Master's thesis

NTNU
Norwegian University of Science and Technology
Faculty of Information Technology and Electrical Engineering
Department of Computer Science

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Utilizing Gamification to Facilitate Nutritional Self-Management in Children

Master's thesis in Informatics: Databases and Search
Supervisor: Yngve Dahl
Co-supervisor: Anita Das
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Preface

This study has been carried out at the Department of Computer Science, under the Faculty of Information Technology and Electrical Engineering at the Norwegian University of Science and Technology. The work presented in this thesis was completed in collaboration with Sintef Digital. Additionally, an expert in clinical nutrition physiology working at Trondheim Kommune worked with us as a consultant.

Statement of Co-Authorship

NTNU

DECLARATION OF CO-AUTHORSHIP

Marius Johan Holm Johansen applies for the evaluation of the following thesis:

Utilizing Gamification to Facilitate Nutritional Self-Management in Children

*) The declaration should describe the work process and division of labor, **specifically identifying the candidate's contribution**, as well as give consent to the article being included in the thesis.

*) Declaration of co-authorship on the following chapter/section:

- Chapter 1 – Introduction
- Chapter 2 – Background Research
  - Section 2.2 – Motivation
  - Section 2.3 – Gamification
  - Subsection 2.3.1 Progression and Reward System
  - Subsection 2.3.2 – Avatar
- Chapter 3 – Related Work
  - Section 3.2 Similar Application
  - Section 3.3 Evaluation
- Chapter 4 – Research Design
- Chapter 5 – Systematic Literature Review
- Chapter 6 – Prototype Development
- Chapter 7 – Prototype Presentation
- Chapter 8 – Evaluation
- Chapter 9 – Results
- Chapter 10 – Discussion
- Chapter 11 – Conclusion
- Additional organizational work (Overleaf, test documents, forms)

In addition, the works on the background, the systematic literature review, concept and development of the prototype, and the evaluation were co-contributed.

Trondheim, 15.06.2021
Place, date

.....
Signature co-author
(Marius Johan Holm Johansen)

*) Declaration of co-authorship on the following article:

- Chapter 2 – Background Research
  - Section 2.1 – Childhood Obesity
  - Subsection 2.3.2 – Avatar
- Chapter 3 – Related Works
  - Section 3.1 – Related Researches
- Chapter 4 – Research Design
- Chapter 5 – Systematic Literature Review
- Chapter 8 – Evaluation

In addition, the works on the background, the systematic literature review, concept and development of the prototype, and the evaluation were co-contributed.

Trondheim, 15.06.2021
Place, date

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Figure 1: Signed Co-Authorship Statement

Acknowledgements

I would like to thank my supervisor at the Norwegian University of Science and Technology (NTNU), Yngve Dahl, and my co-supervisor from Sintef Digital, Anita Das. Without their guidance and contributions to the project, this study would not have been possible.

Additionally, Tove Langlo Drilen deserves gratitude for her invaluable feedback and expert insight into the nutrition and physiology fields. Her contributions helped the author prioritize certain aspects and design the solution in a way we else would not have been able to.

I would also like to thank my research partner, Gorn Phetchpinkaew, for his assistance in conducting the systematic literature review which served as the baseline for this thesis, in addition to the parts outlined in the cooperation statement.

Further, I would like to thank my grandmother, Wenche Gerd Johansen, for her unconditional support throughout my studies, as this would not have been possible without her.

Additionally, I wish to thank Helene Silseth and Eirik Berg Tichy for their support and assistance during the later stages of this thesis.

Lastly, my sincerest gratitude go towards the families of the aforementioned supervisors and experts. Their willingness to partake in the external tests necessitated by the ongoing Covid-19 are greatly appreciated, and the feedback gathered from these experiments proved to be invaluable.

Marius Johan Holm Johansen Trondheim, 15. June, 2021.

Abstract

Worldwide overweight and obesity has become an increasingly significant public health issue over the last 35 years. According to the WHO, overweight and obesity among adults have tripled in that time frame, with 39% and 13% of the world's population respectively struggling with the disease. Likewise, early onset obesity has increased even more substantially in the same timeframe, growing from 4-18%. Statistics collected by the Norwegian Public Health Institute (FHI) suggest an obesity rate for Norwegian children and adolescents ranging between 13% and 20%, reflecting the worldwide state.

In addition to the physical health concerns regarding obesity, children in particular can experience severe psychosocial problems related to their obesity. This can further manifest in problems such as a higher chance of dropping out of school, depression or other mental health issues.

Obesity has an impact on an individual's quality of life, but can be prevented. This study aims to explore, develop and utilize a digital self-help application specifically designed for children, to raise nutritional awareness and prevent early onset obesity. To this end, an application in which to test this will be developed in accordance to the design principles of gamification, which in this context, means the addition of mechanics and elements otherwise present in game design theory.

This solution was subsequently tested on a set of individuals in the target demographic, by giving the testers a set of tasks to be completed during a hands-on session with the application. The results of this process were later collected through an online survey, in which the testers were asked to answer a series of questions relating to different aspects of the solution.

These results suggest that applying the design principles of gamification to an application like this, can facilitate increased motivation and engagement for the end user.

Sammendrag

Overvekt og fedme har vært et signifikant og økende folkehelseproblem i løpet av de siste 35 årene. Ifølge WHO, har overvekt og fedme blant voksne tredoblet seg i det tidsrommet, hvor henholdsvis 39% og 13% av verdens befolkning sliter med overvekt og fedme. Likeså, har fedme blant unge økt vesentlig i det samme tidsrommet, ved å øke fra 4-18% i det samme tidsrommet. Statistikk samlet av Folkehelseinstituttet (FHI) foreslår en fedmerate for norske barn og ungdommer til å ligge mellom 13% og 20%, noe som også reflekterer tilstanden til barn ellers i verden. I tillegg til de fysiske helseproblemene en kan oppleve i forhold til fedme og overvekt, kan spesielt barn oppleve alvorlige psykososiale problemer relatert til sin overvekt. Dette kan videre føre til problemer som en høyere sjanse for å droppe ut av skolen, depresjon og andre mentale helseproblemer.

Fedme har en direkte innvirkning på et individs livskvalitet, men kan unngås. Denne studien har som mål å utforske muligheten for å utvikle og bruke en digital selvhjelpsapplikasjon spesielt designet for barn, for å bevisstgjøre unge i deres valg og kunnskap rundt ernæring, it et forsøk på å forebygge fedme blant unge. For å evaluere dette vil et preventativt selv-hjelpskonsept bli utviklet, basert på designprinsippene til spillifisering, som i denne konteksten betegner anvendelsen av elementer og teknikker kjent fra spilldesign.

Løsningen ble i ettertid testet med et sett individer i den aktuelle målgruppen, ved å gi testerne et sett med oppgaver som skulle fullføres gjennom en praktisk økt der applikasjonen var i bruk. Resultatene av denne prosessen ble senere samlet gjennom en spørreundersøkelse der deltakerne ble stilt en rekke spørsmål relatert til forskjellige aspekter ved løsningen.

Resultatene av denne fasen foreslår at anvendelsen av designprinsippene bak spillifisering i denne konteksten kan fasilitere økt engasjement og motivasjon anngående ernæring og selv-hjelp hos sluttbruker.

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In loving memory of my grandfather

Per Norval Johansen

1935-2021

Chapter 1

Introduction

Obesity and overweight have become one of the world's leading health problems in the 21st century. More often than not, individuals struggling with obesity experience physical-, mental- or psychosocial issues as a consequence of their obesity, and this issue is not contained to only the adult demographic. Early-onset obesity for individuals in the younger demographic has followed this trend over the last 35 years, and even though the growth rate of this statistic has stagnated somewhat, data suggests that it is still quite problematic with 13-20% of children in Norway suffering from early-onset obesity (Norwegian Institute of Public Health (FHI), 2017). The reasoning for an individual becoming overweight or obese is complicated and every individual story may differ, but research suggests that a combination of nutritional knowledge and other health- and exercise factors are key in preventing obesity and supplementing a healthy lifestyle.

While there currently exist several thousands of applications and solutions in the health space ranging in scope from simple tracking of health-based routines, to increasingly convoluted systems for tracking an individual's overall health - few of these solutions have been designed with the younger demographic in mind, and fewer still by incorporating the design principles of gamification. The motivation for this study lies in exploring this space and researching the possibility for developing an application with the ability to aid in the prevention of early-onset obesity, by leveraging individuals' inherent motivation through the application of gamification to create an environment promoting healthy habits.

The goal of this thesis is defined by the following research questions:

RQ1: *How can the principles of gamification be utilized to develop a solution that assists in the prevention of early-onset obesity among the younger demographic?*

RQ2: *How can gamification be used to leverage the inherent motivation an individual possesses by*

incorporating a reward- and progression system?

RQ3: *How does the introduction of a gamified environment affect the motivation of users in the younger demographic?*

Research Question 1 is the main research question for this thesis. By exploring the fields of gamification and the relation these strategies have to motivational theory, the auhors aim to utilize user-centered design to realize a digital solution that supports the acquisition of healthy habits, and aid in the prevention of early-onset obesity. This proof of concept will later be evaluated as part of this question.

Research Question 2 focuses on the specific gamification elements of rewards and progression, and how these systems work in tandem. This question relies heavily on motivational theory, which the author deemed important to explore in order to gain the necessary insight needed to design a thoroughly motivating experience. Additionally, this question will act as supplementary to the first research question and facilitate the last question.

Research Question 3 aims to explore the effect an integrally gamified environment has, and how this approach affects the users in contrast to the addition of gamified elements after the fact.

To answer these questions, a combination of different research methods will be utilized. First, a Systematic Literature Review (SLR) will be conducted, before a prototype of the proposed solution will be developed by utilizing user-centered design principles. Secondary research will be done in tandem with expert interviews to gain further insight into the topics at hand. Finally, the solution will be evaluated by performing an experiment, followed by questionnaires. This process is described in detail in section 3.3.

By answering these questions, the author's contribution hopes to illuminate the current situation of the presented niche and offer insight into the utilization of gamification in the design of health-based applications for the younger demographic. Additionally, the proposed solution and subsequent prototype serve as a baseline for further development and research regarding this specific problem.

1.1 Thesis outline

This thesis is divided into five parts which in turn consist of **11** chapters. This section concludes **Part I**, which has introduced the thesis to the reader.

Part II encompasses the background section of the study. This section includes the secondary research done to support the rest of the thesis. The part also describes other related works and currently available

applications relating to the same space. This part includes chapters 2 and 3.

Part III introduces the methodology of the thesis, presenting the different data generation methods utilized as part of the project, in addition to justifying their inclusion. This part includes chapter 4.

Part IV showcases the results of the thesis. The part begins by describing the systematic literature review, before presenting the development and manifestation of the prototype. The part also includes the evaluation methods used to evaluate the proposed solutions, before concluding by presenting the results. This part includes chapters 5 through 9.

Lastly, **Part V** discusses the results of the thesis, before presenting a conclusion of the project. In addition, a section discussing possible future work is added. This part includes chapters 10 and 11.

Chapter 2

Background Research

In this chapter, secondary background research conducted on several topics relevant to the thesis and subsequent prototype will be presented and examined. The main topics of interest that were researched are in order of appearance Childhood Obesity, Motivational Theory, and Gamification. These fields are highly relevant to this thesis, and the choices made and solution developed as part of this thesis are highly based on the results of this phase.

This chapter opens with section 2.1, presenting the theories related to childhood obesity. The section also describes specific factors such as Parental Habits and the impact this has on early-onset obesity. Further, in section 2.2 the field of Motivational Theory is examined, and psychological theories such as Skinner's Box and the Self Determination Theory are examined. The chapter continues in section 2.3 by examining the theory of Gamification, and describes several key techniques in addition to presenting the up- and downsides of the strategy.

2.1 Childhood Obesity

Overweight and obesity are defined as abnormal or excessive fat accumulation that presents a risk to an individual's health (World Health Organization, 2020a). When an individual has a high Body Mass Index (BMI), the relative risk for contracting other serious diseases such as cardiovascular diseases, diabetes, musculoskeletal disorders, and cancers is high citepwho2. The World Health Organization (WHO) reported in 2016 that 39% and 13% of the world's adult population were overweight or obese, respectively (World Health Organization, 2020b). The situation for children and adolescents is also concerning. In 2016, 340 million children and adolescents aged 5-19, and in 2019, 38.2 million children

under the age of 5 years were overweight or obese (World Health Organization, 2020b). Research suggests that obesity in childhood is linked to an increased risk of adult obesity, premature death, and disability (Franks et al., 2010). Moreover, obese children face breathing problems, a higher risk of fractures, hypertension, early markers of cardiovascular disease, insulin resistance, and other predominantly negative psychological effects (World Health Organization, 2020b). For this reason, it is crucial to detect and prevent obesity at an early age. Obesity is preventable, and family members, parents, in particular, could influence the evolution of potential diabetes through food selection, support, and the creation of healthy habits.

2.1.1 Causes and Consequences

Several causes could lead a person into obesity which includes their food intake, exercise habits, lifestyle, cultural background, genetic factors, and so on. Research suggests that the following listed factors affect children in specific, and that sub-optimal adherence to these factors could lead the individual into obesity (Sahoo et al., 2015).

- *Food Portions and Sugary Beverages* - A study found that children's BMI can increase as a result of heavy intake of sugary beverages (Anderson and Butcher, 2006). Moreover, most of the people associate sugary beverages exclusively with soft drinks and sodas, when in fact juices and other sweetened beverages also contain a high amount of sugar (Sahoo et al., 2015). Many researchers have studied the connection between the intake of sugary beverages and increased weight, suggesting sugary drinks to be a big perpetrator in early-onset obesity as children in specific also tend to prefer sweet drinks (Anderson and Butcher, 2006). In addition, portion size is another factor that could encourage obesity. Research suggests that the relative portion size of meals has increased significantly increased in the last decades, leading people to generally consume more calories than before, further suggesting that imbalanced portion sizes and dietary restrictions also appear as a leading cause for childhood obesity. (Anderson and Butcher, 2006).
- *Activity level* - Another area that factors in to childhood obesity is the physical activities an individual performs during a day, and how many calories are burned during these activities. Coinciding with the technological revolution, the predisposition to sedentary lifestyles have been on the rise, specifically due to the introduction of the TV, internet, smartphones and video-games. A study found that the time children and adolescents spend on watching television has increased drastically over the (Anderson and Butcher, 2006). Further research also suggested a correlation between hours spent watching TV and the consumption of advertised goods including sweets, snacks, and sugary beverages, further increasing levels of obesity (Story et al., 2002).

- *Environmental Factors* - In addition to sedentary behaviour that could lead to obesity, abrupt changes in a child's environment and surroundings may also influence their health. In the last few decades, the way in which children travel to school has changed from walking and biking to utilizing public transportation and private cars, which in turn lead to a decrease in physical activities. Parents may also express concern for their children's safety or convenience as well, choosing to drive them instead. These factors also lead to an level of sedentary behavior. (Anderson and Butcher, 2006).

- *Familial Factors* - Additionally, familial factors have been observed to have a high level of correlation to obesity among children. Depending on what kind of food the family chooses to purchase and keep in their house along with the general food preferences of the family, an individual child's diet could be drastically different to that of another family, and the child's predisposition for obesity could follow suit (Sahoo et al., 2015). Moreover, certain behavior and habits apparent in familial contexts, whether they are active or not, could also influence the children (Budd and Hayman, 2008). Studies have suggested that children who live with a single mother who suffers from obesity, have a higher risk of becoming obese themselves (Moens et al., 2009).

- *Socio-cultural factors* - During social events and happenings, sugary food is often a prize or a treat. Children use food as rewards and this could encourage children to consume unhealthy food and beverages unnecessarily which, again, could lead to obesity (Budd and Hayman, 2008).

- *Psychological factors* - There is a long list of mental health and factors including depression, anxiety, self-esteem issues, body dissatisfaction, eating disorder symptoms, emotional problems, and so on that could lead children to behavior that, in turn, could lead to obesity. The problem with this is that the realization that these factors are the root cause of these health issues, is hard to come by for the individuals in question. Many studies have shown that there is a high correlating factor here, though. (Austin et al., 2009, Cornette, 2008, Decaluwé and Braet, 2003, Goldfield et al., 2010)

As presented, the causes and consequences of childhood obesity may not come from a sole reason but a combination of many. The following sections will expand on this notion.

2.1.2 Nutritional Knowledge

One important aspect that could be interesting to explore would be how much knowledge children have when it comes to nutrition and food consumption, and how this knowledge affects their behaviors and practices. One study showed that among 4700 primary and junior high school students showed

unbalanced diets (low in several essential food materials, but high in nutrients leading to obesity). However, their nutritional knowledge was still deemed adequate (Naeeni et al., 2014). Another study conducted questionnaires for children and concluded that they had moderate nutrition knowledge, poor dietary practices, combined with negative dietary attitude (Kigaru et al., 2015).

2.1.3 Dietary Behavior

A systematic review that looked into the correlation between nutritional knowledge and dietary behavior in children and adolescents found a disconnect between the two (Thakur and Mathur, 2021). The review stated that most of the studies reviewed reported that it was not only the knowledge related to dietary behavior but many other factors such as age, lifestyle, parent's nutrition knowledge, education, and occupation that influenced the children's dietary behavior.

Further studies found that the gender of the children has a relation to their nutrition knowledge and dietary behavior, suggesting that One study found that girls tend to have a better nutrition attitude than boys (Choi et al., 2008), and another found that girls tend to have better nutritional knowledge than boys (Naeeni et al., 2014). The same study also found that boys have higher food intakes of meat, carbohydrates, and fat, but on the other hand, girls have more intakes of fruits and vegetables.

2.1.4 Parental Habits

In general, children tend to get influenced by their parents or guardians in many different ways. Children not only learn to talk and walk from parents, but also absorb other things like characteristics, behaviors, or even opinions and thoughts. It is no surprise, then, that parents would also influence their children when it comes to dietary behavior and consumption habits, whether positively or negatively.

Research suggests that an enhancement of family lifestyle would have a positive influence in many perspectives including those towards the opposition of obesity (Gray et al., 2018), and suggested further that an intervention regarding the topic could be done at a family level rather than only focusing on the behavior of the child. The same study also suggested that such interventions should be applied as early as possible, to achieve a larger outcome and higher chance of success.

Another study found that parents might unintentionally encourage excess weight gain for their children by inappropriately feeding them (Clark et al., 2007), further recommending interventions which for families regarding awareness and consequences of inappropriate child-feeding behavior.

There exist many ways that parents might inadvertently promote excess weight gain to their children. In one article, a doctor was interviewed and said that parents have failed to pay attention to what they feed their children, leading them to not eat enough home-cooked meals, serving unhealthy snacks and premade meals instead (Ehrenfeld, 2018). Other behaviors endorsing further supporting the evolution of childhood obesity are listed in a study that focuses on the parenting style, parent influence of feeding, pressure to eat, family restriction, self-efficacy, parental role-modeling, and control and monitoring aspects of parenting (Danford et al., 2015). On the other hand, a systematic review on parental influence on childhood obesity argues that there is no direct correlation between the two, and commented that the source of childhood obesity is still lacking (Tzou and Chu, 2012).

Regardless of the arguments, many have argued that to tackle childhood obesity, it is better to focus on the entity of the family, rather than the child alone. The research suggests that familial intervention aimed at childhood obesity is most fruitful (Ash et al., 2017). Family interventions are the key strategy in this effort, as parents often have great influence and control over the children's diet, physical activity, and sleep schedules (Berge and Everts, 2011). A study even found that parents who treat children with obesity oftentimes benefit personally, by indirectly changing their behaviors as part of the treatment process (Trier et al., 2016).

2.2 Motivational Theory

Interaction design could be described as the field of understanding the interaction between users and end products. Designing a feature, system or application is tricky, and no solution can satisfy every end-user. Regardless of the field, however, any system designer would be wise to leverage one universal key aspect, motivation. If end users are not motivated to utilize a potential system, it does not matter how powerful the system inherently is, how interesting the core features of the system are or how pretty it looks. To understand this better, the authors present an introduction to core concepts and theories relevant to the development of the prototype as part of this thesis.

2.2.1 Intrinsic and Extrinsic motivation

Motivation is defined as the process of activating goal-oriented behavior in an individual, and different types of motivation are usually described as either *intrinsic* or *extrinsic*. Lepper, David Greene, and Richard Nisbett stated that intrinsic motivation refers to the act of engaging in a personally enjoyable behavior, and as such not done with an external goal in mind. Extrinsic motivation, however, is

characterized as a behavior an individual would engage in for the reward of completing the action - not for doing the action itself. The two appear as contradictions of one another, and research found it likely that intrinsic- and extrinsic motivation and goals were negatively correlated, with an overall appreciation for an activity declining as a result of rewards (Lepper et al., 1973).

Later studies showed, however, that the two are not mutually exclusive, where students were observed not only tending to use a combination of intrinsic- and extrinsic reasoning for engaging in academic endeavors, but likewise for setting intrinsic and external personal goals (Pintirch, 2000). Further research found the correlation between the two (both negatively and positively) to be of small significance (Lepper et al., 2005). Other studies have corroborated this, finding that as rewards stray from binary operant conditioning and rather become more internalized in the activities by focusing on the praise of individual accomplishments within the domain, individuals both like the activity more and perform at a higher level (Hulleman et al., 2008, Ryan and Deci, 2002).

As a practical example of this, consider an individual doing schoolwork for a course they have no interest in, trying only to receive a good grade. This would be categorized as extrinsically motivated because the action of studying the topic is done purely for the external reward. If the student was studying a topic they were genuinely interested in and would like to explore further, however, the action of studying the topic is intrinsically motivated as the reasoning for the behavior is the individual's enjoyment and interest in the subject. Then, if the student has ambitions of a good grade *and* finds the subject interesting, they are experiencing a combination of extrinsic- and intrinsic motivational factors.

2.2.2 Skinner's Box

While on the subject of intrinsic and extrinsic motivation, Lepper relied on the theory of *Operant Conditioning*, coined by his colleague - B.F Skinner (Ferster and Skinner, 2008, Morgan, 2010). Operant conditioning is a widely known concept within behaviorism and is based on the scheduling of reinforcement learning. In contrast to classical conditioning (creating a link between a stimulus and an *involuntary* response), operant conditioning is based on creating a link between a *voluntary action*, and an expected consequence. To do this, one applies punishment or reinforcement to the subjects, either positively or negatively depending on the situation. This reinforcement is applied as part of a predetermined schedule.

The Skinner Box then was designed to facilitate and test this theory. The box was defined as a sterile space in which external stimuli are excluded, including nothing but a lever or other manipulable device the animal can interact with. An animal is then placed in the box and observed closely. Whenever the

animal pulled the lever by accident, the animal is provided with positive stimuli. At first, this occurrence was seemingly random, but over time the animal touched the lever more and more, indicating that the animal has understood that there is a link between the action of pulling the lever and the consequence of receiving positive stimuli. This is positive reinforcement. If one on the other hand imagines the floor to be electric, the animal would likely run around attempting to escape the electricity, and would as such occasionally hit the lever, removing the discomforting factor. Soon, the animal may show signs of rushing to the lever whenever it feels discomfort and has thus been conditioned by negative reinforcement.

2.2.3 Reinforcement

In addition to positive and negative reinforcement, punishment is another interesting strategy. While negative reinforcement concerns removing some factor to relieve or avoid an unwanted situation or outcome, punishment concerns the application of an unwanted outcome, as a consequence of unwanted behavior. For instance, punishing an individual if a set of predetermined criteria is not met, within a given time frame, or delivering a task with a lower level of quality than what was to be expected, is not negative reinforcement but rather the application of punishment. The threat of punishment may motivate individuals extrinsically to finish the task to avoid punishment, but this dynamic has been suggested to facilitate only short-term links, additionally lowering the intrinsic motivation and subsequent intrinsic value the individual experiences for the task (Deci and Cascio, 1972).

While research has suggested negative reinforcement and punishment to be effective in the short term, positive reinforcement has been suggested as being very effective both in the short- and long-term (Ferster and Skinner, 2008, Harter et al., 2003). However, research into a combination of positive and negative reinforcement has proposed better long-term results than those received by applying each strategy separately (Byiers et al., 2014, Doughty and Shields, 2009).

Reinforcement has further been observed to be dependant on the situation and timing but most importantly scheduling. *Continuous* reinforcement (positive reinforcement every time desirable actions are executed) is most applicable during the learning stage of a newly introduced behavior, but once the subject has been conditioned, a form of partial reinforcement should be applied. In the case of continued continuous reinforcement, the subjects may be exposed to overjustification (Lepper et al., 1973), or otherwise lose the perceived intrinsic value of the action. There are several forms of partial reinforcement strategies which can be applied based on individual needs, used to ensure that the new behavior will stay.

