



Norwegian University of  
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# What gamification design do users want in a self-management application for chronic diseases?

The case of Cystic Fibrosis

**Ole Gunhildsberg Hansen**

Master of Science in Computer Science

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Supervisor: Babak Farshchian, IDI

Norwegian University of Science and Technology  
Department of Computer Science





## Abstract

The aim of this thesis is to improve self-management of chronic disease by utilizing gamification in an mHealth app to increase users' motivation. This thesis focuses on Cystic Fibrosis (CF), a rare genetic disorder found in about 70.000 people worldwide. People diagnosed with CF must follow strict treatment regimens in order to maintain health and well being, posing a challenge for patient adherence. The thesis departs from earlier research done by MyCyFAPP, a project creating software solutions for self-management of CF.

In this study we have identified patients' needs and challenges and used them with principles from existing gamification design methods to create an ideation workshop consisting of semi-structured interviews and co-design activities. The workshop was tested, revised and finally conducted with two people diagnosed with CF, resulting in 4 hours of captured audio and 41 gamification design ideas. The results were analyzed and used to create a list of gamification design ideas wanted by participants, and gamification design examples for improving MyCyFAPP's smartphone app.

Our findings confirm that the participants would like gamification in an application for CF self-management to attempt to increase their motivation. Specifically, participants would like social interaction - to communicate with each other. They would also like the application to empower them - to create, and fulfill treatment goals by increasing their knowledge and competence. Finally the findings show that the participants would like to progress - by feeling and tracking progression, and understanding how to improve. In addition to a complete list of gamification design ideas, this thesis also provides gamification design examples inspired by the findings, and a complete user-centered approach on how to plan and conduct a co-design workshop for gamification solutions in an app for self-management of Cystic Fibrosis.

**Keywords** — Gamification, gameful design, motivation, self-management, smartphone, mHealth, app, cystic fibrosis, CF, chronic disease, chronic patients, co-design, mechanics, behavioral outcomes, psychological outcomes, social interaction, empowerment, progression



## Oppsummering

Målet med denne oppgaven er å forbedre selvadministrert behandling av kronisk sykdom ved å anvende gamification i en mHealth (mobile health) app for å øke brukeres motivasjon. Denne oppgaven fokuserer på den sjeldne, genetiske sykdommen Cystisk Fibrose (CF). Det er rundt 70.000 personer med CF i verden, hvor av ca. 325 er nordmenn. For å holde helse og velvære ved like må personer med CF følge strenge behandlingsplaner som kan være utfordrende å overholde. Oppgaven har røtter i forskning gjort i prosjektet MyCyFAPP, et Horizon 2020 prosjekt som utvikler programvareløsninger for self-adminstrert behandling av CF.

For å forstå hvordan man kan designe gamification-løsninger for å øke pasienters motivasjon for selvadministrert behandling av CF har vi identifisert pasienters behov og utfordringer, og brukt dem med prinsipper fra eksisterende gamification design-metoder for å lage en idé-workshop bestående av semi-strukturerte intervjuer og co-design-aktiviteter. Idé-workshopen ble testet, utbedret og til slutt holdt med to personer diagnostisert med CF. Resultatene ble analysert og brukt til å lage en liste med gamification-løsninger for MyCyFAPPs app, ønsket av deltakerne.

Våre funn bekrefter at deltakerne ønsker gamification-løsninger i en applikasjon for selvadministrert behandling av CF for å øke motivasjon. Funnene viser også at brukerne ønsker sosialisering - å kommunisere med hverandre. Deltakerne ønsker også at appen skal styrke dem - ved å la dem styre sine egne behandlingsmål og gjennomføre dem ved å øke deres kunnskap og kompetanse. I tillegg viser funnene at deltakerne ønsker fremgang - ved å følge sin egen progresjon, forstå hva man kan forbedre og hvordan. I tillegg til en liste over ideer for gamification-løsninger inneholder rapporten et foreslått gamification-design for MyCyFAPPs app basert på funnene, samt en komplett brukersentrert tilnæringsmåte for planlegging og gjennomføring av en idé-workshop for gamification-løsninger i en applikasjon for selvadministrert behandling av CF.



## **Preface**

This master thesis is the final product of my research project carried out the spring semester 2017 and the concluding work of my study for the master's degree in Computer Science with specialization in Software Development. The work has been carried out at the Department of Computer Science at the Norwegian University of Science and Technology (NTNU).

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# Terminology

**behavioral outcomes** The intended goal of successful gamification - positive behavior outcomes for the users, as defined in the section on building blocks of gamification (2.4.2). P. 2, 11–13, 17, 18, 29, 30, 47, 70

**co-design** An updated term for participatory design, meaning involving end-users to take a central role in the design process [5]. P. 3, 4, 21, 23, 25, 26, 29, 33, 72

**Cognitive Evaluation Theory** A sub-theory of Self-Determination Theory (See *Self Determination Theory*) focusing on how external consequences affects intrinsic motivation [6]. P. 53

**Cystic Fibrosis** Cystic Fibrosis (CF) is a progressive, genetic disease that causes persistent lung infections and limits the ability to breathe over time [1]. P. ii, 2–4, 6, 7, 9, 14, 18, 47

**empowerment** Feeling autonomous in initiating processes to increase one's knowledge and skills (as defined in the Results chapter (4.2)). P. 34, 37, 47, 49, 52, 53, 66

**gameful design** Designing systems that are intrinsically motivating and fun to use, by applying those techniques that game designers use to keep the players immersed and engaged [7]. P. 16, 21, 24, 25, 27, 55, 73, 74

**gamification** The use of game design elements in non-game contexts [8]. P. 2–6, 8–14, 16–19, 22–25, 27–29, 32–34, 40, 41, 46–48, 51–59, 61, 67–70

**gamification mechanics** See *motivational affordances*. P. 3, 12, 13, 16, 18, 22, 29, 47, 55

**health professional** Generalization of individuals who provide health care services, e.g. doctors or dieticians. P. 3, 8, 37, 48, 63

**ideation workshop** Workshop with end-users, consisting of co-design activities and interviews with the goal to design gamification solutions. P. 4, 21, 25–28, 32–34, 36, 37, 41, 43, 47, 49, 51, 53, 54, 57, 67, 69, 72, 78, 124, 126

**innovation stems** Prompts that frame the design problem in an inspiring manner [9]. P. 73, 75

**mHealth** Mobile health, a term used for the practice of medicine and public health supported by mobile devices [10]. P. ii, iv, 4

**motivational affordances** Corresponds (in gamification) to gamification mechanics, or game design elements, implemented in software to target psychological outcomes/needs and in turn achieve behavioral outcomes, as defined in the section on building blocks of gamification (2.4.2). P. 11, 12, 49

**MyCyFAPP** A European Research project creating software solutions for self-management of Cystic Fibrosis. P. 3, 5, 8, 9, 18, 23, 26, 27, 33, 43, 47, 49, 51, 56, 59–62, 67–69

**progression** The desire to get better at what they do, and feel the actual improvement happening (as defined in the Results chapter (4.2)). P. 34, 39, 47, 51–53, 61, 66, 128

**psychological outcomes** Motivational aspects targeted by motivational affordances (gamification mechanics), that in turn lead to positive intended behavioral outcomes (as defined in the section on building blocks of gamification (2.4.2)). P. 11, 13, 15, 18, 29, 40, 47

**Self Determination Theory** A theory of motivation, addressing three universal, innate and psychological needs: competence, autonomy, and psychological relatedness. P. 9, 52



**self-management** Self-management concerns the active involvement, decisions and behaviors that patients with chronic illness engage in that affect their health. P. 2–4, 6–9, 14, 18, 22, 23, 33–35, 37–39, 43, 46–51, 53–58, 62, 67, 68, 73

**semi-structured interviews** A research method widely used in qualitative research [11]. While a structured interview follows a script, a semi-structured interview is open and allow for new ideas and questions to arise throughout the interview. P. 21, 27

**social interaction** The desire for interacting with, belonging to or caring for other people (as defined in the Results chapter (4.2)). P. 34, 36, 37, 47–49, 52, 62, 66

**thematic analysis** A widely-used qualitative data analysis method. It focus on identifying patterned meaning across data-sets through coding. P. 21, 28, 34

**wear-out** For the effects of something to gradually reduce or disappear entirely. P. 55, 56, 67, 70

## **Abbreviations**

**CET** Cognitive Evaluation Theory

**CF** Cystic Fibrosis

**HP** Health Professional

**ICT** Information and Communication Technology

**NSD** Norsk senter for forskningsdata / Norwegian centre for research data

**SDT** Self-determination theory

**UI** User Interface

**XP** Experience Points

# 1 | Introduction

This chapter contains an introduction for the study thesis. Section 1.1 describes the purpose and motivation of the study, Section 1.2 defines the research scope, Section 1.3 presents a summary of the research problem with corresponding research questions and Section 1.4 lists the study's contributions to research. Finally, Section 1.5 describes the structure and contents of the thesis.

## 1.1 Purpose and motivation

The purpose of this study is to investigate how to design gamification solutions to increase user motivation and engagement in self-management of Cystic Fibrosis (CF).

**Self-management** concerns the active involvement, decisions and behaviors that patients with chronic illness engage in that affect their health [12, 13]. As this approach to health management puts more responsibility on the patient we must employ ways to increase user engagement and motivation effectively [14]. Some illnesses require a lot of attention, making adherence to self-management crucial for the health and wellbeing of patients [15] - this study focuses on **Cystic Fibrosis** (CF), a rare genetic disorder found in about 70.000 people worldwide [16]. People diagnosed with CF must follow demanding treatment regimens to maintain health and well-being [17, 18]. Advances in Information and Communication Technology (ICT) has introduced new technological solutions that can be used in the context of self-management of chronic disease. A modern, rapidly growing approach to health management is using mobile health (mHealth) app solutions [18, 15]. **Gamification** - using game elements in non-game contexts - is a concept that can power these solutions as to foster positive behavior change and treatment adherence through promoting intrinsic values, e.g. motivation. Successful gamification utilizes game elements that lead to positive psychological and behavioral outcomes [2]. Gamification must however be designed and implemented specifically for an application's purpose, its users and their needs to successfully achieve the intended psychological and behavioral outcomes [9, 19, 20]. Though gamification has been used successfully for health and chronic disease self-management [3, 21], there currently exist no studies on gamification design for self-management of CF.

To investigate how to design gamification solutions to increase user motivation in self-management of Cystic Fibrosis we arranged workshops in which we interviewed patients diagnosed with CF

in order to understand their lifestyle and how it may affect motivational aspects. To get the most out of the interviews we spent a significant amount of time to plan, create and test a co-design workshop structure specifically for gamification. In addition to interviewing, the co-design workshops comprise co-design activities to support the creation of ideas on gamification solution that the patients would like in a smartphone app for CF self-management. The ideas were revised by user preference and the best ones will be further tested, evaluated and ultimately implemented into an app for self-management of CF after this study.

## 1.2 Scope

This thesis departs from a self-management app for CF developed in the Horizon 2020 EU Research Project MyCyFAPP, a project creating software solutions for self-management of Cystic Fibrosis. MyCyFAPP works with five target groups, children (4-12 years), teenagers (13-16) years, adult patients (16+ years), parents and health professionals. This thesis will focus on the third group, adult patients above 16 years of age. Accordingly, all interviewees in this study will belong to this user group.

## 1.3 Research questions

In order to design gamification that could lead to the intended behavioral outcome of increased user motivation for self-management, we must investigate *what* psychological needs users want targeted by *which* gamification mechanics. We must also learn *how* users want gamification to be implemented through investigating the implications of CF patients' context for the selection and design of gamification. The objective of this study has been defined with the following research question, and will be answered with the subsequent sub-questions:

**RQ1 What gamification designs do adolescent CF patients want in an app for self-management to increase motivation?**

SQ1 Which psychological needs do adolescent CF patients want gamification to support in order to increase their motivation for self-management?

SQ2 What are the implications of CF management and its patients' context for the selection and design of gamification?

## 1.4 Contributions

The study's research contributions are listed as follows:

- User-centered approach on how to plan and conduct an **ideation workshop** to **co-design gamification** solutions in a **mHealth** app for **self-management** of Cystic Fibrosis. The approach is tested with two non-patients and applied in two workshops with CF patients. Presented in Chapter 3 - Methods.
- Complete list of 41 **gamification** design ideas proposed by CF patients for a **mHealth** app for **self-management** of **Cystic Fibrosis**, with associated psychological and behavioral outcomes targeted. Presented in Chapter 4 - Results.
- Analysis and discussion of CF patients' motivations for utilizing **gamification** to increase motivation for **self-management**. Presented in Chapter 4 - Results and Chapter 5 - Discussion, respectively.

- **Gamification** design examples based on findings, containing enhancements of existing features in MyCyFAPP as well as proposed new features.

Presented in Chapter 5 - Discussion.

## 1.5 Thesis outline

The thesis is structured in the following chapters:

**Chapter 1** - Introduction

**Chapter 2** - Problem analysis

**Chapter 3** - Methods and approach

**Chapter 4** - Results

**Chapter 5** - Discussion

**Chapter 6** - Conclusions

**Problem analysis** contains an introduction to central concepts of the research - Increasing *Motivation for Self-management of Cystic Fibrosis through Gamification*. **Methods and approach** contains and describes the research methods used to plan and conduct this study. **Results** presents our findings and results from data collection and analysis. **Discussion** contains interpretation and discussion of the results, while **Conclusions** presents answers to the defined research questions, research limitations and proposed future work based on this thesis.

Each chapter start with an introduction describing the chapter's purpose and contents. Important recurring concepts are described in the terminology list and presented in **bold** text. This applies for the *first occurrence* of the actual concept in each chapter.

## 2 | Problem analysis

This chapter describes the problem analysis for the study. It will present background information on fundamentals of the study and the relationships between them. Section 2.1 presents **Cystic Fibrosis** (CF), Section 2.2 describes **self-management** and Section 2.3 discusses **motivation** regarding self-management of CF. Section 2.4 describes **gamification**, its definitions, contents and design challenges. Finally, Section 2.5 contains a summary of the research problem.

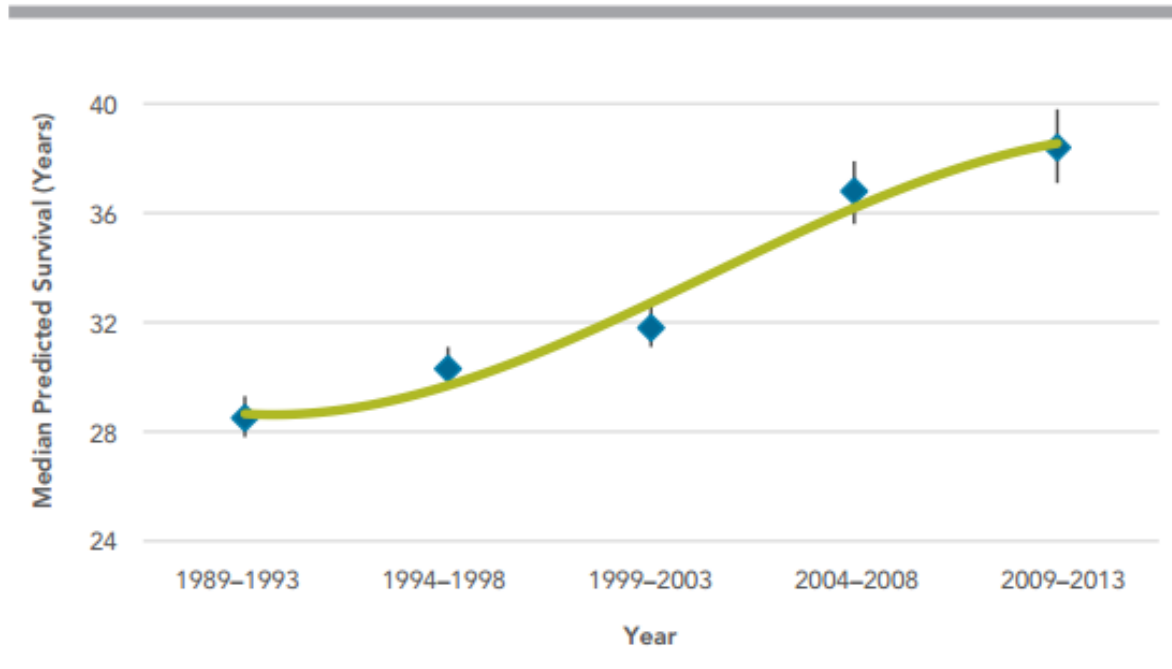


## 2.1 Cystic Fibrosis

**Cystic Fibrosis** (CF) is a rare genetic disorder found in about 70,000 people worldwide [22]. The condition is inherited “autosomal recessive” meaning both parents must carry one copy of a specific mutated gene for their child to develop the condition [16]. People diagnosed with CF must follow demanding treatment regimens to maintain health and well-being [18, 17, 23]. The contents of treatment regimens vary a lot for each individual, but generally consist of maintaining lung function and administering nutritional therapy. In addition to pulmonary care, most individuals with CF require additional therapies such as pancreatic enzyme replacement [24]. Most patients are also recommended regular physical activity [23, 17] to the same extent as healthy people - to be physically active at least 150 minutes each week (21 minutes a day) through endurance and resistance training [25]. Physical exercise is extra beneficial to CF patients, because in addition to general benefits of being physically active, exercise can also help clear mucus from lungs and slow the rate of decline in lung function [26].

**Self-management** of CF is complex and time-consuming, and people may struggle with adhering to their treatment regimen. Estimates suggest that a typical CF treatment takes up to three hours per day [17, 18, 24] with inhaling, physiotherapy and taking notes about their food intake [22]. The disease itself is complex; the development of it is very diverse and patients’ needs are continuously affected by the patients’ life circumstances [22]. There has been major advances in clinical research of CF; in 2015 FDA for the first time approved a drug - Ivacaftor - that treats the primary underlying cause of the illness for 4%-5% of CF patients [27]. In addition to new therapies, the development, adoption and maintenance of a clinical care structure have led to significant increases in patient survival over the past decades [24, 22]; In 1980 the median predicted survival age for people diagnosed with CF was 18 years, compared to 2015 where people live with CF into their 30s, 40s and beyond [1] (See Figure 2.1).

### Median Predicted Survival Age, 1989–2013 (in 5 year bands)



**Figure 2.1:** Cystic Fibrosis Foundation: Median Predicted Survival Age, 1989-2013, [1]

This study is rooted on an multidisciplinary project, **MyCyFAPP**, whose research “aims at developing a mobile application for self-management of CF, an ecosystem that addresses CF patients, parents of children with CF, as well as health professionals involved in the treatment” [28]. There has already been conducted workshops with patients for designing functionality and user interface in a self-management app [28] and MyCyFAPP’s next planned step is **gamification** design before implementing an application to be tested the second half of 2017.

## 2.2 Self-management

As mentioned in the introductory chapter, self-management concerns the active involvement, decisions and behaviors that patients with chronic illness engage in that affect their health [12, 13]. “Effective self-management means acknowledging the patients’ central role in their care, one that fosters a sense of responsibility for their own health” [13]. Furthermore self-management empowers patients by helping them build confidence and education [12]. As peo-

ple with Cystic Fibrosis often have complex treatment regimens, self-management applications can be particularly useful [24, 18]. The regimens are often demanding and time-consuming, impairing the patients' motivation for self-management.

## 2.3 Motivation for self-management of CF

The development of CF varies a lot for each individual, also creating big variations in the level and type of support and motivation needed to live a "normal life" [22]. Many patients stress a need for motivation as low motivation is usually linked to bad treatment adherence [29, 30]. Consequently, MyCyFAPP wants to target "bolstering of motivation" explicitly with the application they develop [22]. Before going into this study, MyCyFAPP identified five central motives driving patients' behavior and needs: 1) Staying in good health, 2) Being "normal" - feel like their peers without CF 3) Forgetting/being distracted from the disease 4) Being independent 5) Living a normal life - not being reminded that they are a "patient" all their life [22].

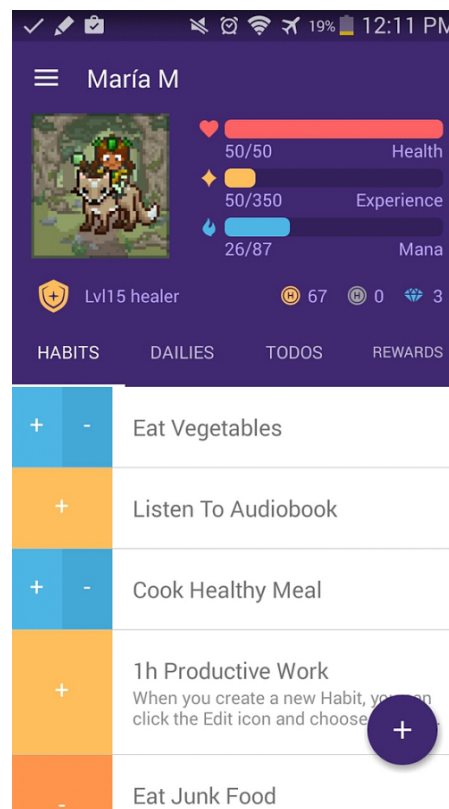
**Self-determination theory (SDT)**, the most dominant theory applied in gamification design research [9, 31], differentiates two forms of motivation, extrinsic and intrinsic motivation. "Intrinsic motivation is doing something because it is inherently interesting or enjoyable and extrinsic motivation is doing something because it leads to a separable outcome" [32]. However, only intrinsic motivation has been associated with improved psychological well-being, enhanced creativity and learning outcome [33]. The theory also describes three universal, innate psychological needs that foster motivation and engagement, specifically competence, autonomy and relatedness. It is argued that using game elements may improve intrinsic motivation by satisfying these psychological needs [31, 9].

## 2.4 Gamification

Utilizing technology for supporting and motivating people towards beneficial behaviours has increased rapidly during recent years [35, 36, 37, 38, 39, 8, 40]. A particularly popular concept in this field is gamification. “Gamification refers to technologies that is used to promote intrinsic motivations toward various activities by employing game design elements” [39]. Examples of commonly employed elements in gamification are points, levels, challenges, leaderboards, badges and so on [41, 2, 21, 42, 40]. Through these elements gamification strive to enrich information technologies to increase users’ motivation towards given activities [39, 36] by satisfying natural human desires, e.g. self-efficacy, altruism, ownership and social status. Gamification has shown promising potential to increase user motivation and engagement in a wide variety of contexts - health, training and education being particularly interesting areas [2, 43]. A recent review shows that a majority of empirical studies on gamification shows at least partially positive results on increasing user motivation and engagement, though being dependant on the system and user context [2].

### 2.4.1 Defining gamification

There exists two well-acknowledged definitions of gamification, both presented in each own articles highlighting shortcomings in the competing definition [8, 36]. The first one was coined by K. Huotari and J. Hamari in 2011, from a service-marketing perspective: “Gamification is a

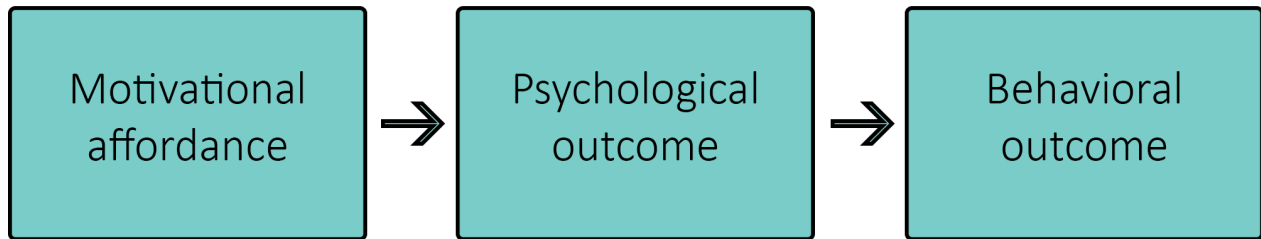


**Figure 2.2:** Gamification example: Habitica, a “habit building and productivity app that treats your real life like a game” [34].

form of service packaging where a core service is enhanced by a rules-based service system that provides feedback and interaction mechanisms to the user with an aim to facilitate and support the users overall value creation” [44] . This definition was discussed by S. Deterding and he criticized the authors for including “rule-based services” in the definition, arguing that doing so “made it applicable to any interactive system”. As an example he stated that “even a touchpad for ordering snacks at a cinema would qualify as a rule-based system as it’s driven by software”. He also stated that the definition excludes any system where the provision of game mechanics is the core service itself, or at least an essential part of it. In the same article he also coins the following definition: “the use of game design elements in non-game contexts” [45]. In 2012 K. Huotari and J. Hamari responded by coining, and replacing their old definition with a new one, referring to Deterding’s definition and arguing that *determining what is a game context* is deeply individual. Their new definition on gamification was “a process of enhancing a service with affordances for gameful experiences in order to support user’s overall value creation”, with the term *affordances* referring to any qualities of the service system that contributes to the emergence of gameful experience [36], gameful experience meaning experiencing non-game contexts as “game-like” by engaging and evoking emotions.

