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Gamification as a Means of Increasing User Commitment in a Mobile Application for Behavior Change

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Abstract

Gamification, most typically described as the use of game elements in non-gaming contexts, has been an ongoing topic of research in recent years. Especially in the domains of education and health, several gamified systems have been developed and evaluated. This master's thesis deals with the design, implementation and evaluation of a gamified mobile application for behavior change in the health domain. Due to the lack of standardized assessment frameworks for gamification, a study design for gauging the effect of the gamification on the users commitment to the application was developed. The evaluation was done with an A/B experiment of both qualitative and quantitative nature. Comparison of the results for the gamified version and the otherwise functionally equivalent non-gamified version showed preference for the gamified one in all tested aspects. For measuring the actual behavior change process, a long-term study would be required.

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1 Introduction and Research Question

Gamification is best described as the use of game elements in a non-gaming context. This is done with the purpose of increasing user engagement and improving user experience (Deterding, Sicart, et al., 2011). While being a relatively young field of study, research on the effect of gamification has been carried out in a remarkable variety. However, as of yet no standardized evaluation method of gamification exists, and only very few studies that directly examine the difference between a gamified and a non-gamified version of the same application have been conducted. Additionally, the vast majority of research on gamification resides in the domain of education, which is why the domain of health was chosen for this thesis. Another area in which the existing research body is lacking is the connection between personality and a preference for game or gamification elements. Personality in this case does not refer to player personalities as introduced by Bartle (1996), but to a users personality traits as determined by a BFI-10 standardized questionnaire (Rammstedt and John, 2007). With this in mind, two research questions have been set:

1. Can gamification help users stay motivated to reach their goals by keeping them motivated to use a behavior change application?
2. Is there a measurable correlation between personality and preferences for gamification elements?

Formulated as hypotheses, the two items read as follows:

H1 Gamification measurably increases user commitment to their goals, by keeping users motivated to use a behavior change application.

H2 Personality and preference for gamification elements show some sort of correlation.

To verify or reject these hypotheses, two versions of a mobile application have been developed. This mobile application aims to guide users in their behavior change process towards a healthier lifestyle by allowing them to set and track goals. One version employs gamification elements to try and increase the users commitment and motivation, while the second version does not. Using these two versions in an on-site A/B experiment, both hypotheses could be supported to some degree.

1.1 Thesis Objective

Designing, implementing and evaluating a gamified health behavior change tool was the main objective of this thesis. Development of the application focused on the following:

- Designing a scalable system architecture with separate front- and back-end
- Including motivational constructs that help users promote their behavior change
- Supplementing the motivational constructs with meaningful gamified elements

Special focus was taken to have the gamified aspect supplement the applications functionality. Often, gamification is added to applications at a later stage. For the implemented application, the elements of gamification were conceptualized in union with the functionality.

1.2 Thesis Structure

A concise overview of the thesis structure is found in Figure 1.1. The common theme that is followed throughout the main part of the thesis is the combination of motivational constructs with meaningful gamification elements. To give interested readers some background knowledge about gamification, **Chapter 2** shortly delves into the history of gamification, its similarities and differences to serious games and the psychology of human

play drive. Essentially, gamification has evolved from games, which is why concepts like game design frameworks and theories of player personalities still apply to it. For this reason, a popular game design framework and a derivative of it are presented along with theory on general player and gamification personalities. Having gone through the background knowledge, the most popular game elements that have been adopted by gamification are presented. As gamification is usually employed to persuade users to engage in activity, an overview on the research of persuasive system design has been included, before insight into a survey on the use of gamification in health and fitness related apps is provided. Then, after a short detour into psychology where the general concept of behavior change is explained, 25 studies that all dealt with measuring the effect of gamification on the users motivation or commitment are examined in terms of their results and used gamificiation elements.

Chapter 3 outlines the mobile cross-platform behavior change application that has been developed in two versions alongside with this thesis. Stating both functional and nonfunctional requirements, special focus is given to the implemented game mechanics and elements. A change of requirements and general parameters of the application that took place during development is also explained. With the knowledge of requirements and desired functionality in mind, **Chapter 4** deals with the technical side of the implementation. Building a cross-platform application from scratch would be more than infeasible, so every used framework is introduced shortly. Afterwards, the considerations that went into picking those exact frameworks are explained. To accommodate readers who may not have access to the implemented application, its gamified version is depicted thoroughly in **Chapter 5**. Again focusing on the interplay of motivational constructs and gamification, an ample array of screenshots and accompanying textual explanations showcases the entirety of the application.

The next chapter, **Chapter 6** describes the setup of the A/B experiment which was conducted to test the two hypotheses stated above. Details on the experiment procedure are laid out and used materials are presented. The participants of the experiment tested both versions of the application and left their feedback in the form of ratings, open-ended questions and interviews. The compiled results focus on the comparison of the performance of the two versions, followed by a discussion with respect to the research questions.

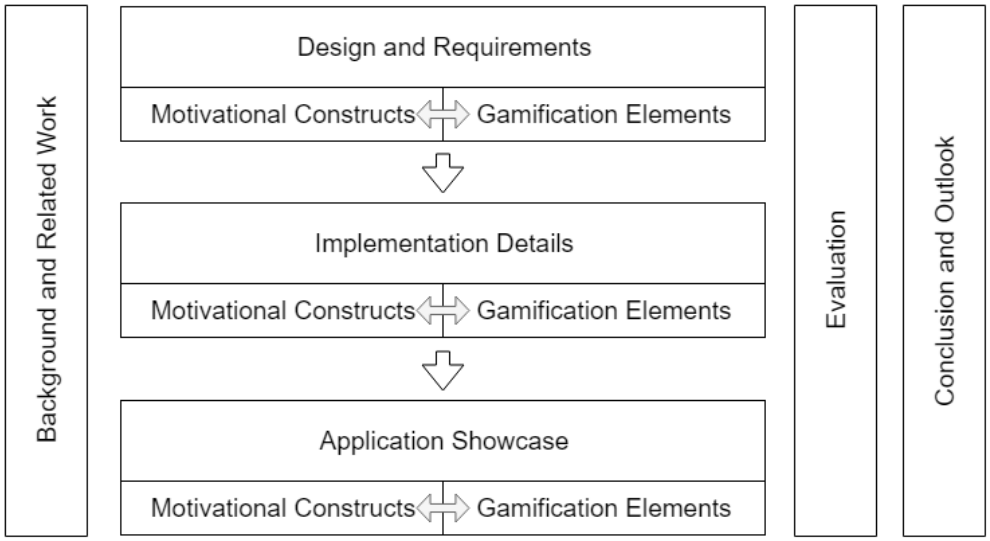


Figure 1.1: Starting with background information and related literature and surveys, the main part of this thesis then deals with the design and implementation of a gamified behavior change application. The three main chapters follow the common theme of the interplay of motivational constructs and meaningful gamification elements. Evaluation and answers to the research questions are provided before coming to a conclusion and a concise incentive for further research.

Chapter 7 deals with the lessons that were learned during the creation of this thesis and implementation of the application. Findings and insights gained throughout this work will be discussed. Possible extensions to the application as well as interesting future research, based on these findings are found in Chapter **8**. Wrapping it all up, **Chapter 9** summarizes both the implemented application and research results.

2 Background and Related Work

Gamification is a field of study that is situated at the intersection of computer science and psychology. As a consequence of this, the psychological aspect of gamification is rather similar to that of behavioral change theories, which is why special care is taken to differentiate these two relevant topics. This background chapter starts with the definition of gamification and serious games, introduces the concept of persuasive system design and gives a short overview of a behavior change process based on popular theories before taking a look at related work in measuring the effectiveness of gamification.

2.1 Gamification and Serious Game Design

Gamification is commonly described as the use of (video) game elements in a non-gaming context. This is done with the objective of increasing user experience and engagement (Deterding, Sicart, et al., 2011). Another, more general definition is "**the process of game-thinking and game mechanics to engage users and solve problems**" (Zichermann and Cunningham, 2011). Serious games are actual games, meaning that unlike a gamified system, they offer a fully fledged game environment. However, unlike traditional games, they do not necessarily seek to entertain the player, but fulfill a purpose that goes beyond the inherent aim of the game itself. They intend to convey real-world ideas to the player and are often employed to influence the players' thoughts and behavior outside of the game (Mitgutsch and Alvarado, 2012). Gamification and serious games have one thing in common: using games as a means of increasing the user commitment towards a topic that is not inherently connected to a gaming context. The major difference is the approach taken: while gamification introduces game elements like

points or achievements to a non-gaming context, serious games cover a topic that would not be considered to be entertaining on its own inside a game world.

Very importantly, one must be clear about the limits of gamification: it will not be able to magically fix a broken, badly conceptualized application. Simply putting some badges into an existing application or creating a game that is just visually heavily branded is not gamification (Zichermann and Cunningham, 2011). The elements used for gamification should be tailored to the context of the application (Winn, 2009). The question why gamification works in the first place is answered by looking at a central trait of the human mind: playfulness.

