a short and easy riddle which describes where the user should go, in addition to this there will be a 'hint' button which has a more specific description of the intended location. At the destination, a 3D model will be visible

in AR which will explain how to find the next clue. Between clues, when the user is walking to or looking for the next clue, there will be nothing but the clue text on the phone screen, to encourage users to look around and not at their phones. Once users get to the destination, the screen will turn to camera view and the user will be able to spawn a 3D model which holds the clue for the next location. Meanwhile, they will then unlock the second clue in text form on the clue page. This is continued until the user is at the last destination, where the hunt ends, and a statistics page will appear on the phone displaying how the user performed.

From the user's distance walked, how much time they took, completed hunts, a score will be calculated. The users can use this score to compare and compete with friends and family. A bigger score will be awarded for longer times, in order to encourage users to take longer on their hunts.

5.2 Walk-through of pages

Home page:

The first page is the Home page, where the user can choose among three clickable icons. In the top centre a logo of the app will be shown. The two most important buttons will be aligned below the other in the middle of the screen. The first of these is Hunts page button, represented by a treasure chest icon and it will show the Hunts page after tapping it. Below this a Profile icon represented by a scroll will be shown, and it will lead to the Profile page after being tapped. In the top right corner, there will be a small information button, upon tapping it will open an expanding menu which will show two buttons leading to their respective pages, the about us button and the contact button. Placing these less important buttons in an expanding menu helps to keep the UI minimal and clean.

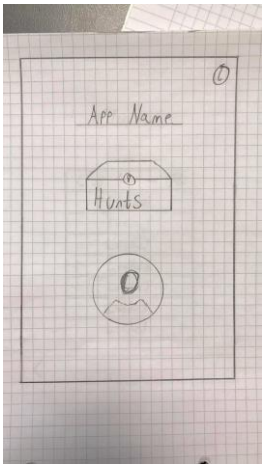


Figure 17: Applications home page.

About page:

The About page will be a simple screen with a brief description of the application. On the top centre of the page there will be the about icon, so the user knows where they are in the application.
Apart from this, there will be a back button to return to the homepage.

Contact Page:

The contact page will include necessary contact details such as an email address, phone number and an address. This will be included so the user can contact a support line if an issue occurs. It will include a contact icon on the top of the page, which will help the user easily know which page they are on. Finally, it will have the back button on the bottom of the screen to navigate back to the home page.

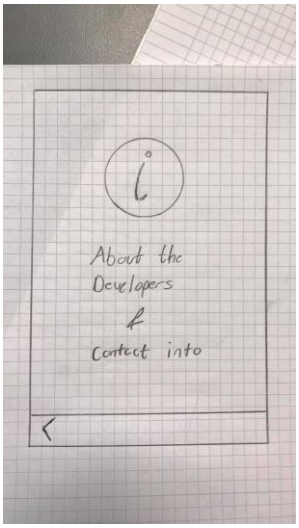


Figure 18: Applications info and about page.

Profile page:

The profile page will consist of the profile icon, from the home page in the top centre of the page. Below this, the user's statistics will be shown. As well as a list of their friends and their scores. Again, the back button will be available to return to the homepage.

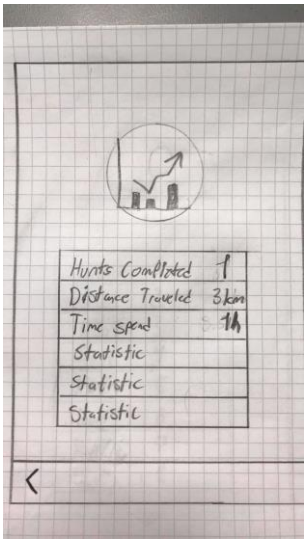


Figure 19: Applications Profile page.

Hunts page:

The hunts page will contain a list of hunts. There will only be one available hunt in the prototype, but there would be several other hunts in the final application. Clicking on a hunt will take the user to the clue page which will be described in depth below.

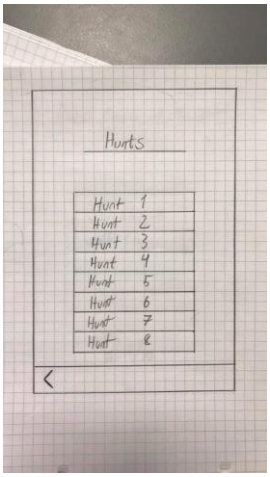


Figure 20: Applications hunts page.

Clue page:

On the clue page there will be a scrollable list of the clues involved in the selected treasure hunt. Upon opening the screen for the first time, the first clue will be visible. The rest will be constrained from the user. This constrain will be implemented graphically using a padlock over the buttons. When an unconstrained clue is interacted with, a page with the clue text will be shown. The first clue will be a riddle that, when solved, leads to a location. When the GPS detects that the user is in the correct area, the camera will be activated. This also constrains the AR page of the app and supplies feedback to the user, so they know they are in the correct place. Apart from the stated interactables, there will also be a back button on this screen to return to the hunts page.

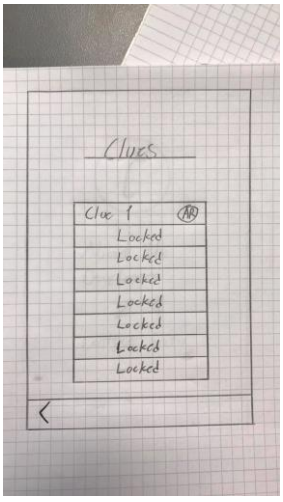


Figure 21: Applications clue page.

AR page:

The AR page is the input from the camera of the device. The user has to tap to spawn the 3D model, and then walk around it and inspect it to find the next clue written on it. When they press the back button, the next clue will be unlocked, when the next clue is pressed, the text from the 3D model will be visible, so they don't need to remember it.

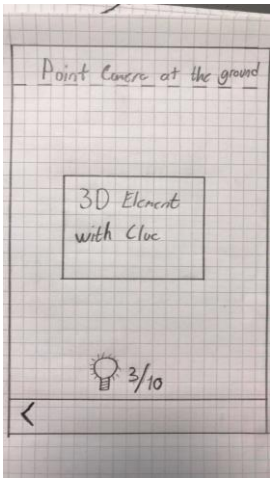


Figure 22: Applications AR page.

End page:

The final page is the end screen, here it will display three main points. The first being that the hunt has been completed, the second being the statistics from the hunt that has just been finished and the third, which is a return button to the homepage. On top of the screen it will display to the user that they have finished the hunt and congratulate them on finishing. This will be written in big bold letters to ensure that the user knows that they have finished. Right underneath this, their hunt score and the most essential statistics such as distance and time for that particular hunt will be displayed.

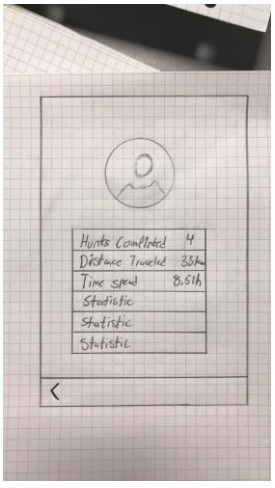


Figure 23: Applications end of hunt page.

5.3 AR Implementation

AR will be implemented inside of the application using AR core, this will hold the clues. Clues will provide information for the user, that when followed, will get the user to a certain location. When the location is reached, the AR camera will be activated automatically. The user will have to tap on the screen to spawn the 3D object. The final 3D model will not provide a riddle but will be a bigger and more detailed object for the user to look at, also referred to as "The Treasure" that the hunt is ultimately focused. To find this treasure is the goal of the hunt.

5.4 Attractive Quality

This section will cover the overall look and feel of the application by going into relevant colour theory, typography and graphic design. It will also cover GUI design and how it can be used in this application.

5.4.1 Colour Theory

The colours used in the application are crucial to the feel generated by using the application. In the State of the Art chapter colours from various applications was analysed. The theme of the prototype is related to nature and eco-therapy, therefore a colour palette inspired by nature was chosen as seen below (24).



Figure 24: Nature inspired colour palette. [93]

5.4.2 Typography

Typography elements and different fonts had to be researched to match our expectations, goals and fit the topic. Having looked at several fonts and typefaces, below is a description of those that seemed the most relevant:

Berlin Sans FB Demi Bold based on an alphabet from the late twenties as well as the first sans-serif typeface ever made.

Comfortaa is a stylish and modern type font. Comfortaa is also considered to be a rounded geometric sans-serif type face intended for large texts. Comfortaa is nowadays used by Google. The rounded geometric look adds a calming element to the text supporting eco-therapy.

5.4.3 Iconography

As all the buttons in the app will need an icon, it is important to know how to design them. As the idea behind the app is to relieve stress, so it is important to make the icons simple and easy to read. Therefore, using icons that are made in such a way that users can easily understand where buttons will lead is imperative. Users need to be able to quickly locate features they want to use, and the application should therefore make it easy to manoeuvre and remember. Icons and buttons explained therefore uses both similar and analogical designs.

5.5 Treasure Hunt Design

As mentioned in the puzzle solving subsection (2.4.4), a well-designed puzzle can reduce stress in a patient by utilising their brain and giving them a sense of fulfilment. The treasure hunt's design is an important aspect to consider for the success of this project. If, it is too difficult, the user could become more stressed than before, this would contradict the entire focus of the application. On the contrary if the hunt is too easy, it will reduce the satisfaction level that is hoped to be achieved. The treasure hunt should also take place in a natural environment. This will ensure that the theories of eco-therapy are being utilised in the application. Keeping the above points in mind, should create a relaxing and rewarding experience for the user.

5.5.1 Clue Design and Riddles

The purpose of the app is to guide the user through a natural setting and to do this each hunt will be accompanied by clues and riddles. After the user selects a hunt, a riddle will be shown. The solution to the riddle will represent some place in the real world. After moving to the specific area, the user will be prompted to use the AR functionality to spawn a 3D model, which will hold another clue or riddle as to where the user has to go next. This cycle will continue until there is no more riddles/clues and the user will find the final treasure which will then lead to the completion of the hunt.

The clues of the treasure hunts must be designed with extreme care. To begin with, this section will describe an example of a clue that will be used in the testing of this prototyping. It will then expand on this, to describe how a clue would be created for a natural environment, such as a forest. The application will provide clues in the form of 3D models in augmented reality. Once

the player is in the correct location, an option to open the AR camera will appear. Once interacted with, the user will have to point the camera at the ground plane and the 3D model will appear through the camera once the screen is tapped once. The user will be able to walk around the object and examine it. This means that, when the user spawns a 3D model a short animation will play, revealing a clue inside or on the object that can be read through the camera. This clue will be in text form and will be added to the clue page of the application, so the user can refer to it later in the hunt. These clues will be in the form of riddles. In the natural environment, the same structure mostly applies. However, the clues will heavily involve the surrounding nature. Such as to look for a distinguishable tree or natural structure.