### 2.4.2 The building blocks of gamification

Hamari, Koivisto and Sarsa deconstructs gamification in 3 linked concepts; 1) **Motivational affordances** that lead to 2) positive **psychological outcomes**, which in turn lead to 3) positive intended **behavioral outcomes**, assuming successful gamification [2] (Conceptualization in Figure 2.3). An example of this is using 1) challenges to 2) develop self-efficacy to 3) increase physical activity. Bunchball, a company describing them-self as the market leader and innovator in gamification, also defines the contents of gamification in three concepts that translate well to Hamari’s concepts; To play into *human desires* (psychological outcomes) through *game mechanics* (motivational affordances) to *influence behavior* (behavioral outcomes) [42].



**Figure 2.3:** Gamification: Successful gamification (Hamari, Koivisto and Sarsa, 2014 [2])

#### 2.4.2.1 Gamification mechanics

Motivational affordances, hereinafter referred to as *gamification mechanics*, may have the potential to increase positive psychological and/or behavioral outcomes in users by triggering intrinsic motivations [2]. An example of how gamification mechanics can be used to trigger intrinsic motivation are rewarding players when completing tasks; Completion of challenges motivates users through an increased feel of mastery while receiving rewards motivate users through their natural desire for acquiring possessions. In addition, making the rewards visible to other users has shown to motivate players to complete more tasks through natural desires for status or recognition [38, 46]. Before going into this project a pre-study was conducted [43] where some of the most commonly employed gamification mechanics and its applications were studied. Table 2.1 shows an overview of the studied mechanics.

A study reviewing research on the effects of gamification shows that the mechanics in Table 2.1 has been tested in empirical studies and that all of them are connected to increased positive psychological and/or behavioral outcomes [2]. It is shown, through a study evaluating 78 other studies on motivation through gamification, that applications using a wide variety of mechanics and interface elements can reduce the boringness of the system and enhance users' sustainability [38].

**Table 2.1:** Commonly employed gamification mechanics / game design elements. The list contains mechanics studied during the pre-study conducted preliminary to this study [43].

<b>Mechanic</b>	<b>Description</b>
Achievements	Any virtual representation of accomplishment.
Avatars	A virtual representation of a character.
Badges	A symbol/trophy representing accomplishment or meaningful work.
Challenges	A challenge using goals that leads to some reward when completed.
Leaderboards	Interface element ranking players users or groups, absolutely or relatively.
Levels	Indicates users' level of experience or skill.
Points	Numerical value used in one or multiple ways (virtual currency, XP, skill points).
Rewards	In-game or out-game rewards awarded to players.
Social	Communication, competition or cooperation among peers.

#### 2.4.2.2 Psychological outcomes

Using gamification mechanics in software can lead to positive psychological outcomes [2] by fulfilling the user's natural desires or needs, e.g. desires for mastery, development, socializing, competing and so on. If the gamification is successful, positive psychological outcomes in turn lead to positive intended behavior changes [2, 22].

#### 2.4.2.3 Behavioral outcomes

The final building block of the gamification conceptualization, behavioral outcomes, is what we intend to achieve with gamifying software. If successfully implemented gamification can ease or enhance the process of achieving the behavioral outcomes [2]. Examples of behavioral outcomes are learning a new language, becoming physically active or getting better at work.

### 2.4.3 Gamification and health

There are several indicators suggesting that gamification may be effective for encouraging health management; A review done of one hundred health applications from Apple's App Store shows a positive correlation between gamification used and high user ratings [35]. A study evaluating 62 gamified systems, collected user feedback on engagement and performance and concluded 81% of users being positive to the gamified applications [38]. For chronic illness management gamification has been used several times, successfully impacting user motivation positively [3, 21], but there are yet no studies on gamification used for self-management of Cystic Fibrosis. Diabetes is a chronic illness that has been targeted by gamification several times [3, 15]. Similar to CF, type 1 diabetes is diagnosed in childhood and demands a lifetime of self-management [3]. Two examples "mySugr" and "bant", both gamified apps for management of type 1 diabetes, are presented in the following examples:

**Bant** lets users register blood sugar levels and be awarded with points for each reading. When user reaches a predefined amount of points, he/she levels-up and gets a reward. The rewards are "out-game" rewards, meaning rewards that have a value outside of the app itself. In bant the rewards are redeemed as App Store / iTunes purchases. Fully adherent users can acquire a reward every 2-3 days [3].



**Figure 2.4:** Gamification and health: Bant app [3]

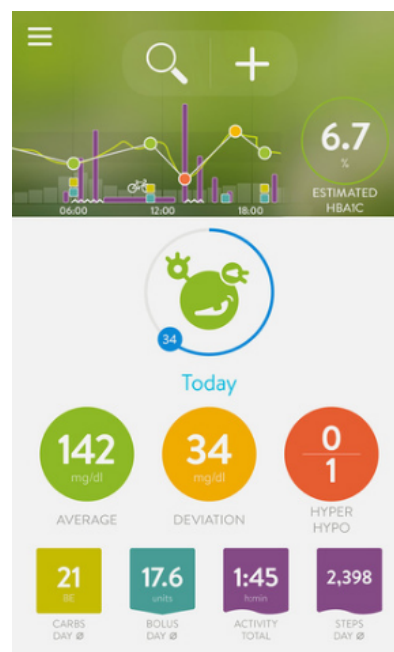


**Table 2.2:** Gamification design in Bant [3]. For some design principles psychological outcomes targeted are not explicitly defined in the source literature.

Design principles	Mechanics	Psychological outcome	Behavioral outcome
Communicate with peers to share experiences and gain or provide support	Microblogging platform	Gain or provide support	Elicit positive health behavior
Allocating gamelike experience points for adhering to best-practice guidelines for blood glucose testing. Leveling up when reaching a predefined amount of XP	Levels, Points (XP)	Undefined*	Increase adherence to blood glucose testing
The points acquired could be redeemed for Apple iTunes and App Store purchases	Rewards	Undefined*	Elicit positive health behavior

\* Not explicitly defined by source

**mySugr** also has users register blood sugar levels, but also lets the user track their nutrition and medication. mySugr uses an avatar called “Diabetes Monster”, and the goal is to tame the monster each day. This is done by completing daily challenges and gaining sufficient amount of points by performing tasks like adding blood sugar readings, giving users definite feedback on daily performance [21].



**Figure 2.5:** Gamification and health: mySugr app [4]

**Table 2.3:** Gamification design in mySugr [21, 47]. For some design principles psychological outcomes targeted are not explicitly defined in the source literature.

Design principles	Mechanics	Psychological outcome	Behavioral outcome
Acquire points by completing daily challenges	Points, challenges	Gain confidence in therapy	Increase focus on specific treatment and therapy goals
Taming the “diabetes monster” by completing daily challenges	Avatar	Undefined*	Increase engagement in self-management

\* Not explicitly defined by source

#### 2.4.4 Gamification term criticism

The term gamification has been heavily debated as industry publications promise “revolutionary” gains in customer and employee motivation through gamification [9]. Describing gamification as the process of applying any predefined set of game elements (i.e. extrinsic incentives) to have a guaranteed increase in user motivation has provoked several gamification professionals, like S. Deterding and J. McGonial. McGonial, who has distanced her work from the label “gamification”, introduced the term “**gameful design**” for selectively adding rewards to challenges that are intrinsically rewarding, for example through gamification mechanics like badges and points [48]. She accuses gamification to focus on the extrinsic rewards rather than the intrinsic, because the extrinsic rewards are easier to sell. She is concerned what would happen to basic human drives like curiosity and desire for knowledge if people get used to being motivated by points and levels [48]. On J. McGonial’s blog, SuperBetter, the differences in purposes for each term are addressed: “While gamification makes you do what companies want you to do, gameful design helps you do what *you* want to do” [49]. Following the blog post is a discussion to whether another term is necessary, and that the differentiation of the terms gamification and gameful design are really just describing “bad” and “good” gamification.

Deterding also pinpoints the difference of “gameful design” and gamification, specifically he defines gameful design as “designing to afford motivating, enjoyable experiences” and gamification as “the means of using game design elements in non-game contexts” [9]. He also mentions that gamification usually will coincide with gameful design: Gamification being the design strategy of using game design elements and gameful design as the goal of designing for gamefulness. Instead of creating new goals, gameful design “has to identify the challenges already inherent in the user’s pursuit of her needs” [9].

Without choosing to exclude one of the terms, we have in this study followed Deterding’s differentiation, **gamification** meaning “using game elements in non-game contexts” and **gameful**

**design** meaning "designing to afford motivating, enjoyable experiences through gamification".

### 2.4.5 Design challenges

A number of statements made by researchers, business analysts and gamification experts address potential benefits by utilization of gamification e.g. [2, 50, 51, 41, 40, 52]. On the other hand, there has also been addressed issues regarding poor understanding for good gamification design [20, 45, 9, 40]. Researchers and gamification experts has highlighted several challenges with designing gamification that successfully enhances or supports achieving the intended behavioral outcomes of the systems gamified; Recurring theories to why gamification design is difficult are 1) Gamification is based on game elements, and games are complex [53, 54, 55] 2) Motivating users through gamification requires a deep understanding of the users [40, 20, 31] 3) Gamification ultimately aims to achieve behavior change, which is typically not fun or even voluntary [41, 21, 39, 43].

As with most things, gamification is perceived differently for different individuals. Especially motivation gained from gamification seems to be highly individual and dependant on the user context [2]. Therefore one should provide a variety activities to appeal to different users [20]. The entity being gamified must also already have some intrinsic value - a reason for users to engage with it. If the entity offers core intrinsic value that users desire, applying gamification can deepen the users' engagement [45]. In his "user-centered theoretical framework for meaningful gamification" S. Nicholson states that developers should use a user-centered design (UCD) when designing meaningful gamification [20], meaning always prioritizing the needs and goals of the users. Though Nicholson's theoretical framework doesn't provide an actual method, it pinpoints aspects of user-centricity important for this project. Gamification that has a strong impact in some people does not necessarily have a noteworthy impact in other people. As K. Huotari has stated, gamification, similar to game services or products, can only *attempt* to support the user in creating gameful experiences [36]. Gamification solutions must also offer some

customizability in order fit people with different goals, challenges, interests, and personalities [20].

It has been heavily debated within gamification whether extrinsic motivators, like game mechanics may undermine users' intrinsic motivation. Researchers has found that the expectancy of extrinsic rewards might undermine people's interest in a task and thereby degrade their performance [56, 54] Another study examining the effects of points, leaderboards and levels on users' performance, and found that none of them did harm the user's' intrinsic motivations [41]. The mixed findings from literature raised some uncertainty that we in this study dealt with by questioning the user how a suggested extrinsic reward would motivate intrinsically, to prevent extrinsic rewards becoming the sole motivation.

## 2.5 Problem summary

The aim of the research is to improve **self-management** of **Cystic Fibrosis** through utilization of **gamification** in **MyCyFAPPs** app to increase the users' **motivation** for self-management.

Utilizing gamification mechanics that lead to positive psychological outcomes, can in turn lead to positive behavioral outcomes in users. Knowing the intended behavioral outcomes of an application, we must identify the psychological outcomes we want to target and then which gamification mechanics that could support them. By having users participate actively in the design process, we can identify these building blocks of gamification, and create gamification solutions that could increase intrinsic motivation.

The development of CF and management challenges varies a lot for different individuals, creating big variations in motivation for self-management as well. In order to design gamification solutions that successfully increases user motivation, we must establish a deep understanding

of users' needs, challenges and motives. There are also mixed findings to whether using extrinsic incentives can undermine intrinsic motivation, thus we must ensure that the activities and challenges supported by gamification are inherent in the users' pursuit of their needs.

## **3 | Methods and approach**

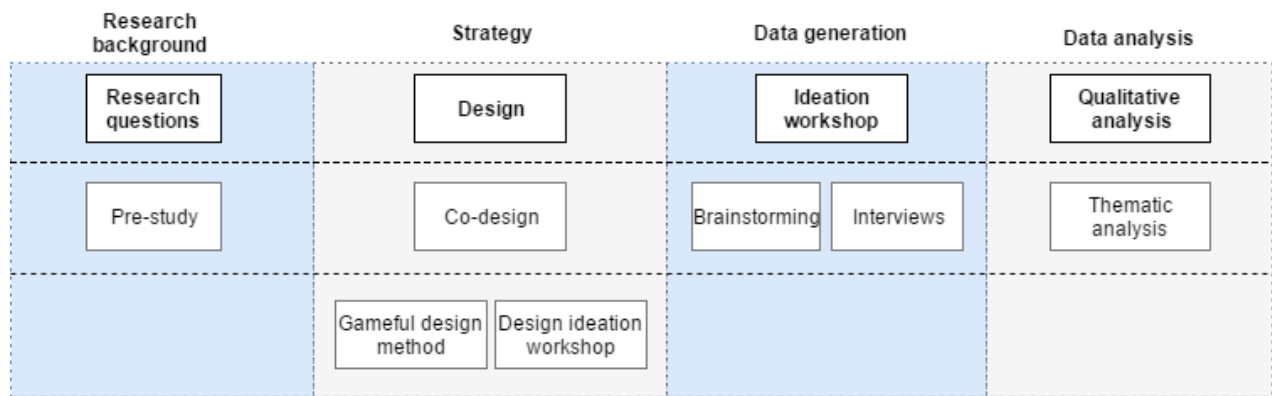
This chapter describes the research methods employed in the study. The first section provides an overview over the research steps and methods used in each step, followed by sections describing each step and associated methods in detail. The chapter ends with a section on ethics regarding the methods employed.

### 3.1 Overview

The research process used is adapted from B. J. Oates' model [57], consisting of the following steps: 1) Research questions 2) Strategy 3) Data generation 4) Data analysis.

The first step in Oates' model, defining research questions, was done by conducting a **pre-study** (Section 3.2) preliminary to this study. Oates presents six different research strategies as overall approaches to answer research questions: survey, design and creation, experiment, case study, action research and ethnography. The research strategy for this study, **design and creation** (Section 3.3), was chosen during the pre-study of this thesis [43]. Specifically we used **co-design** and a method for **gameful design** (Section 3.3.1.1) entailing active involvement of end-users in the design process. The method for gameful design is adapted from S. Deterdings "Lens of Intrinsic Skill Atoms" [9] and was used as base when designing our data generation method, the **ideation workshop** (appendix A). The ideation workshop was conducted with people diagnosed with CF to brainstorm gamification design ideas and to capture participants' motivation and higher level attitudes by semi-structured interviews. Data generated in the ideation workshops was qualitatively analyzed, specifically a **thematic analysis** (Section 3.5.1) was conducted to identify, analyze and report themes within the data.

Figure 3.1 shows a complete representation of the work and associated research methods employed. The top row shows research steps from B. Oates' research process [57]. The second and third row show how they are instantiated in this thesis.



**Figure 3.1:** Methods: Complete representation of the research process and associated methods. The top row shows research steps from B. Oates' research process [57]. The second and third row show how they are instantiated in this thesis.

## 3.2 Pre-study

To gain knowledge on gamification and fundamental skills on research methods a pre-study was conducted during the fall 2016 before starting this thesis' work at the beginning of 2017. The pre-study consisted of background literature search and reading literature on gamification for health management research, with the goal of gaining a complete understanding of research field, address gaps in research and formulate research questions for this thesis. In addition to research on gamification and gamification for health, commonly employed mechanics used in gamification were studied (e.g. points, badges, levels and scoreboards) and whether they were likely to be successful in a gamified application for the purpose of CF management. This was done by looking at papers evaluating gamification mechanics in applications with purposes relevant to CF management. Gamification mechanics that was studied in detail included *Avatars, Badges, Challenges/Achievements, Leaderboards, Levels, Points, Rewards and Social Interaction*. Knowledge gained during the pre-study helped us understand how these mechanics might be used in designing meaningful incentives to increase user motivation through a self-management application for CF. This knowledge was particularly useful during discussions with patients to help them establish an understanding of gamification and support them in design.

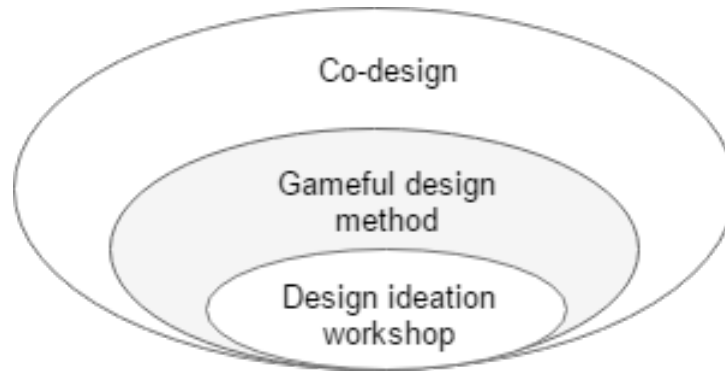


### 3.3 Design and creation

The strategy of design and creation focuses on developing new IT product or some element of the development process. The strategy often makes use of the data generation methods interviews, observations, questionnaires and documents [57]. However, using single activities like interviews can limit the users' creativity to what the user is able to express [58]. Also, the users' experiences and knowledge can be so embedded in their everyday life that they might not even be aware of it, consequently making valuable insights remain hidden in an interview. To strengthen the data gathering of interviews [58] we will use co-design described in the next section.

#### 3.3.1 Co-design

Using a co-design approach means involving end-users and have them participate actively, as experts of their own experience, in the design process [59, 5]. Research shows that involving end-users in the design process improves the level of acceptance of the design and it is more likely to match the users' requirements [60, 40, 20]. While using methods such as interviews and observations can give us access to explicit and observable information, co-design methods allow us to explore the implicit aspects of peoples' lives [61]. MyCyFAPP has already successfully utilized co-design to design user interface of the self-management application [28]. The next planned step is co-design of gamification solutions. Figure 3.2 represents levels of co-design discussed in this section.



**Figure 3.2:** Methods: Research strategy: Co-design - Levels of specialization

### 3.3.1.1 Gameful design method

In research on best practices for gamification design processes, gamification experts stress the importance of focusing on user needs when designing gamification for motivation [40, 20]. Looking into design methods for gamification and paying special attention to the involvement of users, we discovered S. Deterdings method on gameful design in his "Lens of of intrinsic Skill Atoms" [9]. Gameful design means "designing systems that are intrinsically motivating and fun to use, by applying those techniques that game designers use to keep the players immersed and engaged" [7]. While most gamification design methods appears to be optimized for speed and cost, gameful design focuses on "identifying challenges already inherent in the user's pursuit of his/her needs and restructuring them in a motivating manner" [9]. This gameful design method was chosen as base when planning for this study's gamification design process. The method describes five steps for gameful design:

1. Strategy
2. Research
3. Synthesis
4. Ideation
5. Iterative prototyping

In this study we conducted steps 1-4 of the gameful design process. The three first steps of Strategy, Research and Synthesis aims at defining outcomes, user needs, constraints, motivations and activities before translating them into behavior chains and ultimately determine whether the user activities fit for gameful design. S. Deterding states that "The activities is considered fit for gameful design if the following questions can be answered in the positive" [62, 9]:

- "Does the activity connect to an actual user need?"
- "Is lacking motivation a central issue or opportunity?"
- "Does the target activity involve an inherent challenge with a learnable skill?"
- "Is affording experiences of competence the most effective and efficient way of improving motivation?"

Results of these steps are presented in appendix B. While Deterding's method advocates involvement of end-users during these steps, we went a step further on terms of user involvement by applying co-design in the fourth step - ideation - as well, meaning having the end-users take a central role in the design, as recommended by several gamification experts in order to ensure the focus on user needs [40, 20].

### 3.3.1.2 Design ideation workshop

We did discover some challenges with Deterding's proposed activities for ideation in the context of our research. This resulted in planning, design and creation of an **ideation workshop**, which was thoroughly tested and revised to ensure it's ability to support participants in creating gamification ideas. The challenges and work regarding the ideation workshop setup are collected and described in appendix A and resulted in the following setup (briefly presented):

#### 1. Introduction

Informing the user about the project and workshop purpose

## 2. **Presentation**

Present MyCyFAPP and their application support goals, gamification in general and gamification mechanics

## 3. **Ideation**

Brainstorming gamification ideas: The user picks a support goal of the application that he/she finds more interesting and then brainstorm gamification solutions that would motivate the user in achieving that goal. Each idea is written on a post-it and put on the whiteboard. The user has gamification mechanics cards, pen and paper to help the creative process.

## 4. **Revise ideas**

Have user revise his/her ideas, highlighting those of greater preference.

## 5. **Wrap up** Handing the participant an incentive for participation and inform about future steps in the project

The finalized ideation workshop setup is described in details and presented in appendix C.

## 3.4 **Data collection**

To collect data for this study we invited people diagnosed with CF to participate in the designed ideation workshop. Two participants were recruited by e-mail, both young Norwegian males, 22 and 16 years old. Both of the participants have participated in the MyCyFAPP project in earlier stages of interviews and co-design workshops for feature and user interface requirements. They both function well in daily life as students but have different challenges in relation to CF treatment. Because of the risk of cross-infection, It is recommended that people with CF do not meet face to face because of the risk of cross-infection [18]. CF patients carry bacteria in their lungs which can be harmful to other CF patients not having the same bacteria-flora [28]. More details on the participants can be read in the Results Chapter 4 and ideation workshop notes

appendices G and H.

### **3.4.1 Ideation workshop**

The ideation workshops data generation consisted of creating ideas through brainstorming with participants and questioning them in a process similar to semi-structured interviews to understand their motivations. Though brainstorming was the most crucial aspect of the ideation workshops, an interview guide was incorporated in the ideation workshop plan (appendix C) to supplement the workshop and to make sure all themes important to our research questions were touched.

The agenda of the ideation workshop (presented in the preceding section) included 1) Introduction 2) Presentation 3) Ideation 4) Revise ideas 5) Wrap up. Step 3 and 4 was adapted from Deterding's gameful design method which suggests the following steps for ideation:

1. Brainstorm ideas
2. Prioritize ideas
3. Create storyboard concepts
4. Evaluate and refine concepts

As described in appendix A, Creating and testing the ideation workshop setup, we had to make adjustments to Deterding's suggested steps. To make sure the user had a sufficient understanding of gamification and MyCyFAPP's application we included an introductory part and a presentation, estimating each part to 10 and 20 minutes respectively. Because of the limited time we had left with each participant, we decided to allocate most of the time available for step 1, Brainstorm ideas, which was allocated 60-90 minutes. Prioritization of ideas by voting was excluded as we only had 1 participant for each workshop. We did however revise the ideas with

the participant before wrapping up to understand which ideas were of greater preference and why. Deterding's suggested steps 3 and 4 - Creation and evaluation of storyboard concepts - were excluded from our workshop setup as we aimed at keeping the interview duration below two hours, as suggested by Oates [57]. The ideation workshop setup and conducted activities are described in detail in appendix C.

## 3.5 Data analysis

The interviews resulted in 4 hours of audio and 41 defined gamification ideas. In order to develop and refine interpretations from the ideation workshops, the data was thematically analyzed by a coding approach.

### 3.5.1 Qualitative thematic analysis

Qualitative analysis means analyzing non-numerical data, the main type of data used in interpretive research [57]. In this study a thematic analysis was conducted to identify, analyze and report themes within the data [63]. The process consisted of the following steps:

1. Preparing- and formalizing the data

The first step was to use a software for note-taking to write transcripts for each of the interview audio files after running the workshops. In this thesis, input from participants is presented with processed *notes* instead of word-by-word transcripts for two reasons: 1) The participants were assured the audio files and transcripts were stored securely to protect eventual personal information, and 2) The majority of data collection consisted of brainstorming, resulting in an extensive amount of text and incomplete statements, hard to interpret for readers not present at the workshops. The notes are presented in appendix G and H.

2. Read through all data

After writing notes for the audio files they were read through to create a first impression.

### 3. Categorize data

We proceeded by finding key themes observed in the data, known as an inductive approach [57]. These themes were concrete gamification ideas, associated mechanics and psychological outcomes - but also other themes relevant for the study's research questions e.g. user context and personal motivations.

### 4. Refine categories

We split up larger themes into smaller ones, and merged related smaller themes into larger ones.

### 5. Evaluate results

We evaluated the findings in relation to the study's research questions to determine which gamification ideas to include in the proposed gamification design examples.

As a starting point codes were created for three categories, specifically the three building blocks of gamification (Section 2.4.2) - 1) Gamification mechanics 2) Psychological outcomes, and 3) Behavioral outcomes. The first category, Gamification mechanics, contained codes for each gamification mechanic presented to the users during the interviews. The second category, Psychological outcomes, contained codes for psychological outcomes popularly targeted by gamification [42, 38, 46, 45] and the third category, Behavioral outcomes, contained the supporting goals of the application (see Table 3.1) as they were central elements in the co-design activities. This resulted in the predefined codes presented in Table 3.2.