By explaining how reinforcement could be used effectively, in addition to explaining the effects different

scheduling had on reinforcement strategies, Skinner's theories and experiments laid the groundwork for other psychological work in the space of behaviorism. This is especially apparent in how behavior is learned or dissuaded.

2.2.4 Self Determination Theory

The Self Determination Theory (SDT) is a theory encompassing innate human psychological needs and their relation to motivation, personality, and growth tendencies. Ryan and Deci (Ryan and Deci, 2000) conceived the theory in 2000, stating in clear distinction to previous research that human motivation should not be a unitary concept. They suggest that one should not focus on the amounts of motivation in a given context, but rather the different types of motivation, further explaining this distinction by defining the terms *autonomous motivation* (executing a behavior with a real sense of interest, enjoyment, and value) and *controlled motivation* (executing a behavior due to feeling pressured, obliged or demanded).

Ryan and Deci's research suggests that every human being could become self-determined and motivated to grow and change based on three core values: *competence* - the need to gain mastery of tasks and learning different skills, *relatedness* - experiencing the sense of attachment and belonging to other people, and *autonomy* - the need to feel in control of their behaviors and goals. Furthermore, the research suggests that individuals exhibiting autonomous motivation experience increased performance, wellness, and engagement (Ryan and Deci, 2000).

Intrinsic motivation is a clear example of autonomous motivation, so much so that their definitions appear quite similar and as such, one could assume extrinsic motivation to be an example of controlled motivation by contrast. However, through further research, Ryan found that individuals could internalize extrinsic motivation in such a way that they learn the intrinsic values inherent in the activities performed. Individuals identifying with the value of the performed action and integrating it in themselves in this way have therefore been shown to experience an autonomous motivation for the task, leading to positive outcomes for the individuals. (Ryan and Deci, 2020)

2.3 Gamification

As shown in Figure 2.1, the research suggests that the video game industry is the largest entertainment industry in the world by a wide margin, currently exceeding more than double the market capitalization of the movie and music industries - *combined* (Richter, 2020). While the medium of games and their

differing approaches are highly subjective, most games share the fact that they are designed to be engaging and entertaining for the potential end-user. This is often achieved by designing experiences that target certain demographics and cultures and can be achieved by leveraging a mixture of psychological needs or motivational factors, as discussed in section 2.2. A game can, therefore, in a way, be reverse-engineered and disassembled to reveal the individual elements and mechanics that make up the core of the game, and it is these elements and mechanics that are of interest when discussing the topic of gamification.

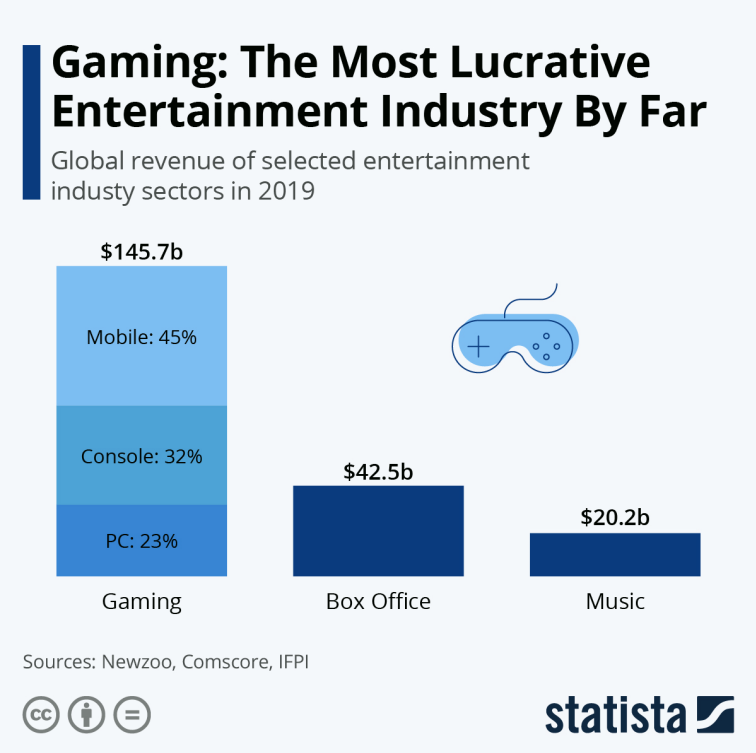


Figure 2.1: Value of the video game industry, in contrast to the film- and music industries, adapted from Gaming: The Most Lucrative Entertainment Industry By Far by Felix Richter, 2020.

While many may think that gamification is the act of incorporating games in preexisting applications or solutions, it is not that simple. Rather, gamification is a strategic concept aimed at enhancing the user experience of an interactable entity like a service or application, through the application of game elements and mechanics in non-game contexts. Since the goal of gamification is the positive alteration of a subject's increased engagement and motivation, it is applicable to many different fields. The literature suggests that gamification can be effectively utilized in a wide variety of areas such as education, health, transportation, or even marketing and business. A recent market study showed that this is indeed the case (Albertazzi et al., 2019). Some fields have already followed the evolution of gamification to such an extent that certain techniques are commonplace, such as the planning strategy *planning poker* being very common in agile development fields (Haugen, 2006).

Gamification has enjoyed an exponential increase in popularity over the last decade, resulting in a market valuation of 9.1 billion USD in 2020, with estimates predicting continued growth into the future (Intelligence, 2020). Certain parts of the world have also implemented certain aspects of gamification in a much broader sense, as is the case with China's implementation of the Social Credit Score Creemers (2018).

Designers that apply gamification techniques aim to leverage the psychological predisposition humans have to engage in play, as a means to increase user engagement (Hamari and Koivisto, 2015). Design strategies and elements from game design such as user avatars, point systems, achievements, or rewards can be used in this context to create a sense of connection and progression for the end-user. One of the main strengths of gamification is the ability it provides to alter a user's perception of a task from a *chore* to that of a *challenge*. The techniques and elements used to facilitate this can be used in a variety of different ways depending on the target demographic and environment in which the solution is to be applied. In other words, how and when gamified techniques are used is very important for the potential result. Research suggests that most gamified techniques rely on rewards and tactics designed to leverage a user's extrinsic motivation (Ryan and Deci, 2000), as many of the most used techniques are inherently partially motivated by external factors. To realize the benefits of applying proper gamification, it is important to consider ways in which the strategy can be deployed to make the solution intrinsically motivating.

2.3.1 Progression and Reward Systems

Research suggests that *points* are the most cited game element to be utilized (Intelligence, 2020), perhaps due to the inherent attributes and possibilities a point system can introduce to otherwise static elements. According to the same study, the second most included game mechanic is the reward- and progression systems.

The sense of progression and subsequent feeling of mastery one can experience when reaching a goal, are both powerful psychological constructs. Being able to tap into these would prove invaluable regarding user engagement in most applications, and this is where gamification comes in. By utilizing techniques that tie the user's actions in the application to an overarching progression system, one can leverage both intrinsic and extrinsic motivation, by in practice creating an environment similar to that of the Skinner Box.

In gamification terms, such systems are usually based on the video-game construct of *levels*, with each level-up rewarding the user with other elements introduced in the environment. Often accompanied

with clear-cut goals and progression bars, level-up systems can function as a continuous *mission* for the users, in addition to supplying new challenges when leveling up, adding a layer of interest to otherwise dull tasks.

A problem with systems like these is that they are often added as an afterthought, or otherwise implemented to already existing systems in a cheap attempt at gamifying certain aspects of the application. In some cases, this can lead to the system appearing disassociated, leading the effect to be opposite of the intention (Toda et al., 2018). However, this is a symptom of the context in which it was applied, not the technique itself.

2.3.2 Avatars

Though people generally associate the term *avatar* with what they know today, the term itself is actually a concept in the Hinduism which means *descent* and *the material appearance* or *incarnation of a God on earth* (Lochtefeld, 2002, Parrinder, 1997). It makes a lot of sense how, in the context of computing, the word is used for self-representation of the user's character or persona in another form, a graphical form. Avatar is widely used among online communities including forums and social media, as well as our daily life devices like contacts in mobile phones, TV streaming services, and video games. Basically, avatars are used to represent who is who, so people do not get confused with one another in virtual environments. One of the purposes of avatar is for identification which could work by other forms like names; however, by using avatar, it adds personal value to such identity because it gives visual which is more relatable. As people spend more time on virtual communities or "online world" nowadays, the use of avatar has become more common and seen more often. When people use avatar in virtual environments, they can sense their presences which are related to their characteristics and perception (Nowak et al., 2008). Depending on their complication, these avatars are not only able to represent static graphical identification, but sometimes sophisticated expression like emotions or body languages. Moreover, in some circumstances, users are also allowed to customize their avatars to suit with their appearances and personalities best. One common example is from the game *The Sims* (Electronic Arts, 2000) where players are able to make full customization to their characters (or, in this case, *avatars*) both for the appearances and characteristics. Certainly, though players do not necessarily need to make their avatars to represent themselves, it is common to see one making the game version of themselves as it is always fun to "play" the game as oneself.

The application of avatar in gamification, if not in games, is also commonly used for representation of the users. Since gamification is a concept of trying to manipulate players into doing common activities, the usage of avatar seems to suit well with such a concept since people tend to be motivated from the

concept of using the avatars. One study uses the approach of applying such concept with gamification regarding an issue with diabetes (Mohd Tuah et al., 2019). They learn that such an approach is able to provide many contributions to the theory and practice, and has promising results seen from users' performance and motivation. Similarly, another study creates a solution combining personalized health interventions with gamification including the use of avatar, and shows that the received feedback is hugely favourable since the users have relatively high involvement using the solution (Kostenius et al., 2018).

Furthermore, it is important to note that while avatars often do reflect the self, it is not a prerequisite for their inclusion, with the figures' connection to the player and sense of identity being left up to individual interpretation. Building on this sense of identity is a key point of value regarding the potential inclusion of an avatar, and oftentimes this is accentuated by the possibility of personal customization of the avatar. Letting the users carve out their own niche by personalizing the avatar may lead to a stronger sense of connection- or identification in the avatar, positively affecting the users perception of the system (Turkay and Kinzer, 2016).

Overall, the authors suggest that the use of avatars has a positive impact when used in a gamified solution; therefore, it is suggested that when one creates such a solution, they should consider the application of an avatar in order to gain more engagement and motivation from the users, along with other elements in the concept of gamification.

Chapter 3

Related Works

In this chapter, the authors' competitive analysis will be presented. The chapter starts by explaining the context of performing a competitive analysis in the case of this thesis. Further, section 3.1 will showcase several other pieces of research, before section 3.2 presents the results of the market analysis of related applications. The chapter will conclude with a section evaluating this process.

As mentioned in chapter 1 and as uncovered in chapter 5, the market for actual applications in the health sector targeting the younger demographic focusing on nutritional self-help solutions is lacking. The following sections, therefore, seek to explore the market for applications that relate to the author's proposed solution. In the case of this thesis, the strategy of competitive market analysis has been used to review the market situation at the time of writing, by exploring the market and identifying key applications in the space. Already available applications that utilize some of the techniques, elements, or ideas present in the authors' concept were reviewed and further analyzed. Additionally, related work containing relevant concepts and prototypes has been reviewed to the same end.

3.1 Related Research

In this section, the authors have taken a deeper look at pre-existing researches that relate especially closely in topic to the concept and solution presented in this thesis. The papers in question, and solutions presented within them, relate closely to the handling of overweight, self-management, or nutritional incognizance in children and adults, but differ in approach and proposed solutions.

3.1.1 Fammeal

Fammeal (Afonso et al., 2020) was a gamified mobile application focusing on young children's lifestyle (eating, drinking, moving, and sleeping habits) integrated with tailored suggestions for parents and serious games for children. The application was developed with collaboration among scientists, health practitioners, developers, parents, and children. The solution was meant to be a recommendation by health personnel after they have detected that the children might be overweight or obese. In addition to this, the application could also work as a preventive solution and a presentation of better lifestyles regarding children's behaviors.

The application contained a prototype and a monitoring website that could be used for both parents and children in different modes. It could also be observed by the health personnel. In the children mode, the app presented a game for a child to play by taking care of an in-game character/avatar in lifestyle topics which were water/food intake, sleeping, and physical activity as seen in Figure 3.1. Though the avatar did not reflect the child's activities and behaviors, the purpose was rather to raise their awareness regarding the topic. Regardless, the avatar had different visual appearances in the game depending on what states and activities it was in. This was to indicate the avatar's needs and emotions which was the key point for the children to understand and learn how to interact with the avatar in the game, resulting in increased awareness as mentioned.

Figure 3.1: In-game screenshots of Fammeal

The research paper included screenshots from the game showing what the user interface looked like and how the user would interact with the game. Moreover, it included a table as seen in Figure 3.2 showing different states and activities the avatar is in which could be inspiring for those who looked for ideas of how avatars should appear in such health management games targeting children.

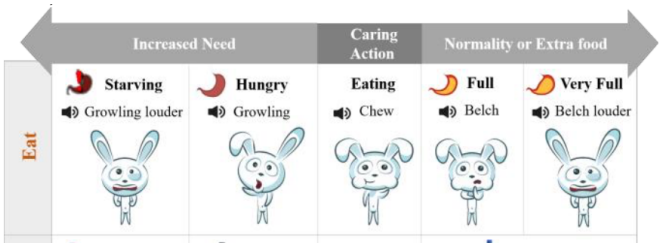


Figure 3.2: Different stages of the avatar in Fammeal

Though the research's participants were parents and children, it was not able to evaluate the acceptance by the children. This was due to the fact that the evaluation was done by the parents who also controlled the access for their children. Nonetheless, the research reported that there was no rejection of the game by the children who participated. It also reported that the health personnel and parents accepted the innovative approach and application.

3.1.2 Monster Appetite

Monster Appetite (Hwang and Mamykina, 2017) was a nutrition game that aimed to address certain facets of the obesity crisis by raising food consciousness, especially in terms of per-serving calories. The research looked into the difference in framing its gameplay (subversive vs. inoculation) applying the usage of monster-like avatars through the game. The game had two versions that varied on the two user groups: subversive and inoculation, or in other words, one with positively- and another with negatively-framed messages. In both versions, the player was to choose snacks of a monster who was presented as an avatar as seen in Figure 3.3. Consequently, the player's consumption choices would have an impact on the appearance of the monster whether it was positive or negative. The player's consumption decision could also be based on the goal stated by the game which was different depending on the group. The avatars would appear in different ranges depending on their weight, from "light" to "heavy" based on what types of snacks the player had chosen to consume.

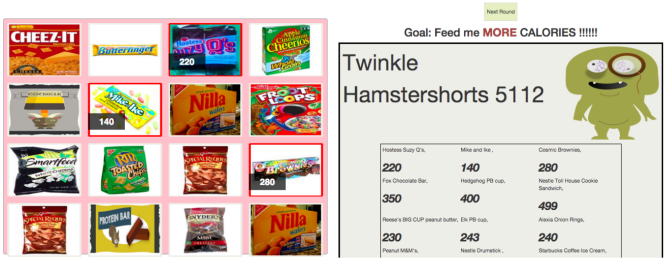


Figure 3.3: In-game screenshots of Monster Appetite

The research was relative when it came to the usage of avatars in a health-themed game. The game's

avatar had seven stages of its weight status which were shown visually from healthy to unhealthy and were to make the player aware of the consumption choices one went for. However, the limitation of the research was that the avatars' appearance only changed in a negative direction, but not the other way round. The suggestion was that it should be possible for the player to be able to see the positive change in the avatars when the consumption decision had a positive result. By doing this, the game could increase awareness, not only of the negative consequences but also of the possessive ones. Nonetheless, the evaluation concluded that the players showed better decisions in the game resulting from the negative visuals through the avatars.

3.1.3 Barty

Barty (Gonçalves et al., 2020) was a game that aimed to teach players to distinguish foods based on healthiness and to consume the right foods at meals during the day. The game applied the use of an avatar to show the player different stages of the player's choice in terms of healthiness, similarly to the one in the Monster Appetite game mentioned earlier. The Barty game consisted of three parts that represented various types of food to the player who needed to decide which one to be consumed, and this would consequently affect the avatar. The avatar was shown in the form of a comical carrot named "Barty" and had four different stages from being healthy to unhealthy.

The validation of the game went towards a positive direction since the paper stated that they were able to prove that the users acquired knowledge, even with limitations the game might have. The users, which consisted of children and caregivers, were motivated to play the game and learn about which food they should consume in order to sustain a healthy lifestyle. However, they found that the avatar did not reflect the progression of the players and could even discourage them and that the results did not reflect directly from the avatar's current state. The paper suggested that the game could be used as a pedagogical tool by health personnel as educators or nutritionists, and also that it could apply the uses of databases and artificial algorithms in order to make the game more responsive and interactive.

3.1.4 Healthy Weight Game!

In comparison with previous related works, *Healthy Weight Game!* (Lentelink et al., 2013) highlighted more on the usage of rewarding system and virtual shop, in addition to the avatar. The game was operated on mobile phones and supported both single and multi-player. After setting a personal workout goal based on research recommendations and personal information like weight and height, the player can start the game by inputting workout information daily to earn in-game credits. This can be done

with other players in a form of competition to help players stay encouraged and motivated. There was a mini-game where players could play with others, where a form of racing comparing physical activities progress in the game, and those who won could get credits as the rewards. The game also used avatars to indicate how the player performed by different visual feedback (avatar's body shape, emotions, and body language). Moreover, it used in-game credit as a rewarding system to compare with other players and to make a purchase in a virtual shop. Some of the items could be purchased from the shop using credits, and some could only be purchased by making progress in the game and leveling up. Overall, the game is a good example of how application of the concepts of gamification in different aspects. Screenshots of the game can be seen in Figure 3.4.

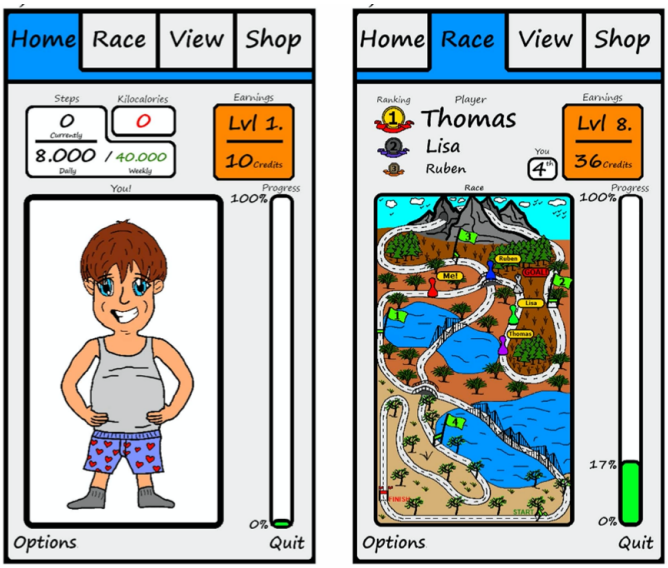


Figure 3.4: In-game screenshots of Healthy Weight Game!

The game was tested and evaluated by a group of young adults, and it concluded that the design of the game showed possibilities for improving both physical and mental health for those people who had issues with overweight and obesity. This was a result of using the game for physical exercises, which also led to behavior changes. The paper ended by stating that the game would like to support overweight and obesity solutions by encouraging players to perform more activities which at the same time were fun and rewarding.

3.2 Similar Applications

Health-related digital solutions and the sheer amount of mobile applications available to consumers, has grown at a massive rate in the last decade (Institute, 2017). In this section, the authors will analyze some of the applications relating to the health and nutrition space, or otherwise interesting offerings

on Google Play Store, subsequently reviewing them. This review will range from simple reminder-type applications to more all-encompassing systems and will serve as a baseline the authors can utilize as a tool of reference when deciding whether or not to add potential features to the proposed solution of the thesis, as presented in chapter 6.

Several applications in the health space offer ways to track certain tasks or create certain routines with the end goal of increasing the user's nutritional balance. *5 A Day Tracker* is an example of such an app, providing a simple customizable tracker that allows the user to log how many fruits and vegetables they eat a day, without the need for concrete sample selectors or other complex nutritional value logging. In addition, the app saves the result for each day to a calendar, providing the user with an overview that can easily be used as a tool for gauging progression.

Water Reminder is another example of a simple health-tracking app. In Water Reminder, the users recommended daily water intake is calculated based on supplied personal information before users are prompted to set a sleep schedule and a notification interval - both of which act to facilitate the user's water intake and to avoid nightly reminders. The app includes a wide selection of different types of drinks, automatically calculating the actual water content of a selected beverage. In addition, Water Reminder includes a system designed to motivate its users by awarding them with medals for sticking to the regime over time. The tangible goal of the app is to make sure the user drinks *8 Glasses A Day*, but the overarching goal is to better the user's routines and overall health.

Lifesum is a nutrition-based health application that allows its users to track personal statistics, set food plans, get recipes, and learn about nutrition. The app has a calm design, which features heavy use of images, icons and colors. To simplify meal tracking, a barcode scanner was integrated, and a large community all over the world help in adding products and defining common portion sizes. Additionally, any scanned food item reveals a food score, used to rank the food based on its inherent level of healthiness.

SmoresUp is a tracking application that aims to simplify household management by creating a single environment for tracking chores and events. The application allows parents to organize the family by giving chores directly to their children individually or as a group, and the family can plan their daily or weekly chores with the built-in calendar. This app introduces a gamified reward system, in which the parents can give their children *S'mores* for completing custom chores, or simply being nice. These S'mores can in turn be used to unlock rewards set forth by the parents beforehand. The design features heavy usage of icons and a comprehensive color scheme

3.3 Evaluation

While the biggest strength in apps like Water Reminder or 5 A Day Tracker lies in their inherent simplicity, which is also the biggest flaw. In 5 A Day Tracker, for example, the application allows the user to track as many fruits and vegetables as they want, upwards of tens if not hundreds every single day(something which quite clearly is unhealthy). Here, the app has a design flaw - the tracker's numbers turn green to signal healthy behavior at a certain intake amount, but does not revert or change at excessive amounts. In contrast to Water Reminder, the app also lacks any form of reward system or other motivators. Additionally, installing many different applications per routine or health habit can quickly grow tiresome. There exist several applications catered to tracking multiple things at once, while simultaneously not overflowing the user's phone with notifications, like Lifesum.

By virtue of being an app that focuses on chores, SmoresUp is an application that at first glance may not seem like it fits into the health- and nutrition space. However, research has suggested that the introduction of routines may result in great health benefits (Fiese and Spagnola, 2007, Taveras et al., 2013). Additionally, the application could certainly be utilized directly for the purpose of preventing health issues, by incorporating bedtime, soccer practice, et cetera with the calendar function.

Reflected by its current rating of 4.5 on the Google Play Store, Lifesum is certainly a powerful and quite well-designed application. However, the design suffers a little bit when attempting to cram too much information and too many big elements into a relatively small space. Despite the colorful and playful appearance of the app, however, it is clear that Lifesum is not intended for use by the younger demographic.

In fact, herein lies the problem that initially piqued the authors' curiosity. While performing the initial research as part of this thesis, the authors found interesting examples of work done in the field as described in the Related Works section, in addition to a large number of articles describing applications and solutions for children regarding health- and nutrition. The authors quickly discovered, however, that many of these applications were either defunct, otherwise not available, or seemingly left in the prototype stage.

Chapter 4

Research Design

In the following chapter, the research methodology utilized in the thesis will be presented. The chapter will give an introduction to how the research in the thesis was done, which types of data were collected, and which methods were utilized in order to gather that data. The different stages are illustrated in Figure 4.1.

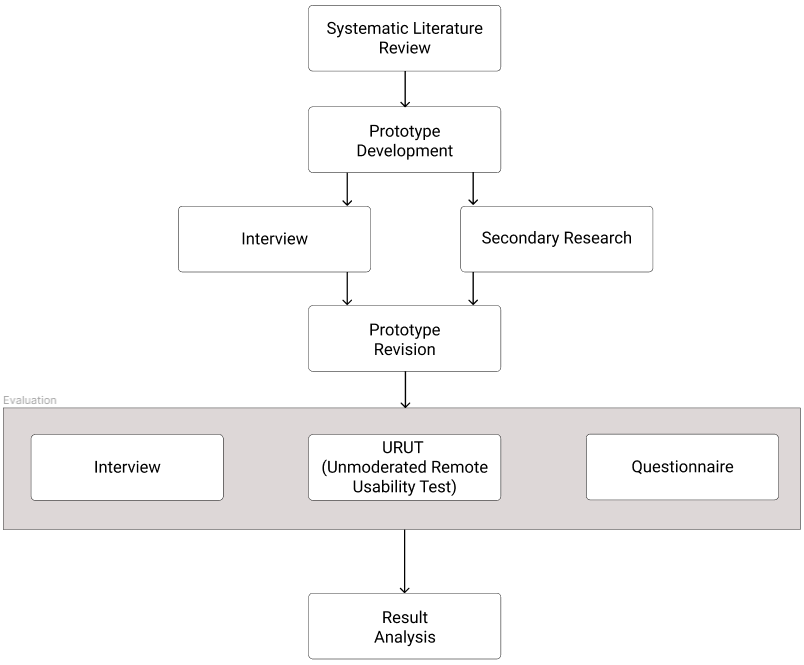


Figure 4.1: Flowchart displaying the different stages of the thesis

4.1 Data Collection

The authors conducted their research initially by collecting and reviewing secondary data, in an attempt to gain the relevant insight required to design and evaluate a proposed solution. With this, the aim was to gather the relevant primary data needed to discuss and analyze the proposed research questions. In contrast to quantitative studies, qualitative studies aim to elicit the inherent *why* given a certain context. While the research team applied the *5-point Likert Scale*, a psychometric quantitative response scale to gauge the test subject's familiarity with digital devices, other data collection methods in the thesis were based on the qualitative approach.