2.1.1 The Psychology of Playing

Gamification would not work without the human drive to play. A study on the motivation for playing games has been conducted by Lazzaro (2004). As the author puts it, humans are not playing games for the game itself, but for the emotions they experience while playing. The study that was conducted as part of their research found that the reasons for playing were mostly entertainment and social connections, but also seeking challenges or mental stimulation, or even refrain from bad habits like unhealthy eating. Whatever the reasons, the urge to play is hardwired into humans.

The underlying concept for the enjoyment of games is a psychological term called flow. Csikszentmihalyi (2014) coined the term for a state of mind that allows people to zone in on the activity they are performing at the moment and entirely forget about their surroundings. Game designers strive to achieve this state of flow in their players by balancing a games challenges to the players skills over time, as seen in Figure 2.1. If a game does not get more challenging as players attain new skills, boredom strikes quickly. The other way round, if a game is too difficult for new players and does not offer any emotion but failure in the beginning, anxiety will get the better of the players and they will not continue playing. Designers must find the delicate interplay of player and system that keeps a player "in the zone" for as long as possible (Zichermann and Cunningham, 2011). Looking at

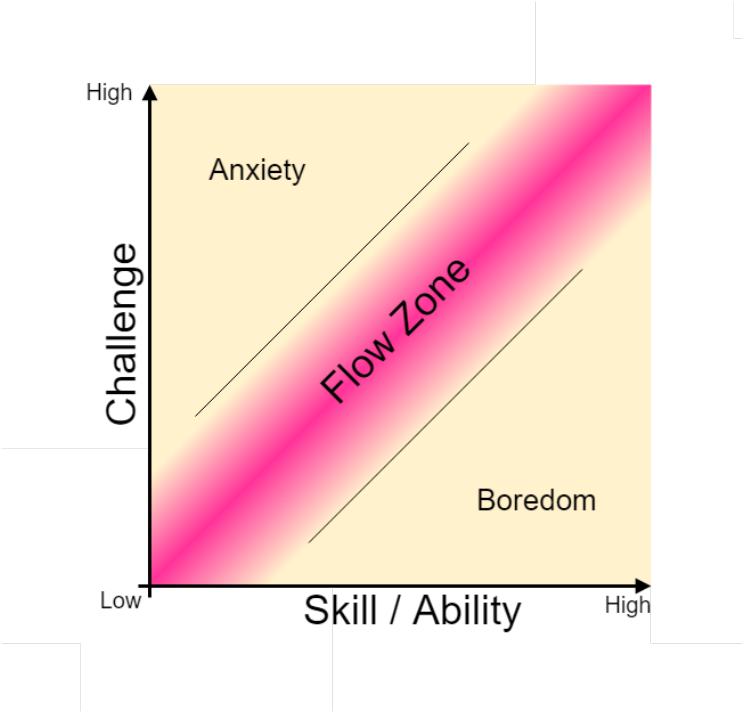


Figure 2.1: Flow is a state of mind at the meeting point of anxiety and boredom. When a player experiences flow, time considerations or other responsibilities are usually set aside (Csikszentmihalyi, 2014).

the history of gamification, flow is not the only game design concept that heavily influenced gamification.

2.1.2 History of Gamification and Serious Games

The idea of using games to convey information and learnings to the user is by no means a new one: Dewey (2004), originally released in 1916, already suggested games as a means of "**reducing the artificial gap between life in and out of school**". The author further elaborates that certain instincts which are based on joyfulness and emotion are helpful in letting the acquisition of knowledge be to its own end instead of being a mere school task. Overall, Dewey somewhat bridges the back then unknown gap between

gamification and serious games by defining the term "**active occupation**", meaning the combination of work and play. While activities like storytelling or outdoor excursions that were deemed playful back then may today seem like a normal school curriculum item, the idea of bringing social aim and playfulness into education was rather uncommon in those days. In more recent times, Foursquare[1] and its badge system have been the ringleader of the advent of gamified apps and services. By allowing the user to check in at locations and subsequently becoming a "mayor" at that location, users are given a certain status. And Foursquare is at its core not about the badges, but about the connectedness of the users and the locations. The very simple mechanics (more on game mechanics in Section 2.1.3) of checking in that Foursquare offers keeps the entry barrier to a minimum and allows for quick and easy rewards and success for the users. More often than not, gamification that is simple, rewarding and fun can be even more effective than large-scale, complex game architectures (Zichermann and Cunningham, 2011).

Today, numerous areas of life are the subjects of gamified services. Some popular representatives are listed here:

- **Education**: This is probably the historically most proven field of application for gamification. Even Dewey (2004) suggested games as a means of learning back in 1916. Today, powerful phones allow the users to educate themselves anytime, anywhere, with gamification helping them to keep their motivation up. Popular representatives include, but are not limited to Duolingo[2] (learning a language) and Codecademy[3] (learning to program). Outside of mainstream education, gamification can be very helpful for in-house staff training: McDonalds used a gamified employee training tool in 2014 to better prepare till workers for a new till system. The tool used classic game elements like various point metrics, streaks, timers and many more and was very well received (Kineo, 2014).
- **Sport**: Countless fitness trackers and training guide apps are available on all major mobile platforms. A varying grade of gamification can be

[1] `https://foursquare.com/about` (Foursquare Labs, 2018a)
[2] `https://www.duolingo.com/` (Duolingo, 2018)
[3] `https://www.codecademy.com/` (Codecademy, 2018)

found in many of them, mostly focusing on the social aspect of working out together or sharing ones progress with other users. Prominent representatives in the social sharing area are Runtastic[4] and Nike+[5]. A gamified platform that focuses heavily on the competition between its users is Strava[6] by pitting their cycling times on certain stretches of road against one another.

- **Business and Professional Life**: While not obvious at the first glance, gamification has entered the business world already: Business networking platforms like LinkedIn[7] use a percentage progress bar to convince their users to enter more information about themselves and their career in order to complete their profile and gain an edge over their competitors.
- **Social life**: Facebook[8] applies the same principle to a non-business social media setting by showing their users a similar progress bar to encourage them to keep their profile as complete and up-to-date as possible. The poking functionality of Facebook is just a lightweight game interaction between two users.

Especially applications from the sports domain make use of environmental data that is provided by the devices that they are running on. This data has helped gamification strengthen its foothold in the application market. However, the idea of having computers tracking and using details about our life and environment while running silently in the background has come up at the end of the 20th century already.

Changes and Chances through Ubiquitous Computing

In 1991, Weiser (1991) coined the term of ubiquitous computing as the disappearance of conscious interaction with computer systems. The user is not tied to a desktop computer anymore, instead any device offers varying degrees of computational capacity to the user. These devices do not have

[4] `https://www.runtastic.com/en/` (Runtastic, 2018)
[5] `https://www.nike.com/us/en_us/c/nike-plus/running-app-gps` (Nike+, 2018)
[6] `https://www.strava.com/mobile` (Strava, 2018)
[7] `https://about.linkedin.com/` (LinkedIn, 2018)
[8] `https://www.facebook.com` (Facebook, 2018a)

to be carried by the user or be with them at all times, but can also be other objects like a refridgerator or even a toilet (Keller, 2018). The step from mere mobile computing to ubiquitous computing is made by having devices that can be aware of their surroundings. This awareness must come from arbitrary types of sensors, as requiring the user to input information about the environment whenever it changes would break with the principle of unconscious interaction. A concept that takes this idea even further is pervasive computing. With pervasive computing, ares are equipped with sensors and tags and can provide information to any device entering them (Lyytinen and Yoo, 2002).

For gamification, ubiquitous computing offers a whole array of new possibilities. Chung-Ho and Ching-Hsue (2014) studied the effectiveness of a mobile learning system that leveraged both gamification and context awareness. The ecosystem that was implemented by the researchers consisted of three modules, one for teachers and students each, and one for the server communication. The module for the students was a mobile application that allowed them to scan QR codes within a defined outdoor learning area. Also, nearby friends were displayed, enabling students to team up for completing challenges set by their teachers. Overall, the study was set up to have one group of students using the gamified, context-aware mobile application for learning a new topic, one control group using a traditional mobile application that just provided the learning content and another control group that used conventional teaching methods. All groups consisted of 34 students. The students who used the gamified mobile application reported both higher learning motivation and achieved better learning results than students of both other control groups, while also spending more time with the learning material. Deterding, Dixon, et al. (2011) mention pervasive games as a type of games which expand the game context temporally, spatially or socially.

The use of environmental data is of course not exclusive to gamified applications. A lot of mobile games, some of them very popular, rely on location data as a central element of their functionality. The similarities between games and gamified services extend beyond that: Proven game design frameworks have been adopted and subsequently adapted.

2.1.3 Popular Game Design Frameworks

Game design by itself is way older than video games. However, it was the rise of video gaming that brought renewed attention to the science of gaming, namely the intricate, often complex architectures of gameful experiences. The field of game design started to emerge as its own discipline. Game design, however, is not to be confused with game development, as designing games is a rather traditional design process like graphic design or sound design, and game development is a lax umbrella term that spans design, implementation, marketing and more (Salen and Zimmerman, 2004).

Several frameworks have emerged over the years, but one is arguably the most popular for general games: the Mechanics, Dynamics, Aesthetics (MDA) framework (Hunicke, LeBlanc, and Zubek, 2004), takes a formal approach by dissecting a game into its interdependent components. For serious games, the DPE framework focuses on the experience and the coherence of game elements and emotions while playing a game rather than analyzing its components. A more detailed explanation of the two frameworks follows.