**Table 3.1:** Overview: MyCyFAPP's application support goals

Goal	Description
G1	Learn about nutrition and how it affects health
G2	Learn and develop the ability to estimate enzyme dosages
G3	Understand own health, increase the ability to communicate it to health professionals
G4	Help make sure the user takes all his/her medication.
G5	Learn more about CF and treatment

**Table 3.2:** Coding analysis: A priori codes. Codes created for three categories (building blocks of gamification), gamification mechanics, psychological outcomes and behavioral outcomes.

Category	Codes
<b>Mechanics</b>	Avatars, Badges, Challenges, Leaderboards, Levels, Progress bars, Rewards, Social interaction
<b>Psychological outcomes</b>	Reward, Status, Achievement, Self-expression, Competition, Altruism
<b>Behavioral outcomes</b>	Learn more about nutrition and how it affects health, Learn and develop the ability to estimate enzymes, Understand own health and increase the ability to communicate it to health professionals, Help make sure the user takes all his medications, Learn more about CF and treatment

The iterative process of categorization, refinement and evaluation resulted in a list of major topics, as shown in Table 3.3. The whole process is described in details in appendix I.

**Table 3.3:** Coding analysis: Resulting concepts after coding analysis. The table shows major topics, associated concepts and counts referrals for ideas on each major concept for each participant. Example: P1 suggested 10 ideas on Social Interaction

Major concepts	Associated concepts	Referrals
Social interaction	Social, user profiles, social interaction, discussions, hashtags, altruism, status, self-expression, voting	P1: 10/16 P2: 6/16
Empowerment	Increase knowledge, increase competence, quiz, challenges, goals, self-efficacy, tips	P1: 5/11 P2: 6/11
Progression	Avatars, levels, progression, progress bars, in-game items, unlockable items	P1: 3/9 P2: 6/9
Motivation	Application support goals, user context, undermining intrinsic motivation, individuality, simplicity	P1: 4/8 P2: 4/8
Competition	Competition, leaderboards	P1: 2/7 P2: 5/7
Achievement	Achievement (psych. outcome), Achievements (mechanic), badges, rewards, virtual currency	P1: 3/6 P2: 3/6



### 3.6 Ethics

In this study we have recruited people to participate in research by sharing from their private lives, requiring a concise plan to protect the participants' welfare. To make the participants comfortable with sharing from their private lives we made sure to thoroughly informing them about the project, their role and why we need their help. We also informed them that they at any point could withdraw themselves from the study without stating reason. To protect the participants from being recognized and for published information to be linked back to them we employed several preventive measures: 1) anonymizing all direct personal information by deleting all personal information data and digital recordings, 2) storing all collected information on a password protected server in a protected physical environment 3) not publishing any directly identifiable personal data 4) not publishing a combination of indirectly identifiable personal data that could be used to identify individuals. During the workshop we would record audio that potentially could capture personal information. Before starting the recording equipment we informed the user about the preventive measures related to information security and gave them a consent that they had to sign to confirm that they accepted and understood the preventive measures.

Before beginning the data gathering step an approval from Norsk senter for forskningsdata (NSD) was required. We sent NSD a notification form, addressing all the preventive measures in the section above and received an approval 01.02.2017. The approval can be read in appendix J.

## 4 | Results

This chapter presents the results from the data collection and analysis. Section 4.1 describes the participants, their background and some information on their experience with games and **gamification**. Section 4.2 lists all ideas gathered in the **ideation workshops** and presents findings uncovered in the data analysis. Finally, Section 4.3 presents a brief summary of each participants' own evaluation of ideas.

## 4.1 Participants

The **ideation workshop** was run with two participants diagnosed with CF with the aim to co-design gamification ideas to increase motivation for **self-management** with **MyCyFAPPs** smart-phone app. In order to protect the identity of the participants and still be able to refer to their input, they will throughout this chapter be referred to as “P1” and “P2”, where P is for “participant”. Table 4.1 contains information about the participants and references to workshop notes.

**Table 4.1:** Overview: Participants of ideation workshops

Participant	About participant	Reference to notes
P1	22 year old male student	Appendix G
P2	16 year old male student	Appendix H

### 4.1.1 Experience with games and gamification

Being interested in figuring out what impact game experience would have in the gamification design activities, we questioned the participants about this in the beginning of the workshop to get a clear impression of their level of interest and experience with video games and computers. This also allowed us to adjust the amount of details needed to be explained to the users before starting the ideation.

Both participants had little experience with gamification, but both participants played video games regularly. P1 favored strategy games (i.e. Age of Empires and Vikings: War of Clans) while P2 favored competitive games (i.e. Call of Duty and FIFA). P1 also used an app for learning languages, which offered some gamification like leaderboards, virtual currency and progress bars. He expressed that the gamification motivated him to some extent: “I think helps on motivation, as it’s more fun.”

When asked about their initial expectations and thoughts regarding gamification in an application for self-management of CF both participants responded positively. P1 said "I think it could be fun, but I'm not exactly sure how it could be done". P2 said that "I think it may be a good solution to increase motivation. I am a really competitive person so competing could definitely be a motivation to use the application for my part". P2 stated that "Daily registrations may feel like a burden, that you spend more time on it than what you actually get in return. The application needs to be easier and more fun to use." P1 had also given this a thought before the ideation workshop, and immediately suggested (before starting the brainstorming activity) that "the registering of food must be easy to do, for example if you could scan all the foods with the product bar code".

## 4.2 Findings

The participants suggested a total number of 41 gamification ideas. Table 4.2 contains the all mechanics discussed, where the ones *presented* for the participants are labeled "Presented", while other mechanics suggested, not presented to the participants before brainstorming, are labeled "Invented". All ideas suggested by P1 and P2 are listed in Table 4.3 and 4.4, respectively. In the following sections findings are presented for each major topic found during the thematic analysis: **Social interaction** deals with the desire for relatedness and the section presents findings that comprise communicating, interacting with, belonging to or caring for other people (Section 4.2.1). **Empowerment** deals with the degree of autonomy people feel regarding initiating processes to increase their level of self-determination, knowledge and skills. The section presents findings that comprise the users' desire for autonomy regarding self-management (Section 4.2.2). **Progression** deals with peoples' desire to, not only get better at what they do, but also to feel the actual improvement. The section presents findings that comprise the users' desire to feel progression in self-management (Section 4.2.3). **Competition** deals with people's de-

sire to compete and the section presents the participants' ideas for competition (Section 4.2.5). **Achievement** deals with people's desires for accomplishment and is powered by extrinsic incentives. The section presents ideas on awarding the end-user when accomplishing things in the application (Section 4.2.6). **Other motivational aspects** deals with topics important to the participants regarding motivation for self-management in general (Section 4.2.4).

**Table 4.2:** Mechanics presented and invented during interviews.

	<b>Mechanic</b>	<b>Description</b>	<b>Presented/Invented</b>
M1	Avatars	A virtual representation of a character	Presented
M2	Badges	A symbol/trophy representing accomplishment or meaningful work	Presented
M3	Challenges	A challenge using goals that leads to some reward when completed.	Presented
M4	Leaderboards	Interface element ranking players users or groups, absolutely or relatively.	Presented
M5	Levels	Indicates users' level of experience or skill	Presented
M6	Points	Numerical value used in one or multiple ways (virtual currency, XP, skill points)	Presented
M7	Progress Bar	Interface element indicating task or user progression	Presented
M8	Rewards	In-game or out-game rewards awarded to players	Presented
M9	Social interaction	Communication, competition or cooperation among peers.	Presented
M10	Achievements	Any virtual representation of accomplishment	Invented
M11	Hashtags	Social networking label	Invented
M12	Discussion	Social discussions	Invented
M13	Goals	User defined goals	Invented
M14	Unlockable items	Items that can be unlocked by achieving something in an application	Invented
M15	Quiz	Questions/tests for users to take on	Invented
M16	User profiles	Social profiles for users of applications	Invented
M17	In-game items	Virtual items that can be acquired in applications	Invented
M18	Likes	Making users able to vote on each other's social posts.	Invented
M19	Tips	Application giving users tips to reach his goals	Invented

### 4.2.1 Social interaction

The majority of ideas suggested in workshops involved social interaction. During the ideation workshops the participants suggested, and strongly emphasized that they wanted a way to communicate and exchange knowledge with other people with CF. P1: "I'd like some kind of forum where you could discuss symptoms and such things." P2: "Having an arena of **discussion** where you could discuss things with other people with CF. I think it would be neat to hear about other people's experiences on different topics, for example hygiene." The participants also expressed that they wanted to be able to get any desired information quickly from the same medium (i.e. the app), as using different forums "required a lot of navigation and reading through posts to get to the information you are looking for".

To make it easier to find relevant social discussions, P1 suggested using **hashtags** for symptoms "If you are struggling with headache you can click the hashtag #headache and see posts from other users regarding headache symptoms. That way you can easily find information on the symptoms you are experiencing." Regarding **altruism**, P2 suggested: "Award points to users for adding posts that get **voted** on a lot to encourage people to **share knowledge** with each other". P1 also suggested including **user profiles** in the app, where each profile has an avatar with a level that would represent the user's knowledge and achieved **status**: P1: "Having avatars with levels that represents which profiles are the most trustworthy. Finding a profile with a "high" avatar you immediately know that the person has used the application a lot, had many registrations and that he/she has a high skill in differing symptoms". P2 also wanted to have user profiles where "You could have a user profile that can be visited and used to talk to other users". Both participants also wanted to "show off" performance in the app by displaying **achievements** on their user profile, increasing their achieved status. P2: "On your profile your level, experience points and badges are displayed." Both participants also stressed the importance of privacy: P1: "Those who would like to keep their profiles private could choose to do so". P2: "Every user should be able to decide what to display their profiles or not. Some people might want to use

nicknames but for my own part I don't mind using my real name in the application.". The participants also suggested ideas for increased motivation through **self-expression**: "I'd like to have an avatar that you, by gaining XP, get coins or something like that and use them to acquire new things for you avatar.", "For my part I'd like the avatar to be customizable so you can make it look like myself, but younger people for example might want it to be a super hero or something similar."

The participants also wanted **health professionals** (HPs) to be part of the social interaction in the application: P1: "What would be really nice is if the doctor could comment on posts by users with high avatars. Because posts by users with a high avatar is more visible in the application the doctor would know that the post would be read by many users." P2: "Doctors could also post answers in discussions, if they have time of course, they could post tips, confirm other users comments or elaborate." P1 also suggested that the HPs and could publish studies "The doctors could also publish studies on new medicines and such" and that the users could "follow" HPs they liked and be notified when the HP posts. He suggested the doctors could have a easily distinguishable "doctor-avatar": "The doctor profile could for example have an extra star or his avatar could have a doctor hat or something similar".

### 4.2.2 Empowerment

The second most discussed psychological outcome found in ideas from the workshop is empowerment. During the ideation workshops the users suggested a number of ideas to engage in activities to **increase knowledge** and **competence** in self-management of CF, specifically for learning more about CF, nutrition and enzyme estimation, primarily through guided **goals, quizzes** and **challenges**.

Both participants suggested several ideas for increased motivation through **self-efficacy**, specifically being able to create nutritional goals with or without HPs. P1: "Create tailored nutritional

goals with dietician or have an option to follow a default nutritional plan for those who don't need strict follow-up". P2: "Create goals with dietician that the user can follow, and then gain experience points or badges for mastering the nutritional goals. Then the user could show these to his doctor or dietician and see that he has reached his goals. This would make it easier to explain how you've been doing to HPs." The participants also wanted the goals to be guided by getting **tips** from the app to ensure the prerequisites needed to take on the goals. For nutritional goals the participants suggested P1: "The application could suggest nice dishes high in nutrients based on your goals." P2: "I need to get better at eating vegetables. What would be nice is if the app could suggest dishes to make it easier to eat vegetables. For me it's much easier to eat soup or taco rich in vegetables rather than cooked vegetables. Getting suggestions like this would be really good for my part."

P2 also wanted the application to offer challenges on physical activity: "If you could set your own goals for exercise and complete them for experience points and badges.", "The app could also offer predefined goal for exercise, like for example jogging 10 kilometres. You shouldn't need to do the whole challenge in one run but be able to do it in parts." The participants also wanted to increase knowledge and competence through completing challenges in the application. P2: "For learning you could have quizzes to confirm that you've learnt something. To read educational material and then taking a quiz on general educational material or for example nutrition". Finally P2 suggested to have challenges for multiple aspects of self-management in the application and to be able to collect points for all of them, which would add up and together become the users "overall" experience points. P2: "You can take on a number of different challenges and have one main user where all your points acquired from challenges are added up. By reaching a predefined sum of points you will get a reward".



### 4.2.3 Progression

The third most discussed psychological outcome found in ideas from the workshop is progression. Both participants suggested having an **avatar** that would represent the user's progression in the application. P1 suggested that the avatar itself could automatically develop visually when **leveling** up in the application P1: "An avatar with a pacifier is clearly less experienced than an avatar with a crown". P2 suggested a similar solution but that the user would get some virtual currency from using the application which could be spent to acquire **items** for the avatar. P2: "Different outfits and gear, for example if you are interested in a sport you could acquire items that represent that sport." That way an avatar with expensive/rare items would be a clear indication that the user is experienced: P2: "If your avatar has rare items then it would represent, in addition to the users experience points, that the user has used the app a lot, that you have a high level of experience and that you know a lot".

P2 suggested using **progress bars** in the educational material to give a feedback to how much the user has read and then confirming the progression by taking quizzes. "When I practiced for my practical driving test, after reading a page the application registered it and saved your progress in a progress bar. When you've read some chapters you could have a reward.", "You could progress in different chapters, where some could be about nutrition, some about enzymes, some about CF in general, health status and so on". When asked what he thought about tracking progression for food intake he answered that "There are big differences for people with CF and how much they can eat. A friend of mine eats almost nothing and has to take supplementary nutrition drinks, but I eat a lot of food and have never had a problem with food. So I think having for example progress bars for food intake would be tricky. I think it would be better to use progress bars for physical exercise". P1 suggested that the users of the application could have levels for different self-management aspects that, when added up, would determine their overall level. "You could for example have one a bar for nutrition and one for symptoms and when added up you get the overall level" This idea was presented to P2 who was very enthusiastic about the

idea, adding "That's a good idea. You could check your profile and see what you are good at and also what you can improve at".

#### 4.2.4 Other motivational aspects

As the preceding sections all address findings on motivation, for defined psychological outcomes, this section address general findings on motivation. The participants touched a popular theme in within gamification research, whether extrinsic rewards can **undermine intrinsic motivation**. There was in particular one **support goal** that was not highlighted as interesting by the users, specifically G4 "Help make sure the user takes all his/her medication". P2 didn't want gamification to help him reach this goal as he suspected it could undermine the importance of taking medications. P2: "You must take your medications no matter what, if you were to be rewarded for doing that every time I'm afraid it would create a faulty focus".

The participants repeatedly emphasized differences in **user context, individuality** of CF and that what's challenging for some people with CF might not be a problem for others and vice versa. P2: "Some people with CF have a really hard time with food and some don't, for my own part I never talk with a dietician, simply because I don't need it. P1: "I eat the same food every day as recommended by my dietician, so I would maybe register food less often than others". The participants suggested multiple ideas that would take different needs into consideration, without actually being told to. P1 suggested a way to customize nutritional challenges by having predefined nutritional goals - diets that are considered good for people with CF - but also letting users customize nutritional goals together with their dietician: P1: "Customized nutritional goals but also have an international standard for those who doesn't need that much individual follow-up." P2, who expressed a strong competitiveness, suggested that the users could determine them self whether they wanted to compete against other users of the application: P2 "I think it's important that the focus is not too much on the competition, because there are probably users that don't want to compete. So there should be a way for users to have the learning

outcomes without competing".

**Simplicity** was also important for the users regarding motivation. Both users suggested that registering foods must be simple and quick. P2: "I think it's important that registering food is not too advanced or difficult, because if it's difficult then it might become a burden each day more than something you'd do to learn, that you'd more effort in it than what you'd get back. Registering should take 2 minutes, not 10". Though not being a conventional gamification idea, P1 suggested to be able to scan the bar codes of the foods: P1: "To make it quicker. So it doesn't become a long, heavy process each morning". He also suggested that the app could make it easier to adhere nutritional goals by reminding him to eat: P1: "Sometimes I forget to eat because I don't feel hunger that much when I'm busy".

#### 4.2.5 Competition

Although a lesser amount of the ideas comprise competition, both participants of the ideation workshops expressed that they wanted to be able to compete: P1: "It would be fun to be able to compare my achievements to other people with CF in my hometown". Maybe you could compete with friends on who eats the most food rich in fat!" P2 was very enthusiastic about learning through competition and suggested that the application could have regular quizzes or challenges that the users could take on to collect points. P2: "Competitive users would probably want to check out the application when new challenges are added, and it can make more people would want to visit the app more often if there's a new competition each week, for example". He wanted international but also global competition. P2: "I think that it could be individual competition between all users from Norway, but also competition between users not living in Norway". "For example a couple of quizzes each week that you can complete and then get points what will be displayed in a **leaderboard**". When asked about how he would be more motivated to climb the leaderboards he said "For me the competition itself is very fun, but one option could be to give prizes for the top 100 positions in the leaderboards, it would depend on the number

of users of course. In Norway it may be just top 10 users that are awarded points".

### 4.2.6 Achievement

To be awarded points and rewards when accomplishing things in the application was discussed enthusiastically by the participants. They wanted to be awarded based on how well they stuck to their treatment, specifically P1 suggested that the amount of **experience points** awarded should be based on how well he followed his nutritional plan. Presenting an example based on a diet rich in fat P1 said: "The user could get XP<sup>1</sup> based on how much fat he's eaten in a day". Another important aspect of **achievements** was to be able to display them for other users. Both users suggested showing their achieved rewards in their user profiles. When asked about what types of **rewards** the user was more enthusiastic about P1 said that "I think out-game rewards could motivate, if they are connected to a user profile so you for example could show other CF-friends, like "look, I've gotten a cinema ticket!". " P2 was more interested in collecting **badges** for completing challenges and displaying achieved ones in his profile. P2: "For each challenge you could get a badge that can be displayed on your profile, together with your achieved levels, XP and badges."

### 4.2.7 Additional findings

We presented an earlier discussion to whether making users have to unlock performance graphs (for health and nutrition) in the application would be exciting or frustrating for the user motivation. P1 didn't consider this a very good idea. P1: "To unlock the graphs may cause some frustration. It's not enough a motivation to unlock them. So I don't think that would be the best alternative."

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<sup>1</sup>Experience points, commonly termed "XP" in games

### 4.3 Participants' evaluation of ideas

In the end of the ideation workshop the participants got the chance to go through which ideas they truly liked and would motivate them the most to use the application for self-management of CF.

For P1 the most interesting support goal of MyCyFAPP was G3 - "Understand health and increase the ability to communicate it to HPs". For this goal he considered the best ideas to be the ones regarding a complete social system where users and doctors could communicate, share experiences and information with each other by using discussions, hashtags and user profiles, having avatars and levels. For the goal G1 - "Learn about nutrition and how it affects health" he liked the idea of being able to create nutritional goals and challenges (together with dietician if needed). He also liked the idea of the application guiding him in the right direction to reach his goals, by suggesting foods that nutritionally fit his goals. He wanted to be rewarded when accomplishing his goals and he would like the rewards to be displayable on his user profile.

For P2 the most interesting support goal of MyCyFAPP was G1 - "Learn about nutrition and how it affects health". He favored the ideas about being able to compete in the application, through completing quizzes, collecting points and be on a leaderboard where he could compare his performance to other users in Norway but also to users from the rest of the world. For this he would like the application to offer regular challenges. He also liked the idea about creating nutritional goals and to be guided by the application on which foods and dishes he could chose to reach the goals.

**Table 4.3:** Suggested ideas: Participant #1. Each row represents an idea suggested by the participant. Each idea has columns representing associated gamification mechanic(s), psychological outcomes and support goals. The last column presents which psychological super-ordinate the idea belongs to, defined in the thematic analysis (appendix I).

Idea	Participant	Description	Mechanic(s)	Motivational aspect(s)	Support goal(s)	Major theme(s)
I1	P1	Discuss symptoms and experiences with other users	Discussions	Social, altruism, knowledge	Understand health (G3)	Social
I2	P1	Hashtags linking to posts about the actual word tag	Hashtags	Social, knowledge	Understand health (G3)	Social
I3	P1	A user level that increases when registering- and discussing symptoms, represented by an avatar, where a “high” avatar represents an experienced user with more knowledge	Levels, Avatars	Social, increase competence and knowledge	Understand health (G3)	Social, progression
I4	P1	Point multiplier for consistent registering	Points	Achievement	Understand health (G3)	Achievement
I5	P1	Link between avatar level and hashtags making higher avatar posts with hashtags more available	Avatars, Hashtags	Knowledge, status	Understand health (G3)	Social
I6	P1	Doctors can verify/correct user posts, making sure high quality information is more visible. The doctors should have avatars easily distinguishable from normal users.	Avatars	Knowledge	Understand health (G3)	Social
I7	P1	To “guess” the right amount of enzymes when registering new types of food	Challenge/ Quiz	Increase competence	Estimate enzymes (G2)	Empowerment
I8	P1	Create nutritional goals with dietician	User goals	Self-efficacy	Learn about nutrition (G1)	Empowerment
I9	P1	Rewards for sticking to diet (user/dietician defined)	Rewards	Achievement	Learn about nutrition (G1)	Achievement
I10	P1	Display achievements and rewards on your social profile	User profiles, rewards	Social	Learn about nutrition (G1), Learn about CF (G5)	Social
I11	P1	Choose which radius you would like to share rewards with (town/country/world)	Achievements/ rewards	Social	Learn about nutrition (G1)	Social
I12	P1	Reminders to register food	None	Other	Learn about nutrition (G1)	None
I13	P1	Challenges for developing nutritional habits, (Smaller challenges to achieve nutr. goals)	Challenges	Self-efficacy	Learn about nutrition (G1)	Empowerment
I14	P1	Get tips on ingredients / dishes based on nutritional goals	Tips	Knowledge	Learn about nutrition (G1)	Empowerment
I15	P1	Discuss foods and recipes with other users	Discussions	Social, knowledge	Learn about nutrition (G1)	Social
I16	P1	Points for how well the user follows his diet	Points	Achievements	Learn about nutrition (G1)	Achievement, progression
I17	P1	Unlocking recipes with virtual valuta	Unlockable items	Knowledge	Learn about nutrition (G1)	Empowerment
I18	P1	Doctor can “flag” their comment for increased visibility. The doctor can also attach studies if he spots recurring medicinal themes in a user profile or discussion.	Discussion, user profiles	Social, knowledge	Understand health (G3)	Social
I19	P1	To be able to “follow” doctor profiles	User profiles	Social, knowledge	Understand health (G3)	Social
I20	P1	Progress bar for different aspects in the application, to help the user increase his performance in the different aspects	Progress bars	Progression, knowledge, altruism	All goals covered (G1, G2, G3 & G5)	Progression

**Table 4.4:** Suggested ideas: Participant #2. Each row represents an idea suggested by the participant. Each idea has columns representing associated gamification mechanic(s), psychological outcomes and support goals. The last column presents which psychological super-ordinate the idea belongs to, defined in the thematic analysis (appendix I).