5.5.2 3D Models

Models used in the app took inspiration from history and navigation tools since the focus is on treasure hunt. These models are going to be an egg, a chest, a book, a spyglass, a compass, and a canvas painting. The egg will have golden texture and will be divided into two main parts; first is bottom half which is solid; second one is the top half and it is divided into four vertical parts, which will be animated to open and a scroll with a clue printed on it will rise out of the egg. The chest will be divided into two parts also, the lid will be animated and a similar scroll with a different clue printed on it will rise from the chest. The chest will have wooden and rusted steel textures. The book model will be animated to fall open and the clue will be printed on the inside. It will be textured using old paper textures and a leather cover. The spyglass will have the clue on its body and textured with wood, copper, cobalt and vivid glass for lenses. The compass will consist of old rusty steel, bronze on sides, the needle will be red and white as usual, and the clue may be placed on the front side with the text in a circle. The last object will be a canvas painting made by Karl Schrag, so the textures will be the painting, fabric, bronze, wood and steel with the clue engraved on the back side.

All of the models will be made to have a limited number of polygons, as to not affect loading speeds too much. The same will be done with the texture resolutions, although the textures with the clues written on may need to be bigger so the user can read it in AR.

5.6 Sketching and Wireframes

After the initial sketches were completed a final wireframe and colour theme were decided upon. Adobe Experience Design (XD) was used to create an interactive wireframe of the application. This differed from the paper wireframe, as, it included fonts, colours and navigation that could be implemented in the final prototype. This wireframe is an important aspect of the project, as it helps to quickly establish the graphical aspects of the design and discover problems in the design early in the process. These problems can be fixed easily before any coding of the application begins, which, prevents wasting time. Once the application is created in XD, it is easy to iterate through different designs. Such as, changing the colour, button hitboxes and layout.

In this wireframe, it was possible to implement some of the design requirements such as nature themed colours. This helped to fulfil the requirements early and, in turn, experiment with different iterations of the requirements.

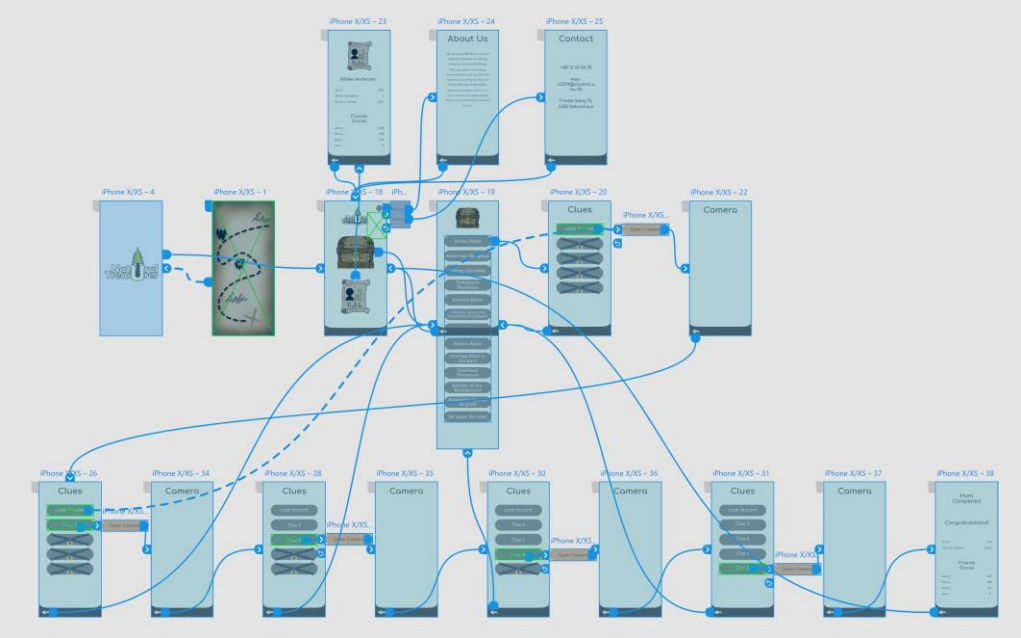


Figure 25: Screenshot from Adobe XD illustrating the prototyping of the navigation and GUI design.

6 Design iterations

In the beginning of the design phase a brainstorm was made in order to generate ideas for the design. The ideas were drawn on a whiteboard and then discussed and redrawn until a general idea had come up. Following this, the members were asked to make some sketches at home and bring them the next day. From this, some initial design choices were made and once again the members would draw new sketches. After this a member in the group would draw up the paper prototype. The sketches were then slightly adjusted and then photographed and put into the application ”Pop-App”, which is a prototyping app. Then an initial low-fidelity test would begin its preparation.

6.1 Low-fidelity test

The goal of the low-fidelity prototype test is to acquire quantitative and qualitative data that shows how the functionality is being interpreted by the test subject in regard to navigation. The test will start off with the participants answering a few general questions about themselves such as what age they are and their gender. The participants will additionally be told that they will remain anonymous. Then they will be given the low-fidelity prototype and they will get some time to look at it and run through it. Finally, they will fill out a second questionnaire that asks them about the usability and furthermore asks them to elaborate if they have any suggestions to improve the experience. The test will be conducted by two people, one person in charge of testing and another in charge of recruiting test subjects. The person in charge of handling the test will introduce the user to the prototype and tell the test subject what they have to do during the testing. The goal is to test the low-fidelity prototype on at least 10 people to gather the needed information on usability in order to continue the design of the final prototype. Furthermore, this sub section will be a short summarizing of what was found during the test and will be gone through, in order to improve the product.

The test had a total of 10 responses, these were from people in the school’s groups rooms for Medialogy students 2nd semester. This might have created some bias since they know the group members and they are perhaps more technology and design minded. Eight men and two women responded in the age range 18 to 28. In one of the questions ”How was the navigation of the app?” the respondents answered in favour of it being easy to navigate. On a Likert scale ranging from 1 to 5, where 1 is poor and 5 is good, 5/10 participants selected 4, 3/10 selected 3 and 2/10 then selected 5. These responses indicate that 7/10 participants found it, to some degree, easy to navigate the application, while 3/10 participants did not find it easy or difficult to navigate. The participants could be more or less lenient to give a more positive response.

For another question, ”What would make the navigation easier”, the test subjects were split, where some thought it was fine and easy to navigate, but others would like to see either a progress bar or a marker to see which clues they had been through. For the question ”Was it easy to figure out how far along you were in the hunt?” almost all participants said yes in some variation and most kept it short, except for two where one answered that they did not know they were on a hunt, and the other participant noted that it does not show a current hunt, only finished ones and a profile page. This is an error in testing as it would seem it is on our hands that we did not explain the goal of the test well enough before the test began. As for the next question ”What do you think is missing?” participants said that they would like more information of what the hunt was about or more clearly stating how far along they were in the

hunt, and others did not feel anything was missing. Finally, the question "What do you think was good?" the test subjects answered that it was minimalist, straight forward, well-structured and consistent.

These are some of the notes that we will consider implementing in the next iteration of the product and the high-fidelity prototype. In regard to what will be improved in the prototype, there will be added a way for the user to see which clue they have made it to, to increase users' feedback. This will be done since this is the area that most participants wanted to see improvements or changes.

6.2 Expert interview

An outline of the procedure and interview questions for the expert interview can be found in the appendix (12.2). In this subsection a summation of the most important points and key elements of the interview will be evaluated. This will be done in order to improve the high-fidelity prototype and to get a professional opinion on the psychological aspects of the overall concepts as well as the execution in the current iteration of the prototype.

The interview lasted 38 minutes and was done by two group members, one main interviewer, one supporting interviewer and the psychologist. The interview took place at the psychologist's home which also serves as her place of work. The interview was done on the 23rd of April. The supporting interviewer took notes which will be used as a main source of information. The interview was also recorded but the audio quality is very mixed and therefore it will not be used as a main source of information in this evaluation, instead the notes taken during the interview will.

The psychologist graduated in psychology from Aarhus University and has been practicing for 20+ years. She also graduated the 'Mindfulness Academy' which teaches mindfulness, which is a form of therapy that, to put it simply, focuses on being in the 'now' and not to worry about the past or future. The psychologist might be somewhat biased because she knows one of the group members beforehand, to counter any bias, it was decided that the main interviewer would be the group member she had no former relationship to. The interview started with an explanation of the project concept, together with a presentation of the current prototype at the time of the interview (The Adobe XD prototype) (5.6).

The interview showed that the psychologist was familiar with eco-therapy. When asked whether or not the group incorporates this therapy method, the psychologist has mixed opinions. On one hand, she agrees with our choice of target group and the fact that we want to help them get outside more. On the other hand, she doesn't feel that the application can fulfil the requirement of the word therapy. She questions if the use of a phone could hinder any beneficial effects of the application. She mentions that researchers haven't come to any conclusions on the subject, but there are good and bad things about mobile usage. She worries that our focus in on the usage of the mobile and not the positive effect of being outside, hearing, feeling, smelling and seeing the nature that surround the user. She mentions that therapy can happen through a person's focus, with this she mentions 'spontaneous attention' and 'focused attention'. She believes we might be working with 'focused attention' which can be a reason for stress. She argues if we're also subjecting the user to spontaneous attention, which is what is at the core of eco-therapy. Because nature doesn't demand any focused attention, it enables

the possibility for something to be therapeutic. And then she asks the rhetorical question ”Isn’t this (referring to the application) to demand something from the user, I am not sure.”.

She then goes on to suggest that the real benefit of using the application is to introduce the target group to nature, and that this could be the main benefit of the application. She likes the fact that there is a score involved in the application and that this can be utilized to motivate people who are driven by competition. Moving on, she mentions that in regard to the age of the target group, the layout or, in other words the GUI of the application could seem a bit childish. She likes the fact that the application is simple and easy to navigate, but she mentions that it might be beneficial to make it more nature inspired. Using real world textures for the background and buttons. Doing this could bridge the spontaneous attention with the focused attention. So that when interacting in the real world, looking at the application will feel more natural instead of demanding a focused attention.

When asked if she could recommend any changes to the application to better utilize eco-therapy she again mention a more natural interface and that maybe it would be beneficial to ask the user to take deep breaths while using the application, reminding them to stop up and look around, smell, listen for natural sounds and also when the treasure hunt has been completed, show some motivational writing in regards to how far the person has walked during the treasure hunt 26. When asked in regard to our final problem statement, she goes back to saying that it might help introduce people to nature, which would be good, but she also wishes that people would go outside regardless. She has some doubts about the application being created by people with no knowledge of psychology, and that this might mean the focus lies the wrong place. However, she believes that the fact that the design is being tested continuously in the process will increase the effectiveness of the application. She argues that activating the senses is a good way to increase relaxation.