MDA - Mechanics, Dynamics, Aesthetics

The fundamental idea of the MDA framework is that games are more like artifacts than media, meaning that their output is not the media that the player experiences, but the behavior they exhibit. The framework also spans a connection between the designer and the player, as they both interact with the same systems, only from different point of views, as can be seen in Figure 2.2 (Hunicke, LeBlanc, and Zubek, 2004).

When describing aesthetics, Hunicke, LeBlanc, and Zubek move away from broad terms like ”fun” or ”gameplay” towards a more defined taxonomy that allows to categorize games by the type of emotions they evoke in a player. It is very important to note that aesthetics in this case is not constrained to the visual world, but rather expresses the emotions and experience the player gets from playing the game:

- **Sensation:** Game as sense-pleasure

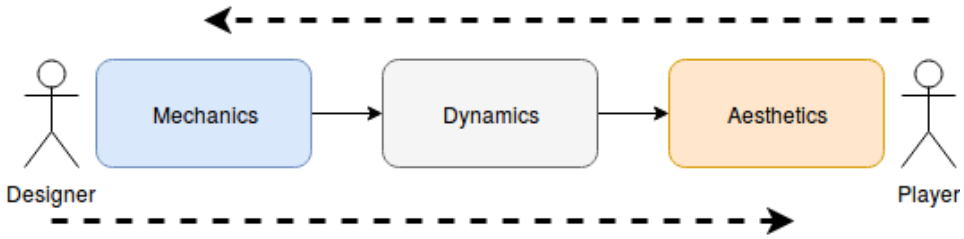


Figure 2.2: The MDA framework dissects a game into its mechanics, dynamics and aesthetics. The game designer has control over the mechanics, which spawn dynamics which in turn define the aesthetics the player can experience while playing the game (Hunicke, LeBlanc, and Zubek, 2004).

- **Fantasy:** Game as make-believe
- **Narrative:** Game as drama
- **Challenge:** Game as obstacle course
- **Fellowship:** Game as social framework
- **Discovery:** Game as uncharted territory
- **Expression:** Game as self discovery
- **Submission:** Game as pastime

Mechanics, on the other hand are options and control mechanisms that are made available to a player within the game context. Dynamics emerge from the application of these mechanics in the context that is created by the levels and assets the game provides. For example, in traditional card games the mechanics include shuffling, taking a trick or betting - from this, the dynamic of bluffing can emerge. Fine tuning of the mechanics can help to keep the dynamics level for all players in a game. For example, in the board game Monopoly, players that are lagging behind the leading player may feel left out of the action. Mechanics that allow catching or penalties for being too far in the lead will improve the average player experience and help keep up the tension of the game. Another way of improving the commitment and tension is the introduction of time constraints. The overall learning of Hunicke, LeBlanc, and Zubek (2004) is that by looking at the three interdependent components of a game, seeing them as levels of abstraction and understanding their effect on each other, a game designer can fine tune a games behavior through a multitude of options, like adding new mechanics that - through newly emerged dynamics - can enhance the aesthetics.

Figure 2.3: The DPE framework builds upon the MDA framework, but specializes in the design of serious games (Winn, 2009).

DPE - Design, Play, Experience

Building upon the MDA framework that is applicable to normal games, the DPE framework is tailored to serious games. As Winn (2009) puts it, the framework "**[...] presents a language to discuss design, a methodology to analyze a design, and a process to design a serious game for learning**". The framework, like MDA ties together the designer and the player. Only the design of the game can be controlled by the designer. As can be seen in Figure 2.3, a feedback loop from the experience to the design exists, representing the influence of the desired experience on the design.

As serious games are actual games (in contrast to gamified services, which have game elements built into non-gaming contexts), the requirements differ greatly in some areas, especially the players experience and commitment after playing. Depending on the nature of the serious game, the connectedness between the content and the mechanics can vary greatly - for example, for exogenous educational games, usually existing well-known mechanics are adopted and filled with new content only. Oftentimes, these games are also labeled as edutainment.(Egenfeldt-Nielsen, 2011) Endogenous games strive to bake the learning content into the game mechanics, promoting problem solving and reinforcing the learning goals (Winn, 2009). The author also introduces the so called "**heart of serious games**", depicted in Figure2.5. Depending on the context of the serious game, more or less when all three areas of the heart are covered, a serious game can be successful and engaging.

For the DPE framework, the authors introduce four layers that need to be considered when designing a serious game:

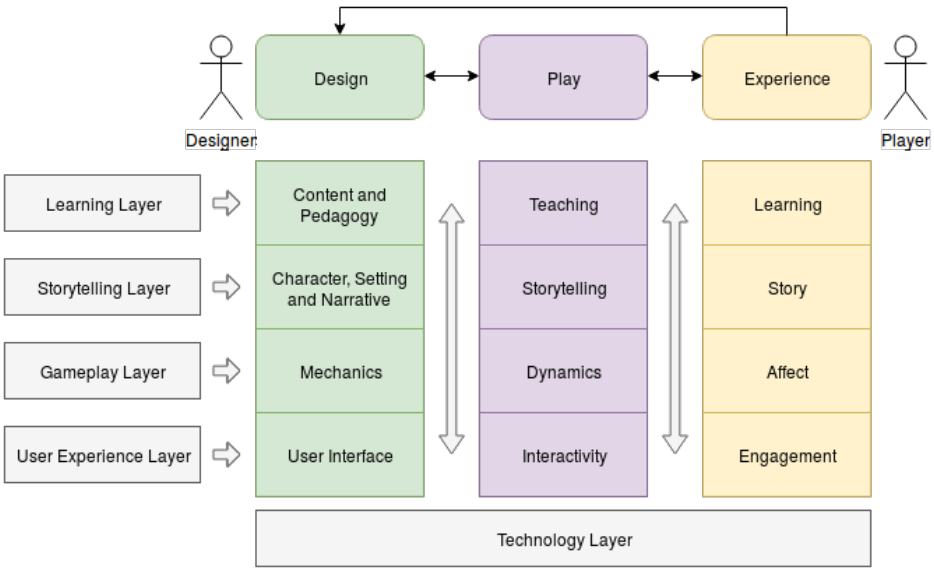


Figure 2.4: The full depiction of the DPE framework shows the layers that make up a serious game (Winn, 2009).

- **Learning Layer:** Desired learning outcomes of the serious game should be defined in this layer. The pedagogic approach is also established.
- **Storytelling Layer:** When designing a serious game, the types of stories the player should be able to experience in the game must be laid out beforehand. For more arcade serious games, this does not pose much of a problem, as there is little story to tell, but for educational games that attempt to teach about past or present topics, the storytelling must not deviate too far from the actual happenings. The narrative, characters and and overall settings of a serious game combine into the story it is attempting to tell.
- **Gameplay Layer:** This layer wraps the MDA framework. An important differentiation is the departure from the terminology of *aesthetics*, and introducing the concept of *affect*, a term stemming from psychology that is used to describe desire or emotion. The very important aspect of balancing that was already discussed in Section 2.1.1 is also covered in this layer, both in terms of difficulty and gameplay itself.
- **User Experience Layer:** This layer forms the foundation for the layers

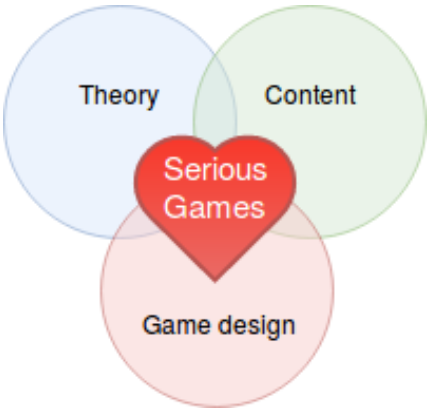


Figure 2.5: The heart of serious games visualizes the overlap of content, theory and game design that needs to exist for a serious game to be more than the part of its sums. One of the biggest challenges is serious game designs is bringing different disciplines like game design and education together and melding their work into the heart of serious games (Winn, 2009).

above it, as the user interface that provides the experience to the player is the manifestation of the game design. A good user experience is delivered by a user interface that is transparent to the player, meaning players do not need to focus on the controls or more generally on how to play the game but rather on the storytelling and learning experience.

- **Technology Layer:** The technological decisions that are made during development define the capabilities and limitations of the implementation of a game, especially for the user interface. A paper prototype may help with sketching the game design and the user interface, but if the system will eventually run on a computer or mobile phone, there will almost surely be large differences between the paper prototype interface and the finished user interface. These differences are not to be seen in terms of advancing development and an iterative development, but just by the limitations of the media the system is set in.

To recapitulate, the MDA framework is a general game design framework that allows designers to split the design into three interdependent building blocks, namely mechanics, dynamics and aesthetics. The DPE framework is a game development framework that expands on the MDA framework to

allow application to serious games. However, while using a tested framework for game design surely helps mitigate common problems and pitfalls, designers need to be aware of their players at all times. Especially the motivation for engaging in and enjoying a game can vary widely from player to player. The notion of player personalities has emerged from research into this direction.