As qualitative research is exploratory in nature, the decision to use this approach in the project seemed fitting, as the authors had little to no prior knowledge of the topic with the exception of certain personal anecdotes. This conclusion was further strengthened due to the inherent nature of the space in which the study was conducted, as the fields of interaction design and gamification were perceived as highly subjective to the authors. This, in turn, lead the authors to rely on qualitative measures, in an attempt to uncover the human connection. Questionnaires were used to collect the primary data for the thesis, and an expanded explanation of this process can be found in chapter 8. Additionally, the questionnaires are located in Appendix C.

4.2 Systematic Literature Review

The research for the project began with a systematic literature review, meant to facilitate the research team by improving insight into areas of scientific importance for the thesis. The process was carried out by performing a detailed review of literature relevant to the thesis. As a part of this process, the team delimited the search phrase utilized for the search, by defining a search query including the project's target demographic and other areas of interest, focusing on terms like "gamification", "nutrition" and "obesity". The actual structured literature review, how it was performed, and which insights were gained from it are described in more detail in chapter 5, and the raw data of the process can be found in Appendix A.

4.3 User-Centric Design

While designing the prototype used to evaluate the proposed solution as part of this thesis, the authors decided to apply parts of User-Centric Design (UCD) in the approach of this study. The author be-

gan by outlining the context of the issue through discussions with stakeholders in order to gain basic insight before the team observed an intervention held for families with overweight children by the local municipality in order to gain fundamental insight into the situation and struggles of affected parents and children. Subsequently, the authors brainstormed about solution alternatives, their advantages, and drawbacks based on the apparent stakeholders, before defining the concept as part of the thesis. During the initial research phase of this thesis, the authors devised a concept based on the insight gained from the aforementioned data collection, SLR, and compound insight gained from supervisor and expert discussion. In an attempt to test and subsequently evaluate this concept, a prototype of the envisioned solution was developed. The prototype was designed based on insights gained from interviews and discourse with experts, in addition to the systematic literature review and other secondary research. The prototype was designed to be tested by individuals of the target demographic, and was utilized for this purpose. This phase, including the design of the initial prototype and the redesign process for the second prototype is described in detail in chapter 6. Additionally, live representations of version one and version two can be found in section E.1 and section E.2 respectively.

Chapter 5

Systematic Literature Review

This chapter will present the Systematic Literature Review (SLR) done as part of this thesis. First, an introduction to what an SLR is, and the reasoning for its utilization in this project is presented. Further, the approach the authors used to execute the SLR including the methods, exclusion- and inclusion criteria and search term is presented. Finally, the results of the SLR are described and presented.

During the initial stages of the thesis, the authors set out to understand the current situation regarding topics relevant to the task at hand. In order to understand this at a deeper level, the authors decided to conduct an SLR, which at its core aims to identify, review and appraise previous research done in relation to a selected space by following a strictly defined criteria protocol. The protocol utilized for this SLR is defined in this chapter, but can be found in its entirety in section A.1.

A literature review is an important component of educational research and has the ability to yield fundamental- as well as specialized knowledge about any mixture of related topics (Xiao and Watson, 2019). By understanding the context of preexisting studies, theories and evaluations in relation to each other, and viewing these in tandem with their inherent disadvantages and contradictions, the authors could gain fundamental insight and further facilitate the creation of a concept as part of this study.

5.1 Methods and Results

When depending on an SLR for fundamental research into a set of topics, a strict criteria protocol is imperative in order to refine the search to fit the scope of the project. To this end, the authors constructed the following search term for this thesis:

(Obesity OR Overweight) AND (Gamification OR Gamified OR Gaming OR Game-Based) AND (Nutrition OR Diet OR Habit OR Habits OR Health OR Eating OR Management)

This search term was in turn used to execute the literature search on the online literature and patent aggregator, Engineering Village, resulting in over three hundred results. From here, the authors examined the papers one by one by examining abstracts and other metadata, to determine whether or not the papers in question were to be included. In addition, a set of inclusion- and exclusion criteria were defined to help determine whether or not to include certain papers in the final review. To be included, a study must be based on empirical findings, available in English or Norwegian, and be available in its entirety. To be excluded, on the other hand, a paper had to either not fulfill the inclusion criteria, be shorter in length than five thousand words, or have a relatively old publishing date rendering the paper outdated.

The process of the SLR as described, can be examined in the flowchart seen in Figure 5.1. During the initial search, 329 papers fit the search term. In an attempt to understand which of these papers would bring value to the study, the abstracts of the papers in question were analyzed, and 177 papers were subsequently dropped from consideration. Additionally, another 90 papers were removed for being apparent duplicates. Further, the application of the inclusion- and exclusion criteria deemed another 43 papers intelligible. In the end, this resulted in 19 highly relevant papers that further were extensively analyzed, three additional papers were dropped during this phase, however, leaving the final number of papers at 16. The raw data collected as part of this process can be found in Appendix A, including the initial result of the search term section A.2, the initially refined results section A.3 and the deeper look of the final 16 which is of particular interest section A.4.

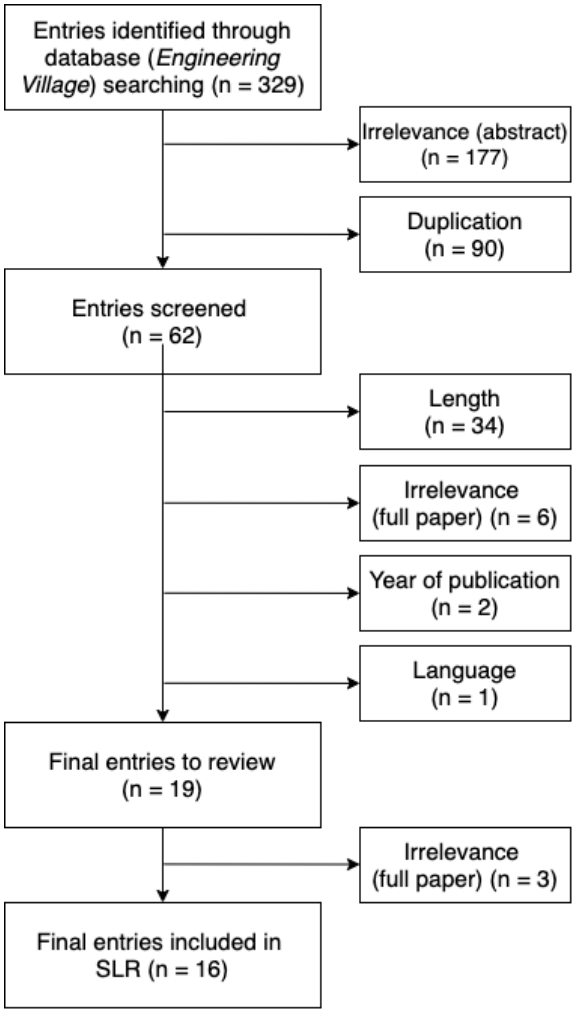


Figure 5.1: Flowchart of search procedure

5.1.1 Review

The following section will present the results of the SLR in several different contexts. By quantitatively reviewing and categorizing the insights the author gained as part of the SLR process, the authors hoped to gain a further understanding of the situation as described at the time of writing. For reference, the numbers displayed in the tables of this section serve to identify the specific papers as outlined in the SLR's deeper look (section A.4).

First, the authors wished to look into which kind of device the uncovered solutions were designed for. As presented in Figure 5.2, the vast majority of solutions described as part of the SLR were designed for use by a mobile device, while some also utilized wearables. A subset of the solutions was designed for web browsers, while the remaining two were designed as a video game and an application for a computer respectively.

Types of Technology Used	Reviewed Paper
Mobile phones	[2] [4] [5] [6] [7] [8] [9] [11] [12]
Websites	[3] [14] [15] [16]
Wearable devices	[9] [11] [13]
Computer	[10]
Video games/video conferences/virtual environments	[1]

Figure 5.2: Type of technology used

Further, the authors wanted to explore the specific concepts and solutions as presented by the different papers. As seen in Figure 5.3, most of the papers featured the principles of gamification heavily. Further, a subset of the reviewed papers described variations of planning or diary systems, while the remaining papers described informative websites, a route tracker and a physical game. Among these papers, gamification as a concept was utilized in many of them, with several concepts utilizing avatars or reward systems. Paper [1] in particular, described a gamified educational intervention program targetting the nutrition of obese children.

Concepts	Reviewed Paper
Gamification	[2] [3] [4] [5] [6] [7] [8] [9] [10] [11] [15] [16]
Plans/diaries	[4] [11] [12] [14]
Tutorials/informative websites	[3] [14]
Route tracker	[12]
Physical game	[13]
Gamified educational intervention program	[1]

Figure 5.3: Concepts

Further, the demography of the users tested in the different papers was reviewed. Even though the area this paper aimed to research revolved around the younger demographic, the authors decided against restricting the search term to this demographic in an attempt to gain additional insight. As such, Figure 5.4 shows that exactly half of the papers reviewed targeted adults. Despite this, six papers share the target demographic of this study, three target teens, and the remaining paper simply targeted obese children.

User groups	Reviewed Paper
Children (age 4-12)	[2] [3] [6] [8] [9] [14]
Adults (age 18-52)	[2] [5] [7] [9] [10] [12] [15] [16]
Teens/students (age 13-18)	[4] [11] [13]
Obese children	[1]

Figure 5.4: User groups and context

Lastly, the different data collection methods used by the papers were of interest. As presented in Figure 5.5, almost all of the reviewed papers used questionnaires to collect data, while a few incorporated focus groups or interviews. Four of the reviewed papers did not evaluate the proposed solutions, due to planning the evaluation stage for a later time. Six of the papers used other methods such as direct user participation, video analysis, training activities and participatory design exercises.

Methodological approaches and evaluations	Reviewed Paper
Questionnaires	[1] [2] [3] [5] [7] [8] [10] [13] [15] [16]
(Not available)	[4] [9] [11] [14]
Interviews	[4] [11] [13]
Focus groups	[1] [12] [13]
Others	[1] [5] [6] [10] [12] [13]

Figure 5.5: Methodological Approaches and Evaluations

5.1.2 Findings

As a result of this SLR, the authors got the overall impression that the users that partook in the different studies in this review generally reacted positively to the proposed solutions, and gamified aspects specifically. Generally, the papers suggested that the utilization of gamification in regards to health and nutrition could have a positive effect on engagement and motivation. Further, this increased motivation showed promise regarding the implicit educational possibilities such systems could have for an individual, as the engagement in the application's systems showed tendencies of not only leveraging the individual's extrinsic motivation, but also increasing the intrinsic motivation for the tasks directly related to nutrition.

Paper 1 ((del Río et al., 2019)), in specific, was especially interesting in this regard. The paper presented a gamified educational program designed to promote healthy habits by utilizing exergaming and

other gamified techniques, in turn, this showed promising results, with quantitative data suggesting a significant increase in nutritional knowledge and behavior across the group. While this approach developed and based most of their contribution on exergames and virtual environments, most of the other propositions reviewed as part of this review included gamified concepts including avatars, reward systems, or other gamified elements in a digital context. Further, most of the studies were evaluated by young adults or children that were not suffering from obesity, and most data was collected through the usage of questionnaires in different forms.

Based on the findings of this SLR and the secondary research as outlined in chapter 2, the authors conclude that gamification could be utilized to great effect in the design of a health and nutrition application for children. To evaluate this claim, the authors thus developed a concept aimed at building healthier habits, increasing nutritional interest, and preventing obesity in the long term. To this end, the proposed solution would incorporate several gamified aspects in order to motivate users to manage their own health, further being facilitated by the development of a fundamentally gamified environment.

Chapter 6

Prototype Development

In this chapter, the process behind designing the prototype developed as part of the thesis will be presented. The chapter opens with section 6.1, defining the inspiration behind the concept and describing the context in which the prototype was developed for the intended purpose. Lastly, section 6.2 presents the process behind selecting a prototyping tool that would fit the project.

6.1 Context & Inspiration

As outlined in the Background Research section of the thesis, previous research supports the notion that nutritional awareness, formation- and maintenance of habits, cultural factors, and parental guidance all are important factors in the case of early-onset obesity. Further, as explored in the Related Works section, the existing solutions in the health- and nutrition space have generally been observed as not being designed with the younger demographic. While research suggests many possible ideas for the topic, as discussed in section 3.1, there exist few solutions with the intention of allowing the younger demographic to focus on nutritional management, or otherwise allow users to focus on self-help in specific areas regarding their health. The solution presented in this chapter intends to bridge this gap by presenting a playful environment in which children would be rewarded for their efforts, all the while nurturing their own nutritional needs through customizable challenges.

6.2 Technology

During the conceptualization phase of the application, the team had to decide on a prototyping framework with which to build the prototype. Some designers may prefer to start developing functional prototypes in the basic HTML/CSS/JS structure with some sort of frontend framework like Vue, React or React Native (depending on the platform the prototype is designed for). This approach, however, is relatively time-consuming, and eventual pivots in layout or design could possibly lock up resources over a longer period of time. Utilizing a prototyping software allows the designer to streamline the design process, allowing for revisions based on internal- as well as external feedback.

When selecting a tool for such a purpose, there are several important factors to take into account, ranging from how long it takes to master the proposed software, to how versatile it is in its application. Perhaps most importantly, however - which level of fidelity can be expected from the final prototype given the selected software over a given time frame, and how could this, in turn, affect a potential end user's experience of the solution during testing?

Initially, the prototype was envisioned as a static wireframe in which simple variations of the proposed solutions would be presented to potential end-users and experts alike. The authors realized, however, that a higher fidelity interactive click-through prototype could possibly lead to more realistic test results, in turn potentially yielding a higher level of insight from the conducted experiments. After reviewing the market for prototyping and UI-design applications, the choice was narrowed down to two - *Axure RP* and *Figma*.

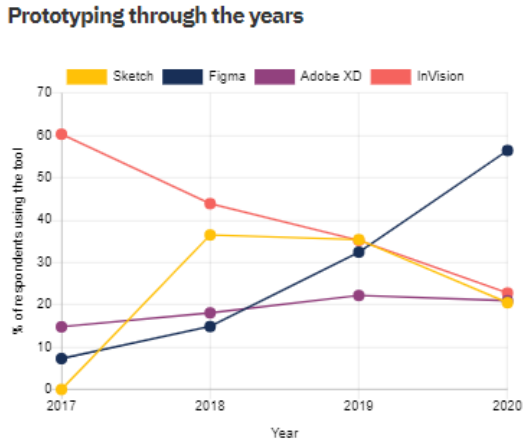
6.2.1 Axure RP

Axure Rapid Prototyping is a very robust piece of software, allowing designers to add complex logic and state handling to the envisioned prototypes. This can give the resulting prototypes the ability to imitate real applications through experienced flow, direct interactions, and user input. However, as these techniques are relatively complex, the learning curve associated with being able to utilize these advantages correctly is relatively high, something the authors experienced firsthand after attaining a student license for the software.

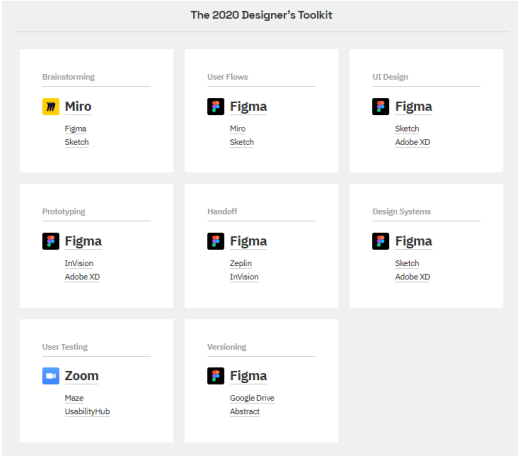
6.2.2 Figma

Figma, on the other hand, is a web-based vector graphics editor and design-first prototyping tool built from the ground up to focus on seamless, real-time collaboration. In contrast to Axure RP, Figma has a more gentle learning curve while simultaneously not impairing the overall quality of the end product substantially. In addition, the Figma environment includes a companion app, Figma Mirror, that seamlessly allows designers to instantly view and interact with parts of a prototype on physical devices.

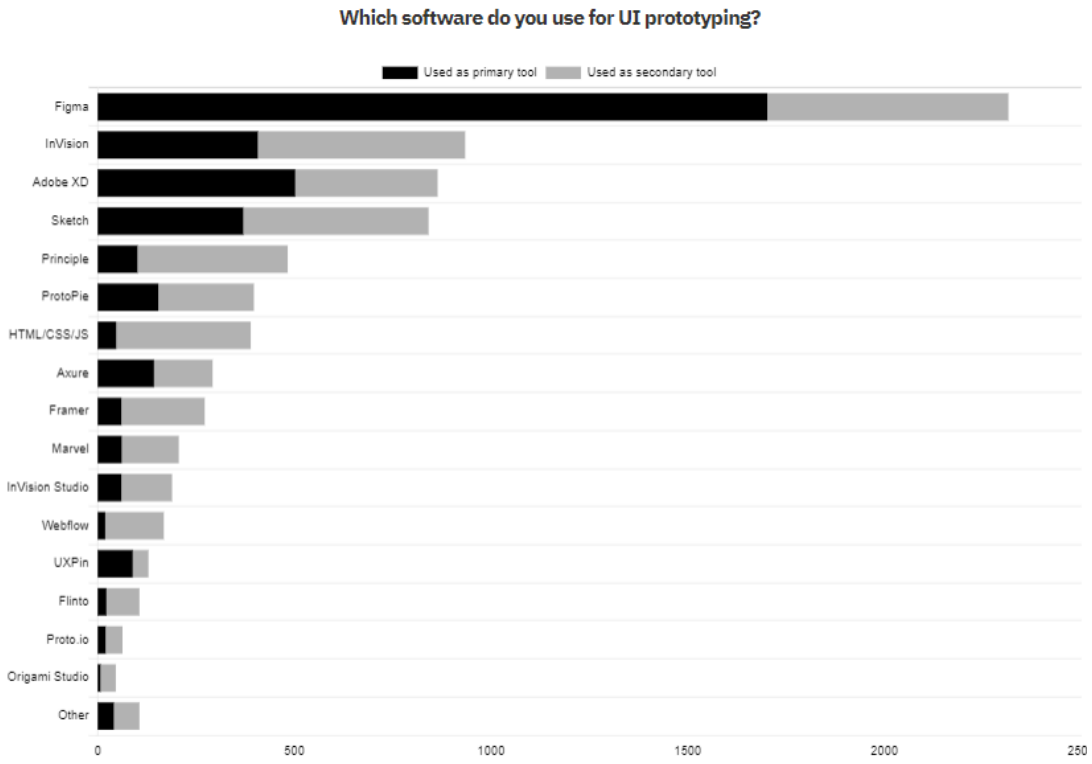
At the time of writing, a recent survey (Palmer and Bowman, 2020) in which more than four thousand industry professionals and students alike partook, suggests that Figma is simultaneously the fastest growing (Figure 6.1a) and most used piece of software in the user experience- and interface-design space, reportedly exceeding the second most used primary user interface prototyping software by more than four times (Figure 6.1c). Additionally, the study suggests that Figma is an exceptionally versatile piece of software, trouncing its competition in several additional different facets of the design space (Figure 6.1b).



(a) The evolution of the Figma market share in comparison to competitors following its release.



(b) Results from each individual surveyed category, showing Figma as the clear collective victor.



(c) Figma's market share for UI Prototyping, in comparison to other tools utilized for the same purpose

Figure 6.1: Results from the 2020 Design Tools Survey. Adapted from the 2020 Design Tools SurveyPalmer and Bowman (2020), by Jordan Bowman and Taylor Palmer, 2020.

While utilizing Axure RP possibly could have yielded a higher fidelity end result, potentially allowing the authors to implement state management and let the prototype account for user input in a more real application-like way, the apparent benefits associated with utilizing Figma due to its ease of use, large industry backing, extensive plugin suite, and instant physical prototype testing, made it the technology of choice for this project.

Chapter 7

Prototype Presentation

In this chapter, the design process for the two distinct prototype representations of the proposed solution, designed as part of the thesis is described and subsequently presented. The presentation of the first prototype was intentionally left relatively brief to focus on the improved second version. Links to working versions of both prototypes are included in Appendix E, with the initial prototype being accessible in section E.1 and the revised version being accessible in section E.2

7.1 Prototype 1

The first prototype was a hybrid between a wireframe and click-through prototype designed in Figma, and featured a dashboard-like design intended for use with an iPad or other tablet device. As showcased in Figure 7.1, the initial design featured a green and blue color scheme, complete with big colorful collectible badges (Figure 7.2a), an icon-heavy design (Figure 7.2b), emotional reactions from the avatar based on user input (Figure 7.2c), a familiarly stylized challenge-list (Figure 7.2d), flashy celebration pop-ups celebrating completed tasks (Figure 7.2e), in addition to intentionally extravagant fonts and colors. (Figure 7.2f)

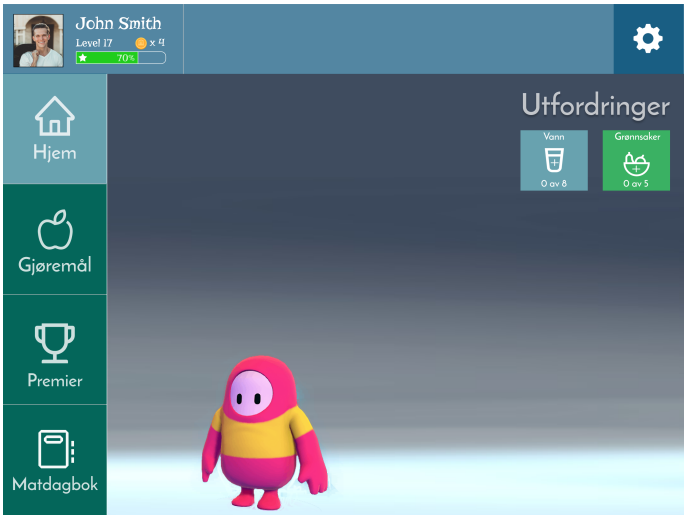
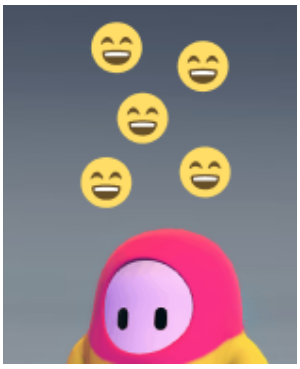


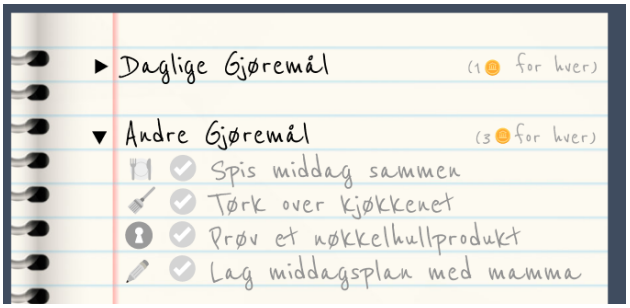
Figure 7.1: Home page of Prototype 1

(a) Colorful, unlockable badges

(b) The first prototype featured heavy use of icons



(c) The avatar reacting to user input



(d) Tasklist, stylized to feel familiar for the target demographic

(e) Congratulatory pop-up when user finished a task

(f) Extravagant fonts and colors, included to capture the target demographics attention.

Figure 7.2: Review of certain design decisions made in Prototype 1.

The younger demographic is used to being exposed to bright colors and loud effects through games, TV shows, commercials, and so on. The main purpose behind the showcased prototype was to design an application that would resonate with the younger demographic, and to this end, the aforementioned design choices were made to facilitate the potential for grabbing the attention of the children, by assimilating the prototype to other, more familiar sensory impressions. The colors chosen were based on creating a calm environment, with energetic alternative tones.