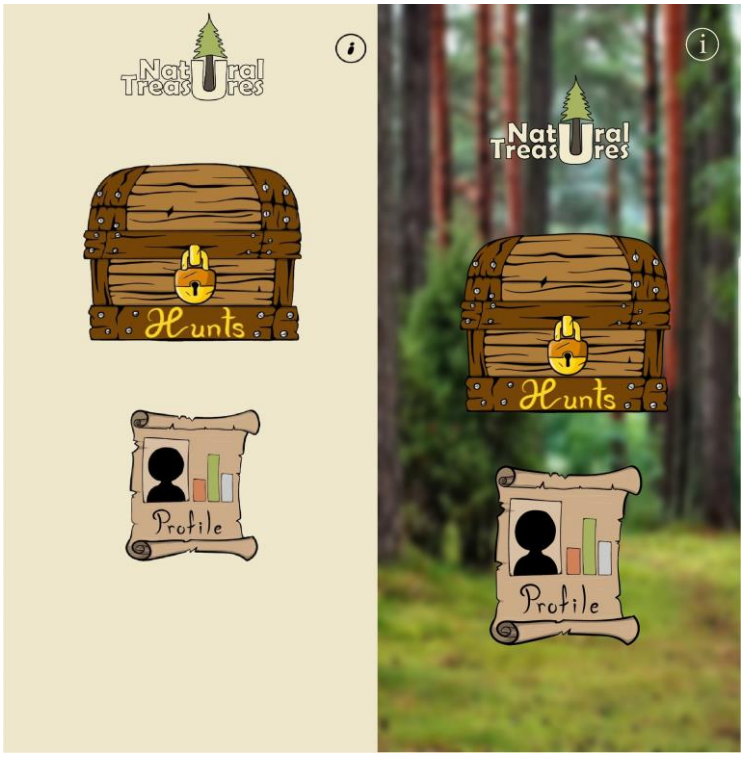


Figure 26: Design before and after the expert interview

6.3 Second Low-fidelity test

The second low-fidelity test was conducted in a similar fashion to the first low-fidelity test (6.1), the main changes was, that the feedback from the first low-fidelity and the expert interview (6.2) was implemented, and the prototype was moved from the Pop-app into Adobe XD. The changes range from making the background more natural to implementing a way to easier identify which clue the user had reached in the hunt. Also, this test would take place in a common area at university to test usability on the general students instead of only Medialogy students, who are probably more biased in one way or another. The main goal was again to test the usability and will also contain questions regarding the changes made from the first low-fidelity test. The structure is mostly the same as the first low-fidelity test but with more questions specifically about the design. The goal is to have 10 participants and then have them answer a few demographic questions, then test the application, and afterwards fill out a questionnaire with questions related to what is stated above.

The second low-fidelity test had 10 respondents, 5 of which were in the age group of the target group and 5 of which were older (25-30). There were 3 females and 7 males participating in the test.

The participants were then asked to rate the navigation of the application 4/10 respondents rated it 4/5 and the remaining 6 rated it 5/5 on a Likert scale wherein 5 was the best, 1 was the worst, making the result better than the first low-fidelity test. The participants were then asked what would make the navigation easier, most of the comments were about the icons, the participants wanted to make buttons seem more clickable. Then they were asked whether it was easy to figure out how far along the test the participant was 8/9 responded that it was, with one saying that it was a bit hard to figure out how far along, they were. This might be fixed with the addition of text clues and the actual AR implementation. When asked what the participant thought was missing, most people wrote that they wanted more information before trying the application. Again, with implementation of game rules and final functionality this might improve. When asked what was good about the application, participants answered positively with comments like ”Everything”, ”Nice graphics”, ”minimalistic”, ”Simplicity” and ”It is simple to navigate the application”.

Furthermore, when asked about the design of the application again 9/10 answered positively with one out of ten participants saying ”it reminds me of a ”kids’ game” like our expert also mentioned. The final question was what the participant thought of the icons, people mostly replied positively and had a few comments like ”Maybe you could make it more tidy, possibly use nature object as icons” this comment correlates again with what our expert said in the expert interview. Other comments include ”They are nice but doesn’t really look like buttons” and ”It looks like a game. If that is the case, it makes sense”. The second low-fidelity test showed that the prototype still needs some work in regard to usability, as per game rules, guiding, functionality and more text in relation to clues.

7 Implementation

This section showcases the transition from design and concept into a prototype. It will show samples of code, models and design with related descriptions.

7.1 setup of the application

From the Design section, the wireframes (5.6) can be setup in Unity (4.2.4). In Unity, there are prefabricated UI elements such as buttons, text boxes and images that are customisable to what the project requires. So, from the flowchart (16), the panels (pages) begin as an empty game object which is a child to the canvas. Each of these game objects represent a page from the flowchart, the elements from the wireframes are then added to each page. These pages are then activated/deactivated depending on what page the user is on. When the application starts, all pages are inactive apart from the homepage.

7.2 Classes for the program

To get an idea of what the program should contain, a setup of classes can give a better understanding of what needs to be done. In the beginning, three custom classes were constructed for player, hunt and clue. These classes are made for making objects with certain data about each of their definition. To get a better of idea of these classes, a class diagram is being setup to see what variables and methods are required.

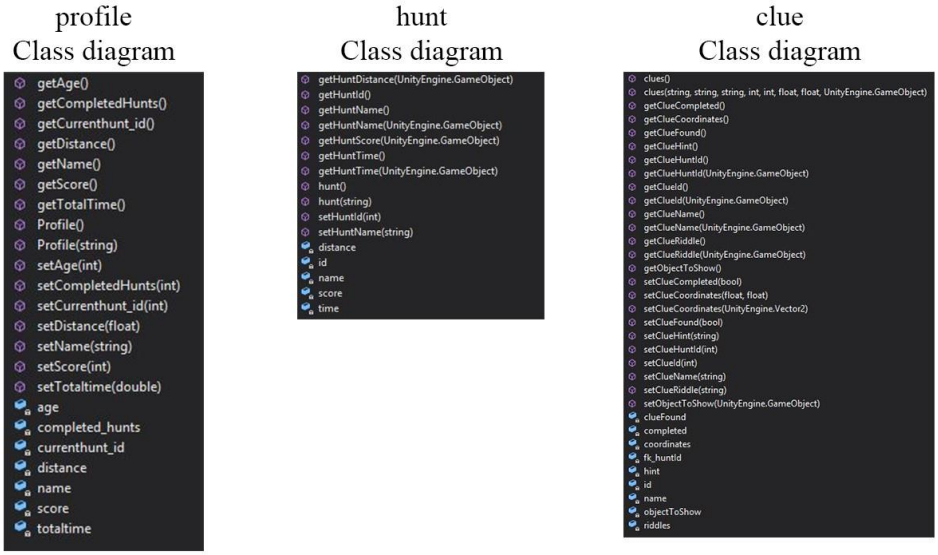


Figure 27: Class diagrams.

The player class (27) will contain information about the player and their achievements from the application. The achievement is shown in the form of a score, the total distance they walked,

the total time they have spent on completed hunts and how many hunts they completed. This information is being displayed on the profile page in the application.

The hunt class has name (27), id, score, time and distance variables where time and distance are obtained through the user. Score is to show how well they have done on the hunt course and the id is later used for the clue class as an identifier. The objects from the hunt class are shown on the hunt page.

The clue class (27) is made for saving information about the clues, such as name, riddle, hint, coordinates, a parent id and what object it should show. The name of the clue will be shown on the clue page and on the AR page, where the riddle and hint are presented. The parent id is used for figuring out what hunt the clue belongs to, so the correct information is being given. All of the classes have a default constructor, get and set methods.

7.3 UI/UX programming

The application's navigation and user experience were implemented using custom C# scripts. Scripts are a sample of code in c sharp and this is primarily used in Unity. Although there are many scripts, the most important ones will be covered here.

7.3.1 Navigation

The navigation of the application is implemented using the navigation script. It contains 4 public GameObject variables: ”BackButton”, ”Info Menu”, ”HomeBar” and an array called Panels. The script is comprised of 3 functions. In the ”Start()” function, the Panels array is initialized, and it is called only once when the GameObject that the script is attached to is activated, which, in this case is the canvas. The ”Update()” function is called once per frame and it is responsible for activating or deactivating the navigation bar depending on whether the user is on the homepage or not. This is done using a simple if-statement, if the user is on the homepage - deactivate the navigation bar. The back() function controls the back button throughout the application. It works by detecting which page in the array of panels is active, and then deactivates and activates the appropriate panel. This function is called when the user presses the back button.

7.3.2 Expanding menus

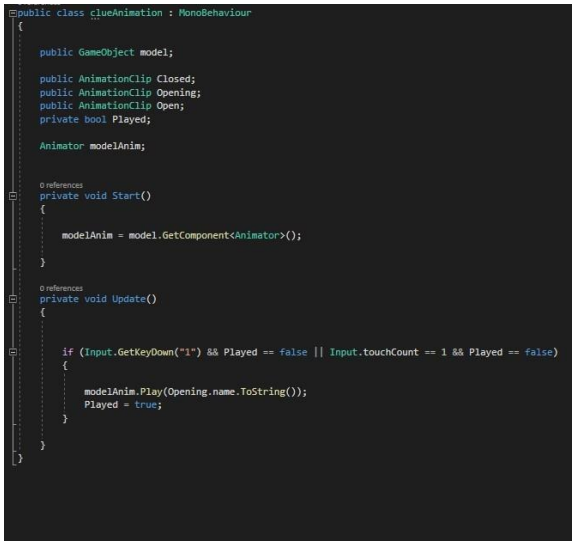
On the home page an expanding menu was used for the information button, which displays the ”about us” and ”contact” buttons. These were decided to be the less important panels within the application, so the expanding menu was an appropriate choice. The menu was animated inside unity and it is simply keyframed scaling values and a short C# script which plays the animation when it is pressed and vice versa.

7.4 Animation Scripts

When the user spawns an object in AR the animation should play automatically. This is implemented in the ”clueAnimation” script which has 1 public GameObject variable which is the model to be animated. It also has 3 ”AnimationClip” variables for the closed, opening and open animation clips of that model. In the ”Update()” function there is an if-statement which detects if the user has touched the screen, if they have, the animation clip is set to opening. This works well as the user has to tap to spawn the object, therefore, the animation will play as soon as it is spawned.

```
public void back()
{

    if (Panels[0].activeSelf)
    {
        Panels[6].SetActive(true);


        Panels[0].SetActive(false);
        Panels[1].SetActive(false);
        Panels[2].SetActive(false);
        Panels[3].SetActive(false);
        Panels[4].SetActive(false);
        Panels[5].SetActive(false);
        Panels[7].SetActive(false);
    } // if on ar cam page, back button sets clue page to active and deactivates the rest


    else if (Panels[6].activeInHierarchy)
    {
        Panels[5].SetActive(true);


        Panels[0].SetActive(false);
        Panels[1].SetActive(false);
        Panels[2].SetActive(false);
        Panels[3].SetActive(false);
        Panels[4].SetActive(false);
        Panels[6].SetActive(false);
        Panels[7].SetActive(false);
    } // if on clues page, back button sets hunts page to active and deactivates the rest

    else
    {
        Panels[1].SetActive(true);


        Panels[0].SetActive(false);
        Panels[7].SetActive(false);
        Panels[2].SetActive(false);
        Panels[3].SetActive(false);
        Panels[4].SetActive(false);
        Panels[5].SetActive(false);
        Panels[6].SetActive(false);
    } // if on any other page, back button sets homepage to active and deactivates the rest



}
```

Figure 28: Example of ”back button” script.



```
public class clueAnimation : MonoBehaviour
{

    public GameObject model;

    public AnimationClip Closed;
    public AnimationClip Opening;
    public AnimationClip Open;
    private bool Played;

    Animator modelAnim;


    0 references
    private void Start()
    {

        modelAnim = model.GetComponent<Animator>();

    }

    0 references
    private void Update()
    {


        if (Input.GetKeyDown("1") && Played == false || Input.touchCount == 1 && Played == false)
        {

            modelAnim.Play(Opening.name.ToString());
            Played = true;
        }

    }
}
```

Figure 29: ”clueAnimation” script.