2.1.4 Player Personalities

When researching different approaches a player could take on a Multi User Dungeon (MUD) environment, Bartle (1996) discovered four dominant traits that drive players. More commonly put, the things players enjoyed about playing were:

- **Achievement:** Reaching goals that are anchored within the game itself were a motivational factor for many players. These goals usually consisted of accumulating large quantities of certain in-game valuables or completing the game as thoroughly as possible.
- **Exploration:** Starting by first exploring the breadth of the MUD, players spent a large portion of their time with in-depth exploration of the game.
- **Social Aspects:** Some players were focused on the role playing aspect of the game and favored interaction with other players over measurable in-game progress.
- **Superiority Over Other Players** Using any means available, some players sought to establish dominance over other players, usually resulting in distress for the dominated players.

From these observations, Bartle then defined four player types which have since been widely adopted: achievers, explorers, socializers and killers. Normally, a certain players personality will be a combination of two or more of the types with one taking a primary role. Figure 2.6 shows the four player types laid out in a simple graph, depicting the desired actions and interactions of each

- **Achievers:** For achievers, points gathering and advancing through progression systems are the main incentives for playing. Other aspects

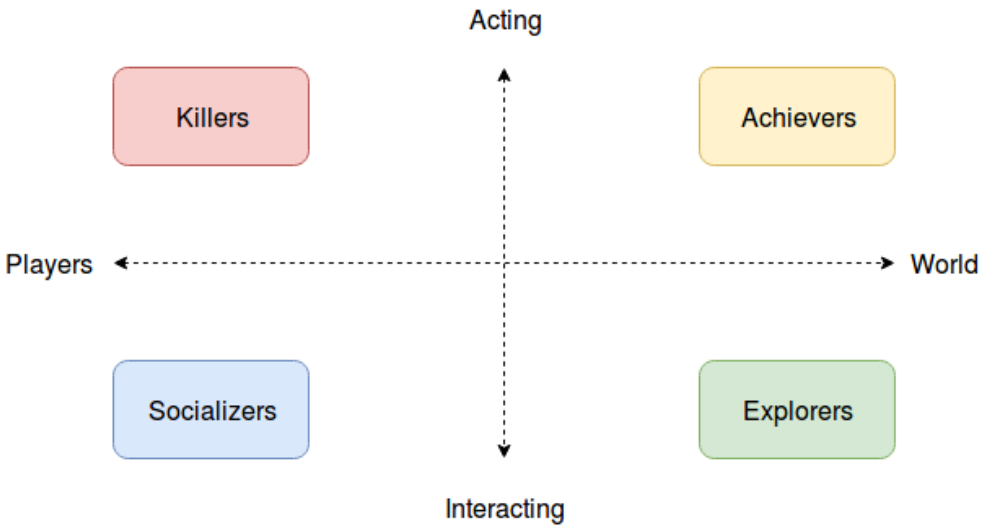


Figure 2.6: This simple diagram represents the four player types with respect to their interests in the game environment or the other players. The four archetypes are very clear cut and distinct, typical players will find themselves on a middle ground, indicating mixed traits with perhaps a dominant one (Bartle, 1996).

are subordinated. Social aspects are of interest mainly when other players can provide information about opportunities of accumulation of points. Similar, exploration and hostility towards other players are enjoyable only when they yield an increase in any kind of score or progression of an achievement.

- **Explorers:** Explorers shine in dissecting the core mechanics of a game. Points and interaction are interesting as long as they are new and give access to unknown explorable sections, but usually an explorer is focused on discovering every single bit of information about the inner workings of a game, even to the point of actively looking for bugs and loopholes.
- **Socializers:** Interaction and relationships with other players are what draws socializers to a game. Sympathizing with others, listening to what they have to say about the game or even unrelated events make the game itself become more of a means to an end. Causing distress to other players, as killers tend to do, is frowned upon among socializers.
- **Killers:** Killers play a game to exert their superiority over other players. This may even happen in a seemingly nice fashion of "**busybody do-gooding**", but the usual approach of a killer to a game is to cause the highest possible amount of distress to other players. To be able to do this, a certain power is required, which is why killers tend to invest quite a bit in exploration and leveling. Unlike achievers and explorers however, these two things are only means to an end for killers. For them, knowing that not only the player character, but the person behind that character they just attacked, is upset is the true reward.

Implications of Player Types for Gamification

As gamification has developed from games, understanding the psychological profile and thus the player type of potential players becomes essential (Juho Hamari and Tuunanen, 2014). However, the four player types of Bartle are not without critique: Tondello et al. (2016) state that these four types were defined for a MUD environment and should therefore not be mapped directly to other gaming or gamified contexts. With the Gamification User Types Hexad Framework, Marczewski (2015) introduced six player types

that are loosely based on Bartles types, but focus on gamification and the suggested elements and mechanics. The six player types are:

- **Philantrophists**: A subtype of Bartles socializers, these players are altruistic and give without expecting anything in return. Possible mechanics are gifting, administrative roles or knowledge sharing.
- **Socializers**: While bearing the same name, socializers in the work of Tondello et al. have a slightly different definition, more towards interaction like it happens in guilds or teams or competition and less towards sharing.
- **Free Spirits**: Motivated by the freedom to explore, this player type maps very closely to the explorers of the four original ones. They are drawn towards exploration, nonlinear gameplay, customization or so called easter eggs, hidden content that often has relations to the outside world.
- **Achievers**: Contrary to the achievers introduced above, players that fall into this category seek progression by completing tasks or challenges, but do not care that much about the bragging status that comes with them. Levels, progression or certificates keep them interested.
- **Players**: As long as there is a reward waiting at the end of the line, a player will do almost anything to achieve it. Points, badges, leaderboards or virtual currencies keep them going.
- **Disruptors**: A mixture of killers and explorers from Bartles classification, the prospect of change entices these players. Trying to disrupt other players or even the system itself, they sometimes even help in improving the system by discovering bugs and loopholes.

Obviously. different player types prefer and use different game elements, which is why gamification in a system should not consist of one single element or aspect. In a study which was conducted to validate gamification mechanics and player type relations, Gil, Cantador, and Marczewski (2015) considered four player types, namely achievers, free spirits or explorers, socializers and philantrophists. These types are in line with the ones presented by Tondello et al. (2016). Concerning the game mechanics and elements each type seemed to prefer, Gil, Cantador, and Marczewski reported the following results:

- Achievers were motivated by challenges, quests and badges.

- Explorers or free spirits were hard to pinpoint and did not really use any of the assumed mechanics like hidden assignments, which were instead picked up by achievers.
- Socializers participated lively in any social activity except competition.
- Philantrophists overlapped with socializers in some points, but generally showed interest in any altruistic action like helping other players.

Overall, designers of gamified systems should take care to provide incentives for using the systems to all four player types. However, a breakdown of the game elements that are typically used in gamified systems reveals that usually any player type will find one or more appealing aspects in a game or gamified experience that is built on these elements.

2.1.5 Breakdown of Typical Game Elements Used for Gamification

When looking at gamified systems, some elements and concepts pop up repeatedly. Most, if not all of these elements stem directly from their usage in actual games, with the most common ones, being points, levels and leaderboards (Mekler et al., 2013). In a survey with the objective of compiling the results of previous studies on gamification, J. Hamari, J. Koivisto, and Sarsa (2014) identified ten recurring elements, this time listing points, levels and achievements as the most common ones. Zichermann and Cunningham (2011) created an extensive list of game concepts that are - to a varying degree - found in any game or gamified system. Extended by elements encountered in Section 2.5, following affordances are more or less popular:

Points

Points are considered one of the or even the most common type of gamification (Landers, Bauer, and Callan, 2017; Mekler et al., 2013; J. Hamari, J. Koivisto, and Sarsa, 2014; Zichermann and Cunningham, 2011). Independently of their accumulation being shared between players or between a player and the designer, they make up a vital part of many games. The degree to which players are able to see their score themselves can range

from completely hidden to playing a central role in the game system. Point systems are also encountered throughout real life, such as the amount of money on a bank account or the number of followers on a social media channel. In theory, any metric of any type can be viewed as a score. For gamification, having a points system is almost a requirement set in stone. Zichermann and Cunningham (2011) identified the following palette of point systems a game developer can draw from for designing a gamified experience:

- **Experience Points**: When a gamified system uses experience points, every action that a player takes should reward them with experience points. These points can usually not be redeemed and should never go down. By assigning different amounts of points to different actions, game designers can help guide the players towards better understanding of the priorities of a game system. Additionally, experience points should not be capped. As long as a player is actively playing the game, they receive experience points, even if a connected level may at some points reach a cap.
- **Redeemable Points**: Commonly understood as a form of currency, redeemable points can fluctuate over time, unlike experience points. The traditional use case for redeemable points is exchanging them for any kind of valuables within the game environment. As with real currencies, game designers need to closely monitor and tweak the flow of capital to provide a smooth in-game economical situation, as inflation and deflation can quickly become a problem. As soon as real world currency can be exchanged for redeemable points in a game, legal and regulatory issues that need to be addressed properly arise.
- **Skill Points**: Points assigned to a distinct subset of skills are dubbed skill points. While not all too prominent in gamification, they are omnipresent in role playing games where things like magic and melee combat have their own progression systems.
- **Karma Points**: Karma points rarely appear in regular games, but can often be found in gamified networks. The unique concept about them is that they are of worth only when given away to other players as a means of endorsement. They provide an outlet for altruism without the player gifting them has to be afraid of losing something that is of worth to them. Seeing that many players have strong socializing traits,

karma points can be an excellent addition to a community system.
- **Reputation Points**: These points form the most intricate system. A high reputation score for a player indicates that they are trustworthy individuals. Reputation points are earned by taking actions that are in some way validated or esteemed by other players. However, a major problem exists: as a reputation point system translates into trust between two or more parties, attempts to ”game” the system will be conducted by the players. Zichermann and Cunningham list Yelp, a restaurant review site, as an example for a platform that struggles with forged reviews that attempt to manipulate the reputation of restaurants.