Idea	Participant	Description	Mechanic(s)	Motivational aspect(s)	Support goal(s)	Major theme(s)
I21	P2	Quiz challenges to answer, for example for nutrition, to compete with other users. Regular challenges (daily, weekly, monthly)	Challenges, quiz	Competition, knowledge	Learn about nutrition (G1), Estimate enzymes (G2), Learn about CF (G5)	Competition
I22	P2	Global and national leaderboards	Leaderboards	Competition	Learn about nutrition (G1)	Competition
I23	P2	Points for leaderboard position at end of period (e.g. 1st = 1000p, 2nd = 700p, 3rd = 400p)	Points, rewards	Competition	Learn about nutrition (G1)	Competition, achievement
I24	P2	Reward for reaching a predefined amount of points	Reward	Achievement	Learn about nutrition (G1)	Achievement
I25	P2	Points for different aspects, e.g. for nutrition, treatment, and a "main" point (XP) that is the sum of all aspect points	Points (XP)	Competence/ knowledge	Learn about nutrition (G1)	Empowerment
I26	P2	User profile to interact with other users	User profile	Social	Learn about nutrition (G1)	Social
I27	P2	Let the user choose to compete or not	None	Competition	Learn about nutrition (G1)	Competition
I28	P2	Progress bars to give users feedback on read educational material.	Progress bar	Progression, knowledge	All goals covered (G1, G2, G5)	Progression
I29	P2	A prize for N read pages/ chapters	Reward	Knowledge	Learn about nutrition (G1)	Achievement
I30	P2	Create user goals in relation to activities, goal progression represented by progress bars. XP for completed goals.	User goals, progress bar	Self-efficacy, progression	Other	Empowerment, progression
I31	P2	Predefined goals in relation to phys. activity. Badges for completing goals.	User goals	Self-efficacy, progression	Other	Empowerment, progression
I32	P2	Display badges and XP on user profile (user choose what to display).	User profile, badges, points	Social, status	All goals covered (G1, G2, G5)	Social
I33	P2	Badges for consistent medicine use	Badges	Competence	Help take medicine (G4)	Empowerment, achievement
I34	P2	Include enzyme in nutritional quiz challenges	Quiz, challenges	Competition, knowledge	Estimate enzymes (G2)	Competition
I35	P2	Guess what enzyme dose to take when registering food	Quiz	Competence	Estimate enzymes (G2)	Empowerment
I36	P2	Use avatar on user profile	Avatar	Social	All goals covered (G1, G2, G5)	Social
I37	P2	Acquire coins when completing challenges that can be spent on items for you avatar. Expensive items represent high knowledge.	Unlockable items, virtual currency	Social, self-expression	All goals covered (G1, G2, G5)	Social
I38	P2	Discuss CF aspects and experiences with other users	Discussions	Social, knowledge, altruism	All goals covered (G1, G2, G5)	Social
I39	P2	Points for good social posts, depending on user voting on the post	Likes	Social, altruism	All goals covered (G1, G2, G5)	Social
I40	P2	Create nutritional goals with dietician that are rewarded with XP and badges when completed	User goals, Rewards (badges, xp)	Self-efficacy	Learn about nutrition (G1), Understand health (G3)	Achievement
I41 <sup>a</sup>	P2	Application tips the users about foods and dishes that help with nutritional goals	Tips	Knowledge	Learn about nutrition (G1)	Empowerment

<sup>a</sup>Idea suggested by P1, presented to P2 for additional input

## 5 | Discussion

This chapter presents a discussion of the findings presented in Chapter 4. The two first sections corresponds to the sub-questions of the study research question, defined in Chapter 1; While Section 5.1 corresponds to SQ1 and focuses on *what* CF patients want targeted by gamification to increase their motivation for self-management, Section 5.2 corresponds to SQ2 and focuses on *how* they want gamification to be implemented and implications of their context in selection and design of gamification. Section 5.3 contains discussion on gamification for self-management in relation to other domains, while Section 5.4 contains reflection on research methods employed. Section 5.5 presents gamification design examples to improve MyCyFAPP's app, inspired by findings of the study.



In this study, we created an **ideation workshop** based on the building blocks of **gamification** (described in Chapter 2) and existing user-centered methods for gamification design. The ideation workshop was run with two adolescent patients diagnosed with **Cystic Fibrosis**, resulting in 41 gamification design ideas, each idea consisting of three sets of key ingredients, **gamification mechanics, psychological outcomes and behavioral outcomes**). The results were analyzed qualitatively to understand what psychological needs CF patients want targeted by gamification, and how gamification could be implemented for these psychological needs to ultimately increase the patients motivation for self-management.

## 5.1 Patients' gamification motives (SQ1)

Our findings show that the most engaging gamification designs for users of a self-management application for CF comprise the needs of 1) **social interaction** 2) **empowerment** and 3) **progression**. Out of a total of five application support goals, the participants considered four of them to be potentially enhanced with gamification targeting these psychological outcomes. Additionally, the users expressed a desire to be able to compete with each other and to be rewarded when accomplishing tasks in the application. The following sections contains discussion of our findings regarding these aspects.

### 5.1.1 Social interaction

Social interaction was the most engaging target motivation for the goals *G3 - Understand health and increase the ability to communicate it to HPs* and *G5 - Learn more about CF*.

Initial research on user needs for self-management of CF in relation to MyCyFAPP's app neglected implementation of social interaction. Specifically, a requirement of a "Digital Meeting Place" was excluded from the initial planned core features of the application [28]. The digital

meeting place would allow patients to communicate with each other and caregivers in order to learn from each other, exchange tips and support. The requirement was excluded from the set of features for the app because of existing dedicated CF forums and groups on social media that allegedly realized the need for social interaction among CF patients [28]. Noticeably, our findings show that the majority of gamification design ideas created in the ideation workshop comprise social interaction.

When the users were asked about existing solutions (i.e. forums and social media groups) they expressed that they'd like to be able to get all information quickly and easily from the same medium as existing solutions "required a lot of navigation and reading through posts to get to the information you are looking for". These statements gave rise to another potential user need - the need to easily access high quality information regarding CF and treatment, also reflected by participants' suggestions on using hashtags to easier find information in the application, and voting to make posts more available for users. Another topic reflecting the need for high quality information was participants' suggestions on having health professionals to participate in discussions to confirm, correct or disprove information posted by patients in discussions to enhance the credibility of information. They'd also like to "follow"<sup>1</sup> health professionals in the application.

In research specifically on promoting CF self-management with smartphone apps, the need for social interaction is highlighted as a valuable inclusion: A study specifically on promoting CF self-management with smartphone apps had 19 participants diagnosed with CF who "almost unanimously agreed that a closed social network separate from existing public social networks or platforms was important, for privacy and to build a community of people with similar experiences". The study concluded that "Social networking may be particularly attractive to people with chronic medical conditions who feel alone in their disease or who are seeking guidance

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<sup>1</sup>Subscribing to a user's activity and receive a notification when the user posts information, similar to Twitter's and YouTube's respective functions of "Following" and "Subscribing"

or support from others in similar situations" [18]. The richness of data on social interaction gathered in our study underpins this statement. Consequently, we encourage MyCyFAPP to reconsider the decision of excluding social interaction from the app.

Another question raised post-analysis was whether the majority of ideas on social interaction had its primary motivation in the actual *gaining of knowledge*, more than the interaction itself. An approximate half of the ideas on social interaction comprised sharing of knowledge. Without reaching a conclusion on this topic, we propose further investigation of this by discussing sharing of knowledge with patients, clearly separating it from the other social interaction topics like self-expression and status.

### 5.1.2 Empowerment

Empowerment was the most engaging target motivation for the goals *G1 - Learn about nutrition* and *G2 - Learn and develop the ability to estimate enzyme dosages*.

Unlike social interaction we *had indications* from MyCyFAPP's user need and requirement interviews, prior to this study, that that the users would like the app to offer motivational affordances for empowerment, specifically user needs for increasing competence on self-management by setting goals to reach in the app [22]. The participants stated that setting goals for nutrition, physical activity and medications would help motivate them in treatment. The participants also suggested the app to offer more playful functions like quizzes to increase knowledge on self-management. Our findings show that these indications were confirmed during the ideation workshops as both participants suggested being able to create goals for nutrition and to take quizzes to learn more about CF. However, unlike suggestions from MyCyFAPP's user need and requirement interviews [22], the participants of our study did not want the app to offer goals regarding medications. This is discussed further in section 5.2.3.

One of the participants suggested that those who needed close follow-up regarding nutrition could create goals with their dietician and that the app could offer predefined nutritional goals for people having lesser challenges with nutrition, goals generally considered healthy for people with CF. Both participants also suggested that the app could *guide them* in reaching their goals, e.g. by suggesting foods high in fat if they took on a goal of increasing fat intake. Another suggestion on guiding the users to reach their goals was for the application to suggest interesting dishes specifically for the users' nutritional goals, i.e. dishes high in nutrients that the user had challenges getting enough of. The key aspect of guiding the user in the app features, rather than defining what the user should do is to let the user feel in control of what activities to do and how to perform them. Literature on motivation for learning [32, 54] and games [55, 9] emphasize control to be an essential aspect in the sense of competence felt when overcoming challenges. Another interesting point made by one of the participants was that setting goals could benefit in multiple support goals of the application - not only help users to learn more about nutrition but also make it easier to communicate their nutritional habits and adherence to HPs.

In addition to goals, the participants suggested that the app could offer more playful mechanics, specifically challenges and quizzes. As the application would offer educational material to promote learning, one of the participants suggested using quizzes on the educational material to support learning. To learn more about self-management he suggested being able to take quizzes on multiple aspects, e.g. nutrition, enzymes and CF in general. To increase the ability to estimate enzyme dosages the participants suggested that they, when registering food, could be questioned how much enzymes they should take for that specific food. As the app already would feature an algorithm calculating the correct enzyme dosages, the idea was that quizzes could increase their own ability to estimate enzymes for new foods, thus being less dependant on having the app at hand. When discussing this in detail it seemed that both users had created their own guidelines on how to do this in their every day life. One of the participants consis-

tently ate the same meals every day, also taking the same amount of enzymes for those meals. The other participant only had minor challenges with foods, and had established a set of rules of how much enzymes to take with different kinds of foods. Though the participants had created their own guidelines regarding enzyme estimation, they thought quizzes could benefit other patients having a harder time with enzyme estimation. The conclusion was that they could *choose* to enable this function in the application, depending on their personal desire to develop enzyme estimation skills.

### 5.1.3 Progression

Earlier interviews with adolescent participants in MyCyFAPP indicate that the users would like to compare their progress with others. Also “Gamification of progress” was explicitly suggested [22]. Results from the ideation workshops confirms that, in order to amplify the participants’ motivation through felt progression, the participants would like to compare their **progression** to others but also have gamification solutions for progression tracking entirely for their own part. Specifically, the the ideas seemed to have three different abstractions of progression; tracking, development and feedback. First of, the participants of this study wanted to be able to track their performance on different aspects of self-management, e.g. nutritional adherence, symptom registration and knowledge, to easier understand how they could improve. One of the participants wanted to have progress bars for each aspect, suggesting this could help him easier communicate his recent self-management performance to HPs. Secondly, the participants wanted to improve at self-management by progressing in the actual use of the application e.g. by developing his personal avatar and level to increase his profiles trustworthiness. Thirdly, the participants wanted clear feedback on progression in tasks of the application, for example using progress bars to inform the user how close he is to achieving a goal, a challenge or how much educational material he’s read or a progress bar showing remaining activity required to achieve a goal on physical activity. These things are also addressed in literature on **flow**, a widely ac-

cepted model of enjoyment: "games need to provide frequent in-game feedback for players to determine distance and progress towards objectives" [64, 55].

While Social interaction and Empowerment were the most engaging target motivations for the discussed application support goals, progression seems to play an important role for these motivations by acting as a supportive component in both and vice versa. One example on how ideas on empowerment are supported by progression is enabling users to create goals to reach, and support it by tracking the goal progress using progress bars to enhance felt progression. Another example on how ideas on social interaction are supported by progression are users being motivated to share knowledge and experiences in social discussions as doing so would develop their avatar or level, then again increasing the trustworthiness of their social profile. For self-expression one of the participants suggested an idea motivating through combining progression and social interaction, specifically acquiring some virtual currency through competing in the application, that he could use to purchase virtual items for his avatar to develop it visually. This idea coincides with Bunchball's<sup>2</sup> definition of self-expression through gamification, arguing it to be the primary human desire fulfilled by virtual goods as gamification mechanic [42]. The participant explained further that expensive items would represent a high level of experience and knowledge, increasing the user profile's status.

#### 5.1.4 Additional discussion

Although we did not use principles from **SDT** to neither plan and conduct the workshops, our findings on social interaction, empowerment and progression coincides to a large extent with the three foundational psychological needs defined in SDT, respectively relatedness, autonomy and competence [6]. We consider this a phenomenon supporting SDTs gravity in gamification design research.

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<sup>2</sup>A company describing them-self as the market leader and innovator in gamification

When discussing empowerment, goals and challenges with participants, they expressed that it would be the best if goals and challenges are things that the user would actively have to *choose to take on* rather than being forced on them. This coincides with a statement made in the pilot run of the workshop, in which a participant suggested an idea on nutritional challenges and emphasized that the user himself would have to initiate a challenge to be motivated to actually learn anything from it. According to **Cognitive Evaluation Theory (CET)**, a sub-theory of SDT, competence alone will not increase intrinsic motivation for learning without autonomy [6]. Transferring this to our terms, felt progression (competence) will not increase without empowerment (autonomy) (example discussed in Section 5.1.3, Progression).

## 5.2 Implications of patients' context for gamification design (SQ2)

### 5.2.1 Individuality in user needs and motivation

Throughout the ideation workshops the participants repeatedly emphasized differences in patient context, variations and **individuality** of CF. As the needs vary a lot from patient to patient, motivation for self-management varies and consequently gamification solutions' impact on motivation also vary. This underpins the importance of **customizability** in the gamification of the application, and confirms findings done in a study examining user preferences for an app for promotion of CF self-management [18], where participants "emphasized the need for customization options to meet individual preferences and disease management goals". During the ideation workshop participants emphasized that the goals and challenges offered by the application should be optional and possible to activate or deactivate. Based on discussion with the participants, and studies examining user preferences to promote self-management of CF [18], there is reason to believe that the primary reason for this is the individuality and continuously changing needs and challenges of CF - while it at the same time could reflect a user need identi-

fied before this study, namely *saving time* as CF patients already spend a lot of time on treatment [22] and might want to, or at least be able to be selective in how much time they want to spend in the app. This user need is also confirmed by the participants statements regarding simplicity; The first suggestions in both runs of the workshop was regarding simplicity, e.g. that registering foods must be simple and quick. One of the participants explicitly said that registering should take 2 minutes, not 10. The other participant's first suggestion was to be able to scan bar codes of foods to make registering quicker.

### 5.2.2 Competitiveness

Before going into this study we had a hypothesis that participants most likely wouldn't care too much about being able to compete with friends in the application. We also suspected that **competition** would have a weak potential regarding increasing motivation as the context deals with illness treatment, which is an atypical thing to compete in. However, both participants expressed a desire to be able to compete with friends and strangers, through quizzes and leaderboards. Our findings nonetheless show any substantial links between the need of competition and the actual context of self-management of CF, thus considering competition more a personal desire, rather than an implication of CF patient context. The most competitive of the two participants somewhat realized this and suggested that the app shouldn't focus too much on competition, but let the users choose themselves whether they wanted to compete.

### 5.2.3 Undermine intrinsic motivation with rewards

There was one support goal that was not highlighted as interesting by the participants of the ideation workshop, specifically *G4 - Help make sure the user take all his/her medication*. Discussing this goal with one of the participants he actually touched a popular theme in gamification research - whether extrinsic rewards can undermine intrinsic motivation. The participant



didn't want gamification to support him in reaching goal G4 as he suspected it could undermine the importance of taking medications. This statement supports research on "undermining children's intrinsic interest with extrinsic rewards" [56], providing empirical evidence that unnecessary use of extrinsic rewards can affect intrinsic motivation negatively. Another study examining the effects of three common gamification mechanics (points, levels and leaderboards) on users' performance and intrinsic motivation concluded that intrinsic motivation would remain unaffected by the mechanics, but suggests that employing them could be an effective way to drive user behavior, at least in the short term [41]. Discussing this further with the participant, he came up with an idea to help the user *remember* daily medicine, rather than to actually *take* daily medicines.

### 5.3 Gamification for self-management

During the study we became aware of an important difference between gamifying for self-management and gamifying for other domains, e.g. business or marketing where the gamification has two goals; 1) Have the users use the application for extrinsic values (e.g. the company earning money through advertising), and 2) Increasing the users' intrinsic value by achieving the intended outcome (e.g. increase the users skills or knowledge). In contrast, when gamifying for increased self-management the latter should be prioritized exclusively. In this study we've utilized **gameful design** principles (See 3.3.1.1) by identifying and using challenges already inherent in the user's pursuit of his or her needs [9] as base for gamification design. In retrospect we consider using gameful design principles a fitting approach for designing gamification solutions for self-management, where the focus should be on the users' intrinsic values.

Discussing this further, questions regarding **wear-out** (gradually reduced effect) arises, specifically whether a user reaching his intended goal of using a gamified function in a self-management application and consequently stops using the function is desirable or not? Discussing a fictive

scenario for MyCyFAPP's application: A user struggling with enzyme estimation increases his skill to estimate enzymes by completing quizzes for a longer period of time, and finally reaches a point where he's consistently able to estimate the correct enzyme dosage for every meal he has. It is likely that the user then would feel that he had achieved the intended outcome of enzyme estimation quizzes and consequently stop taking them. We cannot answer whether this is an actual issue or not for self-management applications in general. For MyCyFAPP's app it is desirable that CF patients continue using MyCyFAPP's app even after all the users' intended goals are fulfilled, but it is even more desirable that the user actually reaches his or her goals even though it may lead the user to stop using certain functions of the app. The participant who expressed the strongest competitiveness suggested an idea that possibly could reduce the app wear-out to some extent, by having daily quizzes and challenges that would be awarded with points when completed. These points would be collected and used in a periodic (weekly or monthly) leaderboard, and the top N users at the end of each period would be awarded, creating an ongoing competition and making "competitive players regularly check the application to see if there are new challenges to complete, in order to climb the leaderboard". In order to reduce wear-out it should be included as a topic in future work on testing and evaluation of gamification.

## 5.4 Reflection on methods used

Research has shown that most gamification efforts fail because of poor understanding of how it should be designed and implemented [40]. A common trend is reducing the complexity of well-designed games (primarily designed for entertainment) to simple components, like points and leaderboards (Stated by E. Lawley [45]) and then transferring them to another environment, expecting it will increase the quality of the solution [40]. Those who spend more time with their users and strive to understand their motivations, needs and constraints and then have them take an active role while designing gamification to amplify their intrinsic motivations, are more

likely to benefit from gamification [20, 45, 40]. In this study we also discovered that - similar to the importance of understanding user motivations - users participating in gamification design must also have a sufficient understanding of gamification to be able to create ideas that could increase their motivation. To investigate how we could provide CF patients with a structure that would enable them to create gamification ideas increasing their intrinsic motivation for self-management, an ideation workshop was created, consisting of 1) a presentation of the project and the application, 2) a presentation on gamification and its applications in health apps, 3) brainstorming of gamification design ideas for self-management of CF and 4) revision of resulting gamification design ideas. The ideation workshop was thoroughly tested and refined before running it with CF patients (See appendix A).

To determine the ideation workshop setup's ability to produce gamification design ideas, questions on main concerns were defined and answered after running pilot workshops. This process was repeated and the questions were answered again after running the workshop with CF patients'. Answers to questions on concerns regarding the ideation workshop setup are presented in appendix A.

The workshop setup proved to be an effective method to create gamification design ideas together with CF patients, resulting in 41 gamification ideas and 4 hours of captured discussion. The workshop setup had two primary functions: 1) provide the participants with the understanding needed to create gamification design ideas, and 2) have participants design gamification that could increase their motivation for self-management. In retrospect, these two functions could have been split up in two separate workshops to spend more time on the actual ideation workshop. Also, by having a workshop to establish an understanding of gamification a week or two before the actual ideation workshop could allow the participants' understanding to mature in the meantime and make it easier to communicate his/her motivations, ultimately resulting in a richer data material, more or better gamification design ideas.

### 5.4.1 Applying the method to other contexts

A matter yet to be determined is the ideation workshop's potential applications, specifically in which other contexts it could be considered a fitting method for retrieving gamification ideas from users. As the workshop is based on potential users' needs, challenges and motivations regarding their context, our theory is that the ideation workshop could be employed for designing gamification for other chronic diseases and *possibly* any user-centered context where the app activities are directly connected to user needs. The latter part of the theory does however require further testing for verification.

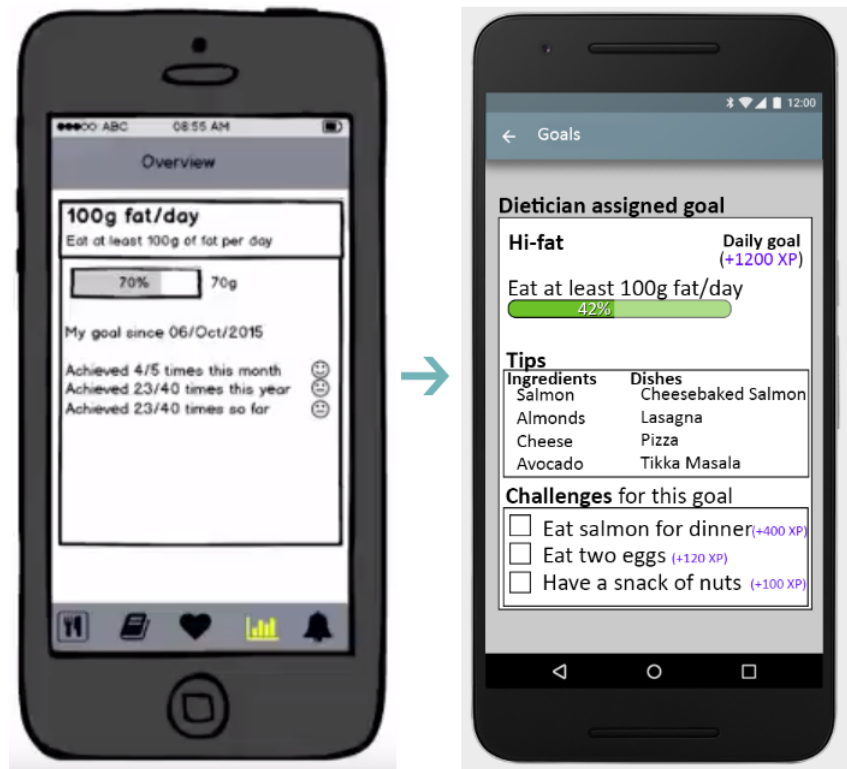
Another matter of the workshop setup regarding utilizing it for different contexts is whether the participants' degree of impact caused by their context (i.e. having CF) in every day life, hereinafter referred to as *context impact degree*, affects the participants' ability to create gamification design ideas to increase motivation for self-management. We tested the workshop with for the context of weight loss before running it with CF patients. The participants of the test workshops were not actually concerned with losing weight, considering them having a low context impact degree. Comparing the test runs with the "real" runs, the test runs shows indications that the context impact degree plays an important role, as the test runs produced a significantly lower amount of ideas taking time spent on each of the runs into consideration. The ideas were also less complete and the participants of the test runs had a harder time in describing how the gamification solutions would motivate them than the CF patients had (e.g. Participant of test workshop #2: "I just want to collect points"). Though it is uncertain whether the reason for this is the difference in context impact degree or just differences in personalities, our hypothesis is that the participants *would have to experience context-related challenges* in order to create gamification ideas that could increase intrinsic values.

## 5.5 Gamification design examples

In this section we present sketches and descriptions of ideas on 1) enhancing existing features of MyCyFAPP's app, and 2) new features. Each proposed gamification design is based on ideas from our findings and are examples of solutions to improve the app. However, the solutions require further testing and evaluation in co-design with end-users before implementation.

### 5.5.1 Nutritional goals enhancement

MyCyFAPP's app lets users set nutritional goals, but does not provide gamification to increase motivation to reach the goals. Based on our findings, we propose that nutritional goals include **tips**, and **challenges** to support the user in reaching the goals and developing nutritional habits. The enhanced app provides tips on ingredients and dishes that fit with the user's goal (being rich in nutrients defined in the goal).

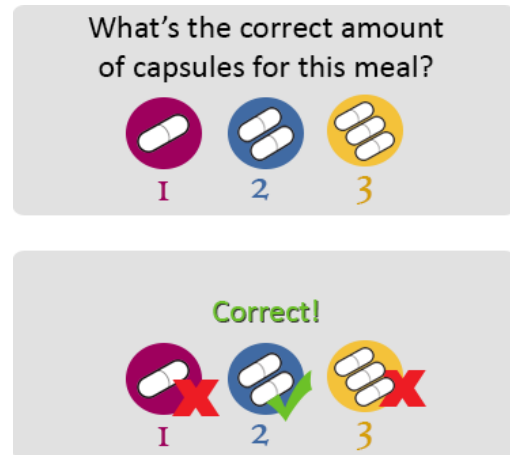


**Figure 5.1:** Gamification design example: Nutritional goals. The left screen is from MyCyFAPP's mockup and shows an example goal - the right screen shows how gamification can be provided within the goal. Figure 5.1 shows how tips and challenges can be provided within the goal. By completing goals users are awarded **badges**, and by completing the associated challenges the users are awarded **experience points**. The user can click the ingredients and dishes for detailed information and, if desirable, register them.