Each model also has a unique controller which defines the flow of animation from each model’s animation timeline. The ”opening” animation is followed by the ”open” animation which loops until the application is terminated.

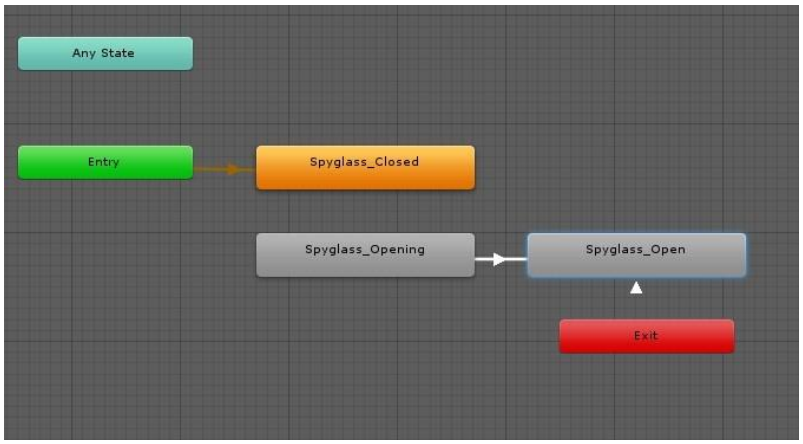


Figure 30: Example of the spyglass controller, it is visible that the ”opening” animation leads to the ”open animation” which then loops (shown by the arrow pointing back at the animation clip)

There is also a separate script for the animation of the scrolls, that are included in some of the models. This script, called ”scrollAnimation”, it is almost identical to the ”clueAnimation” script. However, the scroll had to be imported as a legacy animation which uses the animation component instead of the animator. So, the only difference is the component being accessed in the script.

7.5 Code for Game Manager

The game manager can be found in the Unity's hierarchy and in there it is called "gameMananger". "GamerMananger" is an empty gameobject with four scripts attached to it.

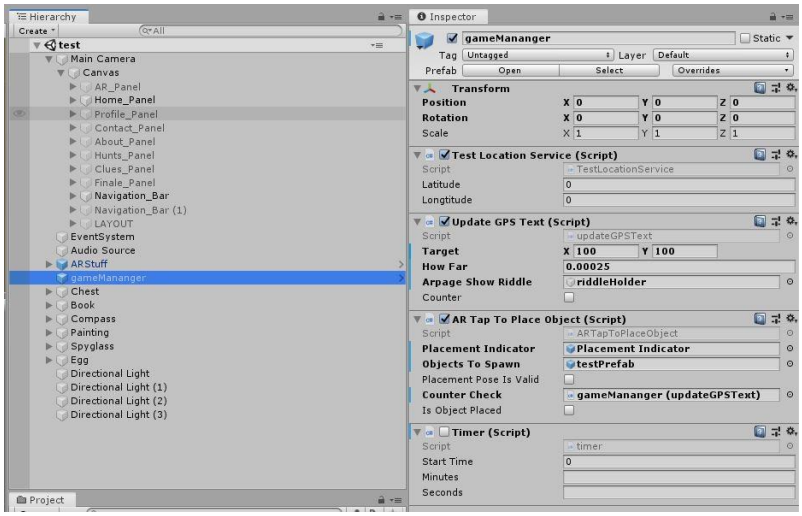


Figure 31: Unity's hierarchy and inspector.

The first script is "TestLocationService", which has two functions, and an "IEnumerator". This is created by following the tutorial, "Unity Mobile GPS - Real World Location - Unity 3D [Tutorial]" [94]. The two function are the build-in ones from unity, which are "Start" and "Update".

The "Start" function(32) is called the moment the object with the script attached to it, is active. The "Start" function consists of an object being created, a method being called, a co-routine being started, and an if-statement made. The object that was created, is a replica of this object called Instance. The method that is being called, is one of Unity's build-in method, "DontDestroyOnLoad". This is to preserve the gameobject when a new scene is loaded, so it can exist until it is forced to destroy.

```
private void Start()
{
    Instance = this;
    DontDestroyOnLoad(gameObject);
    StartCoroutine(StartLocationService());
    if (Permission.HasUserAuthorizedPermission(Permission.FineLocation))
    {

    }
    else
    {
        Permission.RequestUserPermission(Permission.FineLocation);
    }
}
```

Figure 32: "Start" function from "testLocationService".

```
private IEnumerator StartLocationService()
{
    if (!Input.location.isEnabledByUser)
    {
        Debug.Log("user has not enabled gps");
        yield break;
    }
    Input.location.Start(1,0.1f);
    int maxWait = 20;
    while (Input.location.status == LocationServiceStatus.Initializing && maxWait >0)
    {
        yield return new WaitForSeconds(1);
        maxWait--;
    }
    if (maxWait <= 0)
    {
        Debug.Log("Timed out");
        yield break;
    }
    if (Input.location.status == LocationServiceStatus.Failed)
    {
        Debug.Log("Unable to dermin deivce location");
        yield break;
    }
    latitude = Input.location.lastData.latitude;
    longtitude = Input.location.lastData.longitude;
    yield break;
}
```

Figure 33: ”IEnumerator” function from ”testLocationService”.

The co-routine activates an ”IEnumerator”(33), that starts off by checking if the user has allowed the application to use the phone’s location. If that is true, it will get the coordinates at the given time and if it is false, it will write an error message in the console. Lastly, the if-statement is checking for whether or not the user has allowed the phone’s location to be read by the application. If that returns false, it will send a request to the user, to allow the application to use it. The ”Update” function is called every frame and it updates the variables. This script is mainly used to check if user has activated location and if the application has gotten the permission to use location.

To make sure that the input from the phone is updating, a new script is made called ”updateGPSText” (34). At the beginning of the script, a few variables are declared where two of them are of normal data types. These are called ”howFar” and counter and they are in following order float and Boolean. The ”howFar” variable is a measurement of units, that is used for an if-statement and its value is given from the inspector in Unity. The distance is calculated by measure the phone’s coordinates and location’s coordinates, the formula for to get this is the following:

$$Distancebetweentwopoints = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

Once the distance is less than the value of ”howFar”, the if-statement will become true. The counter variable is used to check if the object is placed, and its value is changed every time the user is looking at the newest clue. The third variable is one of Unity’s own datatype called GameObject and the name of the variable is ”arpageShowRiddle”. ”arpageShowRiddle” is used to activate or deactivate gameobject and that happens when the distance between the phone and the target are less than the value of ”howFar”. So, if the distance is less, ”arpageShowRiddle” will deactivate the given gameobject otherwise the object is active. The last variable with another custom datatype from Unity is called Vector2. Vector2 contains x and y coordinates and this is used for getting the coordinates for the clue’s location, this variable is called ”target”.

```
public Vector2 target;
public float howFar;
public GameObject arpageShowRiddle;
public bool counter = false;


private void Start()
{
    Vector2 newPos = new Vector2(TestLocationService.Instance.latitude, TestLocationService.Instance.longtitude);

}
// Update is called once per frame
void Update()
{

    Vector2 newPos = new Vector2 (TestLocationService.Instance.latitude, TestLocationService.Instance.longtitude);

    if (Vector2.Distance(newPos, target) <= howFar)
    {
        arpageShowRiddle.SetActive(false);

    }
    else
    {
        arpageShowRiddle.SetActive(true);
    }
}
```

Figure 34: ”updateGPSText” script.

When the user has arrived at the location, the camera will start, and the user will be met with a red cross on the ground. The red cross and the opening of the camera comes from the ”arTapToPlaceObject” (35) to initiate the AR functionality (4.2.2), with the help from components in the object, ”AR Stuff”. The script for the AR part is coming from a tutorial called ”Getting Started with ARFoundation in Unity (ARKit, ARCore)” [95]. The script has the normal ”Start” and ”Update” function from Unity, but it also has three custom functions. The ”Start” function is looking for a gameobject with the type ”AR Session Origin” and saving that data into a variable. The ”Update” function is running two functions, an if-statement and updating a local variable that contain the phone position.

```
void Start()
{
    arOrigin = FindObjectOfType<ARSessionOrigin>();
}

// Update is called once per frame
void Update()
{
    UpdatePlacementPose();
    UpdatePlacementIndicator();
    Vector2 newPos = new Vector2(TestLocationService.Instance.latitude, TestLocationService.Instance.longtitude);

    if (placementPoseIsValid && Input.touchCount > 0 && Input.GetTouch(0).phase == TouchPhase.Began
        && !isObjectPlaced && Vector2.Distance(newPos, counterCheck.target) <= counterCheck.howFar)
    {
        PlaceObject();


    }
}
```

Figure 35: ”Start” & ”Update” function from ”ARTapToPlaceObject” script.

The first function in the ”Update” function is ”UpdatePlacementPose” (36), which has no arguments. This function is ”Raycast” to detect spots it can use for AR and placing these spots in a list. ”Raycast” in Unity is when an object is being told to cast a line ahead of itself and checking if that line is hitting something. When the line is hitting something, it will return that information to the object. In this case, ””Raycast”” is being cast from the phone’s camera and it returns information.

If ”Raycast” finds more than one spot, that will then turn a Boolean from false to true. Once that is true, it will take the phone’s rotation and rotate the AR object toward the phone.

```
private void UpdatePlacementPose()
{
    var screenCenter = Camera.current.ViewportToScreenPoint(new Vector3(0.5f, 0.5f));
    var hits = new List<ARRaycastHit>();
    arOrigin.Raycast(screenCenter,hits,TrackableType.Planes);

    placementPoseIsValid = hits.Count > 0;

    if (placementPoseIsValid)
    {
        placemantPose = hits[0].pose;

        var cameraForward = Camera.current.transform.forward;
        var cameraBearing = new Vector3(cameraForward.x,0,cameraForward.z).normalized;

        placemantPose.rotation = Quaternion.LookRotation(cameraBearing);
    }
}
```

Figure 36: ”updatePlacementPose” function from ”ARTapToPlaceObject” script.

The second function is ”UpdatePlacementIndicator” (37) and this script is the one placing the red cross onto the ground. This contains an if-statement, where it checks if the same Boolean from ”UpdatePlacementPose” is true. If it is, it will set the indicator’s gameobject to true and place it onto the ground.

```
private void UpdatePlacementIndicator()
{
    if (placementPoseIsValid)
    {
        placementIndicator.SetActive(true);
        placementIndicator.transform.SetPositionAndRotation(placemantPose.position, placemantPose.rotation);
    }
    else
    {
        placementIndicator.SetActive(false);
    }
}
```

Figure 37: ”updatePlacementIndicator” function from ”ARTapToPlaceObject” script.