Levels

For regular games, levels mostly indicate the stage the player is currently on within the game environment. In most cases, this does not smoothly translate to gamification, as no stage progression is present. Instead, levels can be used as markers for players, letting them know where they currently stand in the gaming experience. When designing a level progression system, special care must be taken to find a sweet spot between challenging and overstraining a player in terms of the difficulty or time requirement of getting to the next level. Starting off, progressing through the first few levels should come quickly and easily, but once a player gets more engaged with the game, a certain degree of dedication should be required. Very importantly, level progression should not be linear nor exponential, but sit somewhere in between. Figure 2.7 shows an exemplary level progression curve, with arbitrary actions as means of progressing through levels. For finding level systems in real life, one does not need to look further than the military, where a soldiers rank directly translates to their level in the hierarchy. Generally, levels are one of the most popular elements of gamfication (Deterding, Sicart, et al., 2011; J. Hamari, J. Koivisto, and Sarsa, 2014; Mekler et al., 2013; Zichermann and Cunningham, 2011; Deterding, Dixon, et al., 2011; Zuckerman and Gal-Oz, 2014).

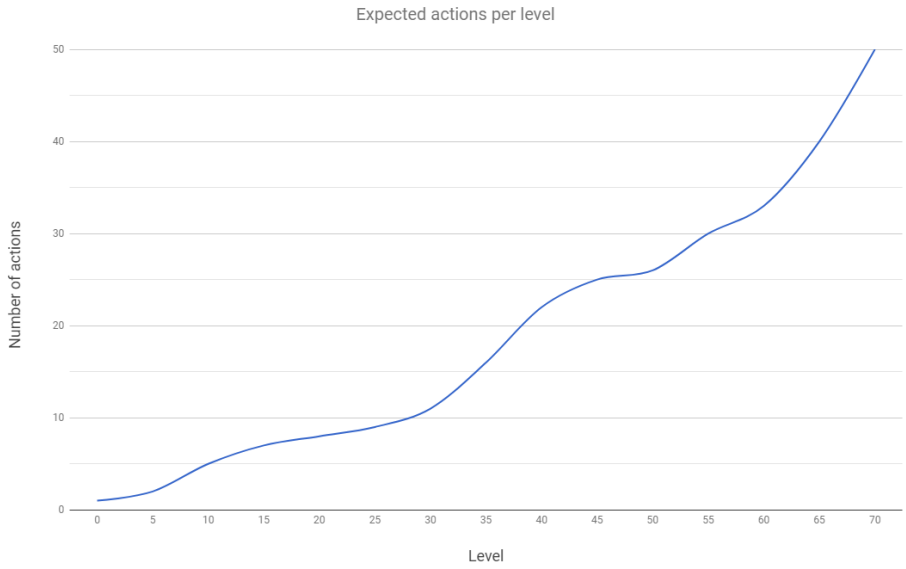


Figure 2.7: An exemplary increase of complexity when progressing through levels. Somewhere between a linear and an exponential growth, the increase should not be too high to throw off players, but still provide a challenge. Note that for specific use cases, the complexity progression could be entirely different (Zichermann and Cunningham, 2011).

Leaderboards

Leaderboards serve a single purpose: allowing players to compare themselves with other players by looking at some point metric. However, with leaderboards, a major problem may arise: Players start to abuse any options of getting points to achieve a higher rating on the leaderboard, essentially faking data and gaming the system (Callan, Bauer, and Landers, 2015). To counteract this effect, leaderboards can be filtered in two ways (Zichermann and Cunningham, 2011):

- **No-disincentive Leaderboards**: Most players will never reach a spot near the top of any leaderboard. On the one hand, to still create a social incentive, a player is only shown a small section of the leaderboard, without absolute numbering. They might see how many points they need to overtake the player in front of them, and how many points still lie between them and their closest pursuers. On the other hand, players that are actually near the top should be given this information, as their rank is likely of importance to them.
- **Infinite Leaderboards**: On arcade machines, there was no way to have the scores of all players that ever played on a leaderboard. Today, leaderboards can in theory get infinitely large, but by slicing and filtering still provide meaningful information to players. Such filter criteria may include friends scores only, a filter that only shows players from the same region or players that have spent a similar amount of time in the game.

With leaderboards, special care must be taken to satisfy all privacy requirements, to avoid possible humiliation of lower ranked players. This is especially true if the metric of the leaderboard is of a sensitive nature, like weight on a weight loss program leaderboard. Ironically, the competitors on leaderboards do not even have to be real: Mekler et al. (2013) conducted a study on performance gains from points, levels and leaderboards and found that even simulated opposition had a strong motivational effect on the participants.

Achievements and Badges

Badges, sometimes also called ribbons, usually indicate the accomplishment of an achievement. The concept of badges was not created by game designers, but again stems from real world counterparts. For instance, every car features a badge on the front and on the back, telling a story about its driver, like how much money they were willing or able to spend on it. Bragging rights come into play hugely once attained badges can be publicly displayed. When designing a badge system, game designers need to make sure that receiving a badge is always something a player looks forward to, not something that happens repeatedly and without actually having to get involved. If designed properly, badges can also be used to replace levels in gamified systems. Looking forward to earning a badge does not necessarily entail knowing what badges can be earned or how they can be earned, the element of surprise can suffice to motivate players in their pursue of badges. Foursquares Swarm[9] hands both out badges that are invisible before being earned, and badges for which players know exactly what to do. Historically, Foursquare was one of the companies bringing on the advent of gamified mobile applications, by awarding badges for social check-ins at predefined places, using the location data provided by mobile devices.

Anderson et al. (2013) showed that badges can even be used to guide player behavior, as players tend to go out of their way to complete a badge. They found that once a player has reached a certain threshold on the progress of attaining a badge, more focus is put on the actions that are required for acquiring that badge.

Storytelling

Humans generally do not recognize the power their own imagination has over them (Gottschall, 2012). Gottschall goes even further than that statements and claims that stories that inspire our mind to wander are what makes us human. By drawing a player into a narrative context, engagement with an application can be increased by a large amount, making players

[9] `https://www.swarmapp.com/` (Foursquare Labs, 2018b)

come back again and again. It is difficult to pinpoint exactly what a compelling story should be like, but especially in the domain of education, storytelling has found its use into many services and programs, helping students keep their motivation up (Robin, 2006).

Streaks

While actually another point metric, streaks deserve their own spot in a listing of typical gamification elements. By encouraging a player to take an action on a somewhat fixed schedule, using a gamified service can become part of the players routine - be that daily, weekly or any other time span. A distinction of streaks from the concept of the other point metrics presented previously is that a streak is very volatile. If a player fails to take the required action until a set deadline, the streak counter is reset to zero. For the language learning platform Duolingo[10], a daily practice streak is the core element of the contained gamification. The effectiveness of this streak has been the subject of a study by Huynh and Iida (2017). The authors found that especially more advanced players were motivated to keep their streak alive as long as possible. Generally, the higher a streak counter gets, the more motivation players can draw from it.

Community Engagement

Considering many players have a strong socializing trait, community features are often a strong incentive for using a system. There does not exist a one-size-fits-all community framework that can be introduced into every gamified system, but concepts like friends and followers emerge repeatedly. Recognition from other players is a desire that drives especially players who have an inclination towards being an achiever or a killer/disruptor. However, a community can do much more than just give players a spotlight to show off their achievements. In social networks, the community is the pillar of the application, as the name suggests. Small, romance-like flirtatious options like poking a friend on Facebook offer an easy way to build a closer

[10] `https://www.duolingo.com/` (Duolingo, 2018)

connection to another player in the community. Chung-Ho and Ching-Hsue (2014) implemented a gamified mobile application for a study that allowed players to complete quests as a team. This concept also lies at the heart of Habitica[11], a general behavior change application (both web and mobile) that has players complete their chores and tasks to raise the points of the whole group - failing to complete tasks not only punishes one player, but the whole group. This application also offers cooperative quests that can only be accomplished in parties of two or even more players. Juho Hamari and Jonna Koivisto (2015) conducted a study on the motivational effect of social factors in the context of exercising. The three concepts contributing to the social factor, the subjective norm, perceived recognition and the perceived reciprocal benefit all contributed to the frequency of use of the application that was tested in the study.