Certain features were developed to consolidate the playful approach of the design in an attempt to resonate with the children's sense of wonder and play as discussed in section 2.3, in an attempt to somewhat mask the serious undertone the proposed application tries to solve. As such, this version of the prototype included daily challenges, a progression system, a customizable task list, an avatar, a trophy collection, a food diary solution, and a settings panel for administrators to customize challenges and other settings. Most of these can be seen in the design showcase in Figure 7.2, and can be explored further in Figure E.1.

7.1.1 Reception and Evaluation

During the development phase of the proposed solution, the authors iteratively consulted with supervisors and an expert in clinical nutrition, to ensure steady development of the application's potential features and look. The group responded positively to the concept, especially liking the avatar and gamification aspects of the solution. Simultaneously, however, the prototype received remarks for looking relatively dated, and concerns were raised concerning the amount of empty space on display. As this stage of the prototype was only meant to represent the core concept in the solution, this was relatively expected.

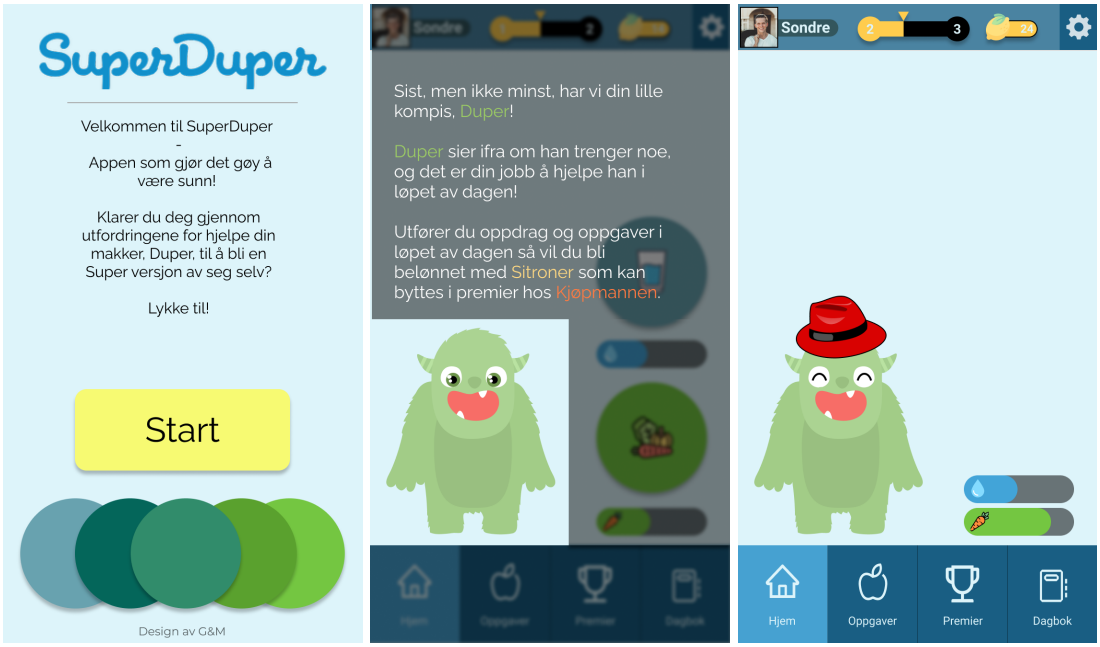
7.2 Prototype 2

The second prototype was developed from scratch and featured a complete overhaul of the design with very little asset re-use from the previous version[1]. The redesigned prototype focused on addressing the issues uncovered during the evaluation phase of the initial prototype. Most importantly updating parts of the application that were initially deemed to look and feel dated. Additionally, during this modernization process, the authors uncovered an equipment issue, which resulted in a change of platform from a tablet, to mobile. This change meant the designers had to be ingenious in their redesign to make

[1]The creature used as the avatar, and some of the icons utilized through the design were borrowed from PublicDomainVectors.org and Flaticon.com respectively

sure the proposed elements would fit the new format.

Another issue the designers uncovered with the first prototype was the inherent lack of identity present in the application. To remedy this, the developers came up with the name *SuperDuper*, a play on the expression for excellent. As discussed in subsection 2.3.2, the inclusion of an avatar was intended to facilitate the personal connection the end user could make to the application, potentially manifesting as a pet-, friend-, and self-relation, or something else entirely, based on individuals experience and predisposition. This approach was further facilitated by naming the app *SuperDuper* (Figure 7.3a), the avatar *Duper* (Figure 7.3b), and giving the users the mission to help *Duper* become *Super*. Rewards gained by completing challenges in the application, would in turn be usable as a form of currency to gain customizable items for Duper (Figure 7.3c). The designers hoped this overall experience would assist in creating a strong sense of attachment to the avatar and its quest to become a more super version of itself. Parts of this approach can be seen in the identity showcase, Figure 7.3.



(a) Welcoming screen for SuperDuper

(b) The avatar, *Duper*

(c) The avatar reacting to user customization

Figure 7.3: Showcase of application identity

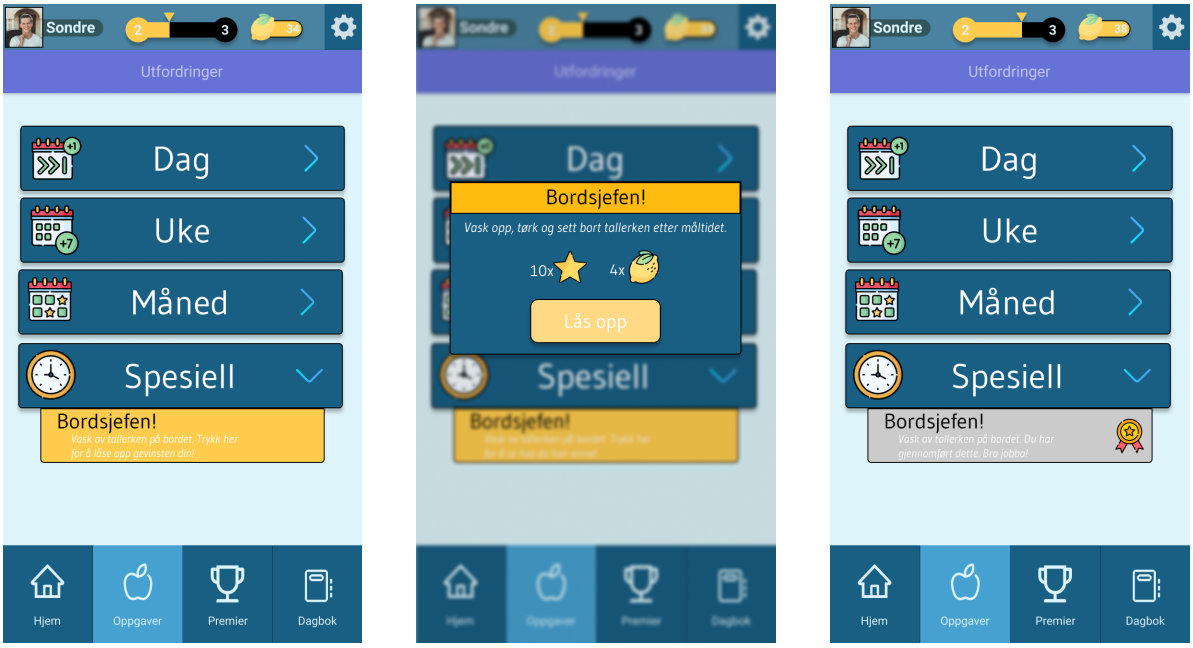
7.2.1 Features and Design

The design of this prototype was more thorough than that of its predecessor. While the main color scheme for this prototype kept variations of blue and green as main colors, the placement of elements in relation to each other and the use of complementary colors assisted in creating a more united design.

Yellow and purple were introduced to increase contrast and create a more cohesive look, with yellow representing collectibles (stars, lemons, experience points), highlighting and buttons, with purple acting as a contrast in the sub-headers. This resulted in a more vibrant look, again in an attempt to appeal more to the target demographic of the solution.

The design was further improved by lowering the amount of empty space present in headers, while still keeping the breathing room between elements sizable enough to prevent the user interface from being too crowded, overwhelming the end-user. Further, in an attempt to improve the usage of icons, a lineal style was introduced and functioned as a standard for every icon in the prototype. This helped highlight the icons by introducing a subtle contrast, while simultaneously helping facilitate a more cohesive design experience. Lastly, smoother animations were introduced while navigating from screen to screen. The incorporation of this style of design was done in an attempt to keep the design clean and clutter-free, as many of the solutions uncovered during the SLR (chapter 5) and Related Works (chapter 3) presented relatively cluttered design.

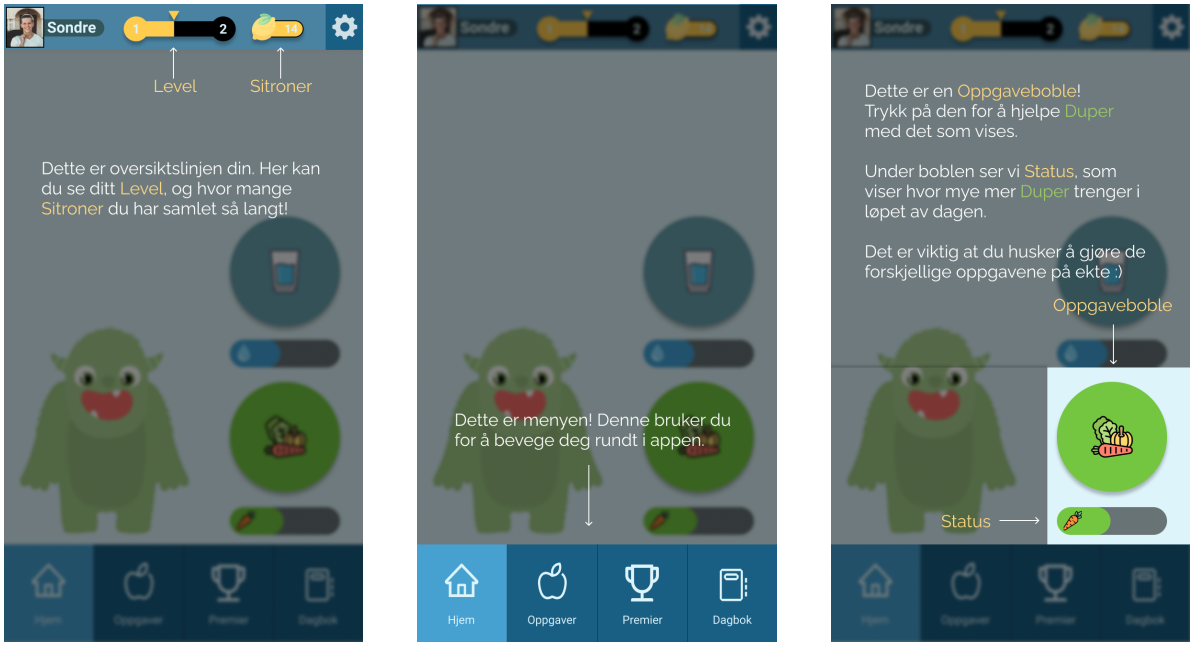
While the navigation bar stayed largely unchanged from the previous iteration, the designers opted to implement a flat navigational structure, with no state in the application going deeper than one additional layer from the navigational component (with the exception of navigating to the contents of a specific meal on a specific day, which has two layers), utilizing modals to help the user orient themselves. As an example, the task-system was redesigned to fit this structure by introducing drop-down sections grouped together by their respective time frames, with individual tasks having associated modal windows which communicate task- and reward information to the user. An example of this new task system and the navigational structure can be seen in Figure 7.4.



(a) Task list (b) Task information (c) Completed task

Figure 7.4: Example showing a special task being navigated to and completed, with the final state displaying the completed task.

While none of the design assets from the first prototype were directly reused, the features they represented were improved upon and transferred to the new version. The first main feature to be added in this version was an introductory tutorial acting as a guide, explaining the different user interface elements to the user. Additionally, the tutorial introduced the user to concepts such as the navigation bar (Figure 7.5a), the progression system (Figure 7.5b) and the newly added events (Figure 7.5c).



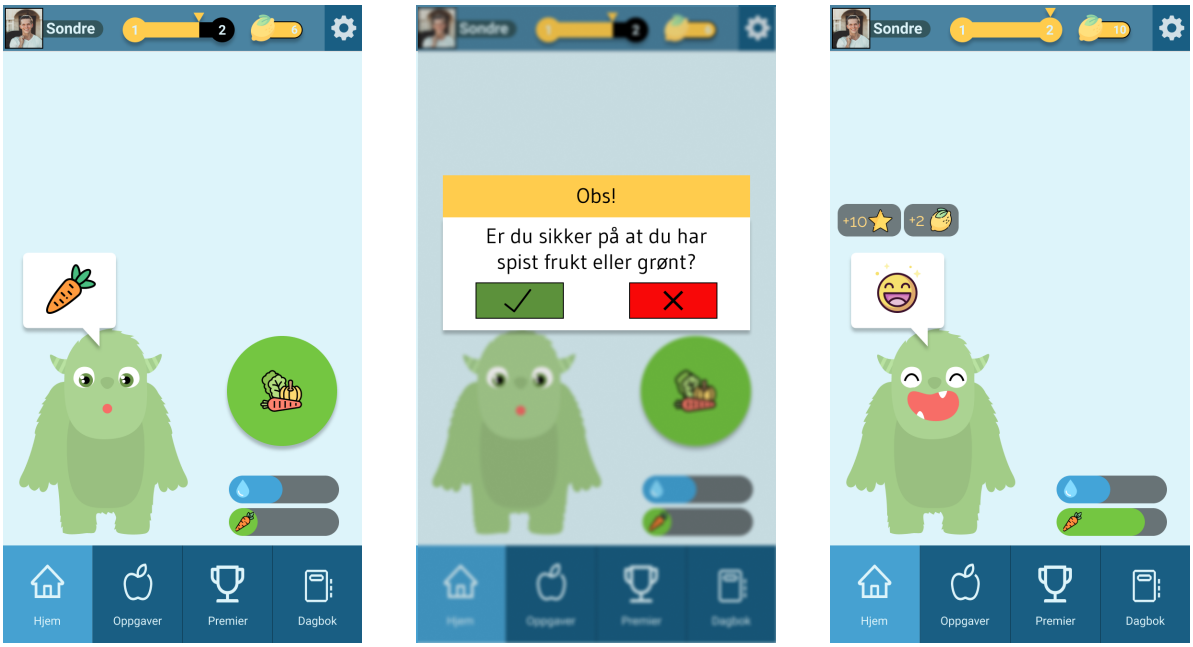
(a) Introduction to reward- and progression-systems *SuperDuper*

(b) Introduction to navigation

(c) Introduction to events

Figure 7.5: Showcase of the tutorial

These timed events were the second new addition to this version, and function by reminding the user a few times daily at predetermined intervals to perform simple tasks such as drinking a glass of water or eating a healthy snack like a vegetable or fruit. The user could be notified of this in one of two ways, either by the avatar telling the user that it is in need directly, or by the user noticing that the attached *status bar* is close to empty. The concept of status bars was also introduced in this iteration, giving the user the ability to track the avatar's current need levels. In Figure 7.6, the process from task to completion is showcased, also showing the new avatar reactions.



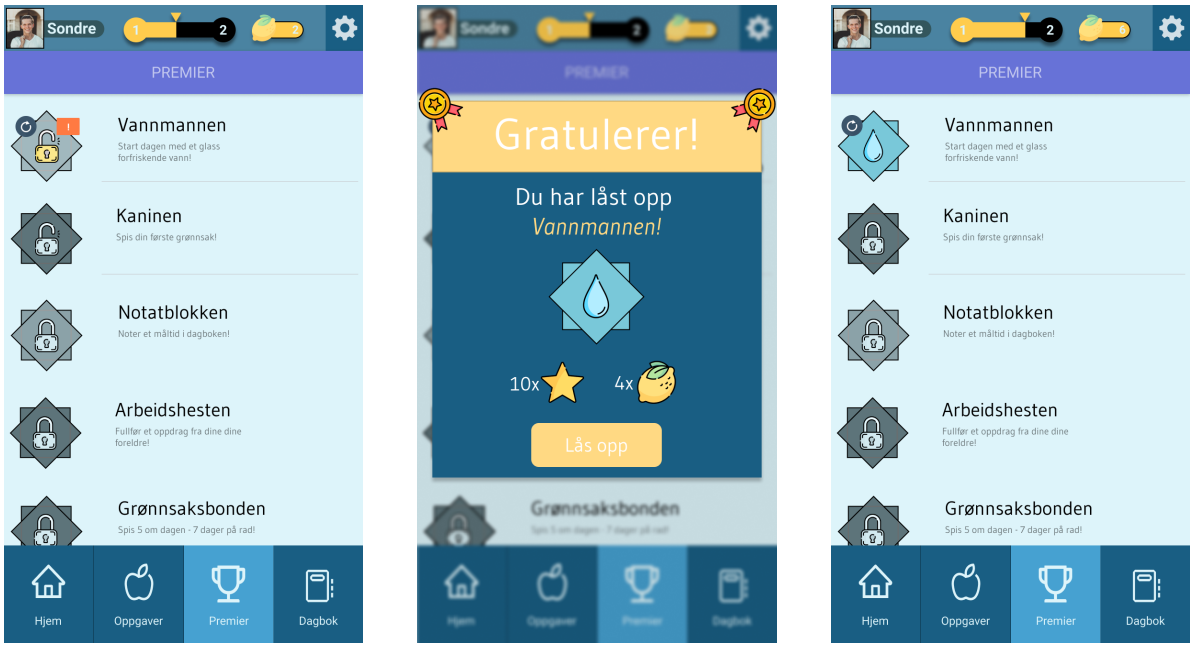
(a) *Duper* notifying the user it is hungry

(b) Confirmation pop-up

(c) *Duper* being happy after eating healthy

Figure 7.6: Showcase of timed events

Further, medal collecting was reworked. To unlock medals, the user would have to complete a challenge like before, but now the medals remained locked until the unlock criteria were met. The challenge and subsequent reward would be visible when interacting with the locked medal, but the medal itself would remain hidden until the challenge was completed, and then the user could collect it. This meant that the users would not know how the medals looked like before completing the challenge, adding a bit of mystery and curiosity to the experience. Additionally, some tasks could now be repeated, as indicated by the small icon on the medal itself. The process of unlocking such a medal is presented in Figure 7.7.



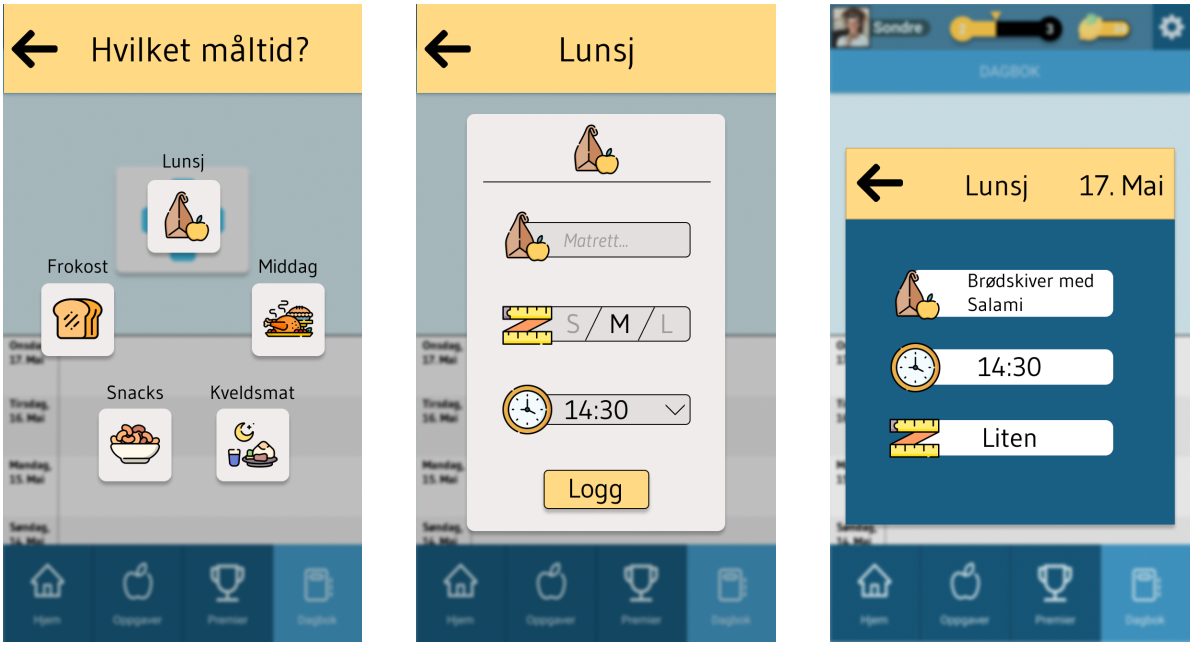
(a) Initial state

(b) Unlocking process, displaying collected medal and associated reward

(c) New state, unlocked medal, increased experience and lemon count

Figure 7.7: Showcase of medals

Lastly, the food diary was reworked. Going from the larger screen of the tablet to the smaller form factor of the smartphone meant that the diary in specific had to be redesigned quite heavily. In an attempt at staying true to the theme of the application, the designers chose to stick to the icon-on-button style that is apparent throughout the rest of the application. This version of the food diary included functionality that lets the user input a meal, select the relative size of the meal, and log at what time of day it was eaten, as can be seen in Figure 7.8.



(a) Selecting the type of meal to log

(b) Filling out details about the meal

(c) Final view after filling int he diary

Figure 7.8: Showcase of the food diary

Both the design of- and features present in these prototypes were heavily based on the theories, techniques and results uncovered during the preceding SLR (chapter 5) and Background (chapter 2) chapters. The inclusion of the various gamified elements present in the final version of the prototype reflects this, and is discussed further in chapter 10.

Chapter 8

Evaluation

This chapter will present the evaluation process utilized to evaluate the proposed solution as part of this thesis. The chapter will begin by presenting the motivation for the evaluation, as well as the participants who took part in the experiment. Further, the methods and techniques utilized as a part of the evaluation process will be presented, and the procedure in which these were deployed will be described. Lastly, a review of the evaluation process will be presented.

As with any UCD process, feedback from potential end-users is invaluable.

While the first prototype was evaluated by experts and supervisors, the second prototype was planned to be evaluated by individuals in the target demographic. By performing a User-Centered Evaluation (UCE), the authors could not only evaluate whether the perceived quality of the solution was acceptable, but also whether or not the selected features and design decisions had merit. Additionally, this approach has the added possibility of uncovering flaws previously unknown to the designers of any particular system.

8.1 Testing Environment

As the prototype presented in this thesis was developed with the specific goal of exploring the research questions presented in the introductory part of this thesis, a prerequisite for the evaluation process was that it had to be able to generate qualitative data regarding the topics at hand. To this end, an Unmoderated Remote Usability Test (URUT) was designed and executed. This specific approach to usability testing gives the observers and participants partaking in the evaluation the freedom to perform the test whenever in the freedom of their own homes. This in particular was the biggest reason

for deciding to utilize URUT for this project, as the study was done during the pandemic outbreak of the Covid-19 virus. This made other forms of testing difficult, and the limitations associated with both the situation itself and URUT as an evaluation strategy, are discussed in section 10.2.

Accompanied by the goal set forth by the research questions, the URUT performed as part of this study contained four specific subgoals; evaluation environment, software selection, participant recruitment, test design, and pilot test. Before any testing could take place, the evaluation process had to be defined, and participants had to be recruited. The target demographic for this study was defined to focus on individuals in primary school, further defining the age range of potential participants from 6 to 13 years old. Initially, the solution was planned to be evaluated by a focus group of individuals in the target demographic struggling with early-onset overweight, but this opportunity was canceled. This meant new potential participants had to be recruited, and in the end, the authors were able to evaluate the solution with three ten-year-olds and one thirteen-year-old.

In an attempt at keeping the process as simple as possible for the participants, the team decided to keep the inclusion of third-party software- to a minimum. As such, the only tool the participants would be exposed to aside from the Figma prototype itself would be Google Forms, which would serve to facilitate the data collection process through questionnaires used in the URUT.

Further, a set of challenges were created with the intention to simulate daily usage of the solution, in addition to providing the participants with a sense of purpose during time spent in the environment. These tasks were evaluated in their own right, through a small pilot test held with acquaintances of the author in order to rid the test of confusing language and identify technical limitations before the participants were to experience the application for themselves. In addition to this, a set of questions for evaluating the different parts of the application the participants had been exposed to was defined as part of an evaluation schema, in order to generate data to support the research questions of the thesis.