The if-statement is checking four arguments, and if all of the arguments are true, it will allow the user to place an object through a third function. This function is called ”PlaceObject”, which instantiates the AR object with a position and rotation from the phone and ”UpdatePlacementPose”. Furthermore, it turns the two Booleans to true, where one of the Booleans is from the ”updateGPSText”. This is used for a check on the clue page and the other one is in this script for making the user place only one object.

Lastly, there is the Timer script (38), and is deactivated from the start. To start off, there is declared three public variables, where one of them is a double and the rest are strings. In the ”Start” function, the double variable called ”startTime” is same as Time.time and set the start

value to a value when it is set active. In the ”Update” function, a function is called with the name ”trigger”.

The function “trigger” gets a local float variable named ”t”, which is set to the same as ”Time.time” minus ”startTime”. This will result in that local variable ”t” will start at zero and is ready to be used as a counter. In there, the two string variables, minutes and seconds is getting their values. Minutes’ value is received by converting ”t” to an int and divide it with sixty and second’s value is getting by taking ”t” and use modulo with sixty to get the remainder from division.

```
public double startTime;
public string minutes, seconds;
private void Start()
{
    startTime = Time.time;
}

void Update()
{
    trigger();
}

void trigger()
{
    float t = Time.time - (float)startTime;

    minutes = ((int)t / 60).ToString();
    seconds = (t % 60).ToString("N0");
}
```

Figure 38: timer script.

7.6 Code for Hunt and Clue Page

The hunt and clue page are a list of objects from their perspective classes. The hunt page is creating a hunt object and the clue page do the same, but for a clue object instead. Firstly, the script for hunt page is called ”testHunt” (39) and consists of three functions. In the ”Start” function there are two custom function called ”generateHunts” and ”goToCluePage” that are called upon waking.

```
void Start()
{
    canvasHolder = GameObject.Find(canvasName);
    hunters = new hunt[numbersOfHunts];
    generateHunts();
}
```

Figure 39: Start function from ”testHunts” script.

The ”Start” function finds a gameobject, makes an array of ”hunt object” called ”hunters” and calling the ”generateHunts” function.

In the ”generateHunts” (40) function, there is a for-loop which creates the ”hunters” object from the hunt class and setting their name and id to match the times of iteration. After that, a prefab of a button is instantiated with a position and use ”goToCluePage” function, with the hunter’s id as a parameter.

```
public void generateHunts()
{
    for (int i = 0; i < numbersOfHunts; i++)
    {
        hunters[i] = new hunt();
        hunters[i].setHuntName(huntNames[i]);
        hunters[i].setHuntId(i);
        int huntId = hunters[i].getHuntId();
        GameObject newPlaceHolder = Instantiate(placeHolder, canvasHolder.transform);
        Vector3 newPosition = newPlaceHolder.transform.position;
        newPosition.y = newPosition.y - (margin * i);
        newPlaceHolder.transform.position = newPosition;
        nameholders = newPlaceHolder.transform.GetChild(0).gameObject;
        hunters[i].getHuntName(nameholders);
        nameholders.GetComponent<Button>().onClick.AddListener(delegate { goToCluePage(huntId); });
    }

}
```

Figure 40: ”generateHunts” function from ”testHunts” script.

The ”goToCluePage” (41) function has a parameter that needs an integer, and when it is called from somewhere else, it will enable the clue page and disable the hunt page. In the transition to the clue page, it will start a timer, and send over the selected hunter’s id.

```
public void goToCluePage(int id)
{
    this.gameObject.SetActive(false);
    cluePage.SetActive(true);
    cluePage.GetComponent<testClues>().fk_hunt_id = id;

    timer.enabled = true;

}
```

Figure 41: ”goToClue” function from ”testHunts” script.

Upon arrival on the clue page, it will do the same process as the hunt page by finding objects and making a list of clue objects called ”listOfClues” in the ”Start” function. Also, in the ”Start” function, it is calling the function called ”generateClues” (42). That function includes two for-loops, one for generating the clue objects and setting its values, and the other for-loop is instantiating the prefab button for clues with a listener that uses a function called ”headToARPage”. Every clue object in ”listOfClues” is getting a check if it’s ”fk hunt id” is the same as the id given from the hunt page.

```
public void generateClues()
{

    for (int i = 0; i < numbersOfClues; i++)
    {
        listOfClues[i] = new clues();
        int n = i + 1;
        string newClueName = cluesNames + n.ToString();
        listOfClues[i].setClueName(newClueName);
        listOfClues[i].setClueId(i);
        listOfClues[i].setClueHuntId(0);
        listOfClues[i].setClueRiddle(cluesRiddle[i]);
        listOfClues[i].setObjectToShow(rewards[i]);
        listOfClues[i].setClueCoordinates(cluesCoordinates[i]);
        listOfClues[i].setClueHint(clueHints[i]);

    }
    for (int i = 0; i < numbersOfClues; i++)
    {
        if (listOfClues[i].getClueHuntId() == fk_hunt_id)
        {
            int clueId = listOfClues[i].getClueId();
            GameObject newPlaceHolder = Instantiate(placeHolder, currentPage.transform);
            Vector3 newPosition = newPlaceHolder.transform.position;
            newPosition.y = newPosition.y - (margin * i);
            newPlaceHolder.transform.position = newPosition;
            nameholders = newPlaceHolder.transform.GetChild(0).gameObject;
            listOfClues[i].getClueName(nameholders);
            nameholders.GetComponent<Button>().onClick.AddListener(delegate { headToARPage(clueId); });
            buttons[i] = newPlaceHolder;
            imageHolder = newPlaceHolder.transform.GetChild(1);
        }
        else
        {
            Debug.Log("no id was picked");
        }
    }
}
```

Figure 42: ”generateClues” function from testClues script.

Now each prefabricated button for clues has three stages, locked, unlocked and completed, and these are determined through the function with the name, ”checkClueBool” (43). The first if-statement is forcing the first clue button to be unlocked by checking if the user has found zero clues, so the user has access to it. Afterwards, a for-loop is made for checking on two statements. The first statement in the for-loop is a check on the ”listOfClues”’s Boolean found for the given ID is true. If that is correct it will go to the second child of the prefabricated button and deactivate a gameobject that holds the image for locked and completed. Otherwise, the gameobject will be active and it will show that the clue is locked. The next statement checks if the ”listOfClues”’ Boolean completed is true and if that is true, it will change the image in the second child of the button to the completed image (sprite in unity). If it is incorrect, it will keep using the locked sprite.

```
public void checkClueBool()
{
    if (cluesFoundSoFar == 0)
    {
        listOfClues[0].setClueFound(true);
    }

    for (int i = 0; i < numbersOfClues; i++)
    {

        if (listOfClues[i].getClueFound())
        {

            buttons[i].transform.GetChild(1).gameObject.SetActive(false);
        }
        else
        {
            buttons[i].transform.GetChild(1).gameObject.SetActive(true);
        }
        if (listOfClues[i].getClueCompleted())
        {
            buttons[i].transform.GetChild(1).transform.GetChild(0).GetComponent<Image>().sprite = buttonImage[1];
        }
        else
        {
            buttons[i].transform.GetChild(1).transform.GetChild(0).GetComponent<Image>().sprite = buttonImage[0];
        }
    }
}
```

Figure 43: checkClueBool function from testClues script.

The function ”headToARPage” (44) does the same as ”goToCluePage” from ”testHunt”, with the page changing, but for the AR page instead. Furthermore, it also sends data to a script and gameobjects. Firstly, it gives the coordinates to ”updateGPSText”’s ”target” and changes text on the AR page where the riddle and hints are displayed according to what integer it was given.

```
public void headToARPage(int id)
{
    setObject.objectsToSpawn = listOfClues[id].getObjectToShow();
    ARPage.SetActive(true);
    ARPage.GetComponent<ARpageTest>().id = id;
    ARPage.GetComponent<ARpageTest>().maxNumberOfClues = listOfClues.Length-1;

    this.gameObject.SetActive(false);
    setTargetcoordinates.GetComponent<updateGPSText>().target = listOfClues[id].getClueCoordinates();
    arpageRiddle.GetComponent<Text>().text = listOfClues[id].getClueRiddle();
    int currentNumberOfClue = id + 1;
    clueOutOfTotalclues.text = currentNumberOfClue + "/" + numbersOfClues;
    showHint.text = listOfClues[id].getClueHint();
}
```

Figure 44: headToARPage function from testClues script.

7.7 Code for AR Page

The main object for the AR page is called ”AR Panel” in the Unity hierarchy, and contains a script called ”ARPageTest”. The script is used to get a connection with the ”gameManager” and ”Clues panel”. This is because ”gameManager” and ”Clues panel” has scripts attached to them, and those scripts have information that the AR page needs. The ”ARPageTest” has two functions called ”goToClue” and ”showHint”, where both of these functions are used for buttons. The ”goToClue” function is called when the back button is pressed, and it does two checks. The first check is to see if the user has found as many clues as the clue list minus one and the object has been placed. This is used to get to the final page, by deactivating the ”AR Panel” and activating the Finale _Page and change the text on Finale Page.

One of these objects can be found as a child to ”AR Panel” and is called ”riddleHolder”. This object has three text fields, a button and an image. The three text fields’ content is changed from the clue page buttons, so the riddle changes to fit what clue the user is currently doing.

To display the low poly 3D objects with high resolution textures in a real-life environment, ARCore is used and its components are contained under the object ”ARStuff” (2.6.3). ”ARStuff”’s children are ”AR Session”, ”AR Session Origin”, and ”Placement Indicator”. ”AR Session” is the one controlling the life cycle, which means that this component is able to start, pause, resume and stop it if needed. ”AR Session Origin” is the component that tracks the ground and control what size the object is going to be in the real world. Finally, there is the ”Placement Indicator”, which shows the user where the object can be placed. The code that places the object can be found in the subsection ”code for game manager” 7.5.

```
public void goToClue()
{
    if (cluefound.cluesFoundSoFar == cluefound.numbersOfClues - 1 && boolCheck.counter)
    {
        backToClues.SetActive(false);
        currentPage.SetActive(false);
        endPage.SetActive(true);
        objectCheck.isObjectPlaced = false;
        int minutes = int.Parse(timer.minutes);
        int sec = int.Parse(timer.seconds);
        float distance = 547;

        float score = minutes*0.5f+sec+0.3f+distance*0.4f;

        textOnEndPage[0].text = score.ToString();
        textOnEndPage[1].text = distance.ToString()+" m";
        textOnEndPage[2].text = timer.GetComponent<timer>().minutes + " : " + timer.GetComponent<timer>().seconds;
        timer.enabled = false;
        boolCheck.counter = false;
        naviBar.SetActive(true);

    }

    if (id< cluefound.numbersOfClues && boolCheck.counter)
    {
        cluefound.showHint.gameObject.SetActive(false);
        testclues.boolChange(id);
        backToClues.SetActive(true);
        currentPage.SetActive(false);
        endPage.SetActive(false);
        objectCheck.isObjectPlaced = false;

    }
}
```

Figure 45: goToClue function from ARPageTest script.