Goals, Challenges and Rewards

In their theory of goal setting, Locke and Latham (1994) describe the positive effect of setting properly formulated goals for task performance. In gamification, self set goals are often used to encourage the user to perform a certain behavior. Oftentimes, upon completing a goal, a reward of either ingame value or even real value is awarded to the player (Landers, Bauer, and Callan, 2017). Challenges work similarly, but are usually predefined by the game or application design.

No matter the exact nature of a game element in a gamified environment, they all serve the same purpose: getting the player involved with the application. Gamified systems and serious games attempt to persuade players to act or think in ways which they would not consider without playing the game. The concept of persuasive system design even precedes gamification theory.

[11] `https://habitica.com/static/features` (Habitica, 2018)

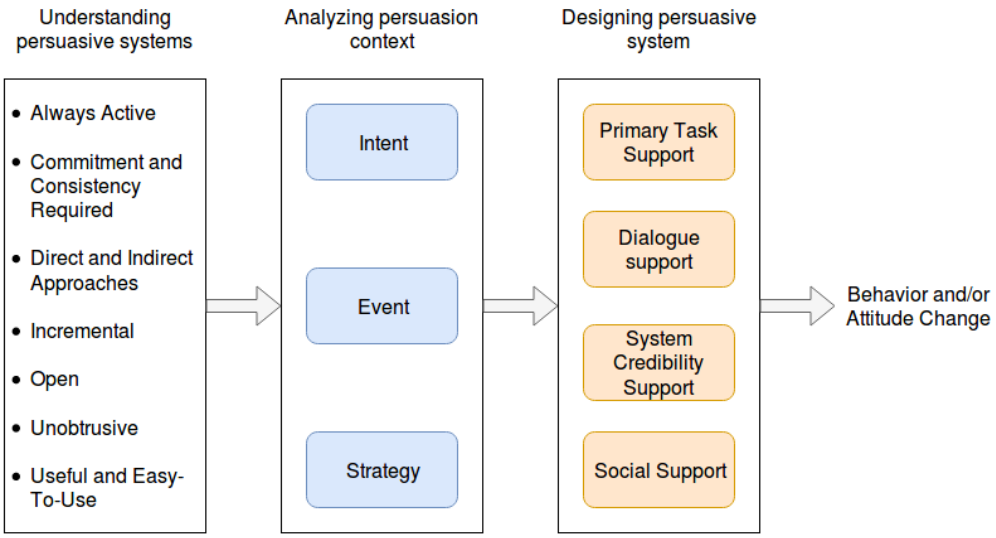


Figure 2.8: The three steps of designing a persuasive system, based on work by Oinas-Kukkonen and Harjumaa (2009)

2.2 Persuasive System Design

A persuasive system is described by Oinas-Kukkonen and Harjumaa as being " **[...] designed for changing users' attitude or behavior**". Therefore, in some way or another, each gamified system or serious game is also a persuasive system. This is especially true in case of the application which was developed alongside this thesis, as it employs gamification in a behavior change context. When designing a persuasive system, usually three steps are involved. In the first step, fundamental issues of persuasive systems must be taken into account. The second step serves the definition of the system context. Lastly, in the third step, actual system features are designed and evaluated. A quick overview of the three steps can be found in Figure 2.8 (Oinas-Kukkonen and Harjumaa, 2009).

2.2.1 Postulates of Persuasive Systems

Based on empirical research and conceptual analysis, Oinas-Kukkonen and Harjumaa (2009) suggest seven cornerstones of persuasive system a designer needs to understand before even starting with a requirement analysis. In no particular order, those seven postulates are:

- **Always Active**: A persuasive system is always active, exerting influence on the users attitude and behavior. Even if not deliberately designed as persuasive, any part of a system can act in such a way. A consequence of this is that persuasion should rather be considered a process than an act, and user objectives may change over time while using the system. A well designed persuasive system should be able to cope with this.
- **Commitment and Consistency**: Allowing commitments, like a paid membership, aids greatly in persuading the user. The concept of cognitive consistency, as described by J. G. Jones and Simons (2017), suggests that inconsistencies between the users expectancies and the world around them put pressure on them to either adapt their attitude or change their behavior in order to change the world around them to better fit their attitude and expectancies.
- **Direct and Indirect Approaches**: Depending on the user, a direct approach of conveying information to persuade them may not be the best approach. The simplest direct approach of persuasion is via text messages, but oftentimes, people are not receptive to text or lack the ability to understand the message. In such cases, an indirect approach that utilizes hidden clues may be in order.
- **Incremental Nature**: Persuading users to perform actions that start out simple and become incrementally harder is more successful than persuasion for one large task. An example would be healthier eating: instead of telling the user to eat healthier, advising them to put five pieces of vegetables on their plate to start out will work better in most cases.
- **Open Nature**: Persuasive systems should be open and honest about being persuasive. Bias caused by the designer of the system should also be made clear.

- **Unobtrusive Nature**: Persuasive systems should aim to integrate seamlessly into the users day-to-day life. This also means that persuasion attempts like notifications should not arrive at inappropriate times.
- **Usefulness and Ease-Of-Use**: Relatively straightforward, a persuasive system should not stand in its own way. A system that is unintuitive to use or feels useless will have very little success in persuading the user.

2.2.2 The Persuasion Context

Understanding the context in which the user should be persuaded to perform some action is vital for designing a system that succeeds in the persuasion attempt. Viewing the user as an information processing system, as McGuire suggests in his work from 1973, attention to and comprehension of the persuasion attempt is shifted into focus. The user must pay attention to the persuasive content provided by the system and needs to be able to actually understand it. Once this is ensured, users can adhere to the new mindset, either for a short time, or in case of a really successful persuasion, actions will be taken to incorporate it into their lives (McGuire, 1973). Another perspective at persuasion is the concept of cognitive consistency. Described already in the postulate of direct and indirect approach, cognitive consistency suggests that not all phases of information processing must be performed by the user. Instead, by creating inconsistencies between the users world view and the world around them, an attitude change can be triggered (J. G. Jones and Simons, 2017). Changing attitudes which are based on personal experiences are harder to change than ones inherited from surrounding people (Otto, 1973). Generally, three aspects of the persuasion context need to be considered carefully before starting work on a persuasive system: intent, event and strategy.

The Intent

Determining whether the intent of the system is to persuade the user to perform a one-off action or to really achieve a long-term behavior change is the first step in exploring the persuasion context. For a one-off action,

generally less persuasion is required, naturally depending on the difficulty of the action. Long-term behavior or attitude change can only be brought about by influencing primary beliefs (Fishbein and Ajzen, 1975).

The Event

Two facets of the persuasion context that are summarized as the event of persuasion by Oinas-Kukkonen and Harjumaa (2009) are the use context and the user context. The use context describes all features arising from the domain of the problem the system attempts to deal with. A popular field of application for persuasive system is the health domain. Many users have the general knowledge of how to live healthy, but years of bad habits and inappropriate behavior keep them from acting on their knowledge of a healthier lifestyle. For such cases, a persuasive system should help with adhering to the already existing knowledge in order to improve the users attitude (Oinas-Kukkonen and Harjumaa, 2009).

The user context of a persuasive system design deals with the individual differences of users in processing information. While some users may react favorably to a direct medium of information, others will generally pay less attention to message contents and will need to be addressed in a more holistic manner. Understanding users goals and the implication they have on the persuasion required also aids in better analysis of the user context. For computer based persuasive system, the technology context comes into play as an important building block. The strengths and weaknesses of the platform must be understood to ensure successful persuasion(Oinas-Kukkonen and Harjumaa, 2009).

The Strategy

When designing a persuasive system, the question of how to reach the user will arise at one point or another. Two options exists, the direct and indirect approach. In the direct approach, persuasive messages are delivered directly to the user. For the indirect approach, the system designer relies on indirect cues built into the system that work on a subconscious level. Under the

premise that users are able to comprehend a direct persuasion message, this approach is favorable (McGuire, 1973). Lately, users are often subject to a constant information flow and even overflow and some of them lost receptiveness for direct messages. For these users, the indirect approach must not be omitted (Oinas-Kukkonen and Harjumaa, 2009).

Designing a Persuasive System

Persuasive system design is contained mostly in the system qualities of the requirements analysis of software development. Oinas-Kukkonen and Harjumaa (2009) split the conception of a persuasive system design into four steps: primary task, dialogue system , system credibility and social support. For their place in the whole ecosystem, Figure 2.8 can be consulted. The primary task is the core approach that is taken to persuade a user and is one or a mixture of the following:

- **Reduction**: Reducing a complex behavior into simple tasks can help users perform them step by step.
- **Tunneling**: A guided experience for users offers opportunities for persuasion along the way.
- **Tailoring and Personalization**: Persuasive content that is tailored exactly to the user and usage context will usually be more persuasive than one-size-fits-all approaches.
- **Self-Monitoring**: Keeping track of the users performance helps with achieving goals.
- **Simulation**: By providing simulations of favorable outcomes, systems may be able to create a link between the desired behavior as cause and the outcome as effect.
- **Rehearsal**: Giving the user opportunity to rehearse certain behavior can help reinforce it.