8.2 Procedure

Once the test was slated to begin, the parents of the participants were sent an instruction form, describing the evaluation process in detail. The document begins by presenting the three distinct parts of the evaluation process, divided into before, during, and after the hands-on test itself. The preparation documents can be found in their entirety in Appendix B. This section will describe the execution of this process.

Stage one of the test consisted of the parents being given information about how the test was going to

be held, and what sort of tasks they could expect. Additionally, they were asked to prepare a set of items, vital to the execution of the test. Further, the parents were made aware of and introduced to the task sheet which the participants were to go through during the test. The parents were instructed to go through these tasks in the prototype themselves, to be able to help guide the participants in the case that they would get stuck. Finally, this stage concluded with an introductory questionnaire, collecting certain personal data such as the age and gender of the participants.

Further, as outlined in the instruction document, stage two consisted of the hands-on test itself, where the participants got to experience the prototype for themselves, and have an attempt at completing the challenges outlined in the task sheet. During this stage, the participants got to explore the prototype freely, while trying to complete the challenges set forth by the authors. The tasks in question ranged from completing certain nutritional challenges by satisfying a need put forward by the avatar, to finding certain predetermined observational answers. The task sheet defining every challenge can be found in Appendix B. For this phase, the parents were instructed to act as observers, and to only help the participants if they got stuck. Additionally, the observers were to tell the participants to think out loud stating their thought process and concerns while selecting actions, in order to uncover otherwise hidden data.

Finally, during stage three, the participants were asked to fill out an evaluation schema together with the observer. The evaluation schema featured a large set of open-ended questions, which let the participants and observers reflect upon the different parts of the prototype, give feedback and generate ideas of their own. These questions, and the subsequent results they generated can be found in chapter 9

Chapter 9

Results

In this chapter, the results of the evaluation will be presented. The results generated from the URUT and subsequent questionnaires will be presented and sorted by the context in which they were asked, before the chapter concludes with a small summary of the relevant findings. The raw data serving as the baseline for this chapter can be examined in Appendix C

9.1 Evaluation Results

In this section, the results of the questionnaires will be represented in tables, and the consensus of the findings associated with these will be described for each section respectively. Each subsection will include an explanatory text defining the context of the results. The questionnaire was answered directly after experiencing the prototype for the first time by all four participants. Two of the participants performed the evaluation together, and the results reflect this.

9.1.1 Concept and Design

As presented in Table 9.1, the findings related to the concept and design part of the evaluation suggest that the design was relatively well-liked, and was deemed easy to navigate by most participants. With that said, some participants responded negatively to this notion, which is further demonstrated in the fact that most participants reported some level of frustration became stuck in some way during their time with the application.

However, it is also worth noting that when asked if anything could be improved, only one participant responded that the navigation should have been improved. This participant deemed the navigation of the application as unintuitive, suggesting to find an easier way to navigate the application and locate tasks. This result was surprising, as the navigation bar which is present on every screen of the application, includes a direct link to the tasks in question. Other than this, one participant thought the textual elements as part of the application were too small.

Table 9.1: Questionnaire Results - Concept & Design

Concept and Design		
ID	**Question**	**Result**
1	Did the participants find the prototype easy and intuitive to use?	50% of the participants deemed the application to be intuitive to use
2	Did the participants get stuck during testing, if so why and where?	100% of the participants got stuck at some point during the test.
3	Did the participants express frustration or confusion for anything in particular?	25% of the participants became frustrated. 25% did not get frustrated. 50% experience minor frustration.
4	Did the participant experience difficulty with navigation?	50% of participants experienced navigational issues.
5	Tell us one thing participant like about the concept or design.	75% of participants liked the avatar and its ability for customization. 25% liked event messages.
6	Tell us one thing the participant think could be improved with the design.	50% reported nothing. 25% reported easier navigation. 25% reported a bug about customization disappearing.

9.1.2 Avatar

As shown in Table 9.2, the findings of the avatar section show that the participants were very happy with the inclusion of the avatar, responding with a 100% positivity rate regarding the inclusion of; the avatar itself, the customization system, and emotional reactions.

When asked for potential improvements, most respondents pointed out that they would like the avatar to communicate in ways other than emotion, like having a voice or included text. One respondent suggested giving the avatar the possibility of evolution and change. Every respondent agreed upon the notion of expanding upon the customization options.

Table 9.2: Questionnaire Results - Avatar

Avatar		
ID	**Question**	**Result**
7	What did the participants think about the avatar?	100% Liked the avatar, all of which used the term ”cute”.
8	What did the participants think about the possibility of customizing the avatar?	100% of the participants liked this feature, but 75% would like more options.
9	Did the participants show an understanding for the connection between the interactive events and their effect on the avatars needs?	100% of the participants understood this. 25% suggested adding text.
10	What did the participants think about the avatar showing expressing emotion?	100% of the participants enjoyed this.
11	What kind of relation did the participants experience towards the avatar?	33% related to it as a pet, 33% as a figure in an app, and 50% as a poor friend that needed help.
12	Would the participant’s motivation or interest increase if the user would be able to control the Avatar in games?	100% reported positively to this notion.
13	Please tell us one thing the participant liked about the avatar.	100% of the participants reiterated that he was cute.
14	Tell us one thing that could be improved with the avatar.	75% of the participants suggested giving the avatar a voice. 25% of the participants suggested the ability to design the avatar, and have it evolve while leveling up.

9.1.3 Progression and Rewards

As presented in Table 9.3, the findings regarding the progression and rewards section of the questionnaire showed great support for the inclusion of both systems. All of the participants responded positively to both the progression and reward systems, including the questions regarding real-life rewards and whether or not the system positively affected their motivation.

In specific, the respondents noted enjoyment from getting rewarded for doing small tasks, and showed understanding of the connection between challenges, rewards and customization. Interestingly, one respondent pointed out that the thing they liked the most about the systems was the related sensation of mastery it introduced. Additionally, respondents responded positively to the included medals, but one participant did not quite understand this concept.

Table 9.3: Questionnaire - Progression and Rewards

Progression and Rewards		
ID	**Question**	**Result**
15	Did the level- and rewards system appeal to the participant?	100% of the participants responded positively to this.
16	What did the participants think about receiving rewards from challenges?	100% of the participants responded positively to this.
17	What did the participants think about collecting medals?	75% of the participants liked this, 25% did not understand this.
18	Did the participants find it motivating to complete challenges and receive rewards?	100% of the participants responded positively to this.
19	Does the participant think receiving rewards in real life would be motivating?	100% reported positively to this notion.
21	Please tell us one thing the user liked about the rewards-system	50% liked the rewards for doing small things, 25% enjoyed the rewards to buy new hats, 25% enjoyed the sensation of mastery.
21	Please tell us one thing that could be improved with the rewards-system	25% wanted to split tasks into smaller pieces, 25% suggested making the difference between medal and rewards clearer. 50% answered that they wanted the avatar to get babies.

9.1.4 Food Diary

As made apparent by the results presented in Table 9.4, the food diary garnered mixed results. While the navigational aspect of the diary was fine, participants reported difficulty in regards to editing and adding to the diary itself. Nonetheless, the participants reported the possibility of viewing an overview of meals, the way in which the meals were presented, and the ability to fill in eaten foods as positive.

A participant also left a lot of suggestions in this area. The participant suggested the possibility of adding their own food, give users the ability to log more days, and adding the possibility of examining dates back in time. Another notion left by this user was the possibility that the diary in its current state may leave a user with a low sense of self-esteem as a consequence of eating too much.

Table 9.4: Questionnaire Results - Food Diary

Food Diary		
ID	**Question**	**Result**
22	Did the user find the diary easy to input?	50% of the participants responded negatively to this, 50% responded positively but pointed out that the diary was pre-filled.
23	Did the users find navigation in the diary to be intuitive?	75% of the participants responded good but not great. 25% responded positively.
24	Please tell us one thing the users liked about the diary.	66% of the participants liked that you could easily see diary results. 33% liked the possibility of saving meals.
25	Please tell us one thing that could be improved with the diary.	25% responded negatively, with several suggestions. 50% had a neutral response, suggesting the inclusion of a table, 25% thought it was fine.

9.1.5 General

As shown in Table 9.5, one participant of the evaluation reported that they would not be interested in using the full version of the evaluated application, while the rest of the participants did. Two of the participants expressed interest in wanting to download the application straight after testing. When asked to mention one thing in specific that they enjoyed about the application as a whole, three of the participants reported liking the avatar very much, following up this notion by pointing out that they believed in the concept. The last individual enjoyed the possibility of physical tasks.

This section also uncovered another result regarding the avatar, with one user suggesting that the avatar should be able to evolve beyond just changing its appearance, but given the ability to have babies which the user, in turn, could start anew with.

Table 9.5: Questionnaire Results - General

General		
ID	**Question**	**Result**
26	Could the participant envision using the completed application?	75% of participants responded positively. 25% responded negatively due to deeming the application childish.
27	Please tell us one thing you liked about the application as a whole	75% reported the avatar as positive. 25% reported believing in the concept. 25% reported liking the physical tasks.
28	Please tell us one thing that could be improved.	25% suggested scanning food. 25% suggested more customization options. 50% thought more creative freedom with the avatar would be nice.

9.2 Summary

The results of the evaluation are generally observed as positive. The participants gave mostly positive feedback regarding the progression system, reward system, medals, tasks, avatar, and customization features while leaving mixed impressions of the food diary. Additionally, some navigational issues arose during testing, leading the users to experience some frustration.

In addition to this general feedback, the participants left several thoughts for improvement of features like an expanded avatar customization shop, expanding the reward system to supply users with customization items directly, and the introduction of the avatar baby, to mention a few.

Chapter 10

Discussion

In this chapter, the results of the research done as part of this thesis will be interpreted and discussed. First, an explanation of the results will be presented, including an analysis of unexpected results. Subsequently, the results will be compared to previous research as outlined in the Systematic Literature Review and Background Research sections of the thesis. Further, the author will put the results into context, describing the baseline for the contribution this piece of work supplies. Lastly, the results will be generalized and set into the context of relevant research in the space.

10.1 Result Analysis

The results collected, as presented in the previous chapter, allowed the authors to make certain deductions in connection to the research questions, and these deductions in addition to other insights gained, will be discussed in this section. Some results, however, stood out as surprising, and this section will aim to investigate these results in an attempt to clarify and offer explanations for these results. Further, the results will be compared to that of other studies in the field.

The main research goal of this project was to explore the design principles of gamification theory, and whether or not these could be utilized to develop a concept that would facilitate preventative nutritional behavior in children. This goal was further described through the proposed research questions. To analyze the results, let us first reintroduce the research questions this study set out to explore:

RQ1: *How can the principles of gamification be utilized to develop a solution that assists in the prevention of early-onset obesity*?

RQ2: *How can gamification be used to leverage the inherent motivation an individual possesses, through the incorporation of a reward- and progression-system?*

RQ3: *How does the introduction of a gamified environment affect the motivation of users in the younger demographic?*

10.1.1 Observations

Even though the test was performed as an Unmoderated Remote Usability Test, the parents of the participants acted as instructors and observers, in order to facilitate the testing process to its utmost extent. This process was described in detail in section 8.2, and included instructions on how to prepare for the test. Once the first instructor had completed the test and subsequently filled in the evaluation questionnaire with the participants, they admitted to not following the instruction sheet supplied for executing the hands-on test. As the instructor was unfamiliar with the application being tested, experiencing it for the first time together with the participant - they could not offer any sort of assistance to the tester.

This, in turn, lead the first participant to experience more frustration with the application than the subsequent participants, appearing dissociated. The results as part of the evaluation questionnaire reflected this notion, with the participant in question responding to the question regarding personal relation to the avatar as nothing more than a ”figure in an app”, suggesting little to no connection in contrast to the other participants. Additionally, the participant mentioned general navigational issues, and the textual elements being hard to read.

During a subsequent interview with this instructor, however, it became clear that these results were inaccurately represented in the raw data. The issues mentioned by this participant turned out to be rather minor, with the textual element issue being contained to only a single instance of the food diary, rather than the whole application as the raw data suggested. Additionally, the navigational issues the participant reported, was apparently a mixture of small bugs with the prototype, and an unprepared instructor. However, the participant deemed the design a bit childish for a 13-year-old, a result that was expected.

10.1.2 Concept, Design and Functionality

While there is definitely still room for improvement in the current version of the proposed solution, the results gathered from the evaluation show that the participants are generally happy with the design, and

believe in the concept. As presented in subsection 9.1.1 however, the participants reported getting stuck, experiencing some level of frustration while testing the prototype. Additionally, concerns regarding specific functionality such as filling the diary or losing a purchased hat were mentioned, but the author has an explanation for this.

As discussed in section 6.2, the prototype used to evaluate the proposed solution was designed with the interface design tool, Figma. While the tool itself fit the scope of the proposed application well, and the utilization of it was good for most purposes, the final version of the prototype, unfortunately, contained some bugs. These bugs hindered the navigation and state management from working as intended in certain areas, and the negative responses regarding navigation coincide with the areas in which these bugs are apparent. In specific, the first bug rendered navigating to the tasks page impossible, until a certain state was met. The second one lets the user input a specific pattern of events to reset the avatar state, meaning the avatar would lose their purchased hat. From the perspective of the user, one can easily understand that this was confusing.

While these bugs could be easily fixed, the developer did not notice them in advance, despite the pilot test covering other bugs. Luckily, the validity of the results was not in question because of this, but some valuable insights might have been lost regardless.

10.1.3 Utilization of Gamification

As presented in section 2.3, the application of gamified design techniques can have great positive effects on user retention, individual motivation and perceived enjoyment of an application. However, the technique can quickly encourage the opposite effect if applied poorly. While gamifying existing solutions, or adding gamified aspects to already designed applications certainly is possible, the potential issues are many.

As presented in chapter 6, the design process of this solution was heavily influenced by this notion. The early incorporation of gamified design principles was of utmost importance, and the initial design process revolved around how to make this work. The aim of this approach was to create an integrally gamified environment, in which the game elements and systems would be of utmost importance, but simultaneously not draw too much attention. This was based on the insight gained from the SLR (chapter 5) Motivational Theory sections, and more specifically the theories behind extrinsic- and intrinsic motivation, and their relation to gamification. By defining reward- and progression systems and building the application on top of these basic reward structures, the intention was to leverage the inherent extrinsic motivation individuals gain by being exposed to reward systems. This was done in an attempt

to build further intrinsically motivated connections for the user, not only to features of the application, but to the underlying actions the features serve to represent.

This was further compounded by the inclusion of the avatar. By giving the user an entity to interact with, and subsequently letting all tasks and their respective rewards influence the possibility of customizing this avatar, the intention was to add the sensation of caring about something, or someone, into the environment. This was based on the principles of the Self Determination theory, as outlined in subsection 2.2.4, by giving the user full control over their own experience based on their inherent skill set, while simultaneously introducing a relatable variable with the avatar. Additionally, the avatar had the added function of removing the direct focus on rewards, rather than shifting the focus onto *how* the rewards could benefit the avatar. These decisions were made to reflect the reality of the situation, as whenever the user does anything to help the avatar satisfy its needs, not only does it benefit the avatar, but also the user.

10.2 Limitations

While the goal for the project was reached, and the research questions indeed were answered, several limitations were present that could have aided in altering the final result.

First, the prototype was developed as just that, an interface design prototype intended to show- and test the inherent concept of the solution. The fidelity of this prototype was high, but as discussed in the previous chapter, this lead some users (and an expert) to mistake it for an actually completed application. This misconception lead to some confusion during testing and may have altered the potential results gathered in certain parts of the evaluation.

Further, the population size of this study was very small and very homogeneous. While the initial intention of the evaluation phase was to test the concept on a sample including children spanning across the target demographic, including both genders, the final stage of the evaluation included three 10-year-old girls and one 13-year old girl. Additionally, every participant in the study was healthy and had similar geographic- and cultural backgrounds. Compounded, this certainly represents a rather homogenous population. This is important to note, as the study thus has not tested whether or not the proposed solution appeals to a broader demographic, nor to children struggling with obesity.

Lastly, the Covid-19 pandemic materialized as a big limitation for the thesis. As presented in chapter 8 and further discussed in chapter 10, the project needed to utilize an evaluation technique that would take the current situation regarding lockdown and restrictive social access into account, and Unmoderated

Remote Usability Testing was chosen for this purpose. While this method came with its own set of drawbacks, such as removing the possibility for direct observation, it allowed the participants to perform the testing in the safety of their own homes - which was deemed important to minimize the risk of spreading the coronavirus. Additionally, the pandemic rendered the recruitment of participants for the study difficult. While the initial plan was to evaluate the solution as part of a predefined focus group, including children struggling with overweight or obesity, This would possibly allow the study to review potential health effects of the solution, but due to the cancellation of the focus group, this was not possible.

Chapter 11

Conclusion

This chapter concludes the thesis by revisiting the introductory section and reiterating the problem, before presenting the research contribution of the thesis by answering the research questions. Lastly, further possibilities and recommendations for future work are presented.

The problem of early-onset obesity is a very real threat to several facets of an individual's life, and the potential consequences are many. While research suggests that the evolution of the problem amongst the younger demographic has stagnated somewhat over the last decade, it is still a very real problem that has the potential to significantly lower the quality of life experienced by those who struggle with the condition, if left unattended.

The relevant papers uncovered as part of the SLR outlined different approaches to the application of gamification in different contexts. As put forward by the third research question, the solution as part of this thesis relied heavily on the integration of gamified elements from the very beginning in an attempt at creating an integrally gamified environment. Based on the results from the evaluation- and following discussion, the author deems this approach a success.

Further, the background section of the thesis presented several important motivational facts and theories. Put forward by the second research question, the insight gained from these sections served as the baseline for the design and addition of the reward- and progression systems in the proposed solution. These additions were designed to leverage the inherent motivation of the potential end-users, in such a way that the extrinsically motivating factors present in any such system would not dominate the potential creation of intrinsic links. This approach was also considered a success based on the results of the evaluation, as every participant responded positively to the systems and the effect it had on their motivation. One specific result was particularly interesting in this context. When met with the question

if anything in specific was appealing about the systems, the participant answered: "*The sensation of achieving something*".

As put forward by the main research question, the results of this study show that the introduction of gamified elements in a preventative health-, nutrition and self-management application has a positive effect on inherent motivation for individuals in the younger demographic. These notions realize the research questions put forward in the thesis and holds the inherent contribution of this research. The results associated with the evaluation of SuperDuper, the proposed solution showcased in this thesis, showed the participants responding positively to the inclusion of every gamified element, exhibiting eagerness to complete challenges during the test, with some participants even wanting to download the solution after the evaluation.

Conceptualized as a result of the systematic literature review (chapter 5), designed as a result of the background research (chapter 2), developed in order to explore the research questions (chapter 1) and evaluated in order to highlight the possibilities of the approach (chapter 9) - the results of this thesis show that gamification indeed can be utilized to facilitate the creation of a preventative health application for the younger demographic.

11.1 Future work

In the last section of this thesis, the possible future work regarding further development of the proposed solution, as well as exploration of the presented findings will be described.

As mentioned during the initial evaluation of the prototype, some flaws regarding navigation and state management were discovered and would be the first concern for further development of the concept.

Further, the evaluation uncovered several ideas that would be interesting to explore:

- Introduce real-life rewards.
- Introduce games, where the user controls the avatar.
- Add attributes to the avatar, which evolve through the level system.
- Tie the attributes together with the needs-system to unlock or increase player performance in the aforementioned games.
- Give the user the ability to form the avatar directly by choosing a body shape, color, etc.
- Make the aforementioned traits changeable after the fact.

- Increase number of customization options.
- Add the possibility of gaining customization options through rewards.
- Give the avatar a voice.
- Redesign the Home-screen to include more effects and colors.

The idea of adding games to the solution was thought of beforehand, and feedback on the idea was evaluated during the questionnaire. The participants responded very positively to this notion, stating that they then could prepare a meal and bring it along while playing. An especially interesting addition to this proposal was the addition of an attribute system. The implementation of this could be done in many different ways, for example borrowing elements from role-playing games by introducing attributes such as *Stamina* or *Agility* to the avatar, letting the users select which stat to upgrade freely when leveling up. Further, this idea could be linked with the games themselves, letting the avatar perform better in certain games, or unlocking certain games or stages upon reaching a predetermined attribute value. By introducing a system like this, the different avatar customization options could also potentially give bonuses to these attributes. Exploring if these additions would amplify the effect of the gamified environment and sense of progression would be interesting. Additionally, as the participants responded very positively to the avatar, it would be very interesting to see if the addition of the ideas as listed would facilitate an even stronger connection to the avatar, amplifying the effect of the gamified environment. Further research into the application of these elements is also recommended.

Lastly, further testing at a larger scale with a more diverse population would be recommended. Exploring whether or not the results align across age groups and genders, in addition to including children currently experiencing early-onset obesity or overweight, could further confirm the results of this thesis or otherwise grant valuable insight. Based on the results of the SLR and subsequent secondary research, the aforementioned additions could have the potential to increase the user retention of the application, and it would be interesting to see if this is the case. Developing a functional prototype including these additions, and deploying it in an experiment over a longer period of time would be recommended in order to evaluate the effect the solution has on user motivation over the long term. By monitoring individuals using the solution over the long term, this approach could also generate data giving an insight into the actual health benefits gained from using this preventative solution.