7.8 Icons and background

Using the analysed data about the icons, different types of icons were created. The icons were created in Adobe Illustrator CC using brushes and fonts only. For colouring the icons, natural colours as well as the project's colour palette chosen earlier were used. The most important icons on the main page is the treasure chest icon, which, when pressed, leads to the hunts page where users can access the available treasure hunts and attempt a hunt; the second icon is a scroll which leads to the user's profile page.

In the clues page, there is a magnifying glass icon, which symbolises searching for something. In the right top corner is a little "i" in a circle representing additional information. After clicking this option, user gets two options: About us or Contact us; in the "about us" page an icon of three people was used to represent a group. The "Contact us" page is enhanced with an icon of a quill pen with a small bottle of ink as a tool to write a message. For the background image, an image of a natural environment was used; it was blurred to make the icons, text and logo stand out [96].



Figure 46: Icons on the main page.

7.9 3D models and animation

3D models and UV maps were made in Autodesk Maya and the animations were done in Blender. Texturing was finished in Substance Painter and finally exported to Unity.

To begin with, 3D models had to be created first. Models were created, usually, from a cylinder or a cube, and the most used tools were "extrude" and the "multi-cut tool". These models are low poly models in FBX format, so they are not too big for exporting to unity. They also have clean topology (max number of vertices in a face should be between three and four) which was

necessary for later texturing. After models were finished, UV maps had to be made. UV maps were usually made for every component, not one for a whole model.

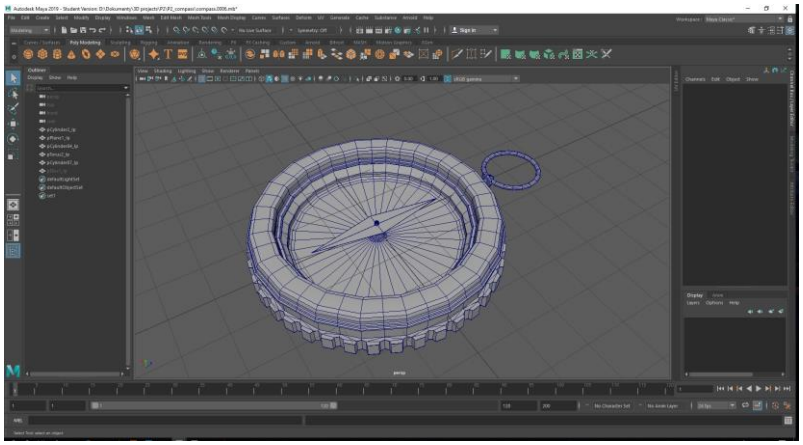


Figure 47: Modelling in Maya.

After UV maps were finished, the animations were created using keyframes and auto-interpolation in Blender. These animations are the simple opening, lifting and rotating of the models. The next step was to create the textures in Substance Painter. Preliminary materials were made and assigned to the different parts of the models in Maya. This made it easier to create the different materials in Substance Painter.

Substance Painter was used to create realistic looking textures using layers, materials, bump masks and normal maps. Some hand drawn paintings were also used, as well as custom brushes to import images for the Karl Schrag painting [97] and the compass [98]. After that, all the textures were exported in suitable resolutions in a format compatible with Unity.

Once the models were imported into unity, the materials were built from the exported texture maps from Substance Painter. The animations were also split into three parts: closed, opening

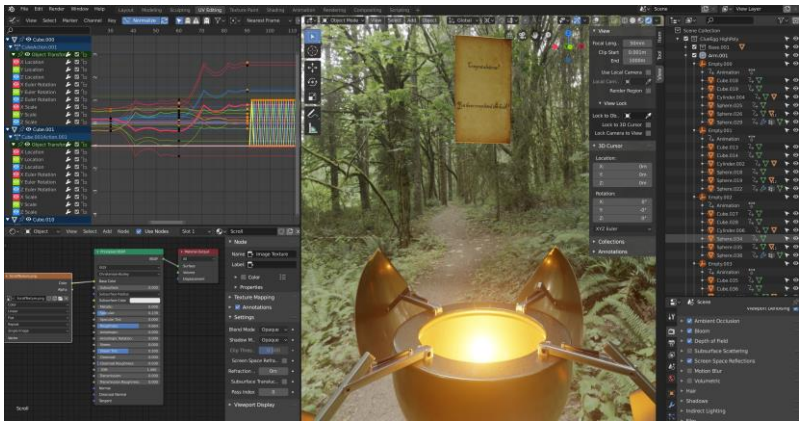


Figure 48: Animation and materials in Blender 3D.



Figure 49: Texturing in Substance Painter.

and open. This way, there were animation clips that could be used in the coding of the animation. The final model of the treasure hunt included confetti effects [99] to celebrate the user completing the hunt.

8 Evaluation

In this section the high-fidelity test will be outlined and analysed. This was done in order to evaluate the high-fidelity prototype in regard to the final problem statement and usability. During the span of this project there has been several tests and an interview to evaluate the state of the prototype.

8.1 Motivation for Evaluation

The goal of this high-fidelity test is twofold. First, it is a proof of concept test and also a test to figure out if the application can provide a relaxing experience to the target group and thereby answer the FPS. The test took place around the campus harbour and was initiated at one specific place next to our University canteen. The goal was to test the application on approximately 20 people in total and to do this over the course of two days. The participants were found using convenience sampling (4.2.7).

8.1.1 System Usability Test

The system usability test or SUS is a way of evaluating the usability of a system in a questionnaire by giving the participants a list of statements about the usability and then ask them to rate it from 1 to 5, where 1 is strongly disagree and 5 is strongly agree. SUS is a standardised usability test for web pages and interactive systems. SUS is appraised for being easy to use and for the accuracy of the outcome. On the other hand, the SUS test is strictly a quantitative test and does not facilitate qualitative feedback, which can make it hard to find out what went wrong since the questions are general [100]. The SUS score will be between 0-100. And, is calculated by converting the 1-5 answers into initial values that when multiplied by 2.5 gives a number between 0-100. Research shows that any score of 68 or above is above average and anything below is below an average score [101].

8.2 Questionnaire

It was decided to create a questionnaire in order to obtain information and answers from the participants before and after testing the application. In the questionnaire, participants were asked to fill out a Likert scale-like questionnaire, 5 being very positive and 1 being very negative opinion. Data gathered was used to assist the prototype development and polishing. The questionnaire consisted of questions regarding participants' relaxation levels before and after testing as well as questions on how the application could be improved and what would make the experience more relaxing. We also needed to make sure that the participants are within our target group. Thus, a question about their age was be constructed. Also based on our analysis, a question about a gender was be created in order to see whether it is true or not that females are more stressed than males (2.1.3). Some of the questions inquired about the difficulty of using the interface and the difficulty of riddles. The questionnaire also consisted of a series of system usability test questions (8.1.1). The questionnaire also inquired about whether the participant is a student or not. Some additional questions should be added for better and more in-depth outcome of the questionnaire. All of the questions can be seen in the (12).

8.3 Procedure

The test started off in the canteen as mentioned. When a participant was recruited, they were first asked to answer the first part of the questionnaire. This asked the participant about their current relaxation levels, which is in relation to the FPS. Then, they were told about the application and how it works by one of the group members and also general information about what the participant was about to do.

After this, the test began, the test subject went outside and tried to complete the task. There were group members stationed around the testing area. A total of 3 members of the group were placed outside to make sure that people did not walk the wrong way and helping if they experienced any bugs or issues with the application. When the participant reached the end of the hunt, a nearby group member stood ready to receive the participant and walk the participant back to the start area. They were then asked to fill out a post-test questionnaire. This questionnaire asked them about the experience and the usability of the application using the system usability scale (8.1.1).

8.4 High-fidelity Test Bias

As mentioned, convenience sampling was used; participants were recruited for the test as quickly as possible, and it relied only on data collected at Aalborg university Copenhagen. This made a difference in the overall results and will be discussed later.

Three phones were ready with the application installed and it was therefore possible to test on up to 3 participants at a time. This, however, also meant that 3 people would sometimes do the treasure hunt very close to another participant, making it easier for them to guess where the next location is. This was especially true for participants that already were familiar or friends.

8.5 Participants

Throughout the testing, there was 7 female participants and 18 male participants that filled out the questionnaire and tested the application. The average age between the participants was 22,76 years of age. Where the average age of participants within the target group was 21,47 years old. Also, all of the participants are currently students. At this point a distinction between target group and non-target group participants was created since some of the participants were too old to fit inside of the target group. 6 out of the 25 participants did not fit the target group as they were older than 24. Those six people are the non-target group participants and their data will only be used in the System Usability Scale test.

8.6 Results

As seen in the box plot graph below there was a difference in the relaxation levels within our target group. Other results we looked at were, how exercising affects the effects of eco-therapy and whether the results differ between people who work out and people which doesn't. Finally,

we looked at data gathered related to gender and split it into female and male results and compared those results.

As seen in the graph below (50), the results suggest a change in relaxation levels before and after the testing. While participants had an average relaxation level of 6.73 points on the scale, the results after the testing averaged at 8 points on the scale. This suggest a rise of more than 1.2 points on this scale.

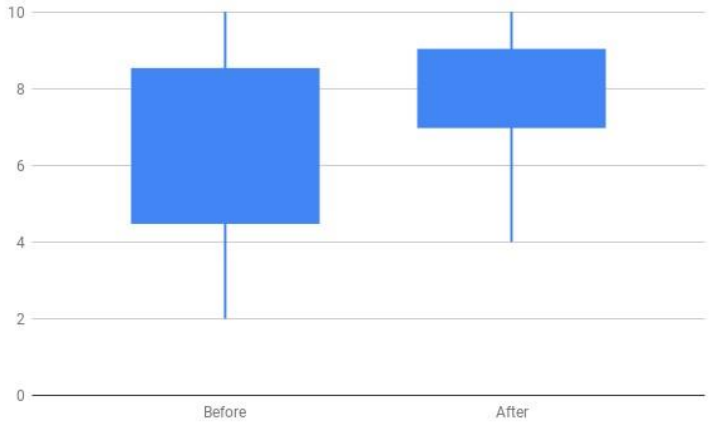


Figure 50: Relaxation difference before and after testing the application [102].

The results show different outcomes for participants who exercise on a regular basis which 16 participants did compared to the participants who do not exercise at all, 3 of which didn't (8.5). The results have shown that the app had less of a relaxing effect on participants who exercised with a positive change of 0.81 points. On the other hand, the relaxation levels of people who do not exercise improved from 5.7 points to 9.33 on average. Meaning that there is more than a 3.5 point improvement on the 10-point scale. Participants that do not exercise had lower relaxation levels before testing but had improved levels by the end of the testing. The reasons for these results would only become clear from further testing. The group of participants that didn't work out was of an insufficient size to conclude on this, but the group thought it was an interesting finding nonetheless (51).