The dialogue system is the part of a persuasive system that provides feedback to users. Looking at various forms it can take, (Oinas-Kukkonen and Harjumaa, 2009) gathered seven design principles from their research. Not by coincidence, the list reads similar to elements of gamification:

- **Praise**: Praising the user in one way or another generally makes them more receptive to persuasion.
- **Reward**: Rewarding target behavior via virtual or even real rewards carries great persuasive power.
- **Reminders**: By reminding users to not forget about their target behavior, the behavior is kept in mind, which helps persuasion.
- **Suggestion**: When starting out, users like to rely on suggestions for an easy way of getting into using a system.
- **Similarity**: By mimicking an already known aspect of their users lives, persuasive systems can have much greater success. An example for this would be an application using slang terms that are well established in the target group (Toscos et al., 2006).
- **Liking**: Even the best designed system will not have much persuasion power if it offers a sub-par user experience or usability. The concept of usability is described as "**[...] a quality attribute that assesses how easy user interfaces are to use**" (Nielsen, 2003).
- **Social role**: By adopting a social role, for example as a virtual health specialist, a persuasive system will come across as more persuasive.

System credibility is a rather straightforward concept. The more credible a system is deemed by its users, the more persuasive power it can have over them. Trustworthiness and verifiability of made claims are two essential requirement. Other options for persuasive systems to gain credibility is through endorsement by well known third-party systems, leveraging a role of actual authority and incorporating proven expertise. The first contact users have with a persuasive system is of utmost importance, as the initial assessments of the system contributes a large portion of its credibility. A bad first impression can therefore strongly diminish a systems persuasive power.

Lastly, similar as in gamification theory, the community of a persuasive system contributes to its persuasive capabilities. Comparison, competition and cooperation with, as well as recognition from other users all aid in raising a users motivation for adopting the target behavior.

2.2.3 Evaluation of Persuasive Systems

Oinas-Kukkonen and Harjumaa (2008) propose a framework for evaluation of persuasive system designs that is mostly congruent with the postulates presented above, formulated by the same authors in 2009. The authors claim that while the framework is of a theoretical nature, practical implications can be drawn from it, as the postulates should be used as guidelines for software quality, be that in functionality or content. The framework aims to evaluate the persuasion effect of the system. This is in line with evaluations for gamification or serious games that try to assess to which level players are responding to the gamified content.

2.3 Evaluation of Gamification and Serious Game Designs

Evaluating the actual effectiveness of gamification or serious games on the motivation and commitment of users to an application has been the subject of several empirical studies, stemming from both psychology and software development (Zuckerman and Gal-Oz, 2014; Juho Hamari and Jonna Koivisto, 2013; Anderson et al., 2013; Deci, Koestner, and Ryan, 1999). J. Hamari, J. Koivisto, and Sarsa (2014) conducted a comprehensive review of more than 20 empirical studies on gamification and gamefulness. They found that, with very few exceptions, both qualitative and quantitative studies reported a positive or mostly positive effect on the user commitment when implementing game mechanics into non-game contexts. The studies which were under inspection by J. Hamari, J. Koivisto, and Sarsa looked at several factors and variables of the gamified context, which allowed the authors to split their findings into several categories. Those categories were:

- Psychological versus behavioral outcome
- Tested motivational affordances, with points and leaderboards being the most commonly found
- Context of the studied implementations, with education being the most common one

The problem with analyzing the effectiveness of gamification or serious games is that no standardized approach exists (J. Hamari, J. Koivisto, and Sarsa, 2014). The authors criticize the lack of comparable results from the reviewed studies, as even the terminology shows great differences between studies that handle the very same subject. Mitgutsch and Alvarado (2012) try to address this issue by introducing a so called Serious Game Design Assessment Framework that strives to not only measure the effect of the serious game on the user motivation and commitment, but also validate the intention-based design, meaning the applicability of the implemented game within the serious application context. The DPE framework by Winn (2009) focuses on evaluating the design of a serious game, but according to Mitgutsch and Alvarado, lacks a measure of the connection between the game and purpose of the system. The central finding of applying the Serious Game Design Assessment Framework is that the purpose of the contained game has to be reflected in the actual game design. The DPE framework is described in more detail in Section 2.1.3. Even though no standardized approach exists, researchers have evaluated the usefulness and effectiveness of gamification in mobile applications. One exemplary research dealt with fitness and health related apps that offered varying degrees of gamification.

In 2014, Lister et al. (2014) set out to review and quantify the use of gamification elements in health and fitness related mobile applications. The purposes of the their study were reviews of two characteristics of the examined apps:

- **Used Elements of Gamification**: Ten typical, effective game elements were determined beforehand and used in a coding scheme. Alongside these ten items, six classic gamification elements were used in the same coding scheme, coding with (1) for presence or (0) for absence of the element in question. The ten elements from games included:
  - Player representation with avatars
  - Three-dimensional environments
  - Narrative storytelling
  - Feedback to players
  - Ranks, reputation, levels
  - Ingame economy and marketplaces

  - Rule based competition
  - Teaming and cooperation features
  - Communication systems
  - Time pressure

  This selection of elements was based on the work of Reeves and Read (2009) and verified by Deterding, Sicart, et al. (2011). The six gamification elements closely matched the ones presented in Section 2.1.5:

  - Levels
  - Leaderboards
  - Rewards (points and badges)
  - Real world rewards
  - Competition
  - Social or peer pressure

- **Inclusion of Health Behavior Constructs**: The 13 health behavior construct elements were taken from contemporary literature, mostly from Cowan et al. (2013). This study is presented in more detail in Section 2.4.6. Like the game and gamification elements, the behavioral constructs were coded using (1) for presence and (0) for absence.

Results

After evaluating and checking for at least one element of gamification, 132 apps from Apples App Store were tested. The mean scores for integration of game elements, gamification elements and behavioral constructs were all belows 50% of their possible maximum. The authors suggested that the lack of any industry standard for gamification or health behavior in apps was the cause of these low scores. Using linear regression, the researchers assessed association between gamification elements, game elements and health behavior construct inclusion. Correlation could be found between the use of gamification elements and health behavior constructs, but not between usage of game elements and health behavior constructs. A possible reason for this is - according to the researchers - the assumption that simple inclusion of rewards or leaderboards was enough to sustain behavior

responses, while more immersive game elements like 3D environments or narrative context were left aside (Lister et al., 2014).

Overall, the study criticized that apps using gamification use it to get user to interact with the app more often, but not to trigger and reinforce the new behavior that should be the underlying objective. Another point of critique for many of the tested apps was that the integrated gamification aspect was no more than a customer loyalty program and doing little to promote the actual behavior change. Therefor, after shortly introducing the most popular behavior change theories, possible mitigations for the lack of proper inclusion of gamification in behavior change are discussed.

2.4 Behavioral Change Theories

The following short section will be a excursus into more psychological terrain. Understanding the theory of why behavior changes helps with incorporating gamification into a health behavior change tool in a meaningful manner. However, it should be noted that gamification already attempts to directly increase motivation, while all presented theories investigate behavior change at the lower levels, such as attitude or personal beliefs and perceptions (Juho Hamari and Jonna Koivisto, 2013).

In the last few decades, understanding behavior as well as the causes and triggers for behavior change in people has been an active research topic (Fishbein and Ajzen, 1975; Ajzen, 1985; Godin and Kok, 1996; Prochaska and Velicer, 1997; Bandura, 1977; Sheppard, Hartwick, and Warshaw, 1988; T. J. Madden, Ellen, and Ajzen, 1992; Marshall H Becker, 1974; Bandura, 1998). While the approaches between the popular theories differ, they all try to explain why human behavior changes. The most prevalent theories explaining behavior change in the health domain are the theory of planned behavior, the transtheoretical model, the health belief model and the social cognitive theory (Cowan et al., 2013). In the following sections, each theory or model is introduced shortly, then possible areas for a meaningful application of gamification within the boundaries of each respective theory are discussed.

2.4.1 Theory of Planned Behavior

Originally formulated in 1985, this theory has been refined in 1991. The theory itself is an extension of the theory of reasoned action, which states that behavior is a result of intentions, based on ones perception of said behavior. The extension was made necessary by the inability of the old theory to model behaviors that lie outside of peoples volitional control (Sheppard, Hartwick, and Warshaw, 1988). A central part of the theory of planned behavior is the intention of an individual to perform a certain behavior. Quite obviously, the higher the intention to perform a behavior is, the more likely its execution will follow. One factor that contributes to intention is that of perceived behavioral control. This concept refers to an individuals perception of the difficulty of performing a certain behavior. Put more simply, a persons behavior is "**[...] strongly influenced by their confidence in their ability to perform it**" (Ajzen, 1991).

Attitude toward a certain behavior is another cornerstone of the theory. As stated by Ajzen (1991), it refers to "**[...] the degree to which a person has a favorable or unfavorable evaluation or appraisal of the behavior in question**". The last factor of an individuals intention are subjective norms, referring to perceived social pressure in terms of performing the behavior in question. The three factors are mostly independent from each other and vary in importance across behaviors and situations.