Bibliography

Afonso, L., Rodrigues, R., Reis, E., Miller, K., Castro, J., Parente, N., Teixeira, C., Fraga, A., and Torres, S. (2020). Fammeal: A gamified mobile application for parents and children to help healthcare centers treat childhood obesity. *IEEE Transactions on Games*, 12. 3.1.1

Albertazzi, D. G., Ferreira, M. G. G., and Forcellini, F. a. (2019). A wide view on gamification. *Technology, Knowledge and Learning*. 2.3

Anderson, P. M. and Butcher, K. F. (2006). Childhood obesity: Trends and potential causes. *The Future of Children*, 16. 2.1.1

Ash, T., Agaronov, A., Young, T., Aftosmes-Tobio, A., and Davison, K. K. (2017). Family-based childhood obesity prevention interventions: a systematic review and quantitative content analysis. *International Journal of Behavioral Nutrition and Physical Activity*, 14. 2.1.4

Austin, S. B., Haines, J., and Veugelers, P. J. (2009). Body satisfaction and body weight: gender differences and sociodemographic determinants. *BMC Public Health*, 9. 2.1.1

Berge, J. M. and Everts, J. C. (2011). Family-based interventions targeting childhood obesity: A meta-analysis. *Childhood Obesity*, 7. 2.1.4

Budd, G. M. and Hayman, L. L. (2008). Addressing the childhood obesity crisis: a call to action. *The American Journal of Maternal/Child Nursing*, 33. 2.1.1

Byiers, B., Dimian, A., McComas, J. J., and Symons, F. J. (2014). Effects of positive and negative reinforcement in a concurrent operants arrangement on compliance and problem behavior. *Acta de Investigación Psicológica*. 2.2.3

Choi, E.-S., Shin, N.-R., Jung, E.-I., Park, H.-R., Lee, H.-M., and Song, K.-H. (2008). A study on nutrition knowledge and dietary behavior of elementary school children in seoul. *Nutrition Research and Practice*, 2. 2.1.3

Clark, H. R., Goyder, E., Bissell, P., Blank, L., and Peters, J. (2007). How do parents' child-feeding behaviours influence child weight? implications for childhood obesity policy. *Journal of Public Health*, 29. 2.1.4

Cornette, R. (2008). The emotional impact of obesity on children. *Worldviews on Evidence-based Nursing*, 5. 2.1.1

Creemers, R. (2018). China's social credit system: An evolving practice of control. *SSRN Electronic Journal*. 2.3

Danford, C. A., Schultz, C., and Marvicsin, D. (2015). Parental roles in the development of obesity in children: challenges and opportunities. *Dove Press Journal: Research and Reports in Biology*, 6. 2.1.4

Decaluwé, V. and Braet, C. (2003). Prevalence of binge-eating disorder in obese children and adolescents seeking weight-loss treatment. *International Journal of Obesity and Related Metabolic Disorders*, 27(3). 2.1.1

Deci, E. L. and Cascio, W. F. (1972). Changes in intrinsic motivation as a function of negative feedback and threats. *The Psychological Record*. 2.2.3

del Río, N. G., González-González, C., Martín-González, R., Navarro-Adelantado, V., Toledo, P. A., and García-Peñalvo, F. (2019). Effects of a gamified educational program in the nutrition of children with obesity. *Journal of Medical Systems*, 43:1–12. 5.1.2

Doughty, A. H. and Shields, M. C. (2009). The power of reinforcement: A review. *The Psychological Record*. 2.2.3

Ehrenfeld, T. (2018). Overcoming childhood obesity: How parents can help... or hurt. https://www.healthline.com/health-news/overcoming-childhood-obesity-how-parents-can-help-or-hurt. [Online; accessed 25-05-2021]. 2.1.4

Electronic Arts (2000). The sims. 2.3.2

Ferster, C. B. and Skinner, B. F. (2008). Schedules of reinforcement with skinner. *Journal of Educational Psychology*. 2.2.2, 2.2.3

Fiese, B. H. and Spagnola, M. (2007). Family routines and rituals - a context for development in the lives of young children. *Infants and Young Children*. 3.3

Franks, P. W., Hanson, R. L., Knowler, W. C., Sievers, M. L., Bennett, P. H., and Looker, H. C. (2010). Childhood obesity, other cardiovascular risk factors, and premature death. *The New England Journal of Medicine*, 28. 2.1

Goldfield, G. S., Moore, C., Henderson, K., Buchholz, A., Obeid, N., and Flament, M. F. (2010). Body dissatisfaction, dietary restraint, depression, and weight status in adolescents. *Journey of School Health*, 80. 2.1.1

Gonçalves, F., Carvalho, V., Matos, D., and Soares, F. (2020). Development of a serious game to fight childhood obesity: "barty". In *2020 IEEE Global Engineering Education Conference (EDUCON)*, pages 1641–1646. 3.1.3

Gray, L. A., Alava, M. H., Kelly, M. P., and Campbell, M. J. (2018). Family lifestyle dynamics and childhood obesity: evidence from the millennium cohort study. *BMC Public Health*, 18. 2.1.4

Hamari, J. and Koivisto, J. (2015). Why do people use gamification services? *International Journal of Information Management*, 35:419–431. 2.3

Harter, J. K., Schmidt, F. L., and Keyes, C. L. M. (2003). Well-being in the workplace, and its relationship to business outcomes. *American Psychological Association*. 2.2.3

Haugen, N. C. (2006). A empirical study of using planning poker for user story estimation. *AGILE'06*. 2.3

Hulleman, C. S., Durik, A. M., Schweigert, S. A., and Harackiewicz, J. M. (2008). Task values, achievement goals, and interest: An integrative analysis. *Journal of Educational Psychology*. 2.2.1

Hwang, M. L. and Mamykina, L. (2017). Monster appetite: Effects of subversive framing on nutritional choices in a digital game environment. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*, page 4082–4096. Association for Computing Machinery. 3.1.2

Institute, I. (2017). The growing value of digital health - evidence and impact on human health and the healthcare system. https://www.iqvia.com/insights/the-iqvia-institute/reports/the-growing-value-of-digital-health. [Online; accessed 31-05-2021]. 3.2

Intelligence, M. (2020). Gamification market report 2020. https://www.mordorintelligence.com/industry-reports/gamification-market. [Online; accessed 28-05-2021]. 2.3, 2.3.1

Kigaru, D. M. D., Loechl, C., Moleah, T., Macharia-Mutie, C. W., and Ndungu, Z. W. (2015). Nutrition knowledge, attitude and practices among urban primary school children in nairobi city, kenya: a kap study. *BMC Nutrition*, 1. 2.1.2

Kostenius, C., Hallberg, J., and Lindqvist, A.-K. (2018). Gamification of health education - schoolchildren's participation in the development of a serious game to promote health and learning. *Health Education*, 118. 2.3.2

Lentelink, S., Spil, A., Broens, T., Broens, T., Hermens, H., and Jones, V. (2013). Healthy weight game!: Lose weight together. In *2nd IEEE International Conference on Serious Games and Applications for Health (SeGAH 2013)*, pages 1–8. IEEE Computer Society. 3.1.4

Lepper, M., Corpus, J., and Iyengar, S. (2005). Intrinsic and extrinsic motivational orientations in the classroom: Age differences and academic correlates. *Journal of Educational Psychology*, 97. 2.2.1

Lepper, M., Greene, D., and Nisbett, R. (1973). Undermining children's intrinsic interest with extrinsic reward: A test of the "overjustification" hypothesis. *Journal of Personality and Social Psychology*, 28. 2.2.1, 2.2.3

Lochtefeld, J. (2002). *"Avatar" in The Illustrated Encyclopedia of Hinduism*, volume 1. Rosen Publishing. 2.3.2

Moens, E., Braet, C., Bosmans, G., and Rosseel, Y. (2009). Unfavourable family characteristics and their associations with childhood obesity: a cross-sectional study. *European Eating Disorders Review*, 17. 2.1.1

Mohd Tuah, N., Yoag, A., Ahmedy, F., and Baharum, A. (2019). A gamification and avatar self-representation application for diabetes self-management. *International Journal of Advanced Trends in Computer Science and Engineering*, 8. 2.3.2

Morgan, D. L. (2010). Schedules of reinforcement at 50: A retrospective appreciation. *The Psychological Record,*. 2.2.2

Naeeni, M. M., Jafari, S., Fouladgar, M., Heidari, K., Farajzadegan, Z., Fakhri, M., Karami, P., and Omidi, R. (2014). Nutritional knowledge, practice, and dietary habits among school children and adolescents. *International Journal of Preventive Medicine*, 5. 2.1.2, 2.1.3

Norwegian Institute of Public Health (FHI) (2017). Overweight and obesity in norway. https://www.fhi.no/en/op/hin/health-disease/overweight-and-obesity-in-norway---/. [Online; accessed 27-05-2021]. 1

Nowak, K., Pandžić, I., Zorić, G., Šmid, K., Grundnig, S., Petri, T., Polzer, C., Sträfling, N., Krämer, N., Trepte, S., Reinecke, L., and Behr, K.-M. (2008). The psychology of avatars: Real life effects of virtual communication. *Presence 2008*, pages 16–18. 2.3.2

Palmer, T. and Bowman, J. (2020). 2020 design tools survey. https://uxtools.co/survey-2020. [Online; accessed 28-05-2021]. (document), 6.2.2, 6.1

Parrinder, G. (1997). *Avatar and Incarnation: The Divine in Human Form in the World's Religions*. Oneworld. 2.3.2

Pintirch, P. (2000). Multiple goals, multiple pathways: The role of goal orientation in learning and achievement. *Journal of Educational Psychology*, 92. 2.2.1

Richter, F. (2020). Gaming: The most lucrative entertainment industry by far. https://www.statista.com/chart/22392/global-revenue-of-selected-entertainment-industry-sectors. [Online; accessed 28-05-2021]. 2.3

Ryan, R. M. and Deci, E. L. (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry)*. 2.2.4, 2.3

Ryan, R. M. and Deci, E. L. (2002). *Overview of self-determination theory: An organismic-dialectical perspective*. University of Rochester Press. 2.2.1

Ryan, R. M. and Deci, E. L. (2020). Intrinsic and extrinsic motivation from a self-determination theory perspective: Definitions, theory, practices, and future directions. *Contemporary Educational Psychology)*. 2.2.4

Sahoo, K., Sahoo, B., Choudhury, A. K., Sofi, N. Y., Kumar, R., and Bhadoria, A. S. (2015). Childhood obesity: causes and consequences. *Journal of Family Medicine and Primary Care*, 4(2). 2.1.1

Story, M., Neumark-Sztainer, D., and French, S. (2002). Individual and environmental influences on adolescent eating behaviors. *Journal of the American Dietetic Association*, 102(3). 2.1.1

Taveras, E. M., McDonald, J., O'Brien, A., Sherry, B., Bottino, C., Schmidt, M. E., and Haines, J. (2013). Healthy habits, happy homes - randomized trial to improve household routines for obesity prevention among preschool-aged children. *JAMA pediatrics*. 3.3

Thakur, S. and Mathur, P. (2021). Nutrition knowledge and its relation with dietary behaviour in children and adolescents: a systematic review. *International Journal of Adolescent Medicine and Health 2021*. 2.1.3

Toda, A., Valle, P. H., and Isotani, S. (2018). *The Dark Side of Gamification: An Overview of Negative Effects of Gamification in Education*, chapter HEFA 2017, pages 143–156. Springer. 2.3.1

Trier, C., Dahl, M., Stjernholm, T., Nielsen, T. R. H., Bøjsøe, C., Fonvig, C. E., Pedersen, O., Hansen, T., and Holm, J.-C. (2016). *Effects of a Family-Based Childhood Obesity Treatment Program on Parental Weight Status*. PLOS One. 2.1.4

Turkay, S. and Kinzer, C. K. (2016). The effects of avatar-based customization on player identification. *International Journal of Gaming and Computer-Mediated Simulations*. 2.3.2

Tzou, I. L. and Chu, N.-F. (2012). Parental influence on childhood obesity: A review. *Health*, 4. 2.1.4

World Health Organization (2020a). Obesity. https://www.who.int/health-topics/obesity. [Online; accessed 24-05-2021]. 2.1

World Health Organization (2020b). Obesity and overweight. https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight. [Online; accessed 24-05-2021]. 2.1

Xiao, Y. and Watson, M. (2019). Guidance on conducting a systematic literature review. *Journal of Planning Education and Research*, 39. 5

Appendices

Appendix A

Systematic Literature Review

A.1 SLR - Criteria Protocol

Online Self-management Support for Young People with Overweight: A Systematic Literature Review

Research questions

- The objective of this SLR is to synthesize lessons reported in existing research literature concerning digital solutions supporting overweight children. In particular, we aim to answer the following research questions:

    - RQ1: What types of technologies go into the digital solutions for weight management?
    - RQ2: What are the concepts used in such solutions?
    - RQ3: Which user groups are the digital solutions designed to support, and in what context are they developed?
    - RQ4: What are the methodological approaches to evaluate digital solutions for weight management?
    - RQ5: What evidence is there to support the impact of the digital solutions on health outcomes?

Search string

Physicality	**Technological**	**Health**
Obesity Overweight	Gamification Gamified Gaming Game-based	Nutrition Diet Habit Habits Health Eating Management

Search engines

- Engines: Engineer Village
- Scope: Title, abstract, keywords

Inclusion/exclusion criteria

- Inclusion
    - The study's main concern is digital solutions regarding childhood overweight obesity.
    - The study is described in a peer reviewed research article written in English.
    - The study reports on empirical findings.
    - The study is reported in an article longer than 5000 words excluding references (thus excluding short-papers, extended abstracts, notes, etc.)
- Exclusion
    - The study's main concern is general training and wellness application.
    - The study's year of publication is 2013 and earlier

Search execution date

- 14 - 20 December 2020

A.2 SLR - Initial Result

No	Name	Relevant?	Gm?	Ob?	Ch?
1	Effects of a Gamified Educational Program in the Nutrition of Children with Ob	y	y	y	y
2	Fammeal: a gamified mobile application for parents and children to help health care ce	y	y	y	y
3	STOP: A gamified approach to support obese patients in changing their health habits.	x	y	y	n
4	The power of gamification to learn and promote healthy habits among children	y	y	n	y
5	Shopright: A game-based approach for motivating healthy shopping habits (Open Ac	n	y	n	n
6	Health promotion for childhood obesity: An approach based on self-tracking o	x	x	y	x
7	Treatment of children obesity and diabetes through gamification: A case of study	y	y	y	y
8	Gamified wearables in obesity therapy for youth	y	y	y	y
9	Gamified educational programme for childhood obesity	y	y	y	y
10	Enhancing Nutrition Learning Using Interactive Tools	y	x	y	y
11	Gamified educational programme for childhood obesity	d			
12	Fighting obesity: A proposed formula for calculating gamified airtime rewards for usin	x	x	y	n
13	Play, learn and eat healthy food: A mobile game for children to fight obesity	yy	y	y	y
14	A gamified system for influencing healthy e-commerce shopping habits	x	y	x	n
15	Planning a health promotion program: Mobile app gamification as a tool to engage ado	x	y	y	y
16	Characterizing diabetes, diet, exercise, and obesity comments on Twitter	n	n	y	n
17	Design, implementation and evaluation of a game-based intervention targeting Latino c	x	y	y	y
18	Media and technology use predicts ill-being among children, preteens and teenagers inc	n	n	y	y
19	AirCycle proof-of-concept: work towards using gamification and IoT to fight the globa	n	y	y	n
20	Media and technology use predicts ill-being among children, preteens and teenagers inc	d			
21	Applying gamification and social network techniques to promote health activities	x	y	x	n
22	Fighting obesity: A proposed formula for calculating gamifiedairtime rewards for using	d			
23	AirCycle proof-of-concept: Work towards using gamificationand IoT to fight the globa	d			
24	CoviHealth: Novel approach of a mobile application for nutrition and physical activity	y	y	y	y
25	Combating Health Inequalities Using IT: The Case of Games for Controlling Dia	n	y	y	n
26	A social robot-based platform for prevention of childhood obesity	y	x	y	y
27	Gamification strategies in weight control applications, where "losing (weight) is winnin	y	y	y	n
28	Gamification and lifestyle technologies for personal health management	x	y	x	n
29	Diet gamification toward chewing amount control via head mounted display	n	y	x	n
30	Exploring the Benefits of Using Gamification and Videogames for Physical Exercise: A	y	y	y	y
31	Gamified Platform to Support Children With Obesity	y	y	y	y
32	NutritionBuddy: A Childhood Obesity Serious Game	y	y	y	y
33	Exploring the Benefits of Using Gamification and Videogames for Physical Exercise: A	d			
34	Body Mass Index Awareness using Game-based Learning in Malaysia: Game Design an	y	y	y	y
35	Design, Implementation and Evaluation of a Game-Based Intervention Targeting Latin	d			
36	Body Mass Index Awareness using Game-based Learning in Malaysia: Game Design an	d			
37	Gamified Platform to Support Children With Obesity	d			
38	Learning healthy lifestyles through active videogames, motor games and the gamificati	y	y	y	y
39	An Ontology-Based Serious Game Design for the Development of Nutrition and Food L	y	y	y	y
40	Applying gamification and social network techniques to promote health activities	d			
41	Gamification system to support family-based behavioral interventions for childhood ob	y	y	y	y
42	Framework for promoting social interaction and physical activity in elderly people usin	n	y	x	n
43	Play, Learn and Eat Healthy Food: A Mobile Game for Children to Fight Obesity	d			
44	Gamification system to support family-based behavioral interventions for childhood ob	d			
45	A Novel Cooperative Game for Reinforcing ObesityAwareness Amongst Children in UA	y	y	y	y
46	NutritionRush-A serious game to support people with the awareness of their nutrition i	x	y	x	n
47	Gamification strategies in weight control applications, where “losing (weight) is winnin	d			
48	Examining enjoyment in gamifying physical exercise and a healthy diet	y	y	x	n
49	NutritionBuddy: a Childhood Obesity Serious Game	d			
50	Health management based on history of personalized physiological data using linear re	n	x	y	n
51	Space adventures: A serious game for childhood obesity prevention	yy	y	y	y
51	Interactive digital mobile gaming as a strategic tool in the fight against childhood obesi	y	y	x	n
52	"Barty" - A serious game to fight childhood obesity: First insights	y	y	y	y
53	Health management based on history of personalized physiological data using linear re	x	x	y	n
54	A social robot-based platform for prevention of childhood obesity	d			
55	Adaptive ubiquitous mobile gaming system for youth obesity rehabilitation	yx	y	y	y
56	Enhancing Nutrition Learning Using Interactive Tools	d			
57	Multinomial logistic regression modelling of obesity and overweight among primary sc	n	n	y	y
58	Healthy weight game!: lose weight together; The design and evaluation of a serious gan	y	y	y	n
59	Healthy Hankerings: Motivating Adolescents to Combat Obesity with a Mobile Applica	y	x	y	y
60	NutritionRush - a serious game to support people with the awareness of their nutrition	d			
61	Healthy Hankerings: Motivating Adolescents to Combat Obesity with a Mobile Applica	d			
62	"Barty" - A serious game to fight childhood obesity: First insights	d			
63	Is there an Optimal Technology to Provide Personal Supportive Feedback in Prevention	x	x	y	n
64	Adaptive ubiquitous mobile gaming system for youth obesity rehabilitation	d			
65	A Novel Cooperative Game for Reinforcing ObesityAwareness Amongst Children in UA	d			
66	Healthy weight game!: lose weight together; The design and evaluation of a serious gan	d			
67	The Effect of Endurance and Strength Physical Activity Program and Nutrition Educat	n	n	y	y
68	Military parents' personal technology usage and interest in e-health information for ob	n	n	y	n
69	Munchy Monster: Using video gaming to objectively evaluate front-of-pack labelling st	n	y	n	x
70	Gamification and geospatial health management	n	x	x	n
71	Development of a Serious Game to fight Childhood Obesity: ldquoBartyrdquo	y	y	y	y
72	TeenPower: measuring the effectiveness of an intervention program and engaging adol	yx	y	y	y
73	Learning healthy lifestyles through active videogames, motor games and the gamificati	d			
74	Supporting a participant-centric management of obesity via a self-improving health ga	y	y	y	n
75	Crowd Generation using Morphological Obesity Criteria	n	n	y	n
76	Games and gamification for healthy behaviours: The experience of PEGASO fit 4 futur	y	y	y	n
77	Design and development of a serious game to fight childhood obesity	y	y	y	y
78	Supporting a participant-centric management of obesity via a self-improving health ga	d			
79	Obesity Related Disease Prediction from Healthcare Communities Using Machine Lear	n	n	y	n
80	MATCHuP: An mHealth Tool for Children and Young People Health Promotion	y	y	y	y
81	Framework for promoting social interaction and physical activity in elderly people usin	d			
82	Redesigning the Healthcare Model to Address Obesity Problem Using the Integration o	y	y	y	y
83	Obesity Related Disease Prediction from Healthcare Communities Using Machine Lear	d			
84	TeenPower: Measuring the effectiveness of an intervention program and engaging adol	d			
85	Augmenting the task of exercise gamification: An expert view on the adoption of a new	nx	y	n	n
86	Pegaso: A serious game to prevent obesity	y	y	y	x
87	Is there an Optimal Technology to Provide Personal Supportive Feedback in Prevention	d			
88	Design application to lose weight of overweight person (Steppy Application)	xy	y	y	n
89	Mobile game approach to prevent childhood obesity using persuasive technology	y	y	y	y
90	Misrepresentation of health research in exertion games literature	n			
91	Serious games to teach nutrition education to children between 9 to 12 years old. Pickit	y	y	y	y

No	Name	Relevant?	Gm?	Ob?	Ch?
92	Design Application to Lose Weight of Overweight Person (Steppy Application)	d			
93	Supporting Learning Activities with Wearable Devices to Develop Life-Long Skills in a	yx	y	y	y
94	OB CITY-definition of a family-based intervention for childhood obesity supported by	y	y	y	y
95	A Game-based Technology Solution to Incite Children to Take Daily Breakfast with He	y	y	x	y
96	Redesigning the healthcare model to address obesity problem using the integration of p	d			
97	Development of a serious game to fight childhood obesity: "barty"	d			
98	OB CITY-Definition of a Family-Based Intervention for Childhood Obesity Supported	d			
99	Examining enjoyment in gamifying physical exercise and a healthy diet	d			
100	A serious game to treat childhood obesity	y	y	y	y
101	Smart homes and sensors for surveillance and preventive education at home: example c	n			
102	An exergame framework for obesity monitoring and management	x	y	y	n
103	Towards a framework for gamification-based intervention mapping in mHealth	x	y	y	n
104	Crowd Generation using Morphological Obesity Criteria	n	n	y	n
105	The design in the development of exergames: a new game for the contribute to control c	y	y	y	y
106	An integration of health tracking sensor applications and elearning environments for c	n	n	y	n
107	MHealth Stakeholder Integration: A gamification-based Framework-approach towards	x	y	y	n
108	Smart homes and sensors for surveillance and preventive education at home: example c	d			
109	Mobile game approach to prevent childhood obesity using persuasive technology	d			
110	Towards a framework for gamification-based intervention mapping in mHealth	d			
111	Serious Game as New Health Telematics Tool for Patient Therapy Education: Example	n	x	y	n
112	An Ontology-Based Serious Game Design for the Development of Nutrition and Food I	d			
113	Serious Game as New Health Telematics Tool for Patient Therapy Education: Example	d			
114	MATCHuP: An mHealth Tool for Children and Young People Health Promotion	d			
115	StarsRace: A mobile collaborative seriuos game for obesity	yy	y	y	n
116	Redesigning the healthcare model to address obesity problem using the integration of p	d			
117	When you exercise your avatar in a virtual game: the role of avatars' body shape and b	yy	y	y	n
118	Active video games and physical activity in overweight children and adolescents: Syster	xy	y	y	y
119	ICT: Health's Best Friend and Worst Enemy?	n	n	x	n
120	Interactive cause and effect comic-book storytelling for improving nutrition outcomes i	yy?	x	y	y
121	Children obesity treatment support with telemedicine	n			
122	A Game-based Technology Solution to Incite Children to Take Daily Breakfast with He	d			
123	An exergame framework for obesity monitoring and management	d			
124	Grocery Hunter: A fun mobile game for children to combat obesity	y	y	y	y
125	the design in the development of exergames: a new game for the contribute to contr	d			
126	Endure: Augmented Reality Fitness Mobile Application	x	y	y	n
127	Engaging teen-agers in the adoption of healthy lifestyles for the prevention of obesity a	x	y	y	y
128	Game-based lifestyle interventions for adolescents: An evidence-based approach	x	y	y	n
129	Exergame development using body composition data for obesity care	y	y	y	n
130	PEGASO companion: A mobile app to promote healthy lifestyles among adolescents	y	y	y	n
131	Health monitoring of obese people through a cloud-based serious game framework	y	y	y	n
132	Complete motion control of a serious game against obesity in children	x	y	y	n
133	Redesigning the healthcare model to address obesity problem using the integration of p	d			
134	When you exercise your avatar in a virtual game: the role of avatars' body shape and b	d			
135	Augmented exergaming: Increasing exercise duration in novices	x	y	y	n
136	Children obesity treatment support with telemedicine	d			
137	Supporting Learning Activities with Wearable Devices to Develop Life-Long Skills in	d			
138	A Cloud-based Pervasive Serious Game Framework to Support Obesity Treatment	x	y	y	n
139	Leveraging personalised feedback as a motivation tool in active games	x	y	x	x
140	Complete motion control of a serious game against obesity in children	d			
141	A cloud-based serious games framework for obesity	d			
142	Could virtual reality be an effective tool to combat obesity and sedentariness in childre	n			
143	Mobile exergames for preventing diseases related to childhood obesity	y	y	y	y
144	Integrated architecture for next-generation m-health services (education, monitoring a	n			
145	A Research of Digital Image-based Cognitive Learning Systems in Applications of Prev	x	x	y	y
146	Health monitoring of obese people through a cloud-based serious game framework	d			
147	Immersion in Virtual Reality Video Games for Improving Physical Performance Measu	x	y	y	n
148	Towards encouraging a healthier lifestyle and increased physical activity – An app inco	xy	n	y	n
149	Evaluation of a mobile phone-based diet game for weight control	y	y	y	n
150	Reducing adolescent obesity with a mobile fitness application: Study results of youth ag	y	y	y	y
151	Design Strategies for Youth-focused Pervasive Social HealthGames	n	x	x	n
152	Towards combating youth obesity with a mobile fitness application	y	y	y	y
153	Healthylunch: A serious game for educating and promoting the intake of the recommen	y	y	y	y
154	Serious Games and Personalization of the Therapeutic Education	n			
155	Videogames: Dispelling myths and tabloid headlines that videogames are bad (Open A	n			
156	Nutritional serious-games platform	y	y	y	n
157	Improving adolescent fitness attitudes with a mobile fitness game to combat obesity in y	y	y	y	y
158	3-D Streaming Supplying Partner Protocols for Mobile Collaborative Exergaming for I	n	y	y	n
159	Dancing in the Streets: The design and evaluation of a wearable health game	y	y	y	x
160	Effects of a multidisciplinary rehabilitation program on pediatric obesity: The CEMHa	n	n	y	y
161	Dancing in the Streets: The design and evaluation of a wearable health game	d			
162	The influence of design in the development of exergames: A practical study in the contr	n	y	y	y
163	A wireless home automation system for childhood obesity prevention	x	x	x	y
164	KinFit: A Factual Aerobic Sport Game with Stimulation Support	n	y	y	n
165	The contribution of mHealth in the care of obese pediatric patients	n			
166	Evaluating the impact of a cloud-based serious gameon obese people	n			
167	A wireless home automation system for childhood obesity prevention	d			
168	AFINA-te: A healthy lifestyle information website, online food diary and exercise log di	y	n	y	y
169	ICT: Health's best friend and worst enemy?	n			
170	Gamifying the city: Pervasive game elements in the urban environment	n			
171	AFINA-te: A healthy lifestyle information website, online food diary and exercise log di	d			
172	An exploratory analysis of game telemetry from a pediatric mhealth intervention	x	y	y	n
173	Enhancing Physical Education with Exergames and Wearable Technology	n			
174	Towards sedentary lifestyle prevention: An autoregressive model for predicting sedenta	n			
175	Adaptation component based on wearable technology to support personalized tracking	n			
176	KidLED: A colorful approach to children's activity awareness	y	x	y	y
177	Leveraging personalised feedback as a motivation tool in active games	n			
178	A systematic review on the usage of games for healthcare	xy	y	y	n
179	Towards Encouraging a Healthier Lifestyle and Increased Physical Activity - An App I	y	x	y	y
180	NEAT-o-Games: Novel mobile gaming versus modern sedentary lifestyle	y	y	y	n
181	Near-realistic motion video games with enforced activity	n			
182	PEGASO: A personalised and motivational ICT system to empower adolescents toward	x	x	y	y
183	Evaluation of the impact in the physical condition of school age children exposed to an	n			