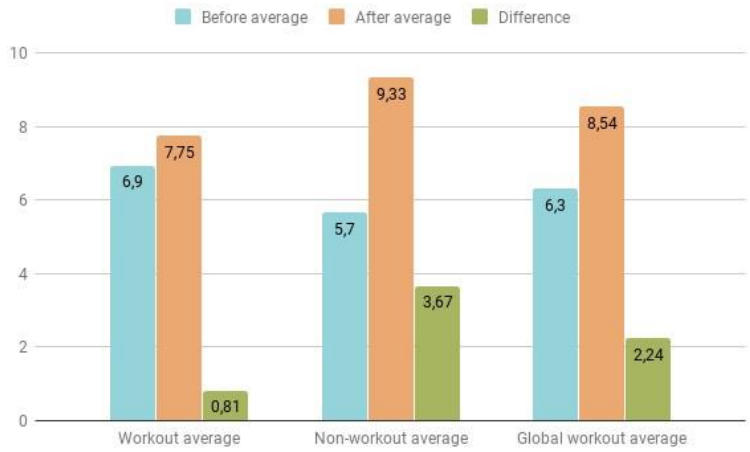


Figure 51: Workout relaxation difference [102].

General results can be seen in the graph below, where 52,6% of the participants had a higher relaxation level on the post-test Likert scale compared to the pre-test scale. Still, 21,1% of the participants reported to feel less relaxed after testing. 26,3% of all of the participants had an indifferent change in their relaxation levels (52).

The following results might be the product of the bias explained above (8.4) but could also show a correlation between the type of activity and the enjoyment experienced depending on the gender of the participant. Not having a sufficient number of females in the tested target group, lead to

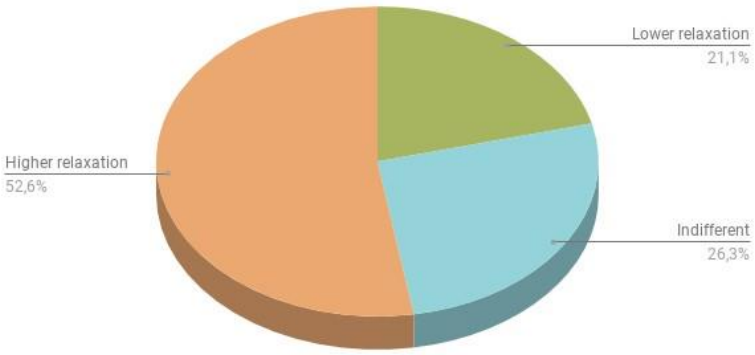


Figure 52: Difference in participants relaxation levels before and after the test [102].

an inability to conclude on this topic with certainty, the results have shown an improvement of 3.6 points on the Likert scale on average for females, while males only improved by 0.43 points (53). This could mean that the application somehow is more relaxing to the female participants. At the same time, the female group started off being less relaxed compared to men prior to the test. The female relaxation levels before testing were more than 2 points lower than the males. This could be due to, as mentioned in the analysis (2.1.3), females are generally more stressed than males in this age category. The reason for their increased relaxation compared to males would require further testing to properly understand (53).

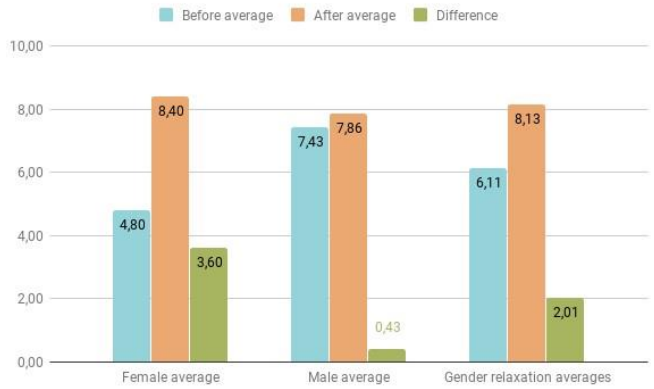


Figure 53: Average values of relaxation levels between genders [102].

8.7 Qualitative Data

Many participants input ideas for the application and how to make the trip a more relaxing experience. All of the following qualitative data was collected from the question ”what would make the experience more relaxing?” The most prominent thing that was noted was that participants disliked having to hold and look at the phone for most of the trip. Looking at the questionnaire answers, it has been suggested by a couple of the participants to add a ringtone, notification or a vibration when the desired location is reached. This could have meant a higher degree of relaxation and would have to be tested further to conclude.

Some of other participants mentioned that if this had been a group activity, that would make it more enjoyable and relaxing, for example going out to hunt treasures with friends or family. Or just in general, add a social aspect to the game. A couple of participants also stated that the app should encourage people to be more competitive, or on the other hand, somehow co-operate together. A few participants also thought it would make for a better experience if small tasks like breathing exercises, which aligns well with what the psychology expert stated was something relevant to implement. More interestingly, several participants mentioned implementing a story into the game to help keep users interested and make them more relaxed. We have also gotten comments on how people would appreciate having some additions, such as adding an approximate time of completion, or distance for an idea of how long it is going to take to finish it, so that users can plan day trips. Making the hunts longer was also suggested by several participants. One of the participants mentioned not having the completion time at the end could make the experience more relaxing. A participant suggested adding a ”minimap” showing the route and an arrow or direction that helps in case of a user getting stuck. Since the testing was done in the university area, a comment recommended locating the hunt in a natural environment, this is the aim of the final product. One of the testers also said that more hints should be implemented in order to make the experience more relaxing. Also, adding music was mentions. However, this contradicts what the expert mentioned in the interview regarding immersion in nature. Finally, some participants did not want the application to be more relaxing but wanted more competitive functionalities and thought the application was more fun than it was relaxing.

To sum up, the application received mostly positive feedback, and participants thought the application was both relaxing and fun while the majority of the participants still had comments on how to make the application more relaxing.

8.7.1 System Usability Scale

The results for the system usability scale showed that participants perceived the usability of the application positively. The average usability score for all 25 participants was 79,8 (SD = 9,5) out of a possible 100. This score is generally perceived as a high score with 68 points being the average and anything below 68 needing serious work to satisfy the user. The highest score was 97,5 while the lowest was 62,5. Our lowest score is below the recommended average and could therefore mean that some users might find the usability inadequate. Further testing with the four individuals scoring below average could bring light to which issues they were having and how to improve the application going forward.

9 Discussion

This section will discuss the results from the testing and compare that to the FPS and analysis to see how much can be answered. Furthermore, it will discuss some aspects of the implementation.

9.1 Evaluation Discussion

During the high-fidelity test a few participants went in groups of 2 people and some were alone but ended up catching up with the ones before them. This meant that some participants could follow the path of the ones before them without doing the hunt themselves. When some of the participants eventually had caught up with the ones before them, they would walk to the finish line and do the hunt together. This could have a positive or a negative impact on their experience but from the results of the test it would seem to be mostly positive. That being said, this is something that should receive more focus and attention in future tests and is an unfortunate event that happened. This, of course, is something that should have been prevented and thought of beforehand.

Overall, the relaxation levels of the participants had increased from before testing the application to after, but while most felt more relaxed a participant had mentioned verbally that they were less relaxed because they were exited that they had finished and in good time. This participant did mention as well, that they had had a great time walking around and taking a break. In another situation a group of three people had come to test, and they were asked to start off with a delay between each other. This ended up not mattering since the first participant had trouble with the first clue and the second person in line caught up with the first. They then began racing to get to the finish line. As the expert mentioned in the interview it might have had a positive quality that they ended up doing it together and competing.

During testing, a few issues or bugs with the application came to light. This is of course one of the reasons for testing, but these issues might have made a difference to our test results. The main issue was that we implemented an icon on the AR camera view, this icon should have functioned as an alternative to the back-button in the bottom. The issue was, that when the icon was clicked, the user went back to the previous page as expected but the progress they had made was lost, as the appropriate script was forgotten to be attached to the button. This meant that people were now able to spawn several 3D models and also weren't able to progress further. This issue was caught midway through testing and testers were then telling people not to use the icon anymore. This issue could have had negative impact on our test.

Another issue was, that the GPS tracking was at some points during the hunt a little off. This meant that people were now not able to use the AR functionality, in the correct location or in other cases were able to load the 6th and final model while also being within reach of the 5th. However, we had group members stationed all around the testing area and these proved very useful in helping the participants get back on track. Since the results show a general increase in relaxation these issues might not have had a huge impact on the purpose of the application.

A problem with combining eco-therapy and using technology is that users might use their phone while they are on the walk and thereby get distracted by the phone and other applications on the phone or just not have enough ”spontaneous attention” (6.2) while walking

in nature, which is what makes it a relaxing experience. This was also mentioned by several people in the high-fidelity questionnaire. A way to counteract this, could be by adding a timer for how long the screen has been active and rewarding users for using the screen the least number of minutes/seconds.

One of the main issues with using convenience sampling for our high-fidelity test is, as described in the convenience sampling subsection of the methods chapter (4.2.7), is that the results are prone to being unreliable. This is simply because we would have had to test on our target group for more reliable results. In our FPS, we state that it is danish students we want to help relax but this was also not made sure of for the high-fidelity test. These are issues that could make our data inaccurate. A way to get more accurate data would be to do a focus group test with people within the target group. This focus group test could also be placed in a more natural setting than the school harbour, a forest for example, this would make the data more reliable in general. Even though the data might be inaccurate or unreliable, we still think that it shows some tendencies that are worth noting. The fact that we tested on a multicultural group of people could indicate that the application would work in other countries than Denmark.

9.2 Implementation Discussion

We used Unity to implement our design. To implement the AR functionality, we started out by using the Vuforia which is a freeware that facilitates the implementation of AR into Unity. The reason for using Vuforia was, that on the in the guides on Unity's website, Vuforia was being used. We spent a lot of time trying to implement this software into our application, but after running into a lot of issues we decided to switch to AR core. AR core is a Google software that turned out to be much better for our case. We might have lost valuable time doing this switch. Mainly, due to the fact we had comments and suggestions from our low-fidelity tests and our expert interview that didn't make it into the application. Such as, the expert regarding the icons as slightly childish for our target group and some test participants suggesting the buttons need to look more interactable.

Furthermore, working in Unity, it was necessary to implement the idea for the application we wanted to create, but only a limited number of members of the group were familiar with the Unity workspace when this project started. Several members joined in to help implement various functionality. These attempts turned out in most cases not to help with the implementation, simply because group members needed more time to understand the Unity workspace and C# programming language. This meant that for some time, most group members were left to wait for the finalisation of the implementation before testing, evaluation, discussion and any conclusion could be done.

Finally, the 3D models for the application were done by many group members and this turned out to be a good way to get a lot of modelling done in a short time frame. However, only one group member had experience with animating such models and therefore we ran into the same issues as mentioned with Unity above. Also, the animations were done in Blender and when exported and imported into Unity. The animations proved difficult to implement into unity due to some incoherence between the software; Again, we had to postpone testing until these issues were resolved.

10 Conclusion

The motivation for this project was to design an application to increase the well-being within a group of people using technology. Through our initial research we identified stress as a prevailing and increasing issue within the demographic of young adults. This was further narrowed down to danish students between the ages of 16 and 24 years old. Through our analysis we found that, first of all, we wouldn't be able to test whether or not stress levels could be decreased, the scope of the project simply wasn't large enough for that. Instead, we identified that we could design an application that could help people relax. This relaxation could presumably in turn then decrease the stress of the user.