### 5.5.2 Enzyme replacement enhancement

MyCyFAPP's app provides an algorithm that automatically calculates, and provides the user with the correct amount of enzymes for corresponding food registrations. To develop the user's own ability to estimate enzymes and to be less dependant on having the app at hand, we propose an optional **quiz** where the user could guess the corresponding enzyme replacement dosage for registered meals (Figure 5.2). The idea is that doing this over time could increase the user's ability to estimate enzyme dosages for new types and amounts of food. The sketch example presents a "multiple-choice" approach for the enzyme replacement quiz - this ap-

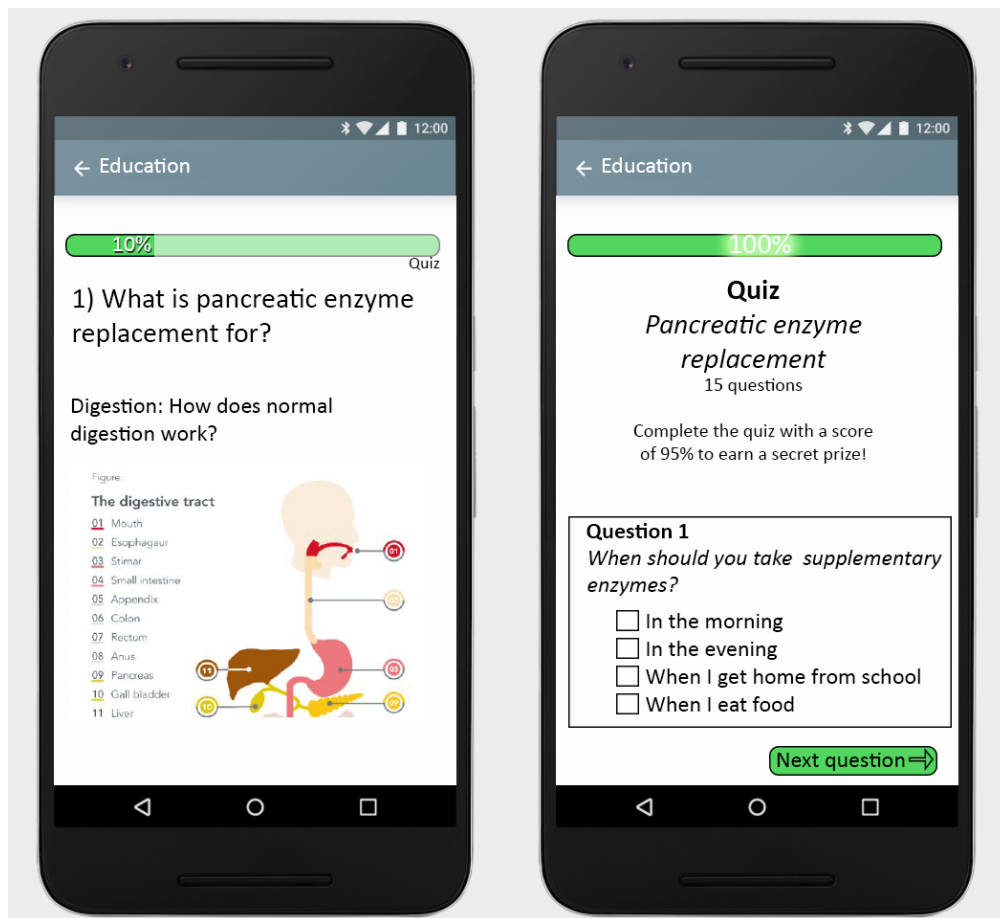
proach in particular is *not* based on data collected, meaning an approach where users would input the exact amount without having alternatives presented might be better. The best approach should be investigated through further testing and evaluation of design with end-users.



**Figure 5.2:** Gamification design example: Enzyme dosage quiz. When registering new foods the user can choose to guess the right amount of enzymes.

### 5.5.3 Educational material enhancement

MyCyFAPP's app provides educational material for users to read, but does not provide gamification to increase motivation to read or learn more. Based on our findings we propose that the educational provides **progress bars**, so the user can follow his progression when reading the material. We also propose that chapters of educational material ends with a **quiz** that the user can complete to verify that he/she has learned. Completing the quizzes with a high score, e.g. > 95% correct answers, the users are awarded a **badge** representing their knowledge on the chapter topic. By completing quizzes, more quizzes are unlocked and the difficulty is increased. Harder quizzes are awarded accordingly with badges representing a higher level of knowledge.

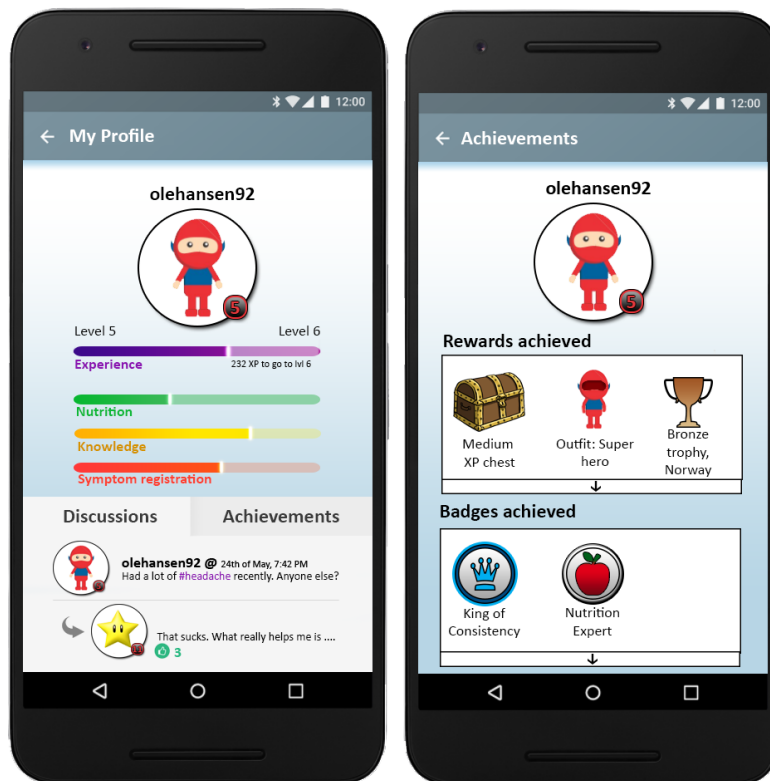


**Figure 5.3:** Gamification design example: Educational quizzes. The left screen shows how the educational material can provide a progress bar, and the right screen shows a quiz at the chapter end.

### 5.5.4 Social interaction feature

As discussed in Section 5.1.1, MyCyFAPP excluded social interaction from the app's core features. Our findings does however show strong engagement regarding social interaction - the most engaging solutions comprise **user profiles** and **discussions**.

Our design example on user profiles (Figure 5.4) is based on the participants' ideas as well as a sketch one of the participants drew (presented in appendix G). It provides an **avatar**, a **user level** and **progress bars** for different aspects of self-management and one for overall experience. Experience points are acquired by performing self-management activities and when reaching a predefined amount of points, the user level is incremented.

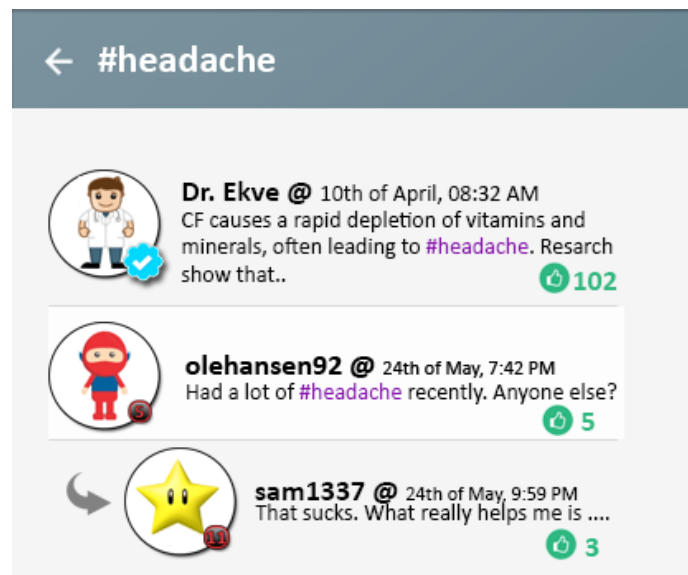


**Figure 5.4:** Gamification design example: User profile. The left screen shows the user profile design. The right screen shows the user profile displaying achieved rewards and badges.



The user profile also displays the user's **achievements**, specifically achieved **badges** and **rewards** (Figure 5.4). The profile also provides an overview of discussions that the user has participated in. The user however has full control over what he wants to share on his profile, and can choose to keep parts of it (or the entire profile) private.

Discussions use **hashtags** for navigation, so that the user easily can find relevant information. Health professionals can participate in the discussions, having distinct "doctor"-avatars. The users are able to **vote** on other posts so that the posts with the most votes are positioned further up than those with less votes. For posts with equal number of votes, the post posted by the user with the highest user level is positioned on top. Figure 5.5 shows an example of social discussion using the hashtag "headache".



**Figure 5.5:** Gamification design example: Discussions

### 5.5.5 Competition feature

The participants wanted the app to offer competition for competitive users. The users should be able to turn the competition feature on or off, depending on their desire to compete. The design example lets users gather points each month by completing periodic quizzes (weekly/daily) based on educational material, nutrition and enzyme estimation. The acquired points are used in two leaderboards; a national and a global leaderboard (Figure 5.6). At the end of each month, users on the leaderboards are awarded experience points for their profile based on their placement, e.g. 1st = 1000 XP, 2nd = 700 XP, 3rd = 400 XP. Top 3 users are also rewarded with a bronze, silver or gold trophy for the month, which is displayed in the users' profile (Figure 5.4).

National		Global	
#1	daveG		1969 p.
#2	nate_68		1301 p.
#3	olehansen92		1020 p.
#4	hawkins_drummer		921 p.
#5	guitar_george		859 p.
#6	ashiflett		569 p.

**Figure 5.6:** Gamification design example: National and global competition

## 6 | Conclusions

The aim of this study was to improve self-management of CF through utilizing gamification in MyCyFAPP's app to increase the user's motivation. By identifying patients' most engaging psychological needs through design of gamification solutions, we have achieved a rich understanding of CF patients' context, its implications on design of gamification, as well as a concrete list of gamification solutions that could increase motivation for self-management.

This chapter presents the conclusions of the study. Section 6.1 presents answers for the study's research questions. Section 6.2 contains a discussion of limitations of the research and, finally, Section 6.3 presents proposed future work based on findings of the study.

## 6.1 Answering the research questions

**RQ1 - What gamification designs do adolescent CF patients want in an app for self-management to increase user motivation?**

**SQ1 - Which psychological needs do adolescent CF patients want gamification to support in order to increase their motivation for self-management?**

Our findings show that the most engaging gamification designs for a self-management application of CF comprise 1) **social interaction**, through discussions, hashtags, and voting, 2) **empowerment**, through challenges, quizzes and goals, and 3) **progression** through avatars, virtual items and progress bars. Interviewees also expressed a desire to be able to compete with each other, through quizzes and leaderboards, although our findings do not show any substantial links between the need of competition and the actual context of self-management of CF.

**SQ2 - What are the implications of CF management and its patients' context for the selection and design of gamification?**

Our findings show that the selection and design of gamification is highly dependant on what challenges the patients are having in their treatment. As the challenges themselves - but also their significance - vary a lot from each individual with CF, the gamification must emphasize customizability and be adaptable to the actual patients' context. The findings also show that patients do not want gamification of certain activities, where the gamification potentially could harm important intrinsic interest of the activity, like taking their medications.

## 6.2 Limitations

Recruiting a higher number of participants for the ideation workshops could possibly have produced an even richer understanding of gamification for self-management of CF. As we only managed to recruit two participants diagnosed with CF, our findings can not be generalized for a larger population of CF patients. The low number of participants was mainly due to the rareness of CF, with around 325 people diagnosed with CF in Norway [65] spread out all over the country. In addition to being diagnosed with CF, prerequisite for recruitment included 1) the participant living within travel distance to the research institute 2) the participant having time to participate, and 3) the participant agreeing to participate in the study. If more people was put to conduct this study, for example students from other countries represented in MyCyFAPP, more participants could be invited. This could produce a richer collection of gamification ideas, and possibly enable us to identify patterns in the collected data.

Another limiting factor of the study is the short time frame. The research steps in this study was conducted from mid January until and including April, allocating May for writing and finalizing the study report. The work done also had to fit with MyCyFAPP's research and development schedule. Initially we wanted to create prototypes and have users evaluate them during the time frame of this study. However, we quickly realized that evaluation of *gamification* and *usability* are different things, as gamification solutions should be evaluated by continuous user play-testing over time [40] (months at minimum), letting the users evaluate based on experience rather than impression. The short time frame thus excluded another important aspect of gamification, specifically the **wear-out** effect over time. Also, MyCyFAPP plan to release a pilot after the end of this study, possibly featuring gamification solutions from this study. Considering these things we excluded implementation and evaluation of a prototype during the time frame of this study, and focused on writing a report of significant value for MyCyFAPP to use in their future research and application development.

## 6.3 Future work

This study on gamification is one of several planned steps in Project MyCyFAPP. The project's plan is to have the self-management application implemented and ready for testing during the second half of 2017. This study's scope is on gamification design, until and including ideation. The remaining steps of gamification design - prototyping, implementation, evaluation and monitoring - is not carried out in this study because of the limited time frame. Testing and evaluating gamification requires a larger time frame as we want the users to evaluate based on experience, rather than impression. How MyCyFAPP chooses to use this study for implementing gamification is entirely up to the project to decide. However, based on my acquired knowledge, experiences and discussions with people involved in the MyCyFAPP project, I present my proposals for future work in the following sections.

### 6.3.1 Refine ideation setup

Though the ideation workshop designed and conducted in this study has proven to be an effective method to create gamification ideas with CF patients, the method could still be improved. Firstly, as discussed in 5.4, the ideation workshop could have been split up in separate workshops, or shifted to an approach where the participants would come into ideation workshop with a mature understanding of gamification and its applications for self-management - in short being more prepared to create ideas. Secondly, as discussed in 5.4, to increase the ideation workshop's applications the workshop could be tested with different domains to determine its ability to produce gamification design ideas for different contexts, other than health self-management. We are confident that the ideation workshop could be employed for designing gamification for other chronic diseases than CF, and theorize that it also could be used in any user-centered context where the app activities are directly connected to user needs. Also, as discussed in 5.4 there is some uncertainty regarding utilization of the workshop in different contexts, specifically how the participants' context impact degree could affect the participant's

ability to create gamification ideas for increased user motivation in this workshop. Using this study as a starting point, we propose further research on improving the method and its applications, possibly in a dedicated research paper.

### **6.3.2 Increase source data**

To uncover the best gamification designs for the application MyCyFAPP should consider running the ideation workshops over with more participants, preferably with different demographics (age, nationality), as a larger amount ideas would increase the chance of discovering - not only the best gamification solutions - but also the ones more applicable to a larger population of CF patients. More effort at this stage would also likely reduce the time spent on iterative evaluation.

### **6.3.3 Apply gamification to MyCyFAPPs app**

#### **6.3.3.1 Prototyping**

The author suggests using the gamification examples (Section 5.5) inspired by findings from this study to create evaluable prototypes and, as recommended by gamification experts, iteratively test the success of the gamification designs [40]. The prototypes should be “playable” as gamification is closely connected to the experience of the user must be evaluated over time; An interactive wireframe or mobile application prototype is preferable.

#### **6.3.3.2 Implementation**

A natural continuation of evaluating the prototype is implementation of a pilot that can be used for field evaluation of the gamification designs. In order to optimize the gamification designs, and because the wear-out effect for each of the gamification solutions yet remain uncertain, we recommend letting the users use the pilot over a long-term period.

### **6.3.3.3 Evaluation and monitoring**

To investigate whether the gamification solutions achieve the intended behavioral outcomes, as well as generally enhance the users motivation and experience, an evaluation phase is recommended. Gamification experts recommend interviews, surveys and playtesting [40], meaning observing the users while performing tasks in the application as some users may struggle to express their experiences. We also propose that the evaluation includes investigation and mitigation of wear-out effect, as dicussed in 5.3.



# **Appendices**

# A | Creating and testing the ideation workshop setup

## A.1 Designing the ideation workshop setup

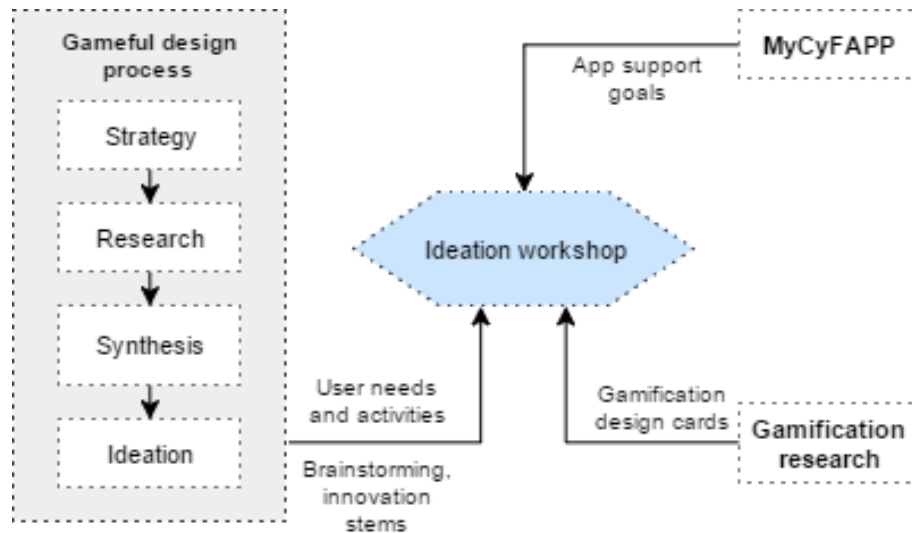
The goal of this thesis is designing *gamification solutions* which is different from designing user interfaces. Firstly because of the very complexity of gamification design and its challenges, discussed in section 2.4.5. Secondly, the gamification solutions should be designed for self-management of CF - an illness of great complexity and individuality. Lastly, it currently exists no scientifically proven co-design method specifically for retrieving gamification ideas from users. Because of these challenges it was decided to design an **ideation workshop**, and utilize it as an extension of Deterding's ideation to co-designing gamification solutions for self-management of CF.

To get the most data from ideation, we thoroughly planned, designed, tested and revised the ideation workshop. This to be confident that the designed workshop had all necessary prerequisites to produce high quality output. We used the building blocks of gamification, as defined by Hamari [2], namely **motivational affordances**, **psychological outcomes** and **behavioral outcomes** as building blocks for the ideation. As we already had established a base of motivational affordances (gamification mechanics) studied in the pre-study on gamification [43] (see 2.4.2.1), and behavioral outcomes (MyCyFAPP's application support goals [66, 22, 28]) we used this as a

starting point. In order to achieve the intended behavioral outcomes, the intermediary component of psychological outcomes must also be identified to understand what they want gamification to act on in order to increase their motivation for self-management.

In Deterding's gameful design method [9], he underpins the challenge of ideation - to enable non-game designer to come up with gamification ideas. To deal with this challenge he proposes utilization of **innovation stems**, "prompts that frame the design problem in an inspiring manner" [9]. However, in this study innovation stems alone wasn't considered a sufficient solution to provide the participants with the understanding needed to create gamification ideas to increase motivation. To strengthen the workshop setup this we decided to use some tools to stimulate and guide the ideation, suggested by gamification experts [40, 9] and research on interviews [58]. For this, we evaluated tools like gamification card toolkits [67] but didn't discover any existing tool convincing us enough to adopt. A study reviewing existing methods for designing gameful systems highlights the lack of guidance in choosing and customizing gamification design elements for a given context [9]. Some methods emphasize the importance of choosing the right mechanics but provide little guidance how to reach and decide upon specific elements [9]. Because of the shortcomings in the reviewed methods, we decided to make our own design cards out of the studied gamification mechanics (See Table 2.1). Using the design cards only as aiding tools, rather than a strict ingredient/approach for designing ideas, allowed the participant to focus more on the motivation than which mechanic to choose. Tools used in the workshop ideation were blank papers, pencils, post-it notes, whiteboard and game mechanics design cards (presented in appendix D). Figure A.1 presents how we designed the ideation workshop by combining Deterding's gameful design process [9], MyCyFAPPs support goals and research on gamification mechanics.

From the initial work a workshop setup draft was created which was then reviewed with my supervisor researchers, B. Farshchian and T. Vilarinho, resulting in the following setup:



**Figure A.1:** Designing the ideation workshop setup. The figure shows how we combined Deterding’s gameful design method [9], MyCyFAPP support goals and research on gamification mechanics to create an ideation workshop setup to co-design gamification solutions with CF patients to increase motivation for self-management

1. **Introduction** (~10 min)

Informing the user about the project and workshop purpose

2. **Presentation** (~20 min)

Present MyCyFAPP and their application support goals, gamification in general and gamification mechanics

3. **Ideation** (~60-90 min)

Brainstorming gamification ideas: The user picks a support goal of the application that he/she finds more interesting and then brainstorm gamification solutions that would motivate the user in achieving that goal. Each idea is written on a post-it and put on the whiteboard. The user has gamification mechanics cards, pen and paper to help the creative process.

4. **Revise ideas** (~15 min)

Have user revise his/her ideas, highlighting those of greater preference.

5. **Wrap up** (~5 min) Handing the participant an incentive for participation and inform about

future steps in the project

To see how the workshop acted out, we held a rehearsal run together with J. Floch, researcher in the MyCyFAPP project, acting as a end-user. Aside from uncovering ideas of improvement, the rehearsal also gave rise to concerns in relation to the ideation part of the workshop. The concerns were about whether the user actually would be able to come up with gamification ideas in such a “large room”, or if they would need some more constraints or structure in order to come up with ideas. There were also concerns to whether the user only would create ideas of the mechanics we present to them or if they would think beyond those. Discussing this resulted in a hypothesis that it would depend a lot on the user and that the method *might* be sufficient if supported with good prompting and guiding questions. Consequently, we prepared some open guiding questions, or **innovation stems**, as suggested by S. Deterding [45], in case the user would get "stuck": 1) What challenges are inherent in [activity]? Why is this [goal]/[activity] challenging? The complete workshop setup can be studied in appendix C.

## A.2 Testing the ideation workshop setup

As the subject of the rehearsal was in fact a researcher, the rehearsal run led to more discussion about the method rather than the actual purpose of the pilot - to investigate how the workshop would act out with an end-user. Because of this, we decided to investigate the setup validity further by running another test of the workshop with a different profile acting as end-user, using a fictive scenario within a different context, specifically nutrition tracking for weight loss support from the smartphone application MyFitnessPal<sup>1</sup>. This context was chosen because we considered it easy to grasp, also we didn't consider the choice of context as crucial as the point of the pilot workshop was to evaluate the actual ideation process, independent of the context. In order to be confident of the method we defined the following questions to be answered after running

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<sup>1</sup>www.myfitnesspal.com: "The fastest, easiest to use calorie counter app."

the pilot.

**Q1** Will this setup be sufficient for the participants to come up with his/her own ideas?

**Q2** Will the participants think beyond the presented gamification mechanics when creating ideas?

**Q3** Will the participants make ideas based on the supporting goals of the application?

**Q4** Will the participants' statements help us understand how the mechanics contribute to increase motivation?

**Q5** What are the implications of participants' game experience on suggested ideas?

### **A.2.1 Ideation workshop test runs**

We arranged two test workshops with two participants, one participant per workshop. Participant #1 was a 24 year old male structural engineering student, while participant #2 was a 23 year old female nurse. The participants were not informed what they were gonna participate in - this to make sure they had no way to prepare, consequently being the most dependant on the workshop setup as possible. Details and summaries of the test runs with participant #1 and #2 are presented in appendix E and appendix F respectively. After running the tests we were able to answer the defined questions:

**Q1** Will this setup be sufficient for the participants to come up with his/her own ideas?

**A1 Positive - Both participants managed to come up with a number of ideas, though having very different relationships and experience with games and computers. When the participant had trouble proceeding the prompting questions showed to be very effective to help the user come up with new ideas.**

**Q2** Will the participants think beyond the presented gamification mechanics when creating ideas?

**A2 Positive - Both participants suggested multiple ideas using other mechanics than the ones presented to them. This indicates them focusing on the goal, challenges and motivation rather on the mechanics themselves, which is what we want.**

**Q3 Will the participants make ideas based on the supporting goals of the application?**

**A3 Partially positive - The participants mostly came up with ideas directly connected to user goals but would occasionally drift off to thoughts not connected to the goals. This might have something to do with the participants not living a daily life matching the context of weight loss. We will see if this changes when we run the workshop on real participants in their context. However, we don't consider this a problem as it is brainstorming and limiting the participants' "creative space" could impact the ideation flow negatively.**

**Q4 Will the participants' statements help us understand how the mechanics contribute to increase motivation?**

**A4 Neutral - The participants' statements were sometimes less clear and the motivation behind them could be difficult to understand. When failing to understand how the mechanics would contribute to increase the participants' motivation we prompted them to discussion. Most of the times prompting would help us understand the participants' motivation, but occasionally the participants' weren't able to explain how he/she'd be motivated by the mechanics. However, both participants came up with ideas that they, when revised post-brainstorming, truly liked and believed would help motivate them to achieve their goals. A recurring tendency is that the ideas the participants are most satisfied with appeared in the beginning of brainstorming for a new support goal, happening in both of the pilot runs. The participants also had no problems gaining our understanding when discussing the ideas of greater preference.**

**Q5 Will participants with a higher level of experience with games suggest more ideas not using the presented mechanics?**

**A5 Neutral - One of the participants had above average level of experience with games while the other had below average experience. The majority of ideas suggested by both participants used one or more of the presented mechanics, but both participants also suggested ideas not using the presented ideas. The low experienced participant suggested ideas less detailed/technical than the high experience participant, but the difference do not indicate a pronounced effect to how the participants is able to think freely from the presented mechanics.**

We also discovered some general ideas to improve the workshop by running test workshops. One example is that writing the post-its while doing the ideation might disturb the flow of the conversation. We therefore decided to have one of us talking to the participant while another one would write down all the ideas on post-its and put them up on the whiteboard. This confirms statements in literature on interviews [58] suggesting a team of two persons, where one of them lead the interview with the other person backing him up. Results from the test workshops made us confident that the chosen ideation setup was good enough to use with real participants. The finished ideation workshop setup can be studied in appendix C. We decided to answer the questions again after running the workshop with real end-users to address any differences between the pilot and actual runs of the workshop, presented in the following section.