No	Name	Relevant?	Gm?	Ob?	Ch?
184	A virtual reality grocery shopping game to improve awareness for healthy foods in your	y	y	y	y
185	Spaceship launch: Designing a collaborative exergame for families	y	y	y	y
186	Monster appetite: Effects of subversive framing on nutritional choices in a digital game	y	y	y	n
187	3-D streaming supplying partner protocols for mobile collaborative exergaming for hea	n			
188	Exertainment: Designing Active Video Games to Get Youth Moving	y	y	y	y
189	Fit for play: Developing an adaptive exergame platform to motivate inactive ch	y	y	y	y
190	Design strategies for youth-focused pervasive social health games	n			
191	Preventive Self-Care Serious Games for Diabetes: A Game Design	y	y	y	n
192	Use of Information Technology Media on Physical Activities of Students	n			
193	Mobile games to improve healthier lifestyle amongst youth: "are we there yet" or shoul	n			
194	"On the top of high towers..." discussing locations in a mobile health game for diabetic	n			
195	HealthyLunch: A Serious Game for Educating and Promoting the Intake of the Recom	d			
196	KinFit: A factual aerobic sport game with stimulation support	d			
197	Feed the dragon wisely: designing for childhood awareness as a means of lifelong obesit	n			
198	Swiss foodquiz: Inducing nutritional knowledge via a visual learning based serious gam	n			
199	1st International Conference on Ambient Intelligence for Health, AmIHEALTH 2015	n			
200	A modular mobile exergaming system with an adaptive behavior	x	y	y	y
201	Mechatronic system for the promotion of physical activity in people with motor limitati	n			
202	Make your garden grow: Designing a physical activity estimation improvement game	y	y	y	y
203	A Position Paper Managing Youth Screen Time versus Physical Activity: Encouraging A	n			
204	Evaluating the impact of a cloud-based serious game on obese people	d			
205	Monitoring and measuring sedentary behaviour with the aid of human digital memorie	n			
206	Go with the Dual Flow: Evaluating the Psychophysiological Adaptive Fitness GameEnv	n			
207	Exertainment: Designing active video games to get youth moving	d			
208	LunchTime: a slow-casual game for long-term dietary behavior change	y	y	y	n
209	Use of Information Technology Media on Physical Activities of Students	d			
210	Development and Efficacy Testing of a Social Network-Based Competitive Application	n			
211	A modular mobile exergaming system with an adaptive behavior	d			
212	Fit for play: a proof of concept in computer games for health	n			
213	Are serious games too serious? Diffusion of wearable technologies and the creation of a	x	y	y	n
214	Enhancing Physical Education with Exergames and Wearable Technology	d			
215	LunchTime: a slow-casual game for long-term dietary behavior change	d			
216	"On the top of high towers&mellip;" discussing locations in a mobile health game for d	y	y	y	y
217	Design of an enhanced disc golf game to facilitate players with visual impairments	n			
218	CBMAS-EH 2012 - Proceedings of the 2012 ACM Workshop on Cloud-Based Multimec	n			
219	Which motives are predictors for long-term use of exergames?	n			
220	Near-realistic motion video games with enforced activity	d			
221	Exposure of metals and PAH through local foods and risk of cancer in a historically co	n			
222	A fully accessible arabic learning platform for assisting children with intellectual challe	n			
223	Motivation in lifestyle changes: Using mock-ups as a tool for exploring the design space	n			
224	Grab Apple: The Design of a Casual Exergame	y	y	y	n
225	Endure: Augmented reality fitness mobile application	n			
226	Low cost video game technology to measure and improve motor skills in children	n			
227	Interval training with Astrojumper	n			
228	Using mixed reality to map human exercise demonstrations to a robot exercise coach	n			
229	Motivation in lifestyle changes: Using mock-ups as a tool for exploring the design space	d			
230	Mercury interferes with endogenous antioxidant levels in Yukon river subsistence-fed s	n			
231	From a physical system to a pervasive solution to increase people physical activity: Is it	y	x	y	n
232	IXercise: An immersive platform for exercise intervention for special needs population	n			
233	A systematic review on the usage of games for healthcare	d			
234	Fit for play: a proof of concept in computer games for health	d			
235	The use of IT to increase nutritional awareness in young children	y	n	y	y
236	Exertion interfaces	n			
237	iBall to Swim: a Serious Game for Children with Autism Spectrum Disorder	n			
238	Using mixed reality to map human exercise demonstrations to a robot exercise coach	n			
239	Identifying predictors of continuance intention on social media-based physical activity	n			
240	iBall to Swim: a Serious Game for Children with Autism Spectrum Disorder	d			
241	MeMaPads: Enhancing children's well-being through a physically interactive memory	y	y	y	n
242	Flourishing and video games	n			
243	IXercise: An immersive platform for exercise intervention for special needs population	d			
244	Evaluating Player Experience in Cycling Exergames	n			
245	Do sedentary behavior and physical activity spatially cluster? Analysis of a population-	n			
246	Designing educational exertion games for young children	y	y	y	y
247	Learn-pads: A mathematical exergaming system for children's physical and mental wel	n			
248	Towards using social media to identify individuals at risk for preventable chronic illnes	n			
249	Developing software for motivating individuals with intellectual disabilities to do outdo	n			
250	Towards mobile collaborative exergaming	n			
251	Make your garden grow: Designing a physical activity estimation improvement game	d			
252	Towards sedentary lifestyle prevention: An autoregressive model for predicting sedenta	n			
253	Developing engaging exergames with simple motion detection	n			
254	Nutritional serious-games platform	x	y	y	n
255	Towards using social media to identify individuals at risk for preventable chronic illnes	n			
256	Human health implications of environmental contaminants in Arctic Canada: A review	n			
257	Modular indoor games: A hybrid of video and outdoor games	n			
258	Improved Body Mass Index classification for football code masters athletes, a comparis	n			
259	GrabApple: The design of a casual exergame	d			
260	Improved Body Mass Index classification for football code masters athletes, a comparis	d			
261	Go with the Dual Flow: Evaluating the Psychophysiological Adaptive Fitness GameEnv	d			
262	Monitoring and measuring sedentary behaviour with the aid of human digital memorie	n			
263	GrabApple: The design of a casual exergame	d			
264	WiFi treasurehunt: A mobile social application for staying active physically	n			
265	Genre in genre: The role of music in music games	n			
266	Based on the best standard model the influence of swimming exercise to lose weight	n			
267	Pose presentation for a dance-based massively multiplayer online exergame	n			
268	VI-bowling: A tactile spatial exergame for individuals with visual impairments	n			
269	Designing mobile multiplayer exergames for physical education	n			
270	Identifying predictors of continuance intention on social media-based physical activity	n			
271	Freegaming: Mobile, collaborative, adaptive and augmented exergaming	n			
272	Variations of body mass index with age in masters athletes (world masters games)	n			
273	Low cost video game technology to measure and improve motor skills in children	d			
274	Evaluation of the exertion and motivation factors of a virtual reality exercise game for	n			
275	The loess regression relationship between age and BMI for both sydney world masters	n			

No	Name	Relevant?	Gm?	Ob?	Ch?
276	Design Strategies for Playful Technologies to Support Light-intensity Physical Activity	n			
277	The loess regression relationship between age and BMI for both sydney world masters	d			
278	Work with mil: disciplining the body in the Wii Fit program	n			
279	The design and development of electronic playground equipment to increase fitness in	n			
280	AHFE 2017 International Conference on Design for Inclusion, 2017	n			
281	Designing mobile multiplayer exergames for physical education	d			
282	Dance dance education and rites of Passage	n			
283	CEUR Workshop Proceedings	n			
284	Freegaming: Mobile, collaborative, adaptive and augmented exergaming	d			
285	Integration of kinematic Analysis into Computer Games for Exercise	n			
286	User-centric exergaming with fine-grain activity recognition: A dynamic optimization a	n			
287	Game design principles in everyday fitness applications	n			
288	The short-term effect of Xbox Kinect active videogame on physical activity levels and e	n			
289	Sport psychological constructs related to participation in the 2009 world masters game	n			
290	Sport psychological constructs related to participation in the 2009 world masters game	d			
291	Effective pose presentation & demonstration in exergames	n			
292	Walk2Build: A GPS game for mobile exergaming with city visualization	n			
293	Towards mobile collaborative exergaming	n			
294	ACM International Conference Proceeding Series	n			
295	20th International Conference on Human-Computer Interaction, HCI 2018	n			
296	20th International Conference on Human-Computer Interaction, HCI 2018	d			
297	20th International Conference on Human-Computer Interaction, HCI 2018	d			
298	Virtual electronic game playing by children can be active	n			
299	Virtual sport system for optimum exercising based on a user model	n			
300	Serious games and personalization of the therapeutic education	n			
301	Virtual sport system for optimum exercising based on a user model	d			
302	The use of IT to increase nutritional awareness in young children	d			
303	Proceedings - 2020 IEEE 44th Annual Computers, Software, and Applications Confere	n			
304	VI-Tennis: A vibrotactile/audio exergame for players who are visually impaired	n			
305	7th International Conference on Well-Being in the Information Society: Fighting Inequ	n			
306	An embodied user interface for increasing physical activities in game	n			
307	Exergame effectiveness: What the numbers can tell us	n			
308	Inhibiting the diffusion of contagions in bi-threshold systems: Analytical and experime	n			
309	Internet use, videogame playing and cell phone use as predictors of children's body ma	n			
310	Design and testing of a novel interactive playground device	n			
311	Adaptation of graphics and gameplay in fitness games by exploiting motion and physio	n			
312	A position paper managing youth screen time versus physical activity: Encouraging act	d			
313	Adaptation of graphics and gameplay in fitness games by exploiting motion and physio	d			
314	Which motives are predictors for long-term use of exergames?	d			
315	The impact of ordering behavior on order-quantity variability: a study of forward and	n			
316	Evaluation of the exertion and motivation factors of a virtual reality exercise game for	d			
317	Statistics and Operational Research International Conference (SORIC 2013)	n			
318	Body mass index for australian athletes participating in rugby union, soccer and touch	n			
319	Creating physically active games for young adolescents	x	y	y	y
320	A fully accessible Arabic learning platform for assisting children with intellectual challe	n			
321	A fully accessible Arabic learning platform for assisting children with intellectual challe	d			
322	HAVE 2013 - 2013 IEEE International Symposium on Haptic Audio-Visual Environme	n			
323	Evaluating player experience in cycling exergames	n			
324	From a physical system to a pervasive solution to increase people physical activity: Is it	n			
325	An embodied user interface for increasing physical activities in game	x	y	y	n
326	Power, policy, politics, and fat	n			
327	Weight reduction of players by active playing using accelerometers	n			
328	13th International Conference on Systems Simulation, AsiaSim 2013	n			

A.3 SLR - Refined Result

#	Name	Rele	Gm?	Ob?	Ch?
6	Health promotion for childhood obesity: An approach based on self-tracking of data (Open Access)	x	x	y	x
48	Examining enjoyment in gamifying physical exercise and a healthy diet	y	y	x	n
135	Augmented exergaming: Increasing exercise duration in novices	x	y	y	n
38	Learning healthy lifestyles through active videogames, motor games and the gamification of educational activities	y	y	y	y
30	Exploring the Benefits of Using Gamification and Videogames for Physical Exercise: A Review of State of Art	y	y	y	y
31	Gamified Platform to Support Children With Obesity	y	y	y	y
52	"Barty" - A serious game to fight childhood obesity: First insights	y	y	y	y
91	Serious games to teach nutrition education to children between 9 to 12 years old. Pickit! and cookit!	y	y	y	y
3	STOP: A gamified approach to support obese patients in changing their health habits.	x	y	y	n
129	Exergame development using body composition data for obesity care	y	y	y	n
145	A Research of Digital Image-based Cognitive Learning Systems in Applications of Preventive Medicine-An Example of Redd	x	x	y	y
176	KidLED: A colorful approach to children's activity awareness	y	x	y	y
74	Supporting a participant-centric management of obesity via a self-improving health game	y	y	y	n
103	Towards a framework for gamification-based intervention mapping in mHealth	x	y	y	n
72	TeenPower: measuring the effectiveness of an intervention program and engaging adolescents towards physical activities usi	yx	y	y	y
39	An Ontology-Based Serious Game Design for the Development of Nutrition and Food Literacy Skills	y	y	y	y
88	Design application to lose weight of overweight person (Steppy Application)	xy	y	y	n
89	Mobile game approach to prevent childhood obesity using persuasive technology	y	y	y	y
130	PEGASO companion: A mobile app to promote healthy lifestyles among adolescents	y	y	y	n
21	Applying gamification and social network techniques to promote health activities	x	y	x	n
241	MeMaPads: Enhancing children's well-being through a physically interactive memory and math games	y	y	y	n
80	MATCHuP: An mHealth Tool for Children and Young People Health Promotion	y	y	y	y
4	The power of gamification to learn and promote healthy habits among children	y	y	n	y
59	Healthy Hankerings: Motivating Adolescents to Combat Obesity with a Mobile Application	y	x	y	y
77	Design and development of a serious game to fight childhood obesity	y	y	y	y
124	Grocery Hunter: A fun mobile game for children to combat obesity	y	y	y	y
32	NutritionBuddy: A Childhood Obesity Serious Game	y	y	y	y
41	Gamification system to support family-based behavioral interventions for childhood obesity	y	y	y	y
45	A Novel Cooperative Game for Reinforcing Obesity Awareness Amongst Children in UAE	y	y	y	y
202	Make your garden grow: Designing a physical activity estimation improvement game	y	y	y	y
246	Designing educational exertion games for young children	y	y	y	y
86	Pegaso: A serious game to prevent obesity	y	y	y	x
156	Nutritional serious-games platform	y	y	y	n

#	Name	Rele	Gm?	Ob?	Ch?
15	Planning a health promotion program: Mobile app gamification as a tool to engage adolescents (Open Access)	x	y	y	y
95	A Game-based Technology Solution to Incite Children to Take Daily Breakfast with Healthy Food	y	y	x	y
149	Evaluation of a mobile phone-based diet game for weight control	y	y	y	n
153	Healthylunch: A serious game for educating and promoting the intake of the recommended number of daily serv	y	y	y	y
76	Games and gamification for healthy behaviours: The experience of PEGASO fit 4 future	y	y	y	n
100	A serious game to treat childhood obesity	y	y	y	y
34	Body Mass Index Awareness using Game-based Learning in Malaysia: Game Design and Initial User Experiences	y	y	y	y
178	A systematic review on the usage of games for healthcare	xy	y	y	n
10	Enhancing Nutrition Learning Using Interactive Tools	y	x	y	y
191	Preventive Self-Care Serious Games for Diabetes: A Game Design	y	y	y	n

A.4 SLR - Deeper Look

#	Study	Title	Main Research Contribution	Location	Duration	Tech used	Concept	User group	Methods and Evaluations	Outcome
1	Del Río et al. (2019)	*Effects of a Gamified Educational Program in the Nutrition of Children with Obesity*	The project has developed a gamified educational program for healthy habits, based on active video games and motor games. It has created and validated a frame of reference for intervention, monitoring and emotional, biomedical, interactive, social, psychological and educational evaluation, based on games, applied to the treatment of childhood obesity and to preventing associated complications. It has also produced various technological products (exergames, serious games, webapps, sensory libraries, wearables, etc.).	Canary Islands	3 years	- Video games (Active video games) - Video conferences - Virtual environments	Gamified educational intervention program	46 obese children aged 6-12	- Experimental and control group - Training activities - Questionnaires	Quantitative data shows a significant improvement user group's knowledge and behaviors of healthy eating
2	Afonso et al. (2020)	*Fammeal: a gamified mobile application for parents and children to help health care centers treat childhood obesity*	The study presents a solution to support the prevention and treatment of childhood OB at health care centers. This solution is based on a platform that is innovative when compared with those existing because: a) it is directed to both parents and young children and involves them through tailoring and gaming strategies; b) it is designed to prevent or support the treatment of OB by promoting parents' skills to change the family lifestyle; and c) it is designed to be used at health care centers.	Portugal	4 weeks	Mobile phone	- Gamification - Avatar - Rewarding system	34 children aged 3-6 (also parents)	Questionnaires (acceptance and pilot tests)	- The retention rate was 71.4%. - Health care center's professionals and parents of children with overweight/obesity accepted this innovative approach. - Not able to evaluate the acceptance by children, as the access was controlled by their parents; nonetheless, parents reported no rejection of the app by children.
3	Saad et al. (2018)	*Play, Learn and Eat Healthy Food: A Mobile Game for Children to Fight Obesity*	The proposed serious game allows the children to learn about the importance of taking health breakfast daily. The game helps the children to eat more fruit and vegetables, exercise daily and change their habits of just eating anything they found around them.	Qatar	7 months	Website	- Gamification - Tutorial - Avatar - Rewarding system	Children aged 6-12	Questionnaires	- The game helps the children to eat more fruit and vegetables, exercise daily and change their habits of just eating anything they found around them. - Overall, the study shows that all the children are strongly engaged with the game with minimum difficulty in understanding and playing the game, but with high educational impact in raising children's motivation to eat healthy breakfast. This study proves that this game achieves its desired goals.
4	Villasana et al (2019)	*CoviHealth: Novel approach of a mobile application for nutrition and physical activity management for teenagers*	The main contribution of this paper is a detailed specification of an integrated mobile [app] for promoting healthy habits for young people. Additionally, it leverages the effects of gamification and medical control on stimulation education with healthy habits.	Spain	2 months	Mobile phone	- Gamification - Physical management/diary - Diet/training plan	356 teenagers aged 13-18 (tentative)	N/A	*(No evaluation, though the solution is planned to be evaluated to the user group mentioned.)*
5	Beranyi et al (2017)	*NutritionRush - A Serious Game to Support People with the Awareness of Their Nutrition Intake*	The study provides tangible evidence that supports the creation of serious games as a tool for increasing nutritional awareness. Even though their application met mixed response, the fact remains and the idea could be executed better.	Austria	N/A	Mobile phone	- Gamification - Avatar - Rewarding system	14 people (mostly adults) aged 10 and 18-52	- Interview - Questionnaires - Analysis from video records	- Qualitative - The feedback showed that there is a lot of potential for such serious games and that the prototype is a good initial starting point for different identified requirements.
6	Lamboglia et al. (2016)	*Interactive Digital Mobile Gaming as a Strategic Tool in the Fight against Childhood Obesity*	The exergame represents a differential tool for the promotion of a healthy lifestyle among children by combining digital game elements with health awareness in a fun and motivating fashion. The tool is useful for both health professionals and children, making it possible to establish a dialogue and an exchange between scientific information and common-sense experience.	Brazil	N/A	Mobile phone	- Gamification - Avatar - Rewarding system	30 children aged 8-10	User participated in all stages of development	*(No complete "evaluation" but the solution is assumed to perform well since it was developed closely with user interaction.)*
7	Broens et al (2013)	*Healthy Weight Game!: Lose weight together. The design and evaluation of a serious game for overweight and obesity.*	A design for a serious game for improving physical, and indirectly mental health of the people who deal with overweight or obesity.	Netherlands	1 year	Mobile phone	- Gamification - Avatar - Rewarding system	53 adults aged 18-25	Questionnaires	- Quantitative - The game resulted in a design for a serious game which shows potential for improving physical, and indirectly mental, health of people who deal with overweight and obesity by focusing on increasing adherence to physical exercise programmes and achieving positive behavioral change.
8	Gonçalves et al. (2020)	*Development of a Serious Game to fight Childhood Obesity: "Barty"*	The game has a great pedagogical aspect that can be applied not only to children, but also to their caregivers, which latter have a tool of assistance in the education and accompaniment of their children.	Portugal	2 weeks	Mobile phone	- Gamification - Avatar	16 children aged 3-10	Questionnaires	- The developed game is an important contribution because it has a great pedagogical aspect that can be applied not only to children, but also to their caregivers, which latter have a tool of assistance in the education and accompaniment of their children. - From the initial and final survey, it was possible to verify that the children acquired knowledge, and motivated to play and learn.
9	M.T Aredondo et al (2016)	*OB CITY—Definition of a Family-Based Intervention for Childhood Obesity Supported by Information and Communication Technologies*	The tool itself can be used by physicians in the future, allowing for better diagnostics and follow up not only for the children in need, but for any family regardless of obesity levels..	N/A	N/A	- Mobile phone - Wearable device	- Gamification - Avatar	Children and parents	N/A	*(No evaluation, though the prototype is planned to be evaluated to the user group mentioned.)*

#	Study	Title	Main Research Contribution	Location	Duration	Tech used	Concept	User group	Methods and Evaluations	Outcome
10	Joo and Kim (2017)	*When You Exercise Your Avatar in a Virtual Game: The Role of Avatars' Body Shape and Behavior in Users' Health Behavior*	The results suggest that (i) a virtual game environment can be an effective intervention to influence users' health behavior, and (ii) both avatars' behavior and appearance should be considered when designing an effective virtual intervention to increase users' health. We believe these findings suggest that health-related online courses involving thin and active avatars with a healthy lifestyle can be helpful for users to control weight in the long run by improving their health behaviors.	South Korea	1 hour	Computer	- Gamification - Avatar	124 adults aged 20-29	- Questionnaires - Experiment	- A virtual game environment can be an effective intervention to influence users' health behavior - The findings suggest that health-related online courses involving thin and active avatars with a healthy lifestyle can be helpful for users to control weight in the long run by improving their health behaviors.
11	Andreoine, G., et al (2014)	*Engaging Teen-agers in the adoption of Healthy Lifestyles for the Prevention of Obesity and Related Co-morbidities*	The PEGASO System.	Italy, Spain, UK	N/A	- Mobile phone - Wearable device	- Gamification - Diary - Avatar	300 teenagers	N/A	*(No evaluation, though the solution is planned to be evaluated to the user group mentioned.)*
12	Ladwa et al. (2018)	*Towards Encouraging a Healthier Lifestyle and Increased Physical Activity – An App Incorporating Persuasive Design Principles*	- Persuasive design principles do have a positive impact on users and it has the potential to determine the success or failure of a mobile application. - Although it is difficult to assess whether the application can change behavior long-term and whether or not it assists in tackling obesity, it is evident that users are encouraged to use the application and attempt the new behavior, which is likely to change their behavior for the time being.	N/A	1 day	Mobile phone	- Route tracker - Calorie log - Rewarding system	10 adults	- Focus group - Individual "think aloud" session	- Persuasive design principles do have a positive impact on users - Although it is difficult to assess whether the application can change behavior long-term and whether or not it assists in tackling obesity, it is evident that users are encouraged to use the application and attempt the new behavior, which is likely to change their behavior for the time being.
13	Milller, Andrew D, et. al (2013)	*Designing Strategies for Youth-focused Persuasive Social Health Games*	The study resulted in a lot of information about the end results of games, as designed and created by younger adolescents themselves. This gives great insight into what we may need to focus on when designing apps for said age groups.	N/A	3 years	- Wearable device - Other non-tech approach	- Participatory design - Physical game - Rewarding system	112 students	- Participatory design exercises - Focus groups - Interviews - Questionnaires	- Qualitative - The paper described a set of design strategies, conundrums and possible paths forward for creating social media games to incentivize healthy physical activity which seemed to work out.
14	Guimaraes et al. (2015)	*AFINA-te: A Healthy Lifestyle Information Website, Online Food Diary and Exercise Log Directly Towards Children*	Afina-te is a learning platform for children consequently leading them to better understand, apply and monitor healthy behaviors, therefore preventing and help treating obesity and overweight.	Portugal	N/A	Website	- Food diary - Exercise log - Informational website	Children	N/A	*(It is assumed that they didn't perform user testing.)*
15	Hwang, M (2017)	*Monster Appetite: Effects of Subversive Framing on Nutritional Choices in a Digital Game Environment*	The study showed that when positive messages were embedded in MA mixed with negative visuals through the monster avatars, participants exhibited better snack choices post-gameplay.	United States	N/A	Website	- Gamification - Avatar	225 adults aged 18 and over	Questionnaires	- Quantitative and qualitative - The study showed that when positive messages were embedded in MA (the game) mixed with negative visuals through the monster avatars, participants exhibited better snack choices post-gameplay.
16	Orji et al. (2013)	*LunchTime: a slow-casual game for long-term dietary behavior change*	- To propose an approach for developing a persuasive game for dietary interventions (goal-based approach), which allows the player to move from goal to solution. - To formulate the slow-casual game technique that combines both casual and slow attributes to induce learning, reflection, attitude and/or behavior change. - To model two recognized determinants of well-being (away-from-home foods and portion sizes) into dietary interventions. - To design, implement, and evaluate LunchTime to demonstrate the feasibility of our proposed technique for sustained learning, reflection, and attitude change.	Canada	10 days	Website	- Gamification - Rewarding system	6 adults aged 19-40	- Questionnaires - Interview	- The game is capable of educating people about healthy eating in line with their health goal. - Playing the game led to a positive attitude change toward healthy eating. - Intentional slowness in the game is an important attribute to consider in any intervention intending to change behavior using education and reflection.