While analysing stress and the factors that cause it, we met an array of possible ways of treating stress. One of these were eco-therapy. Put briefly, eco-therapy is when a person is using nature to rid themselves of factors that supply stress. This includes light exercise, sunlight, fresh air, sounds and more. We then had to find a way to utilize this form of therapy while combining it with technology. We researched virtual reality and augmented reality in various forms and through various platforms. To reach the largest amount of people within our target group, we decided to work with augmented reality through a mobile interface.

After choosing this path, we had to figure out how to motivate our target group to use the application, for this, we researched gamification combined with puzzle solving. To match these motivational factors with eco-therapy we had to generate a concept that could include all these in one application. The choice went to design an application that should give the user a relaxing treasure hunt experience. Treasure hunts normally take place outside, incorporate puzzle or riddle solving and seem to match our criteria for the application.

We then started working on the design, we researched Gestalt principles, Don Norman design principles and more within the interactive design genre. With this knowledge we put forward our final problem statement, which reads: *How can a location-based mobile interface, relying on ecotherapy theory, gamification, and augmented reality, create relaxing walking experiences on behalf of Danish students between the age of 16 and 24 by guiding them to specific locations in nature?*

With this problem statement in mind we put forth a list of functional and non-functional requirements for the application. We then started the design process of the first low-fidelity prototype. This was tested on a group of ten people with a focus on usability and navigation. After implementing the knowledge gathered from the first test, we had an interview with a psychologist. This interview showed that to some degree eco-therapy was utilized in our application, and we also got feedback from the interview that was implemented into the application. We then tested a second low-fidelity prototype which had a higher degree of fidelity while still missing some core functionality. This test yielded information on the overall design and usability through a questionnaire and comments from the participants.

With these tests complete, we began work on our high-fidelity application. The implementation was done in the Unity Game Engine. We implemented features like augmented reality through Google AR Core and GPS location tracking. With a working high-fidelity prototype in hand, we took to testing this final iteration of our design.

Testing was done over the course of two days with a total of 25 participants. The results showed that more than half of the participants were more relaxed after using the application.

People within our target group showed a higher level of relaxation than those outside the target group age category. There were some concerns regarding the use of convenience sampling which might have had an effect on the reliability of the test. A few participants were less relaxed after using the application and it would require further testing to find out how and why this happened. All 25 participants completed a system usability scale questionnaire consisting of 10 questions related to the usability of the application. This test produced positive results in regard to the usability with an average score of 79,8 out of a possible 100 points.

The high-fidelity test was also a proof of concept test which also turned out positive. Since participants understood the idea and were able to complete the treasure hunts. This is important in regard to future work with the application.

In conclusion, our high-fidelity application received positive feedback in regard to our final problem statement, both in terms of usability and as proof of concept. However, further design iterations and more testing with the target group would be required to deem the final problem statement completely answered.

11 Future work

In this section we will discuss the future of the product and possible changes that could be implemented in a finished version.

11.1 Scalability

The proof of concept worked out and was relatively well received, but if the application was to actually be released, it would need to have more content, so that users have different places to go as well as different routes. Nowadays user generated content is very popular, because it lowers the cost for the producer of the application and also heightens the user interactivity and ownership. Furthermore, this allows for content to be created that a wide variety of people could enjoy, for each of their specific interests. There could be different ways this could be achieved. If this proved to be possible it could be that the application would recommend routes from a catalogue of user generated routes and then these routes might be completed with the addition of 3D models and clues from a user.

11.2 Exercise

As both the expert interview as well as a few of the participants of the high-fidelity test said, a good idea to implement would be small exercises to be made e.g. breathing exercises or meditation. It could easily be implemented into the treasure hunts, but it would be hard to measure if the user did these exercises. Further testing would be needed to find out if this is something the target group would do.

Another possibility is giving the user points for going off somewhere and seeing and exploring something else, though that might not be the intended nature area that the destination of the treasure hunt might lead to. Also, users should be rewarded for extra exploration after the treasure hunt has ended. An ”Keep on exploring” feature could be added and might motivate users to keep going around the area or even deeper into the nature. A way to keep the user wanting to explore could be by rewarding them in the application or by making more 3D models available.

It’s also a possibility that the application would have two modes, relaxation and exercise. Relaxation is the default one, while the user could choose the exercise mode, this mode might give points for faster speed instead of longer time and differences as such.

11.3 Competitiveness and Teams

A few high-fidelity test participants noted that it would be a great team exercise. This is defiantly a possibility to implement, using a ”friends” feature would make it possible to compare statistics. Moreover, you could also be split into teams, let’s say for example four friends are out together and are then split into two teams of two that then competes on who is fastest to solve the riddles or reach a certain destination.

11.4 Other features

3D model interactivity would also be something interesting to implement. Right now, users spawn a 3D models themselves and is able to read the riddles on the models. In the future, it would be interesting to be able to interact with the models at a higher level, maybe having to actually find the model, or have something on the model that users could use, play or in other ways interact with.

Implementing the end of the treasure hunt to be something more extraordinaire than just a congratulations is also something that many wanted to be done. Making users find specific locations that might be of interest. Adding to this, it might be possible to work with restaurants or tourist attractions to bring people to their place of business through the application.

11.5 Further testing

Due to time limitation we tested the levels of relaxation and not levels of stress. However, had the scope of the project been larger, it would have been able to test whether the application could help reduce stress or not. A way to do this could be to employ two groups of people. A control group within the target group who did not use the application and another group from the same group that did use the application several times a week. This would make it possible to gather information on long term effect of using this application. The group members might both be interviewed, asked to write diaries and fill out questionnaires along the way to gather both quantitative and qualitative data in the testing period.

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12 Appendix

12.1 Low-fidelity test

Method of interview: A questionnaire, is a method of interviewing or information gathering. It is used to find out the opinions of the costumer, population or in other cases, someone testing an early prototype. A questionnaire can be designed in many different ways to fit the need of those who use it. For this project and in relation to the low fidelity prototype the questionnaire will be made using Google Surveys. Within the questionnaire there will be use of like-it scales and self-fill-out answer boxes. In the end of the questionnaire the data will be collected and a new one will be set up. All participants will remain anonymous.

Recruiting: One member of the group will approach around 10 people total, mostly from the near area in the university or the group rooms. The one member will introduce them-self and explain the general purpose of the interview and testing. When they are at the testing area the second person will take over and start testing.

The introduction will consist of the first member introducing them-self and the purpose of the interview, also if they want to participate. Then the second person takes over and will then explain the idea of the application and ask initial questions, like what is your age and gender. Finally, the application will be given to the test subject where they can try it out. After they have finished the walk through of the low-fidelity prototype they will be asked a few follow-up questions in the questionnaire, where the test-subject will have to give a first look evaluation.

The questionnaire will consist of a two start questions and after they have used the prototype, further elaborations of the comments made by the test subject.

Questions: 1. How old are you?
2. What gender are you?

Show low-fidelity prototype.

Questions: 1. How was the navigation of the app?
2. What do you think is missing?
3. What do you think is good?
4. What would make the navigation easier?
5. Was it easy to find out how far along you were in the hunt?

12.2 Expert interview

The purpose of the Expert interview is to get feedback on the concept of the prototype and more specifically to find out if a psychologist believes that the finished application will be able to help the target group.

The method for evaluation is a semi-structured expert interview. The expert interview is an interview method that will assist in the evaluation of an idea or concept. For this project, the interviewer will present the concept of the application, explain the utilization of eco-therapy and gamification to then gather the expert's opinion of the viability of the concept. The interview will be conducted in the semi-structured fashion where the interviewer will present questions related to the concept and follow up any expert opinions with questions. There will

be two group members present at the interview, one will be interviewing the psychologist while the other is in charge of recording the interview and taking notes of important statements.

Recruiting the expert: The expert has a degree in educational psychology from Aarhus University. The expert was known through a group member that wrote the person personally. The interview will be conducted by a group member with no former relationship to the expert to avoid as much bias as possible.

Procedure: Present concept, show low-fidelity prototype and present current design ideas and pictures of current design.

Questions: 1st question:
Har du hørt om natur-terapi før?
"Have you heard of eco-therapy before?"

If no to above:
Hvad vil du normalt foresl˚a til en patient, hvis du skulle foresl˚a dem en afslappende oplevelse?
"What would you usually recommend to a patient if you had to recommend to them a relaxing experience?"

If yes to 1st:
I din mening, udnytter vi s˚a natur-terapi til dets potentiale?
"In your opinion are we using eco-therapy to its potential?"

If we are using it:
Har du nogle forslag til at forbedre p˚a konceptet? "Do you have any recommendations to improve the concept?"

If we aren't using it:
har du nogle foreslag til hvordan vi kan f˚a det bedre med i vores konceptet?
"Do you have any recommendations for how we can better incorporate it into the concept?"

2nd question:
Har du yderligere nogen forslag til hvordan vi kan forbedre konceptet? "Do you have any other recommendations as to how we can improve the concept?"

3rd question:
I din mening, vil dette konceptet kunne hjælpe unge danske studerende i alderen mellem 16-24 med at få en afslappende oplevelse?
"In your opinion, will this concept be able to help young danish students in the ages between 16-24 to get a relaxing experience?" End of interview.

12.3 Adobe XD low-fidelity test

The goal of the second low-fidelity test iteration is to get feedback on some of the changes from the expert interview and the initial low-fidelity test. Furthermore, it is to get feedback from the actual target group.

The procedure for the test: Two members of the group will be doing the testing. One member will approach a student and ask them if they are willing to help test and make sure they are

within the target group. Then the newly found participant will be asked to answer some initial questions like age, gender and if they are students at the school. Then they will be given the application and get some time to use it. Then the second member of the group will ask them to find something is the application and time them to see how long it takes. After this, the participant will be asked to answer some follow up questions in a questionnaire and then the participant is done. The two members will then find a new participant, and this will repeat a total of ten times.

Questions: 1. How old are you? 2. What gender are you?
3. Are you currently a student?

Let them use the low-fidelity XD prototype. Ask them to find some things in the app & time them. Find the profile page, About page and first hunt.

Questions: 1. How was the navigation of the app?
2. What would make the navigation easier?
3. Was it easy to find out how far along you were in the hunt?
4. What do you think is missing?
5. What do you think is good?
6. What do you think of the design of the application?
7. What do you think of the icons?
8. Do you remember where to find the total distance?

12.4 High-fidelity test

Questions for the high-fidelity test: 1. How old are you?
2. What gender are you?
3. Are you currently a student?
4. How relaxed are you right now? 1-10 where 1 is not relaxed at all and 10 is completely relaxed.
5. If you work out, which kind of workout and how many hours a week?

Test. Questionnaire: 1. How relaxed are you right now?
2. Did you enjoy being outside while using the application?
3. What would make the experience more relaxing?
4. How difficult were the riddles?
5. Did you use the hints?
6. Did the hints improve the experience?
7. I think that I would like to use this system frequently.
8. I found the system unnecessarily complex.
9. I thought the system was easy to use.
10. I think that I would need the support of a technical person to be able to use this system.
11. I found the various functions in this system were well integrated.
12. I thought there was too much inconsistency in this system.
13. I would imagine that most people would learn to use this system very quickly.
14. I found the system very awkward/difficult to use.
15. I felt very confident using the system.
16. I needed to learn a lot of things before I could get going with this system.