### **A.3 Verifying the ideation workshop setup**

In this section we answer the questions on concerns regarding the ideation workshop setup again after running it with "real participants" i.e. CF patients, to verify the ideation workshop's ability to produce gamification ideas, and also to address differences from the test runs.

**Q1** Will this setup be sufficient for the participants to come up with his/her own ideas?

**A1 Positive - The participants of the real workshop runs had an even easier time coming up with ideas than the participants in the pilot workshop had. The participants came up**



**with 50 ideas, 41 of them being gamification ideas. A hypothesis to why the real run produced a larger amount of ideas is that the scenario was real and based on the participants daily challenges, while the pilot workshops were based on a fictive scenario of weight loss with participants not having a daily life in that context.**

**Q2** Will the participants think beyond the presented gamification mechanics when creating ideas?

**A2 Positive - The participants actually suggested/invented an even higher number of gamification mechanics than the number of mechanics presented to them, confirming the method's ability to let the users focus on the goals, challenges and motivations rather than limiting them to a set of specific mechanics.**

**Q3** Will the participants make ideas based on the supporting goals of the application?

**A3 Positive - The users focused on the supporting goals when creating ideas. However, one participant suggested creating ideas for the goal "Learn to estimate enzymes" and then proceeding creating several ideas specifically for the goal "Learn more about nutrition". Another participant created several ideas involving multiple support goals. The fact that the users sometimes drifted to other goals than the one we focused on was considered perfectly fine as interrupting their creative flow could result in missing out on important insights. The users picked supporting goals to brainstorm based on what needs and challenges they had with their illness. The psychological outcomes mentioned firstly in the interviews was also the most recurring target motivation. For P1 it was the social aspects and for P2 it was competition.**

**Q4** Will the participants' statements help us understand how the mechanics contribute to increase motivation?

**A4 Positive - The participants came up with ideas they truly liked and believed would help motivate them to achieve their goals. As with the test workshops, there were tendencies**

**to users liking the ideas they suggested in the beginning of the brainstorming the most.**

**Q5** What are the implications of participants' game experience on suggested ideas?

**A5** The participants had a quite similar level of experience with games, both playing video games daily. A slight majority of the suggested ideas used presented gamification mechanics and the rest came entirely from the users fantasy. As with the test workshop participant with a high level of experience with games, both participants formulated their ideas in a quite detailed manner.

The workshop setup proved to be an effective method to create gamification design ideas, as it successfully provided the participants with the understanding needed to create gamification design ideas and resulted in 41 gamification ideas and 4 hours of captured discussion.

## **B | Gameful design plan**

This appendix describes how we have used the five steps for gameful design, in innovative mode, described in Deterding's "The Lens of Intrinsic Skill Atoms: A Method for gameful design" [9], to identify target outcomes, user constraints, needs and activities. The activities deconstructed into needs, motivations, hurdles and behavior chains and ultimately evaluated for gameful fit. This appendix presents step 1-4. The next step is ideation, at which we involved users to co-designed gamification solutions for the activities. The ideation workshop setup is presented in a separate appendix C.

<b>1 Strategy</b>	
a. Define target outcome and metrics	<ul style="list-style-type: none"> <li>● Increase user motivation and encourage for self-management activities.</li> <li>● Increase number of registered data by users.</li> <li>● Increase knowledge about nutrition and content of food products.</li> <li>● Increase knowledge about Cystic Fibrosis</li> <li>● Increased understanding about the relation between treatments and health status</li> <li>● Increase physical activity</li> <li>● Learn to estimate creon intake</li> <li>● Eat healthier</li> <li>● Reach nutritional goals</li> <li>● Save time</li> </ul>
b. Define target users, context, activities	<p>The users are people diagnosed with CF. MyCyFAPP have identified three main factors that influence the patients daily life, namely age, health condition and situation. Also five main motives for the users were identified: (a) wanting to stay healthy (b) live their life as “normally” as possible (c) feel independent, and (d) forget about-/being distracted away from their disease. Users spend hours each day on treatment, taking medications in the form of pills, inhalers, and enzyme replacement. Most patients are also recommended regular physical exercise.</p>
c. Identify constraints and requirements	<ul style="list-style-type: none"> <li>● Time: Users already spend several hours each day with their treatments. The design must therefore allow for simple and quick use.</li> <li>● Rarity: It’s not likely that CF patients have other friends who also have CF which might put constraints on social game design mechanics.</li> <li>● Customization: Patients knowledge about health, nutrition and disease varies a lot, requiring the game mechanics (e.g. challenges) to adjust accordingly.</li> <li>● Varying perceived increase in motivation: Individuals might have different perceptions on which game elements that motivate them. We must therefore use the identified main motives when discussing gameful design.</li> <li>● Pressure: Penalization should be avoided as users have enough pressure from the disease</li> <li>● Sickness: Users may not be able to register data or follow up a diet when very sick</li> </ul>

2. Research	
<p>a. Translate user activities into behavior chains (optional)</p> <p>b. Identify the needs, motivations, hurdles</p> <p>c. Determine gameful fit</p> <p>The activity is considered fit for gameful design if the following questions can be answered in the positive:</p> <ul style="list-style-type: none"> <li>● Does the activity connect to an actual user need?</li> <li>● Is lacking motivation a central issue or opportunity?</li> <li>● Does the target activity involve an inherent challenge with a learnable skill?</li> <li>● Is affording experiences of competence the most effective and efficient way of improving motivation</li> </ul>	<div data-bbox="630 296 1360 827" style="border: 1px solid black; padding: 5px;"> <p><b>Activity: Register meal</b>                      User goal: Eat better, get an estimated recommended enzyme dosage                      System goal: Increase number of registrations                      User needs: Learn about nutrition and how it affects health                      Behavior chain: plan meal &gt; get ingredients &gt; input ingredients/favorite dish &gt; input ingredient amount/portion size &gt; confirm number of taken enzyme capsules with meal                      Motivation: Mastery: Maintaining health and well-being;                      Learning: Learn about food nutrition and how it affects symptoms, as well as increase creon estimation skills.                      Hurdles: Registering takes some time to do, in addition to actually making the meal;</p> <p><i>The activity is considered a gameful fit</i></p> </div> <div data-bbox="630 863 1360 1394" style="border: 1px solid black; padding: 5px; margin-top: 10px;"> <p><b>Activity: Daily health registration</b>                      User goal: Increase user motivation                      System goal: Increase number of registrations                      User need: Collect and share information with HP and get an overview of health                      Behavior chain: input health symptoms &gt; input mood &gt; register                      Motivation: Learning: Learn to interpret symptoms,                      Autonomy/Control: Perform activities known to help specific symptoms                      Hurdles: Registering takes some time to do, can become another daily repetitive action. Also may become a reminder about their disease which can be tiresome if they want a break or to be distracted.</p> <p><i>The activity is considered a gameful fit</i></p> </div> <div data-bbox="630 1430 1360 1892" style="border: 1px solid black; padding: 5px; margin-top: 10px;"> <p><b>Activity: Read education material</b>                      User goal: Acquire more knowledge on CF                      System goal: Increase user competence                      User need: High quality information                      Behavior chain: have questions &gt; navigate educational material &gt; read material                      Motivation: Learning: Acquire advanced knowledge and self-management skills.                      Hurdles: User knowledge may vary from each individual. Many do not wish to be constantly reminded of their condition, so high quality information must be ensured.</p> <p><i>The activity is considered a gameful fit</i></p> </div>

	<div data-bbox="630 226 1360 695"> <p><b>Activity: Register physical activity</b>                  Goal: Increased user well-being and overall health.                  User need: Maintain health and learn about nutritional compensation in relation to physical activities.                  Behavior chain: perform physical activity &gt; input activity data                  Motivation: Learning: Learn how physical activity affects symptoms, Learn to compensate with nutrition after doing intense physical exercise. Autonomy: Perform activities known to help relieve symptoms.                  Hurdles: Estimating activity intensity</p> <p><i>The activity is <u>not</u> considered a gameful fit as it does not support an actual user need.</i></p> </div> <div data-bbox="630 730 1360 1226"> <p><b>Activity: Manage treatment reminders</b>                  Goal: Remind user to take medicine/perform treatment and track treatment                  Metric:                  User need: Remember to take medicine, be in control of managing reminders.                  Behavior chain: create reminder &gt; be reminded &gt; take medicine/treatment &gt; confirm taken medicine/snooze                  Motivation: Mastery: Get used to performing treatment, Reduce stress: Ease worrying about- and planning treatment                  Hurdles: Alarm taking too much attention while in social settings (needs to be discreet and practical).</p> <p><i>The activity is considered a gameful fit.</i></p> </div>
<p><b>3. Synthesis</b></p>	
<p>a. Formulate activity, challenge, motivation triplets for opportune activities/behaviors. These triplets serve as main input for the ideation step.</p>	<div data-bbox="630 1423 1360 1623"> <p><b>Activity: Register meal</b>  <i>Activity-Challenge-Motivation triplet:</i>                  Register meals &gt; Make registering more enjoyable and less of a burden &gt; Maintain health and well-being and learn about food, nutrition and how it affects health.</p> </div> <div data-bbox="630 1654 1360 1854"> <p><b>Activity: Daily health registration</b>  <i>Activity-Challenge-Motivation triplet:</i>                  Register health symptoms &gt; Make registering more enjoyable and less of a burden &gt; Learn, understand and communicate health status</p> </div>

	<p><b>Activity: Read education material</b>  <i>Activity-Challenge-Motivation triplet:</i>                  Read educational material &gt; Make educational material fun to learn (not just be a reminder of illness) &gt; Acquire advanced knowledge and skills of CF and self-management</p> <p><b>Activity: Manage treatment reminders</b>  <i>Activity-Challenge-Motivation triplet:</i>                  Manage reminders &gt; Taking too much attention, becoming a tiresome reminder of illness &gt; Complete all steps of treatment regimen to maintain health and well-being</p>
<p><b>4. Ideation</b></p>	
<p>a. Brainstorm ideas using innovation stems</p>	<p><b>Activity: Register meal</b>                  Goals: Learning about nutrition and how it affects health, Enhance ability to estimate creon, prevent “boring” repetition</p> <p><b>Activity: Daily health registration</b>                  Goals: Understand health and increase the ability to communicate it to HPs.</p> <p><b>Activity: Read education material</b>                  Goals: Increase knowledge and skills on CF and self-management.</p> <p><b>Activity: Manage reminders</b>                  Goals: Remember to take all medicines to maintain health</p>

## **C | Ideation workshop setup**

This appendix presents the setup and interview guide used in the conducted workshops. The appendix is presented in Norwegian and English; as the workshops were held in Norwegian speech is presented in Norwegian while planned steps/content are presented in English.



## C.1 Tools

Post-it notes, Whiteboard and markers, Blank papers, Gamification mechanic design cards, Innovation Stems [9], Application activity screenshots, Projector, Project PowerPoint presentation

## C.2 Structure

Bold text represent a planned part of the interview, italic text represents speech and lines beginning with a 'Q' represents a question.

### C.2.1 Intro (10 min)

#### 1. Inform the participant about estimated workshop duration

*Tusen takk for at du kunne komme og stille opp her i dag! Som du kanskje har fått beskjed om tidligere har vi satt av 2-3 timer til det vi skal gjøre i dag.*

*Q: Passer det for deg?*

#### 2. Describe the purpose of the interview

*Jeg heter Ole Hansen og studerer datateknologi ved NTNU. Jeg holder på med min masteroppgave i samarbeid med SINTEF og MyCyFAPP. Som du vet holder prosjektet MyCyFAPP på med utvikling av sin app for CF og prosjektet er nå på et stadie hvor det skal designes løsninger for å øke motivasjonen og brukergleden i applikasjonen. For å gjøre det har vi tenkt å bruke et konsept som heter Gamification.*

*Q: Har du hørt om Gamification?*

#### 3. Describe gamification briefly and discuss

*Gamification er et konsept som går ut på å bruke spillelementer i seriøse kontekster for å gjøre applikasjoner morsommere å bruke. Vi skal snakke mer om det senere.*

#### 4. Inform the participant about his/her role in the research project

*For å finne ut hvordan vi kan bruke gamification i denne applikasjonen er vi avhengige av å samarbeide med potensielle brukere, dere. Vi må forstå hva dere synes er viktig med applikasjonen og passe på at vi velger gamification som ivaretar de tingene. I tillegg vil vi finne ut av hvilken gamification som kan motivere dere og få dere til å oppleve applikasjonen som mindre strevsom-, eller rett og slett morsommere å bruke!*

*I dag er du eksperten og vi vil gjerne lære av deg. Etersom dette er et forholdsvis langvarig forskningsprosjekt med flere trinn vil du, litt avhengig av hva du selv ønsker, kunne være med på å skape en viktig verktøy for mennesker med CF.*

#### **5. Inform the participant about the workshop steps**

*I dag skal vi hovedsakelig gjøre noen idéaktiviteter også vil det være noen spørsmål underveis. Det vi ønsker i dag er å få i gang en slags tankeprosess der vi kan bruke fantasien og tenke ut ideer til gamification som dere kunne tenkt dere i en app for CF. Ingen svar eller ideer er dårlige, ikke hold igjen - bare spytt ut så fort du kommer på noe. Vi kommer til å stille noen åpne spørsmål underveis, for å skape litt diskusjon og kanskje grunnlag for enda flere ideer.*

#### **6. Ask if the user has any questions before starting**

*Q: Har du noen spørsmål før vi begynner?*

#### **7. Inform the participant about the information security and hand out consent that the participant signs.**

*Nå skal jeg opplyse litt rundt informasjonssikkerhet som jeg gjerne vil ha din godkjenning på før vi begynner. Hvis det er greit for deg, så tenkte vi å gjøre lydopptak her i dag som det sannsynligvis vil skrives transkript på i ettertid. Det som snakkes om her i dag vil resultere i et datamateriale. Det datamaterialet vil lagres på en server her på SINTEF og være beskyttet av passord. I tillegg vil datamaterialet anonymiseres. Det vil si at det ikke er mulig å føre opplysningene tilbake til dere som intervjues.*

*Q: Var det klart og tydelig?*

## C.2.2 Presentation (20 min)

### 1. Hold an introductory presentation of two parts

#### (a) Present the MyCyFAPP project and application support goals

Presentation. See appendix D, page 1-3.

#### (b) Ask the user questions to get an impression what relationship they have to games and gamification, as well as which things motivate them.

*Q: Hvilke data/videospill spiller du og hvorfor?*

*Q: Hvordan er ditt forhold til applikasjoner som bruker gamification?*

*Q: Har du noen umiddelbare tanker i forhold til gamification i en app for CF?*

#### (c) Present gamification and popularly used gamification mechanics

Presentation. See appendix D, page 4-9.

## C.2.3 Ideation

The user picks a support goal in the application that they are more interested in.

### C.2.3.1 Brainstorming (60min - 90min)

Brainstorm gamification ideas while asking questions to gain useful insights in relation to research questions. The user has gamification design cards available as guiding tools, and can also draw sketches to help the creative process. Ideas are written on post-its when created and then put on the whiteboard. If the user is "stuck" we ask them some guiding questions. We create ideas until the user is satisfied, then pick another support goal and repeat the process.

*Nå skal vi gå gjennom mål for mål og forsøke å tenke ut ideer på gamification-løsninger for hvert mål. Vi har disse målene og nå kunne vi gjerne tenke oss at du velger et av disse målene som du synes er viktig også starter vi med det. Vi bruker disse arkene til inspirasjon også skriver vi ned*

*alle ideer vi kommer på på post-it-lapper, kanskje diskuterer de litt og henger de opp på tavla. Vi kan også bruke ark og penner.*

**Guiding questions:**

*Q: Hva gjør at det er ønskelig å [mål]/[aktivitet]?*

*Q: Hva er utfordringene med dette [målet]/[aktiviteten]? Hva kan gjøre det enklere å overkomme de utfordringene?*

**C.2.3.2 Revise ideas (15min)**

We go through the ideas on the whiteboard to determine which ones are the most promising, based on participant preference.

*Nå skal vi gå gjennom ideene og rangere dem fra best til dårligst for hvert mål.*

**C.2.4 Wrap up (10 min)**

We hand the participant a gift card for their participation. We inform the participant on the future stages of the project and thank them for their time.

*Vi kommer til å jobbe med tilbakemeldingene fra alle rundene med intervjuer og ut i fra det lage et konsept. Vi kommer til å kontakte dere igjen for evaluering av konseptet og dere kan også få mulighet til å teste ut applikasjonen så fort vi har en klar testversjon.*

*Q: Er det noe du tenker at vi enda ikke har vært innom? Har du fått noen ideer underveis som du ikke har fått sagt?*

*Q: Er det noe du vil spørre oss om?*

*Tusen takk for intervjuet og tiden du har brukt her i dag, det setter vi stor pris på!*

## **D | Workshop presentation**

This appendix presents the presentation used in the design workshops to inform the participants about the project but also provide the user with some understanding to what gamification is and how it has been used earlier. Pages 5-11 presents the gamification mechanics cards employed as tools in the ideation workshop.

## MyCyFAPP prosjekt



2015: Intervjuer & co-design

2016: Godkjenning av design & start av utvikling

2017 – Første halvår: Gamification design

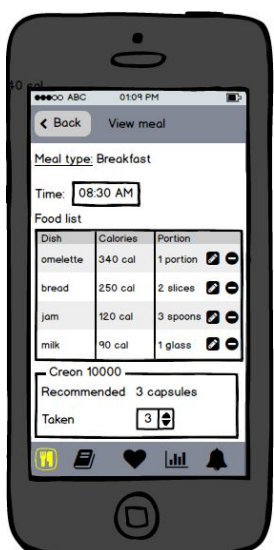
2017 – Andre halvår: Klar applikasjon

## Hvordan kan MyCyFAPP støtte selvadministrering av CF

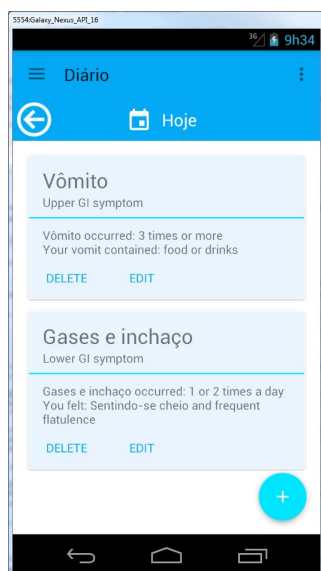


1. Lære om ernæring og hvordan det påvirker helsen.
2. Lære- og utvikle evnen til å estimere enzymer mer presist.
3. Forstå helsetilstand og øke evnen til å formidle det til legen.
4. hjelpe til å være sikker på at man tar den medisinen man skal.
5. Lære mer om CF og behandling.

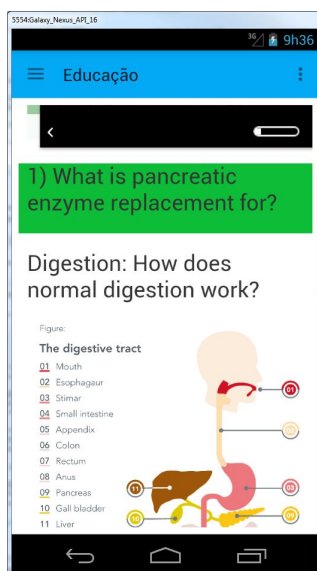
## Hvordan ser applikasjonen ut?



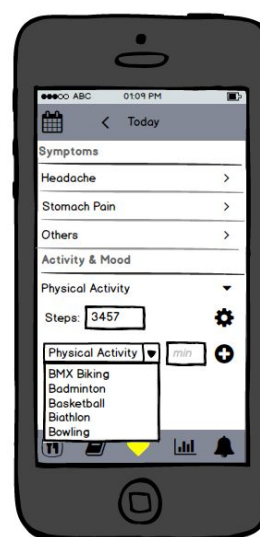
Registrering av mat og beregne Creon-dose



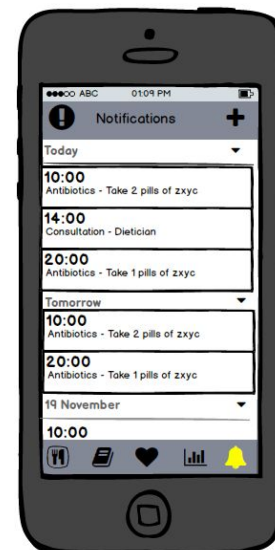
Registrering av symptomer



Læringsmatriale



Registrering av fysisk aktivitet



Påminnelser & notifikasjoner





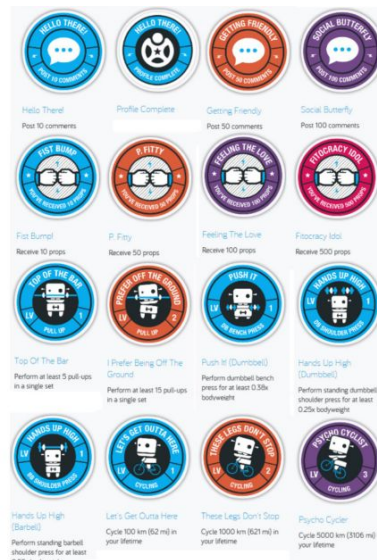
## Gamification: Hvorfor? Hvordan?

- *Bruke spill-elementer i ikke-spill-sammenhenger*
- Fokuserer på brukerens naturlige behov og ønsker, f.eks:
  - Mestring
  - Eierskap
  - Utvikling
  - Økt kompetanse
  - Konkurrans
  - Samarbeid
  - Sosialisere
- Trigge *meningsfull* motivasjon
  - Legge til en *ytre* verdi
  - Øke en *indre* verdi



# Badges

Et symbol/trofé på meningsfylt arbeid.



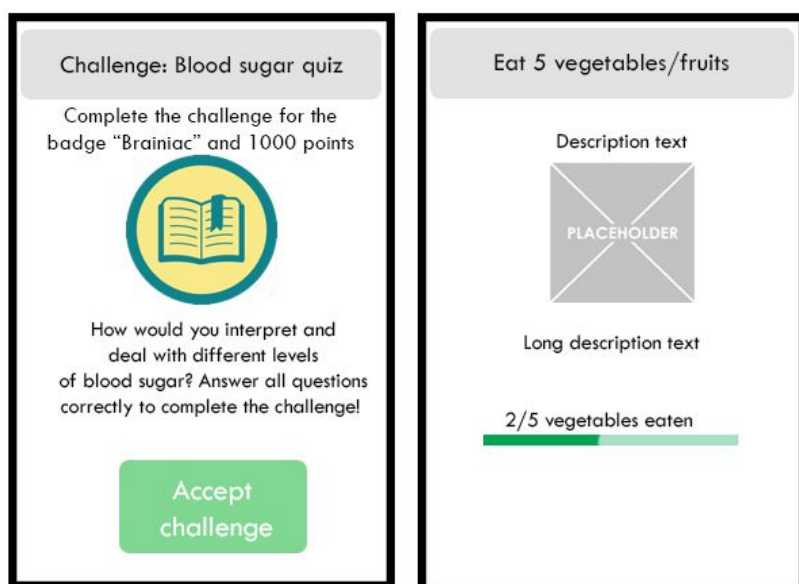
Eksempel: Fitocracy

## Motivasjonsaspekter

- Måloppnåelse: Lykkes med å nå mål
- Sosialt: Vise frem hva man har oppnådd for andre brukere.

# Challenges

Utfordringer med konkrete mål som leder til en gevinst.



Eksempel: Pre-definert utfordring (quiz)

Eksempel: Lage sine egne mål

## Motivasjonsaspekter

- Mestringstro: Føle seg rustet til å gjennomføre en utfordring og få det bekreftet ved å gjennomføre den.