Appendix B

External Test Documents

B.1 Instruction Sheet

Instrukser for testing av app

Så hyggelig at dere kunne tenke dere å prøve ut vår. Vi anslår at testen vil ta ca. **10** minutter.

Testprosessen inneholder 3 stadier:

1. Et **spørreskjema** for innsamling av informasjon om test-deltakerne (barn såvel som forelder/verge).
2. En **test** av selve prototypen, hvor deltakerne vil få en rekke oppgaver, og skal navigere seg til diverse mål i prototypen.
3. Et **evalueringsskjema** hvor dere sammen med deltakerne skal besvare spørsmål relatert til de forskjellige delene av appen.

Før Testen

Aller først vil dere få et informasjonsskjema, hvor dere fyller inn enkel informasjon om deltakerne. Under selve testen har vi lagt inn oppgaver for å simulere dagligdags bruk av applikasjonen. Her blir deltakerne bedt om å gjøre ting som å drikke vann, spise frukt, eller simulere oppgaver som foreldre har lagt inn på forhånd. Derfor er det greit om dere har disse tingene tilgjengelig på forhånd:

- **Et glass vann**,
- **En grønnsak/frukt**
- **En skitten tallerken** (gjerne bare en de brukte for grønnsaken)
- Utskrift/skjerm med oppgavearket klart.

I tillegg ønsker vi at dere går igjennom oppgavene en gang selv før deltakerne skal gjennomføre testen, slik at også dere får et inntrykk av appen.

Under Testen

Underveis i testen ønsker vi at barna får prøve seg fritt på oppgavene, uten hjelp fra dere som observerer. Ved visse stadier av testen skal de utføre praktiske oppgaver, før de går videre i testen og fyller inn i svararket. Her er det fint om dere passer på at de faktisk *gjør* oppgaven og ikke bare trykker seg videre.

Før de starter, er det fint om dere forklarer at de underveis i testen bør *tenke høyt*, altså snakke om oppgavene de utfører, og hvorfor de gjør valgene de gjør, f.eks: “Jeg trykker her fordi jeg tror denne knappen gjør dette”. Siden det er barn som skal utføre testen, skjønner vi at denne biten kan være vanskelig for de aller yngste, og dersom det ikke går for disse så er det helt greit - men det er da viktig for observatøren å notere eventuelle utfordringer.

Dersom deltakeren ikke kommer seg videre i testen ønsker vi at dere noterer ned hvilket steg de sliter med og hvorfor, før dere hjelper de videre slik at de får fullført testen.

Etter Testen

Etter fullført test er det tid for evalueringsskjemaet. Vi ønsker her at dere prater med deltakerne og finner ut hva de synes var vanskelig og hva de synes om de forskjellige delene av appen. Deretter ønsker vi at dere bruker denne informasjonen, samt deres egne observasjoner og notater for å svare på spørsmålene som kommer frem i skjemaet. Skjemaet er delt opp i fem seksjoner, ett for hver del av appen. Det er i

denne prosessen dataen vi skal bruke kommer frem, så gjerne skriv utfyllende her. Til slutt kommer et fritekstfelt, hvor dere kan gi oss deres tilbakemeldinger, eller andre synspunkter dere har.

B.2 Challenge Sheet

Oppgaveark

Velkommen til testen av SuperDuper! Fyll inn svarene deres i svarrutene underveis som dere finner de. For oppgavene som ikke er spørsmål, holder det å sett et kryss i ruten til høyre.

Nummer	Oppgave	Svar
1	Fullfør veiledningen!	
2	Duper er tørst. Hjelp han!	
3	Lås opp ***Vannmannen***.	
4	Duper er sulten. Hjelp han!	
5	Lås opp ***Kaninen***.	
6	Hva trengs for å låse opp ***Grønnsaksbonde*** medaljen?	
7	Hvilken dag ble det ikke spist frokost?	
8	Hva ble spist til frokost **17. Mai**?	
9	Hvor stor var lunsjen som ble spist **17. Mai**?	
10	Hvor mange sitroner har du?	
11	Hvor mange sitroner koster ***Disney***-hatten?	
12	Hvilket level er du nå?	
13	Hvilken av hattene ser best ut på Duper?	
14	Kjøp ***Italia***-hatten.	
15	Hvor mange ***Sitroner*** har du nå?	
16	Hva heter Oppgaven du kan gjøre èn gang i måneden?	
17	Utfør den ***Spesielle*** oppgaven!	

Appendix C

Data Collection Surveys

C.1 Personal Survey

Deltakerundersøkelse

I dette spørreskjemaet ønsker vi å samle informasjon om deltakernes alder, kjønn og generelle it-kunnskaper.

Next

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Deltakerundersøkelse

* Required

Deltakerundersøkelse

Hvor mange skal barn skal utføre testen? *

- [ ] 1
- [x] 2
- [ ] 3

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Deltakerundersøkelse

* Required

Datainnsamling for 2 deltakere

Deltaker 1 - Alder *

Choose

Deltaker 1 - Kjønn *

- Gutt
- Jente
- Annet
- Ønsker ikke svare

Hvor godt kjent er deltaker 1 med bruken av digitale enheter? (mobil, tablet, pc, etc..)

1	2	3	4	5
○	○	○	○	○

Deltaker 2 - Alder *

Choose

Deltaker 2 - Kjønn *

- ○ Gutt
- ○ Jente
- ○ Annet
- ○ Ønsker ikke svare

Hvor godt kjent er deltaker 2 med bruken av digitale enheter? (mobil, tablet, pc, etc..)

1	2	3	4	5
○	○	○	○	○

Back Next

Deltakerundersøkelse

* Required

Informasjon om verge/foreldre

I denne seksjonen ønsker vi å samle informasjon om verge/foreldre.

Hva heter du? *

Your answer

Hvor gammel er du? *

Your answer

På en skala fra 1 til 5, hvor høy IT kompetanse vil du si du har? *

1	2	3	4	5
○	○	○	○	○

Er det noe du ønsker å legge til?

Your answer

Back Submit

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Deltakerundersøkelse

Your response has been recorded.

Submit another response

C.2 Evaluation Survey

Evalueringsskjema

I dette skjemaet vil dere få spørsmål knyttet til evalueringen av appen. Ved hvert spørsmål ønsker vi at dere skal ta utgangspunkt i deltakerens meninger, men legg gjerne også til deres egne meninger/tanker som utfyller eller forklarer deres synspunkt.

Til sist har vi et langsvarsfelt, hvor dere får muligheten til å gi oss tilbakemelding på hva dere selv synes om appen, eller vil gi annen tilbakemelding.

Next

Evalueringsskjema

* Required

Konsept & Design

Denne seksjonen inneholder spørsmål relatert til det overordnede konseptet, og designet av appen.

Synes deltakeren at appen var enkel og intuitiv i bruk? *

Your answer

Satt deltakerne seg fast under testen, i så fall hvor og hvorfor? *

Your answer

Ga deltakerne uttrykk for frustrasjon eller forvirring under testen? *

Your answer

Opplevde deltakeren noen problemer med å navigere seg rundt under testen? *

Your answer

Fortell oss èn ting deltakeren likte godt med designet/konseptet. *

Your answer

Fortell oss èn ting som kunne blitt forbedret med designet/konseptet. *

Your answer

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Evalueringsskjema

* Required

Avatar

Denne seksjonen inneholder spørsmål relatert til avataren i appen.

Hva synes deltakerne om Avataren? *

Your answer

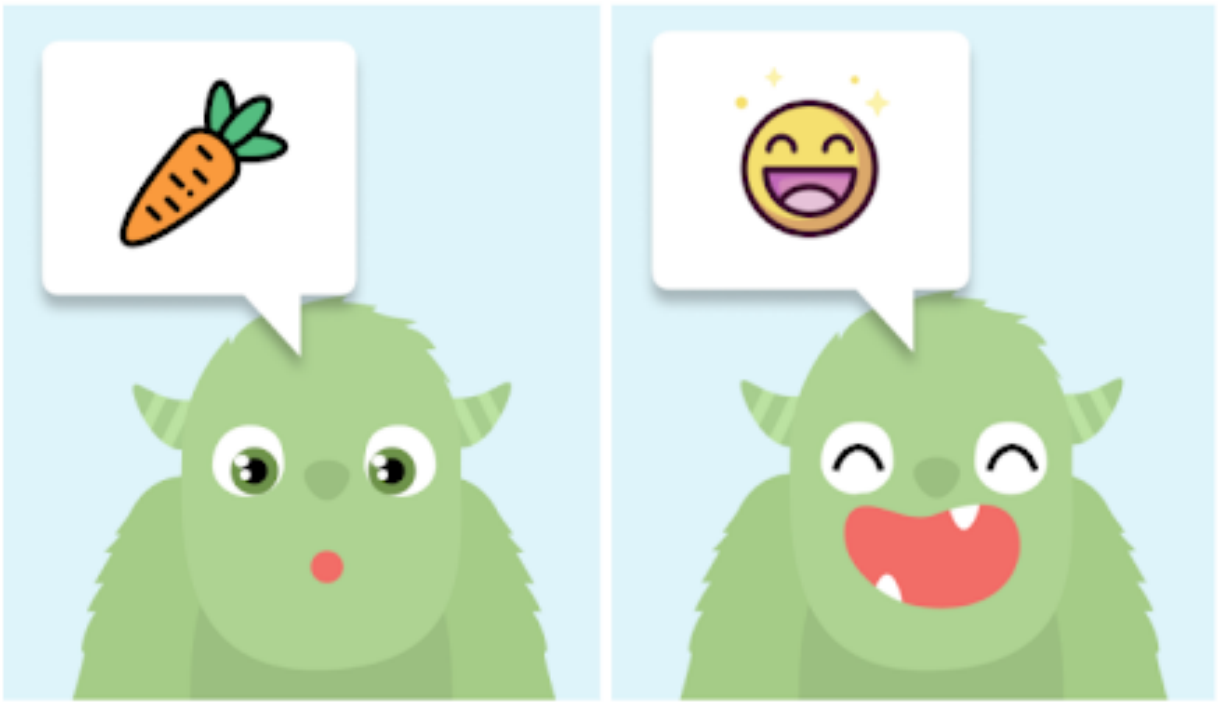
Hva synes deltakeren om muligheten til å endre utseendet til avataren? *

Your answer

Viste deltakerne forståelse for koblingen mellom de interaktive hendelsene og deres effekt på avatarens behov? *

Your answer

Hva synes deltakeren om avatarens evne til å vise følelser? *



Your answer

Hvilken relasjon følte deltakeren til avataren (en selv, venn, kjæledyr, etc)? *

Your answer

Ville deltakerens interesse for motivasjon/interesse økt dersom det hadde vært mulig å spille spill hvor styrte sin avatar? *

Your answer

Fortell oss èn ting deltakeren likte med avataren. *

Your answer

Fortell oss èn ting som kunne vært forbedret med avataren. *

Your answer

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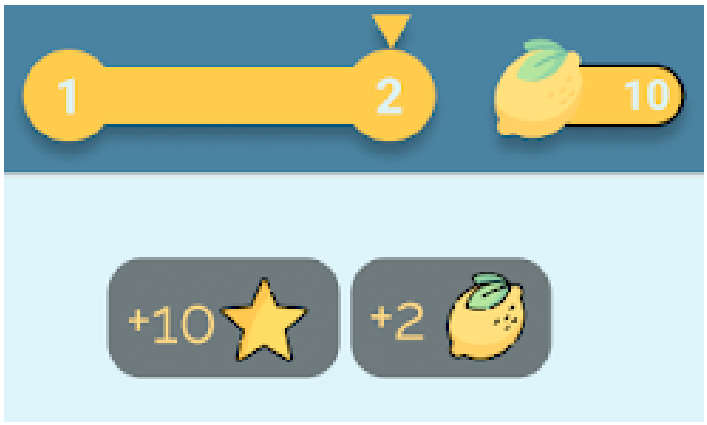
Evalueringsskjema

* Required

Belønninger

Denne seksjonen inneholder spørsmål relatert til belønningssystemet i appen.

Appellerte level- og belønningssystemet til deltakeren? *



Your answer

Hva synes deltakeren om å motta belønning for å fullføre utfordringer? *

Your answer

Hva synes deltakerne om å samle medaljer? *

Your answer

Synes deltakerne det var motiverende å fullføre utfordringer og motta belønninger? *

Your answer

Synes deltakeren det hadde vært motiverende å motta belønninger på ekte? *

Your answer

Fortell oss en ting deltakeren likte godt med belønningssystemet. *

Your answer

Fortell oss en ting deltakeren ville forbedret med belønningssystemet. *

Your answer

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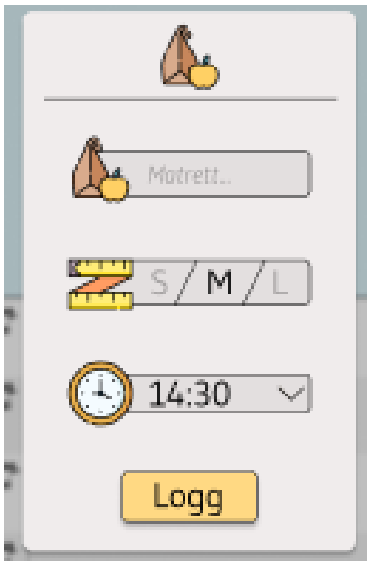
Evalueringsskjema

* Required

Dagbok

Denne seksjonen inneholder spørsmål relatert til belønningssystemet i appen.

Synes deltakeren det var enkelt å skrive i dagboken? *



Your answer

Synes deltakeren det var enkelt å finne frem i dagboken? *

Your answer

Fortell oss en ting deltakeren likte ved bruk av dagboken. *

Your answer

Fortell oss en ting som kunne blitt forbedret ved dagboken. *

Your answer

Back Next

Evalueringsskjema

* Required

Generelt

Denne seksjonen inneholder generelle spørsmål om applikasjonen.

Kunne deltakeren settt for seg å ta i bruk den fullførte applikasjonen? *

Your answer

Fortell oss èn ting deltakeren likte spesielt godt med appen som helhet. *

Your answer

Fortell oss èn ting deltakeren synes kunne blitt forbedret. *

Your answer

Ønsker dere å legge til noe? *

Your answer

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Back Submit

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Appendix D

Result Raw Data

Evalueringsskjema

3 responses

Publish analytics

Konsept & Design

Synes deltakeren at appen var enkel og intuitiv i bruk?

3 responses

Sånn passe. Det var ikke alltid like lett å vite hva man skulle gjøre videre. Det var også vanskelig å lese noe av teksten.

Nei, den var vanskelig å forstå og finne ut hvor de ulike oppgavene var.

Vanskelig å lese med så liten skrift. Greit å skjønne hva man skal gjøre.

Satt deltakerne seg fast under testen, i så fall hvor og hvorfor?

3 responses

Fikk ikke til å låse opp grønnsaksbonden, og heller ikke hente gevinst for den spesielle oppgaven.

Fant ikke hvor oppgaven du kunne gjøre en gang i måneden var.

Fikk ikke opp spesiell oppgave. Når vi skulle ta egne valg i dagboka, så hadde appen allerede bestemt både størrelse, type mat og tidspunkt.

Ga deltakerne uttrykk for frustrasjon eller forvirring under testen?

3 responses

Ja, litt innimellom.

Ja. Vanskelig å se sammenhengen mellom de ulike oppgavene. Hvorfor skulle man plutselig kjøpe hatter. I tillegg fungerte det ikke optimalt da de "forsvant" etter at de hadde kjøpt de og gikk tilbake til de andre vinduene.

Ja, hun ene ble litt, men den andre ikke.

Opplevde deltakeren noen problemer med å navigere seg rundt under testen?

3 responses

Litt, men det gikk greit etterhvert.

Ja. Fikk ikke til å trykke på alle knappene hun hadde behov for.

Nei, det var helt ok.

Fortell oss èn ting deltakeren likte godt med designet/konseptet.

3 responses

At man kunne kjøpe ting til Duper.

At det kom opp meldinger om hva du måtte spise/gjøre.

Likte at det var en måte for å få barn til å spise sunnere. Duper var søt.

Fortell oss èn ting som kunne blitt forbedret med designet/konseptet.

3 responses

Større og tydeligere tekst. Mer direkte overgang til/lettere å forstå hva man skal gjøre videre.

Enklere måte å finne de ulike oppgavene på.

De kjøpte hatten, men den forsvant da vi gikk inn i en oppgave og kom tilbake igjen. Da maste Duper om ny hatt.

Avatar

Hva synes deltakerne om Avataren?

3 responses

Søt.

Søt type.

Begge 10-åringene likte han godt, syntes han var søt.

Hva synes deltakeren om muligheten til å endre utseendet til avataren?

3 responses

Artig.

Bra. Kanskje flere type hatter. Kunne også få mulighet til å endre farge på avataren.

Helt ok. Kunne ønsket seg flere valgmuligheter her.

Viste deltakerne forståelse for koblingen mellom de interaktive hendelsene og deres effekt på avatarens behov?

3 responses

Ja.

Ja, men det kunne også vært skrift. Eks. Jeg er tørst!

JA, det var lett å skjønne.

Hva synes deltakeren om avatarens evne til å vise følelser?

3 responses

Liker dette.

Bra.

Det var fint, ekstra gøy at han ble så glad.

Hvilken relasjon følte deltakeren til avataren (en selv, venn, kjæledyr, etc)?

3 responses

En figur i en app (7. klassingen).

Kjæledyr.

En venn/en fattig venn som vi måtte hjelp.

Ville deltakerens interesse for motivasjon/interesse økt dersom det hadde vært mulig å spille spill hvor styrte sin avatar?

3 responses

JA, det hadde vært gøy.

Ja

JA, dette hadde vært veldig kult. Da kunne de hentet seg mat og spilt.

Fortell oss èn ting deltakeren likte med avataren.

3 responses

At den var søt.

Utseende (søt).

Han var søt.

Fortell oss èn ting som kunne vært forbedret med avataren.

3 responses

At avataren kan utvikle seg når man går opp i level. Mulighet for å designe sin egen avatar, kroppsform, farge, utseende. Større utvalg i ting man kan kjøpe.

Kunne si noe (ha en stemme).

At han kunne sagt ordene, han kunne pratet og lest opp det som stod i teksten. Stemme i tillegg til bildet. Bra for de som er døve. Han kunne lese opp det de skulle gjøre, i steden for at det bare stod der som en liten skrift det var vanskelig å lese.

Belønninger

Appellerte level- og belønningssystemet til deltakeren?

3 responses

JA, likte dette godt. Men lurer på hvorfor dere har valgt akkurat en sitron? Det hadde vært bedre med medalje, mynter el.l. Heller eple enn sitron.

Ja

Ja, det var gøy å få belønning.

Hva synes deltakeren om å motta belønning for å fullføre utfordringer?

3 responses

Bra, fordi da kan man kjøpe ting til avataren.

Bra, slik at man fikk flere penger til å kjøpe hatter.

Bra. Man kunne fått noe utstyr eller klesplagg til Duper som belønning, istedenfor å kjøpe.

Hva synes deltakerne om å samle medaljer?

3 responses

Gøy, men fikk ikke til å låse opp alle.

Skjønte ikke helt dette.

Det var gøy. Helt greit.

Synes deltakerne det var motiverende å fullføre utfordringer og motta belønninger?

3 responses

JA.

Ja.

Synes deltakeren det hadde vært motiverende å motta belønninger på ekte?

3 responses

Ja, men lurer på hva dette kan være? Ikke vant til å få belønning for å drikke vann og spise grønnsaker ;p

Ja, så absolutt.

JA, det hadde vært gøy. Etter at man har gjort noe bra over en periode, så kunne man fått belønning fra foreldrene. For eksempel om foreldrene gir en oppgave om å ta ut av oppvaskmaskina i en uke, så kunne man fått belønning dersom man hadde vært flink.

Fortell oss en ting deltakeren likte godt med belønningssystemet.

3 responses

Opplevelsen av å ha oppnådd noe.

At man fikk penger til å kjøpe hatter.

At man får mye belønning for å gjøre små ting.

Fortell oss en ting deltakeren ville forbedret med belønningssystemet.

3 responses

At man kan dele opp i mindre deler, hvor man kan gjøre flere ting for å få sitroner/stjerner

Forskjellen på medalje og belønning.

Det hadde vært utrolig gøy at avataren vokser og utvikler seg for hver level, og ettersom han får mye mat. Så kan avataren få en baby når han blir ferdigvokst, og så kan man følge opp babyen på nytt igjen.

Dagbok

Synes deltakeren det var enkelt å skrive i dagboken?

3 responses

Nei. Matretten var allerede bestemt. Det kom opp brødskive med salami som standard, uten mulighet for å velge. Det samme for klokkeslett.

Har ikke skrevet noe.

JA, men appen bestemte innholdet. Det var dumt. Fikk ikke til å legge til snacks på 17. mai, og det synes de at man skal få på 17. mai. For eksempel is.

Synes deltakeren det var enkelt å finne frem i dagboken?

3 responses

Helt greit.

Ja

Sånn passe.

Fortell oss en ting deltakeren likte ved bruk av dagboken.

3 responses

At man kunne se en oversikt over alle måltidene.

At det går an å skrive inn "ting" du skal spise.

Det stod på rekke, sortert etter dato. Kunne vært litt enklere oversikt.

Fortell oss en ting som kunne blitt forbedret ved dagboken.

3 responses

Mye. Mulighet for å legge inn egen mat, mulighet for flere dager, mulighet til å bla tilbake i tid. Hva er hensikten med at barn skal skrive ned det de spiser? 13-åringen mener det kan være en måte å huske og spise til alle måltidene, men at det ikke må være sånn at man skal få dårlig selvfølelse for at man spiser for mye el.l.

Synes den var grei.

System eller tabell, hvor man kan bla seg frem og tilbake mellom dagene.

Generelt

Kunne deltakeren settt for seg å ta i bruk den fullførte applikasjonen?

3 responses

Nei, det ble litt for barnslig for en 13-åring.

Ja.

JA, de har lyst til å laste den ned.

Fortell oss èn ting deltakeren likte spesielt godt med appen som helhet.

3 responses

Likte Duper godt, og har tro på selve konseptet. Men det må gjøres mer brukervennlig og mer fengende for aldersgruppen 13 år.

Gjøre fysiske oppgaver.

Liker konseptet, at barn skal spise mer grønnsaker. Og avataren, som var søt. Litt kjedelig startskjerm, kunne vært mer fargerik og kulere førsteside som var fengende. Tidligere nevnt muligheten for at avataren kan utvikle seg.

Fortell oss èn ting deltakeren synes kunne blitt forbedret.

3 responses

Skanne inn bilder av egen mat, som kan overføres til Duper på en enkel måte.

Flere "ting" å kjøpe.

Man kunne bestemt navn på avataren selv. Spillet kan fortsatt hete Superduper. Den yngste syntes først at appen var kjedelig og ville ikke bruke den, men etter at vi hadde gått gjennom evalueringen, og hun fikk komme med tilbakemeldinger på hva som kunne blitt bedre, så svarte hun JAAA på at hun ville laste ned appen.

Ønsker dere å legge til noe?

3 responses

Her er det kun 13 åringen som har svart, tar de to 10- åringene i neste pulje.

Litt vanskelig å forstå bruken av den i starten og sammenhengen mellom oppgavene.

De syntes det var et bra spill, og at dere som har laget det har vært flinke ;o)

Appendix E

Prototypes

E.1 Prototype 1

Link to an interactive version of Prototype 1:

Figure E.1: QR-Code, links to Prototype 1

E.2 Prototype 2

Link to an interactive version of Prototype 2:

Figure E.2: QR-Code, links to Prototype 2

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