# Sosiale aspekter

La brukere kommunisere, samarbeide eller konkurrere.

#1		Norway	49211p.
#2		Italy	42215p.
#3		Germany	21888p.
#4		Portugal	12092p.
#5		Spain	9660p.

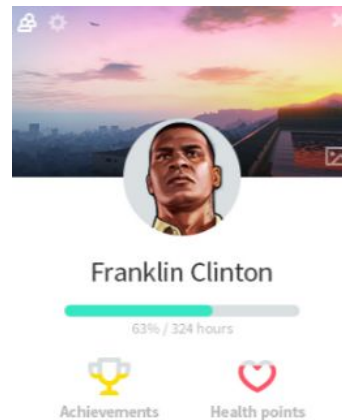
Leaderboard: Samarbeide i konkurransen



Eksempel:  
Konkurrere/samarbeide mot venner

## Motivasjonsaspekter

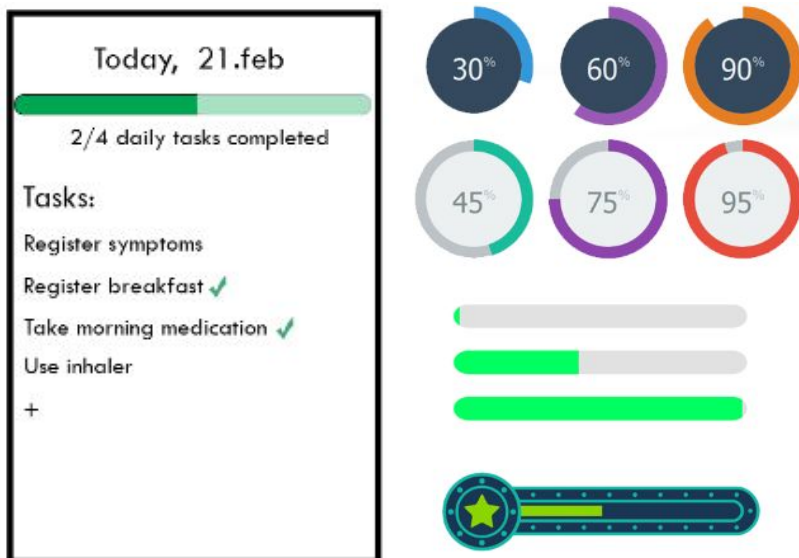
- Konkurransen: Å konkurrere med kjente og ukjente i applikasjonen
- Samarbeid: Samarbeide mot et felles mål



Eksempel:  
Offentlig/privat profil

# Progress bars

Indikerer progresjon hos brukeren



## Motivasjonsaspekter

- Progresjon: Håndfast indikasjon på at brukeren er på vei i riktig retning mot et mål.

# Avatars

En virtuell representasjon av en karakter



Fantasikarakter



Representasjon av brukeren

## Motivasjonsaspekter

- Progresjon: En avatar som utvikler seg etterhvert som brukeren oppnår mer i applikasjonen.
- Feedback: Bruke avatar som feedback på prestasjon.



Example: Waze



Example: Ninja Fitness



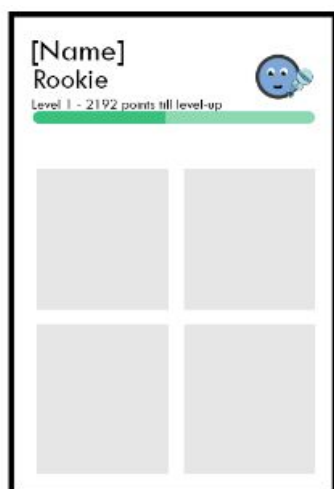
Example: Diabetes Monster  
from mySugr

# Points and levels

Poeng som tildeles brukeren ut når handlinger, oppgaver eller utfordringer utføres.

# XP

Eksempel:  
Erfaringspoeng



Eksempel:  
Virtuell valuta

## Motivasjonsaspekter

- Utvikling: Når man oppnår et nytt nivå i applikasjonen har man også blitt bedre på det applikasjonen egentlig skal gjøre en bedre i.

# Rewards

## In-game rewards



## Out-game rewards



### Motivasjonsaspekter

- Belønning: Belønninger som gir ekstra motivasjon i forbindelse med utførelse av oppgaver.



## **E | Test workshop # 1**

This appendix describes the first test workshop run we held to validate the workshop method. We used a fictive scenario within a different context, specifically nutrition tracking for weight loss with support from the smartphone app MyFitnessPal.

## E.1 About participant

The participant is a 24 year old structural engineering student. He plays Counter-Strike and Hearthstone for fun. He has mixed experiences with gamification. He has used Untappd <sup>1</sup>, in which the gamification didn't really impact his motivation at all. He has also used Endomondo <sup>2</sup>, which he liked and in which he enjoyed the impact gamification had on his motivation.

## E.2 Brainstorming

The ideas are presented in chronological order. The participant chose the goal "Help to control daily calorie intake" as the goal to begin the ideation with.

### E.2.1 Goal 1: Help to control daily calorie intake

**"Fruit Ninja for every registered ingredient"** The participant was asked how that idea would help him control daily calorie intake, which he couldn't answer.

**"Extra points each time you eat a food considered healthy"** Each time one register something you will get points, and every time it is a healthy registration you would get bonus points.

**"An avatar that reflects your eating"** An avatar that would get slimmer and in better shape for each day the user would stay below his maximum daily calorie limit. The avatar can be a mix between a real representation of himself and fantasy. The participant would like the face to be his, for example by the use of a photo function. He'd like the body of the avatar to be more like in a caricature to make it more informal.

**"To buy in-game items for some virtual currency that can be applied to your avatar"**

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<sup>1</sup>[www.untappd.com](http://www.untappd.com): Untappd is a free app for iOS, Android and Windows Phone that allows you to socially share the brew you're currently enjoying, as well as where you're enjoying it, with your friends!

<sup>2</sup>[www.endomondo.com](http://www.endomondo.com): Endomondo is a free app and website that makes fitness fun and helps you stay motivated.

**"Buy "mystery boxes" that can contain items"** A chance to "gamble" your acquired currency on a mystery box that can contain items for your avatar.

**"Achievements, for example eating ten different kinds of vegetables"** Achievements, for example to help people replace calorie rich food with vegetables. The available achievements should be visible as guidance so the users know what to do to improve their eating. The participant was asked how we could be motivated to take on achievements like this, and he suggested to be awarded with badges that represent the achievement and a number of points, where the number of points would reflect the difficulty of the achievement.

## **E.2.2 Goal 2: Learn about nutrition**

**"Nutritional challenges, for example eating 15 grams of fiber in a day."** Challenges that you can accept to take on and then you would, in this example, get tips to which ingredients that are rich in fibers. The same applies for proteins, meat low in fat or fish. The participant emphasized that the challenge should be something the user initiates to learn anything from it.

**"Point system that would give you points in different aspects of nutritional knowledge"** Another type of points to be acquired that would allow the user to "rank up" in knowledge levels. An example could be if you complete all fiber challenges you could have a rank title like "Fiber Expert".

**"Super-rare items as reward when completing all challenges within a specific theme"** . For example a pet for his avatar

**"Avatar reflecting nutrient balance"** Your avatar could lose muscles from eating too little protein and also look sick or tired if you are eating too much junk food.

**"A profile showing your avatar with level and achieved badges"** One must have privacy options, for example let users keep the profile private.

**"A user level that reflects experience and another "rank" reflecting dedication"** A level representing time spent in the application, and then another one to reflect the user's dedication. In that way you can show that you are experienced without being dedicated, but also the other way around.

## **E.3 Review ideas**

### **E.3.1 Goal 1: Help to control daily calorie intake**

The participants liked the idea about the avatar the best, and wanted it to be the main element in the gamification implementation should be the avatar. He also liked the idea about achievements for the goals to complete and help them choose "calorie-smart" foods.

### **E.3.2 Goal 2: Learn about nutrition**

The participant really liked the idea about "nutritional challenges with guidance" for learning. He also liked having Levels and Ranks so the user gets a feel of progression in the application, either by experience, dedication, or both.

### **E.3.3 Observations**

I felt that the participant was above medium "easy" to work with. He is skilled and experienced with computers and games but also creative. He came up with a lot of good suggestions in the ideation.

His ideas often emerged from each other. When he suggested an idea the next one would often be connected to it. He created some ideas directly connected to the application support goals, for example challenges with guidance to learn more about nutrition. We had some flow issues regarding writing all ideas on post-its, and the result of this was that only the ideas discussed was put up on the board. I think the prioritization part didn't really matter much because of the low number of post-its. Some ideas also were directly connected to other ideas and it was hard to

rank these ideas above/below each other. Next time we will review the ideas and discuss which ones the user likes best, rather than to strictly rank/prioritize them. The participant himself didn't think the structure is insufficient to come up with ideas. His performance was really good taking into consideration that he didn't have any way to prepare beforehand.

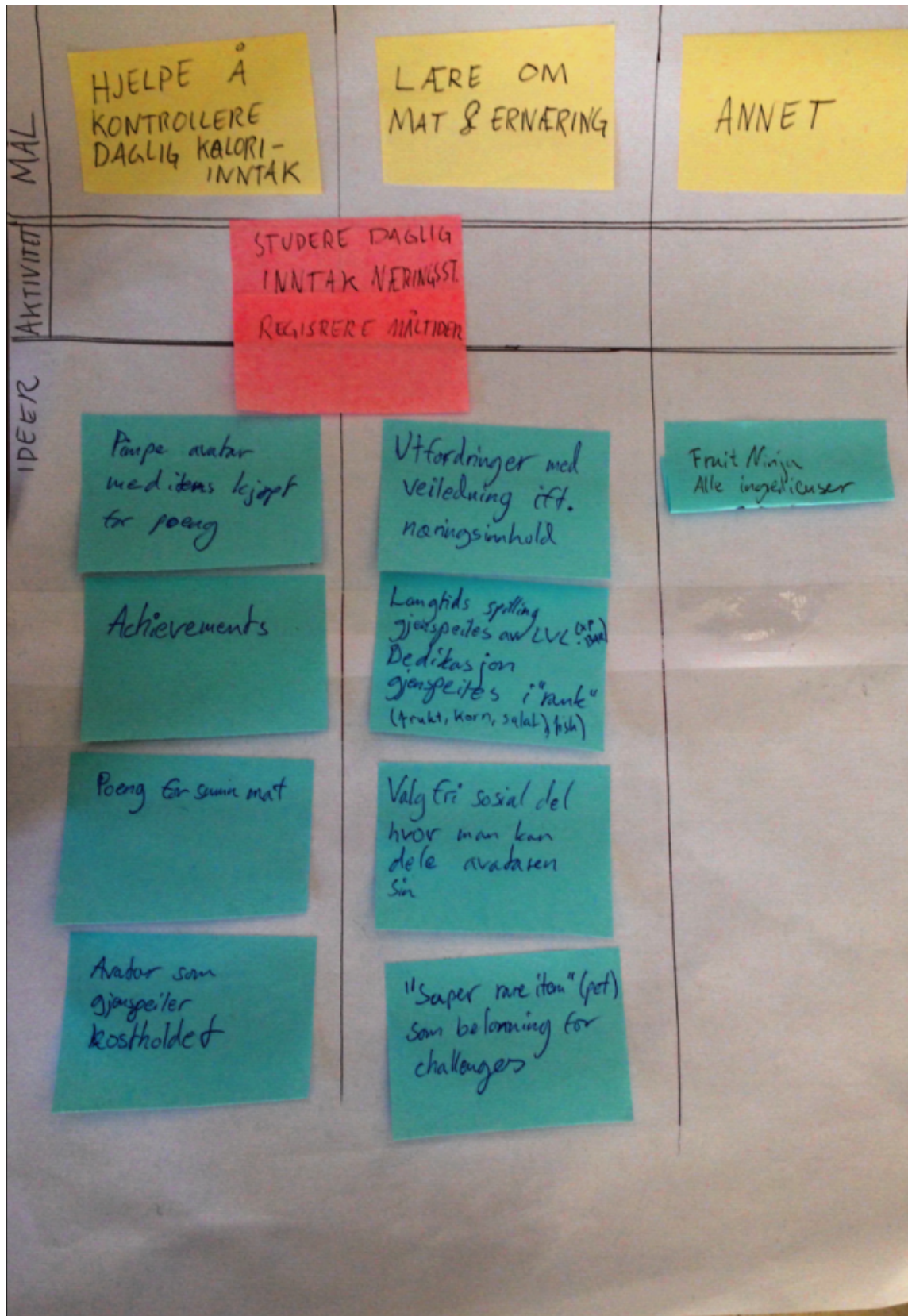


Figure E.1: Test workshop #1: Resulting ideation board

## **F | Test workshop # 2**

This appendix describes the second test workshop run we held to validate the workshop method. We used a fictive scenario within a different context, specifically nutrition tracking for weight loss with support from the smartphone app MyFitnessPal.

## F.1 About participant

The participant is a 23 year old female nurse. She doesn't play computer or video games. She has never heard of gamification and no experience with gamified applications.

## F.2 Brainstorming

The ideas are presented in chronological order. The participant chose the goal "Help to control daily calorie intake" as the goal to begin the ideation with.

### F.2.1 Goal 1: Help to control daily calorie intake

She spent some time and didn't quite know how to begin. I noticed this and asked her a guiding question "What do you think are the challenges in the associated activity of registering meals?". This got her going right away. She answered "I think the registering might take a lot of time and be boring if you have to do it for all meals". She continued to propose an idea:

**"Small prize for registering meal, and then a larger prize for a whole day of registrations"** I asked her what prizes could motivate her to register all meals.

**"Points for registering meals"** I asked here how gaining points would help her control her daily calorie intake. She answered "I just want to collect points". I replied with "Do you have any idea how the points can motivate you to want to collect them?" She answered with an idea:

**"Getting badges for reaching a predefined number of points"** She also suggested getting nicer and nicer badges the more points she could acquire.

**"Reward at the end of the week if you have stayed below max calorie amount all week"** The application lets the user set a calorie "roof" for each day to know how much users can eat to



lose weight. The participant suggested getting points for registering meals and then a reward at the end of the week if they managed to eat less than their calorie goal all days of the week. I asked her "What reward would motivate you to eat healthy all week?" She answered with another idea:

**"Getting access to more advanced functionality"** She suggested getting some "Pro features" when accomplishing the weekly goal. I prompted "You said you wanted badges for reaching a predefined number of points. Would you also like badges that reflect the motivation of the goal?" She answered:

**"Badges that represent weight loss"** She suggested that users could register their weight in the end of every week and be awarded a badge when they had lost N kilos or N% of their starting weight. I asked: "Do you want these badges to be listed so you can go see what badges are available and how to achieve them?" She answered "No, I want them to be a surprise" before suggesting another idea.

**"A progress bar that shows how close you are to your goal weight"** I asked whether she'd like to create goals in the application. She answered:

**"I'd like to be able to create activity goals"** She suggested custom goals like going to exercise N times a week.

**"Input what physical activities you enjoy and get tips based on that"** She suggested getting tips to fun activities similar to activities the user enjoys doing. I asked her if she'd like to share her accomplishments with others also using the application. She didn't want a social aspect but came up with another idea:

**"Some leaderboard where anonymous users can see their weight loss compared to others"** She suggested an anonymous leaderboard where users can see how much weight they have lost compared to people in the same town/country. Then the ones who lost the most weight in one month could get a rare badge for it.

### **F.3 Observations**

The participant did sometimes get stuck but proceeded easily when being asked guiding questions. The participant also had less detailed and specific ideas than the first participant in workshop #1 (See appendix E. This is probably because of her little experience with games and gamification. The participant produced a satisfyingly high number of ideas considering we only spend twenty minutes on the ideation. This was also considered a particularly hard case because of the participant's little experience with computers and games, and the results are really promising for my planned workshop method.

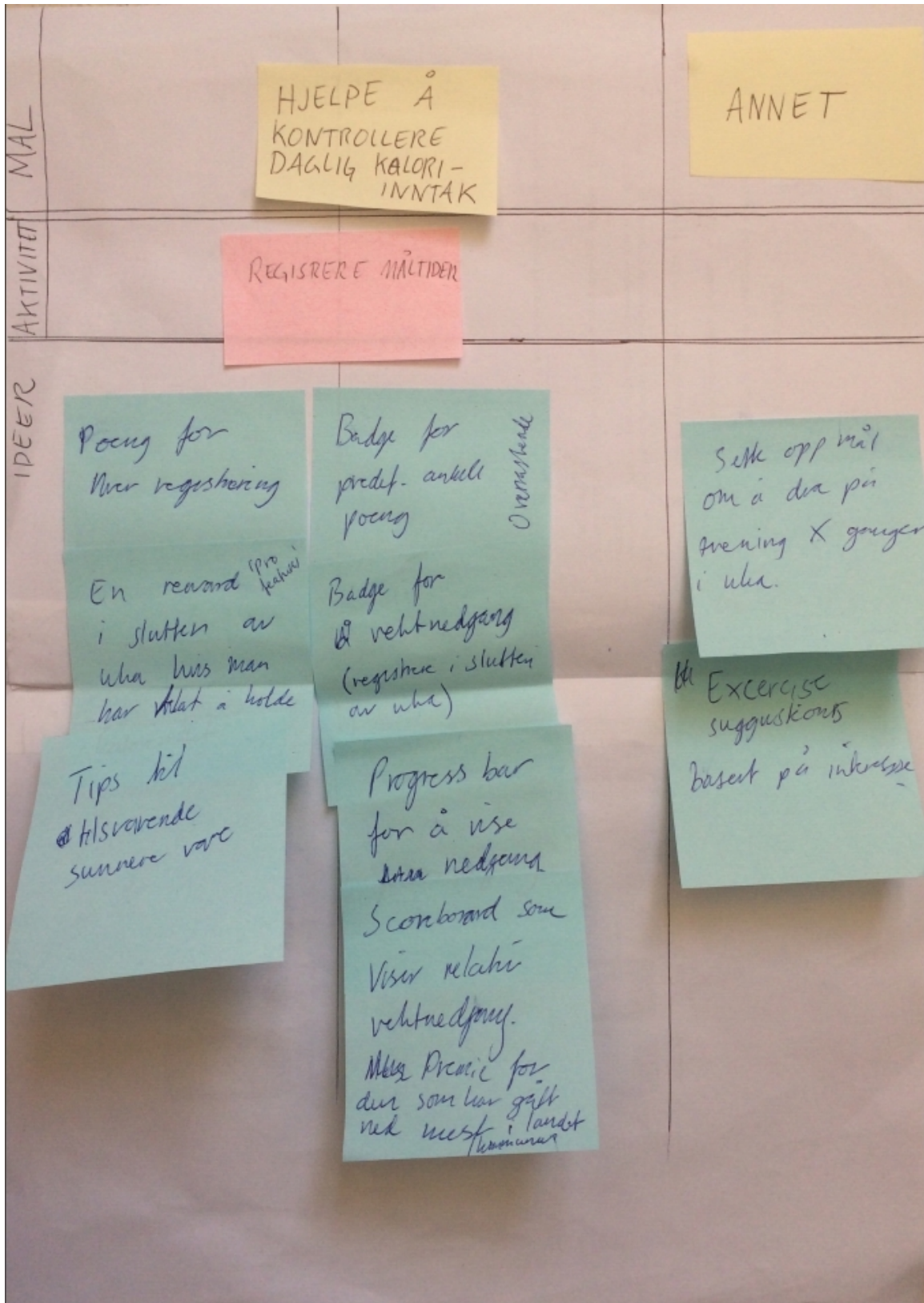


Figure F.1: Test workshop #2: Resulting ideation board

## **G | Ideation workshop #1 notes**

This appendix presents notes written post-data collection from the audio file captured during ideation workshop #1. The notes also contain time-stamps and topic labels, applied during qualitative thematic analysis. The ideation workshop was held in Norwegian, accordingly the notes are also written in Norwegian. A photo of the resulting ideation whiteboard is presented in the end of the appendix (Figure G.1).

Notes	Topics
23:56 Om hvilke spill han spiller: Vikings og war of clans	
24:18 Liker strategi	
26:32 Age of Empires 2	
<b>29:10 Hvilke applikasjoner bruker du som anvender gamification?</b>	
29:20 Duolingo: Bruker appen for å lære andre språk	
29:51 Duolingo: Bruker «Lingots» som en virtuell valuta	
31:02 Syns gamification motiverer litt i Duolingo	
<b>31:41 Hvilke tanker har du til gamification i denne applikasjonen?</b>	
32:01 Nevner poeng, eller noe liknende duolingo.	
32:18 Ide: Scanne maten	Simplicity/functionality Social Competition
32:35 Ide: Lage forskjellige profiler og konkurrere om å spise mest mulig fett	
<b>49:01 Ideation</b>	
52:23 Start mål "Forstå helsetilstand og øke evne til å formidle det til lege"	
52:29 Ide: Sosial interaksjon - Gjette riktig symptom	Social, Quiz
53:04 Ide: Forum, diskutere symptomer med en profil	Social, Discussions, altruism, knowledge
53:25 Ide: Profil som viser symptomer (privat eller public) så man kan få råd	Social User profiles
54:13 Ide: Hastags/søk på symptomer (eks #hodepine) til å finne profiler som også har hodepine eller diskusjoner i forumet.	Social, Hashtags, simplicity
54:32 Ide: Avatar & Levels - Hvis du rapportere symptomer ofte vil levelen øke. En grunnleggende indikasjon på hvilken profil som er troverdig, ved at det representeres med en god avatar. Det kan brukes til å finne ut hvem som har kunnskap. Man kan få en poeng-multiplier for konsistent registrering (Nevnes senere).	Progression, Social, Avatars, Levels, Knowledge
59:50 Ide: Kobling mellom avatarer og hashtags, men også et alternativ med at du kan søke opp venner med brukernavn	Simplicity Avatars, hashtags
<b>60:59 Vil noe av dette kunne være viktig for lege/helsepersonell?</b>	
61:12 Ide: Ja, hvis legen/en ansatt har kapasitet kan han kommentere på de med høyest avatar (verifys kommentarer/gå god for det brukere skriver). På den måten når legen ut til de mest synlige profilene, og dermed blir informasjon av høy kvalitet ut til mange (legeinformasjon).	Health professionals, discussions

66:06	Legene kan også rette opp i feil i informasjon som brukerne deler og publisere info eller henvise til studier.	<i>Social,</i> Avatars, knowledge
65:49	Ide: Doktoren vil også ha en avatar og en profil som skiller seg ut fra brukerprofilene, med en stjerne eller en hatt (noe som er lett å skille fra vanlige brukere).	
65:49	Start mål "Øke evnen til å estimere enzymer".	Simplicity
68:42	Ide: Scanne mat, gjøre det enklere å registrere maten	
69:53	Ide: Påminnelse på at man skal registrere mat (f.eks. i morgen klokka 9)	Functionality
71:43	Ide: Rewards - Premier for god ernæring og hvor flink man er til å registrere. (God ernæring er definert i samarbeid med ernæringsfysiologer).	<i>Achievement</i> Health professionals Rewards Individuality
73:50	Ide: Sette opp ernæringsmål med ernæringsfysiolog	<i>Empowerment,</i> Goals Self-efficacy
74:01	- Mulighet for universal "standard"-diett eller en personlig tilpasset diett.	Individuality
74:18	- Vise hvilke rewards man har oppnådd på sosial profile.	<i>Social, Achievement</i> Status, Rewards
76:54	Ide: Definere område som man vil kommunisere/dele achievements med (feks. trondheim, norge, eller overalt)	<i>Social</i> Achievements Rewards
83:12	Ide: Kunne gjette enzymdose når man registrerer ny mat	
84:15	Ide: Challenges for å utvikle ernæringsvaner, kunne sette opp mål iforhold til endring av ernæring. Sette opp mindre mål for å oppnå større mål.	<i>Empowerment,</i> Challenge, quiz Rewards
89:58	Ide: Få tips til ingredienser / gode middager basert på næringsmål	<i>Empowerment,</i> Tips, knowledge
90:35	Ide: Snakke med andre om mat	<i>Social</i> Discussions Knowledge
91:56	Ide: Konkurransen om å finne den beste middagen	<i>Competition</i> Social challenge
92:26	Ide: XP deles ut for hvor godt du følger dietten din (f.eks mye fett du klarer å få i deg)	<i>Achievement,</i> <i>progression,</i> points
94:42	Ide: Konkurransen - Poeng konkurranse med venner	<i>Social, competition</i> Challenge, points
97:47	Ide: Virtuell valuta - Unlocked oppskrifter	<i>Achievement,</i> Virtual currency, unlockable items

112:55 Snakker om hashtags og helheten med ideen med symptomer og informasjonsforum

114:05 Kommentere på symptomer (viser oss Duolingo)

114:55 Ide: Doktoren kan kommentere på symptomer og "flagge" kommentaren sin så den ligger øverst. Legen kan også linke til en studie på en profil, hvis han ser at det er et medisinsk tema som er gjennomgående i profilen.

*Social,*  
Discussions, user  
profiles, knowledge

118:07 Deltakeren går gjennom ideene.

129:29 Deltakeren tegner på tavla.

130:58 Ide: Ha progress bar for progresjon på hvert tema (feks ernæring, symptomer) og en for helheten.

*Progression,*  
Progress bars,  
knowledge, altruism

137:51 Deltakeren: Beskriver brukerprofilen til brukere, og legeprofiler

138:56 Ide: At man kan "følge" leger som man liker, at man får varsler når de publiserer innlegg.

139:37 Deltakeren blir spurt om hvordan han ønsker at avataren skal være. Han tror ikke det spiller så stor rolle annet enn at det må være lett å skille leger fra vanlige brukere.

*Social,*  
User profiles,  
Health professionals

144:16 Deltakeren får gavekort for deltakelsen.



Figure G.1: Results: Ideation whiteboard from workshop run with participant #1



## **H | Ideation workshop #2 notes**

This appendix presents notes written post-data collection from the audio file captured during ideation workshop #2. The notes also contain time-stamps and topic labels, applied during qualitative thematic analysis. The ideation workshop was held in Norwegian, accordingly the notes are also written in Norwegian. A photo of the resulting ideation whiteboard is presented in the end of the appendix (Figure H.1).

## Notes

## Topics

8:20 Spiller litt Call of Duty og FIFA.

9:00 Usikker om bruker noen applikasjoner m. gamification

9:15 Positiv til gamification i MyCyFAPP. Deltakeren liker å konkurrere

### 20:16 Ideation

20:17 Start mål: Lære om ernæring og hvordan det påvirker helsen

23:15 Deltakeren ønsker at registrering av mat må være veldig lettvin og ikke ta mye tid (2 min istedetfor 10)

24:45 Ide: Utfordringer / Kunnskapsquiz som man kan ta (for eksempel ernæring)

26:15 En individuell konkurranse mellom alle i Norge og også konkurranse globalt.

26:28 Ide: Leaderboard nasjonalt og globalt

27:12 Ide: Man kan ta et par quizer i uka og få poeng som man tar med seg i leaderboardet

### 27:52 Hva kan motivere deltakeren til å ville begi seg ut på quiz?

28:13 Deltakeren setter pris på selve konkurransen men foreslår også følgende ide:

28:18 Ide: Brukere får poeng basert for posisjon på leaderboardet, feks hver måned (førsteplass får 1000 poeng, andreplass får 750, tredje får 500, fjerde 300, osv.)

### 30:41 Hvordan kan poengene motivere deg til å ville få tak i dem?

30:50 Ide: Det kan være en premie for å nå opp til en viss mengde poeng

31:10 Ide: En brukerprofil hvor alle poengene fra forskjellige utfordringer samles og legges sammen.

32:04 Ide: Brukerprofilen kan sees på av andre

32:12 Ide: Et alternativ til å lære om ernæring for de som ikke er så opptatt av konkurranse.

33:45 Ha en innstilling hvor man kan bestemme om man vil konkurrere eller ikke.

32:21 Ide: Å lese læringsmateriale om ernæring.

### 34:46 Hvordan kan de motiveres til å lese læringsmateriale?

35:02 Ide: Progress bar som viser hvor mye du har lest på hvert dokument. Når man har fullført en kapittel for eksempel kan man få et kapittel. (Kanskje sikre det med en liten quiz med alternativer).

36:45 Ide: Ha regelmessige (ukentlige/daglige) konkurranser slik at de som liker konkurranse får lyst til å følge med og ta utfordringer regelmessig.

39:15 Deltakeren snakker om stor forskjell på folk med CF i hvor mye man kan/må spise.

Motivation / Simplicity

Empowerment  
Challenges/quiz,  
Competition,  
knowledge

Competition  
Leaderboards

Motivation

Points, rewards,  
competition

Achievement  
Rewards

Social  
User profile

Motivation,  
Competition

Empowerment

Progression  
Progress bar  
Knowledge

Competition  
Challenges,

Motivation

39:45 Ide: Bedre å ha progress bars med fysisk aktivitet. Sette sine egne mål og registrere at man har gjort det. Få XP for fullførte aktivitetsmål.	<i>Empowerment , progression, Progress bars, goals, self-efficacy</i>
40:58 Ide: Applikasjonen kan tilby utfordringer innenfor aktivitet. F.eks. (jogge 10 km over så lang tid man vil)	Goals, self-efficacy, progression
<b>41:58 Hvordan kan folk motiveres til å ta utfordringer i forbindelse med aktiviteter?</b>	<i>Achievement, Accomplishment, badges</i>
42:09 Ide: Bruke badges for hver utfordring som man klarer. Badgene kan vises på din brukerprofil i tillegg til din XP.	
42:27 Ide: Man kan bestemme selv hva man vil vise frem og ikke på profilen (public/private)	<i>Privacy</i>
48:18 Diskutere målet "passe på å ta den medisinen man skal"	Undermine intrinsic interest
43:54 Deltakeren snakker om at det å passe på medisinene ikke trenger gamification da det kan ta fokus vekk fra viktigheten av å ta medisin.	
47:24 Ide: De som vil kan, når de får påminnelse om å ta medisin, kan de krysse av om at de har tatt medisinen. Man kan kanskje få badges for å huske å ta medisinen sin alle dagene i en måned for eksempel. Da kan man vise til legen sin så legen får en oversikt over medisininntaket	Badges, challenges, user profiles, competence
50:01 Start mål "enzym estimering"	<i>Competition, knowledge quiz, challenges</i>
50:18 Ide: Inkludere enzymer i quiz om ernæring (f.eks. hvor mange enzymer ville du tatt til denne maten?)	Functionality
54:18 Ide: At man kan søke opp forskjellig mat og se hva anbefalt estimering av Creon.	Quiz Competence
56:27 Ide: Kunne velge om man vil prøve å "gjette" enzymdoser til mat for å bli bedre til å estimere enzymer.	Functionality
59:19 Ide: En enkel mulighet til å "slå opp" mat og se anbefalt creondose.	<i>Social, Avatar, Unlockable items, virtual currency</i>
<b>60:21 Hva med avatarer? Kan det være interessant i forbindelse med leaderboard?</b>	
60:58 Ide: Ha en avatar som, når man fullfører utfordringer, får "mynter" (virtual valuta) som man kan bruke til å kjøpe ting til avataren.	Social, self-expression
<b>62:31 Hvordan kunne du tenke deg at avataren ser ut?</b>	
62:41 Ide: Den kan godt være et menneske som man lager lik seg selv, også kan man skaffe eiendeler til avataren. De som er yngre kan kanskje ha lyst til å ha superhelter og sånne ting. Man kan velge hvilken avatar man vil ha selv.	

65:57 **Hvilke eiendeler kunne være morsomt å skaffe seg til avataren sin?**

66:08 Ide: Klesplagg og utstyr man kan holde i hendene. (Tenn racket osv) Billigere og dyrere (sjeldnere) utstyr. Dette viser at man har brukt appen mye og kan mye.

Self-expression,  
In-game items

69:57 Deltakeren lurte på om applikasjonen vil inneholde informasjon om hygiene og sier at det kunne vært interessant.

71:08 Ide: Å kunne diskutere temaer, som feks hygiene, med andre brukere som kan dele fra sine erfaringer og i tillegg at leger kan delta i diskusjoner. Man kan også diskutere andre temaer som symptomer og ernæring.

Social,  
Discussions,  
knowledge, altruism

73:18 Vi presenterer en veldig lik idé som ble foreslått på forrige workshop.

75:27 Deltakeren synes ideen^ passer bra med hans ønsker .

Social  
Likes (votes)  
Altruism

76:34 Ide: Å få poeng for å gi gode råd, slik at man kan stemme opp hverandres innlegg. Det kan gjøre at folk blir motivert til å dele av sin erfaring.

78:05 Vi presenterer en annen idé, fra første workshop, som likner på noe vi har vært innom tidligere i intervjuet.

79:43 Ide: Det er individuelt, men at de kan sette opp egne mål og utfordringer i forhold til ernæring (med eller uten ernæringsfysiolog) høres bra ut. Så kan man få XP og badges for å klare ernæringsmålene. Så kan man ta med dette til leger/ernæringsfysiolog. Da blir det lettere å formidle det til legen.

Achievement/  
Empowerment,  
Goals, Rewards  
(badges, xp)

81:23 Viser frem en sketch fra forrige workshop angående sosial profil/avatar og poeng

82:31 Ide: Synes ideen er god. Så ser man hva man kan bli bedre i. Badges representerer utfordringer og vises på profilen.

84:06 Presenterer ide fra forrige workshop angående veiledning til å velge ingredienser som passer til ernæringsmålene

84:23 Ide: Synes ideen^ er god. Han kunne tenke seg å bruke en slik funksjon til å gjøre det lettere å spise grønnsaker. Som å få tips til gode matretter som suppe/taco i stedetfor å koke grønnsaker.

Empowerment  
Tips  
Knowledge

88:33 Deltakeren avslutter med å understreke hans interesse for konkurranse og at det er en stor motivasjon til å bruke appen.

Motivation

89:09 Deltakeren får gavekortet og takkes for intervjuet.

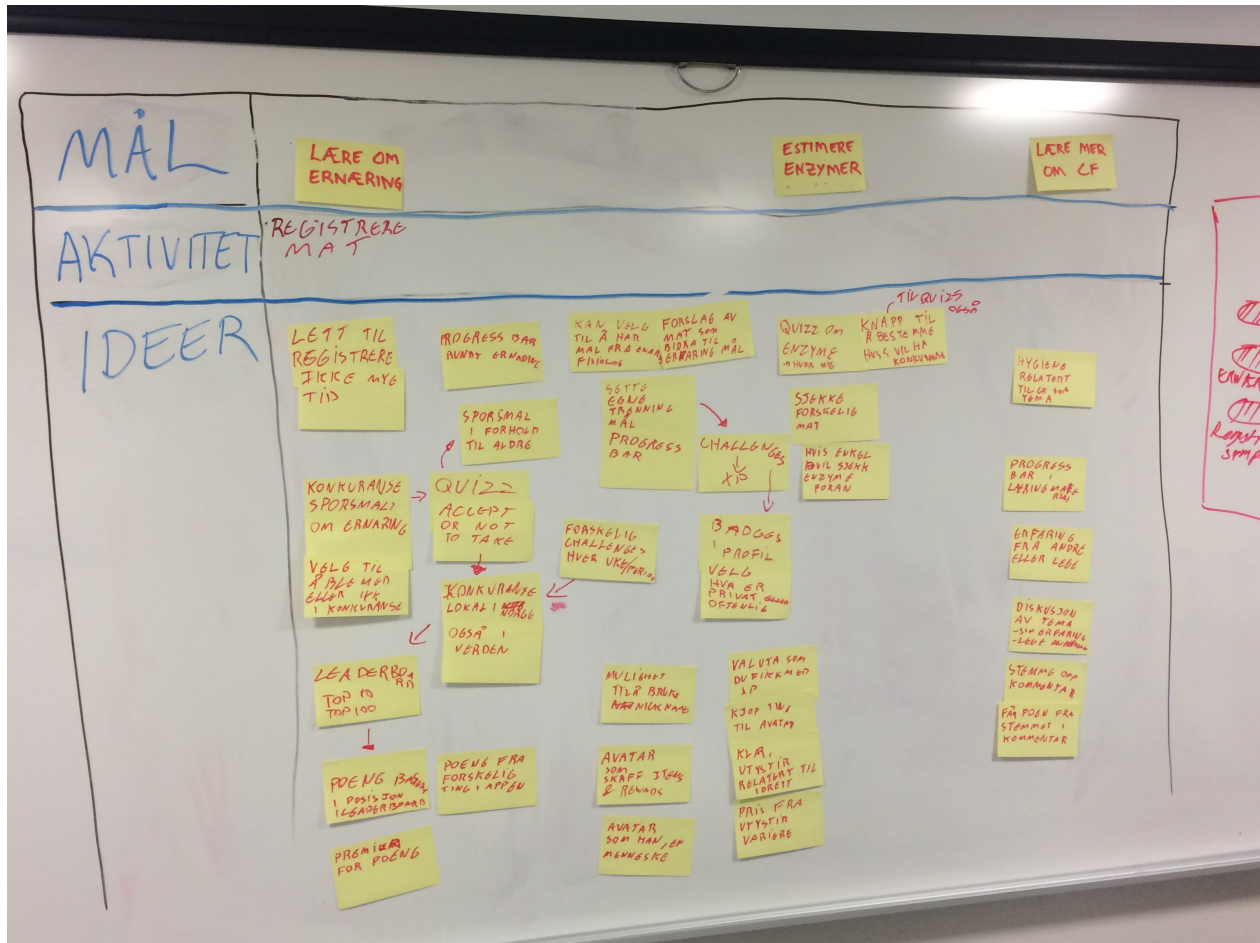


Figure H.1: Results: Ideation whiteboard from workshop run with participant #2

# I | **Thematic analysis**

This appendix describes in detail how the thematic coding analysis was performed. The ideation workshops resulted in 4 hours of audio, 41 defined gamification ideas and additional user input to be analyzed. To be able to categorize the data, input was labeled with predefined codes and codes emerging from the input, before collating the codes and defining major topics.

## I.1 A priori codes

As a starting point codes were created for three categories, specifically the three building blocks of the interviews and co-design activities (See A) - 1) Gamification mechanics 2) Psychological outcomes 3) Behavioral outcomes. The first category, Gamification mechanics, contained codes for each gamification mechanic presented to the users during the interviews. The second category, Psychological outcomes, contained codes for psychological outcomes popularly targeted by gamification [42, 38, 46, 45] and the third category, Behavioral outcomes, contained the supporting goals of the application (See Table 3.1) as they were central elements in the co-design activities. This resulted in the following predefined codes (Table I.1):

**Table I.1:** Coding analysis: A priori codes

<b>Category</b>	<b>Codes</b>
<b>Mechanics</b>	Avatars, Badges, Challenges, Leaderboards, Levels, Progress bars, Rewards, Social interaction
<b>Psychological outcomes</b>	Reward, Status, Achievement, Self-expression, Competition, Altruism
<b>Behavioral outcomes</b>	Learn more about nutrition and how it affects health, Learn and develop the ability to estimate enzymes, Understand own health and increase the ability to communicate it to health professionals, Help make sure the user takes all his medications, Learn more about CF and treatment

## I.2 Emergent codes

As a result of a first round of topic analysis of transcribed ideation workshops the following codes emerged (Table I.2):

**Table I.2:** Coding analysis: Emergent codes - Mechanics and psychological outcomes

Category	Codes
<b>Mechanics</b>	Achievements, Hashtags, Discussions, Goals, Unlockable items, Quiz, User profiles, In-game items, Voting, Virtual currency, Tips
<b>Psychological outcomes</b>	Social, increased knowledge, increased competence, self-efficacy, progression

Naturally, as three of the behavioral outcomes/support goals are about learning, we found learning to be a recurring theme in the data as well. Learning it self is not used as a code because we want to go deeper into different types of learning. The recurring types of learning are therefore distinguished by "increase knowledge" and "increase competence", e.g. respectively, learning about nutrition and developing enzyme estimation skill. These types of learning are considered "self-learning" which we again distinguish from learning from others (social interaction).

In addition to codes specific for the gamification ideas there were also several recurring themes not being specifically connected to the suggested ideas but more in the context of personal motivation (Table I.3):



**Table I.3:** Coding analysis: Emergent codes - Other themes

Category	Codes
Other themes	User context, simplicity, health professionals, individuality, undermine intrinsic motivation

### I.3 Collating codes

I started of this phase by categorizing psychological outcome concepts and general concepts.

Table I.4 shows the merged topics and sub topics:

**Table I.4:** Coding analysis: Merged topics and associated topics #1

Merged topic	Associated topics
Social interaction	Status, Altruism, Self-Expression, Competition
Empowerment	Increase knowledge, Increase competence, Self-efficacy
Motivation	Application support goals, User context, Simplicity, Individuality, Undermine intrinsic motivation

We early discovered that some topics would overlap to lesser or greater extent. E.g. avatars have the tightest connection to "progression" as the avatar reflects progression to oneself and others, but also have a function by representing the user in social discussions. Consequently, to be able to determine which topics to merge, definitions for each of the category topics were created:

**Social interaction** deals with the desire for relatedness and the section presents findings that comprise interaction with other people. **Empowerment** deals with feeling autonomous in initiating processes to increase one's knowledge and skills. The section presents findings that comprise users' self-determined activities to enhance self-management. **Progression** deals with peoples' desire to, not only get better at what they do, but also to feel the actual improve-

ment. The section presents findings that comprise the users' desire feel progression in self-management. **Motivation** deals with lesser topics important to the participant regarding motivation. **Competition** deals with people's desire to compete and the section presents the participants' ideas for competition. **Achievement** deals with people's desires for accomplishment and is powered by extrinsic incentives.

With these definitions we proceeded by categorizing gamification mechanics topics. Most mechanics had a clear connection to a specific psychological outcome. User profiles, Discussions, Hashtags, Voting was directly connected to ideas for altruism, self-expression and status and were consequently merged with "Social interaction". Leaderboards was merged with "Competition" because all ideas using leaderboards were ideas on competition. Challenges, Quizzes, Goals and Tips were merged with "Empowerment" because the ideas using these mechanics required the user to actively choose to engage with them, thus increasing autonomy. Achievements, badges, rewards and virtual currency were merged with "Achievement" as ideas using these mechanics was primarily powered by extrinsic incentives, i.e. the mechanics themselves. Avatars, progress bars, in-game items and levels were merged with "Progression" as these ideas primary motivation was to give the user feedback and enhance the feeling of progressing. Table I.5 shows the merged topics and sub topics:

**Table I.5:** Coding analysis: Merged topics and associated topics #2

<b>Merged topic</b>	<b>Associated topics</b>
Social interaction	User profiles, Discussions, Hashtags, Voting, Leaderboards
Empowerment	Challenges, Quiz, Goals, Tips
Achievement	Achievements, Badges, Rewards, Virtual currency
Progression	Avatars, Progress bars, In-game items, Levels

Subsequently the connections and occurrences between gamification mechanics and associated psychological outcomes were merged into super-ordinates. In addition to the merged psychological outcomes and gamification mechanics, another recurring theme from the ideation

workshop was the users' wish to be able to communicate with health professionals, and for health professionals to be active in the social interaction happening in the application. Input relating this topic was labeled "Health professionals" and merged into "Social interaction". Table I.6 shows merged topics and sub topics:

**Table I.6:** Coding analysis: Merged topics and associated topics #3

Merged topic	Associated topics
Social interaction	<p><b>Mechanics:</b> User profiles, Discussions, Hashtags, Voting</p> <p><b>Psychological outcomes:</b> Social, Altruism, Self-expression, Status</p> <p><b>Other:</b> Health professionals</p>
Empowerment	<p><b>Mechanics:</b> Goals, Challenges, Quiz, Tips</p> <p><b>Psychological outcomes:</b> Increase knowledge, Increase competence, Self-efficacy</p>
Progression	<p><b>Mechanics:</b> Avatars, Levels, Progress bars, In-game items, Unlockable items</p> <p><b>Psychological outcomes:</b> Progression</p>

## I.4 Major topics

Finally we defined the major concepts of the super-ordinates from the previously merged topics that I will use to present my findings. We also counted clauses referring to the respective major categories. Table I.7 presents the concepts and associated sub-concepts.

**Table I.7:** Coding analysis: Resulting concepts after coding analysis

<b>Major concepts</b>	<b>Associated concepts</b>	<b>Referrals</b>
Social interaction	Social, user profiles, social interaction, discussions, hashtags, altruism, status, self-expression, voting, health professionals	P1: 10/16 P2: 6/16
Empowerment	Increase knowledge, increase competence, quiz, challenges, goals, self-efficacy, tips	P1: 5/11 P2: 6/11
Progression	Avatars, levels, progression, progress bars, in-game items, unlockable items	P1: 3/9 P2: 6/9
Motivation	Application support goals, user context, undermining intrinsic motivation, individuality, simplicity	P1: 4/8 P2: 4/8
Competition	Competition, leaderboards	P1: 2/7 P2: 5/7
Achievement	Achievement (psych. outcome), Achievements (mechanic), badges, rewards, virtual currency	P1: 3/6 P2: 3/6

## **J | NSD approval**

This appendix presents the approval received from NSD regarding personal information processed in the study.

Babak Babak  
Institutt for datateknikk og informasjonsvitenskap NTNU  
Sem Sælandsvei 7-9  
7491 TRONDHEIM

Vår dato: 01.02.2017

Vår ref: 51855 / 3 / HIT

Deres dato:

Deres ref:

## TILBAKEMELDING PÅ MELDING OM BEHANDLING AV PERSONOPPLYSNINGER

Vi viser til melding om behandling av personopplysninger, mottatt 02.01.2017. Meldingen gjelder prosjektet:

51855	<i>Gamification mechanics for self-management of chronic disease</i>
Behandlingsansvarlig	<i>NTNU, ved institusjonens øverste leder</i>
Daglig ansvarlig	<i>Babak Babak</i>
Student	<i>Ole Ole</i>

Personvernombudet har vurdert prosjektet, og finner at behandlingen av personopplysninger vil være regulert av § 7-27 i personopplysningsforskriften. Personvernombudet tilrår at prosjektet gjennomføres.

Personvernombudets tilråding forutsetter at prosjektet gjennomføres i tråd med opplysningene gitt i meldeskjemaet, korrespondanse med ombudet, ombudets kommentarer samt personopplysningsloven og helseregisterloven med forskrifter. Behandlingen av personopplysninger kan settes i gang.

Det gjøres oppmerksom på at det skal gis ny melding dersom behandlingen endres i forhold til de opplysninger som ligger til grunn for personvernombudets vurdering. Endringsmeldinger gis via et eget skjema, <http://www.nsd.uib.no/personvern/meldeplikt/skjema.html>. Det skal også gis melding etter tre år dersom prosjektet fortsatt pågår. Meldinger skal skje skriftlig til ombudet.

Personvernombudet har lagt ut opplysninger om prosjektet i en offentlig database, <http://pvo.nsd.no/prosjekt>.

Personvernombudet vil ved prosjektets avslutning, 12.06.2017, rette en henvendelse angående status for behandlingen av personopplysninger.

Vennlig hilsen

Kjersti Haugstvedt

Hildur Thorarensen

Kontaktperson: Hildur Thorarensen tlf: 55 58 26 54

Vedlegg: Prosjektvurdering

*Dokumentet er elektronisk produsert og godkjent ved NSDs rutiner for elektronisk godkjenning.*



## Personvernombudet for forskning

### Prosjektvurdering - Kommentar

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Prosjektnr: 51855

#### SAMARBEIDSSSTUDIE

Prosjektet er en nasjonal samarbeidsstudie. NTNU er behandlingsansvarlig institusjon. Personvernombudet forutsetter at ansvaret for behandlingen av personopplysninger er avklart mellom institusjonene. Vi anbefaler at det inngås en avtale som omfatter ansvarsfordeling, ansvarsstruktur, hvem som initierer prosjektet, bruk av data og eventuelt eierskap.

#### FORMÅL

Formålet er beskrevet på følgende måte: The aim of the thesis is to understand how to "gamify" a self-management App for cystic fibrosis (CF). The thesis departs from a self-management App for CF developed in the H2020 EU Research Project MyCyFapp. It will investigate which gamification mechanics (points, goals, levels, badges, etc) are of interest to people with CF in conjunction with the self-management.

The project will run interviews and/or co-design workshops so that people with CF can specify which gamification mechanics are suitable and how they should be designed.

The research nature of the project is mainly of Computer user interaction design..

#### INFORMASJON OG SAMTYKKE

Utvalget informeres skriftlig og muntlig om prosjektet og samtykker til deltakelse. Informasjonsskrivet er godt utformet, men det bør tydeliggjøres at det er NTNU som er behandlingsansvarlig.

#### DATAMATERIALETS INNHOLD

Data innhentes gjennom personlig intervju. Det behandles sensitive personopplysninger om helseforhold.

#### INFORMASJONSSIKKERHET

Personvernombudet legger til grunn at forsker etterfølger NTNU sine interne rutiner for datasikkerhet.

#### PROSJEKTSLUTT OG ANONYMSIERING

Forventet prosjektslutt er 12.06.2017. Ifølge prosjektmeldingen skal innsamlede opplysninger da anonymiseres. Anonymisering innebærer å bearbeide datamaterialet slik at ingen enkeltpersoner kan gjenkjennes. Det gjøres ved å:

- slette direkte personopplysninger (som navn/koblingsnøkkel)
- slette/omskrive indirekte personopplysninger (identifiserende sammenstilling av bakgrunnsopplysninger som f.eks. bosted/arbeidssted, alder og kjønn)
- slette digitale lydopptak.

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