2.4.2 Transtheoretical Model

The transtheoritical model, first published by Prochaska and Velicer (1997), uses the core constructs of stages and processes of change, decisional balance, self-efficacy and temptation. Stages of change represent a temporal axis in the behavior change process. Each stage found by the researchers is characterized by an attitude about changing some aspect about oneself. From precontemplation, during which no thought is given to a behavior change, over contemplation and preparation of a change, people reach the stages of action and maintenance, in which a behavior change is performed and maintained. Relapse into old behavioral patterns become very unlikely in the maintenance stage, while practically no temptation of falling back into

those old patterns can be observed at the stage of termination. A classical example for running through those stages would be stopping to smoke. The processes of change describe the activities that people use to progress through the aforementioned stages. Raising their consciousness, reevaluating themselves and their environment or self liberation are some example processes. Decisional balance is nothing but a weighting of the pros and cons of a behavior change process, individual to each person. Self-efficacy describes a persons confidence to not give into temptation and relapse into unwanted behavior.

2.4.3 Health Belief Model

The health belief model was developed in the 1950s as a means of trying to understand the failure of people to accept disease prevention and preventive screening for early detection of illnesses (Rosenstock, 1974). Its first formulation was done by Marshall H Becker (1974). Later it was expanded to responses, symptoms and compliance to medical regimens (Janz and Marshall H. Becker, 1984). Behavior and its change are modeled with two main variables: the value an individual places on a particular goal or outcome is the first variable, while the second is the estimated likelihood that an action will help in achieving that goal or outcome. More specifically, the following aspects are what make up the health belief model, formulated in the domain of health and illness prevention:

- Perceived susceptibility refers to the individual perception of the risk of contracting an illness or general bad health condition.
- The perceived severity describes the importance an individual assigns to an already ensued contraction of an illness. It ranges from personal consequences like disability or death to social consequences like the impact of the illness on work or family environments.
- The two upper items both describe the awareness of an individual about a certain health condition. The belief in the effectiveness of actually taking a step towards curing or preventing an illness is called the perceived benefit.

- Antagonistic to the perceived benefit, the perceived barriers describe the potential negative aspects of a health action. Concepts like inconvenience or dangers of certain treatments belong to this aspect.

These four dimensions and a cue to action for triggering form the core of behavior change theory in the health belief model.

2.4.4 Social Cognitive Theory

While the social cognitive theory was developed for use in the domain of psychology, it has since been transferred into various other domains like business, academics, gender development, culture, communication and last, but not least health (Wood and Bandura, 1989; Lent, Brown, and Hackett, 1994; Bussey and Bandura, 1999; Bandura, 2002; Bandura, 1998). Generally, the social cognitive theory depicts behavior change as a multi-faceted structure of causals. In that structure, cognitive goals, expectations of outcomes, beliefs on self-efficacy and an individual perception of environmental barriers work together in forming the core of behavior change. More simply put, the social cognitive theory relies on a schema of triadic causalization (Bandura, 2009):

- Level of self-efficacy towards the behavior
- Perceived social response after performing the behavior
- Environmental impediments that can inhibit performing the behavior

2.4.5 Persuasive Systems, Gamification and Behavior Change

As stated before, gamification attempts to bring about a behavior change by improving the users motivation. For each model, implications and possible applications for a persuasive system and gamification are discussed.

A persuasive system attempts the persuasion at a deeper level than, as it is generally designed to change attitude, thus allowing the user to be persuaded to engage in new behaviors (Oinas-Kukkonen and Harjumaa, 2009). A connection to the theory of planned behavior can easily be made, as

attitude towards the target behavior is one of the cornerstones of the theory. For the health belief model, careful analysis and design of the intent within the persuasion context is required, as both perceived susceptibility and perceived severity influence whether a behavior change is considered one-off or long term. In the transtheoretical model, each new stage of change might require its own strategy for the persuasion context, as well as a custom primary task. In the social cognitive theory, the persuasion context as a whole could be modeled to emulate the social response a person is attuned to. By simulating a positive social environmental response, the persuasive system would encourage repetition of the target behavior.

Incorporating gamification in a way that allows it to work in union with the behavior change theory is perhaps a little trickier, as gamification attempts to increase motivation directly. But still, for the theory of planned behavior, the playfulness of gamification might be helpful in lowering the estimated difficulty within the concept of perceived behavioral control. Masking the true action with a gamified one might increase a persons confidence in their ability to perform it. Concerning the transtheoretical model, several mappings of gamification elements to theoretical constructs come to mind: using levels to guide users through the stages of change, preset goals as processes of change and narrative storytelling with a clear cut antagonist as a means of making people aware of the looming temptation. Additionally, by bringing entertainment into the behavior change process, the decisional balance might be skewed positively to the pro side. For the health belief model, storytelling appears to be a good fit to improve both perceived susceptibility and severity, while the more common gamification elements like points or challenges could positively contribute to the perceived benefit. As with the transtheoretical model, awareness for the perceived barrier could again be raised through a narrative context. Community and social features are obviously the way for merging gamification with the social cognitive theory, as the social response within social networks can take place in much larger scales. Again, for overcoming any environmental impediments, raising awareness about them through means of storytelling might prove effective.

2.4.6 Inclusion of Behavior Change Models in Healthcare Apps

Cowan et al. (2013) conducted a study about the incorporation of the four presented behavior change theories in 127 four to five star rated apps coming from the Health & Fitness category of Apples App Store. Using established theory based instruments, the apps were tested for inclusion of theoretical constructs of popular behavior change theories. After thoroughly exploring each user interface to improve familiarity and rule out missing out on content of apps, the conductors determined inclusions scores for four theories, namely the health belief theory, the transtheoretical model, the theory of planned behavior and the social cognitive theory. Looking at 100 different items, 20 from each theory and 20 from a previous study by Doshi et al. (2003) that were designed to evaluate theoretical content of physical activity websites, scores from 0 to 100 were assigned to the tested apps. The highest score achieved by an app was 28 points, while two apps shared the lowest score of one point. A correlation between app score and app price was also noticed, as more expensive apps achieved higher scores. Overall, the authors state that the low scores of apps did not come as a surprise, given the lack of background in behavior change theory of the typical app developer, and as mitigation suggested tighter collaboration between health behavior change experts and developers.

2.5 Related Work in Measuring the Effectiveness of Gamification

Table 2.3 shows a concise listing of 25 papers which in one way or another investigate the effectiveness of gamification in gamified applications and services. The work of J. Hamari, J. Koivisto, and Sarsa (2014), as well as the study of Lister et al. (2014) provided the basis for this list, which was then expanded with several newer papers. An emphasis was made on restricting the implementations used in the studies to be gamified apps and services, not serious games. An distinguishing overview on the results will be provided, along with an analysis of used game elements.

2.5.1 Types and Setups of Studies

Concerning the evaluation type, 19 of the studies were conducted in a quantitative only manner, meaning usage data analysis, experiments followed by questionnaires without any open questions or similar methods. 2 studies took a purely qualitative approach, generating their results from interviews. The remaining 4 studies lay in between, using a mixed approach of both quantitative and qualitative nature. Looking at the domain of the gamified application or service that was under inspection, education of some form was the most prominent one with nine occurrences, closely followed by health, combining both mental and physical health, accounting for seven papers. Business or general productive environments were also featured in seven papers, this is however a very rough grouping. One paper focused solely on social interaction.

2.5.2 Analysis of Game Elements

Table 2.1 shows the total amount of times a single game element occurred throughout all the applications that were under examination. Badges, and points occur most often, with leaderboards following on third place. Levels also occur repeatedly, as well as storytelling, which adds a narrative element to an application. The tenth element on this list, games, deserves a short explanation: They are not serious games as previously described in this chapter, but just small, really simple game-like activities. The game implemented in the paper by Eickhoff et al. (2012), for example, just consists of guiding text bubbles into containers which represent documents that are getting matched to the tags.

Nr.	Game element	Occurrences
1	Badges	12
2	Points	10
3	Leaderboard	8
4	Levels	6
5	Storytelling	5
6	Challenges	4
7	Community	4

8	Rewards	3
9	Goals	2
10	Games	2
11	Feedback	1
12	Streak	1

Table 2.1: Game element occurrences and number mapping for Table 2.2.

Looking at the cooccurrences of game elements in Table 2.2, some interesting observations can be made:

- When sticking with only a single type of game elements in a gamified application, badges are by far the most popular choice. An explanation for this might be that levels or leaderboards usually require points to function properly. Subsequently, even though being the second most popular choice, points are never used without accompanying elements. Badge systems can also easily be integrated into existing systems, and research on and guidelines for badges are available in more depth than for many other elements.
- The game elements with the highest number of coocurrences are points. Given that points often form the basis of other elements, like levels or leaderboards, this does not come as a surprise.
- Narrative elements that tell a story seem to be coupled with challenges, where a player has to either overcome an obstacle by themself or needs to help the protagonists of the story do it by completing some form of challenge.

	1	2	3	4	5	6	7	8	9	10	11	12	Standalone
1	-	3	4	1	1	-	3	-	1	-	-	1	4
2		-	7	3	1	1	2	-	-	2	-	1	-
3			-	2	1	1	1	-	-	1	-	-	-
4				-	2	2	1	-	-	-	-	-	1
5					-	3	1	2	-	-	-	-	1
6						-	-	2	-	-	-	-	1
7							-	-	1	-	-	-	1
8								-	-	-	-	-	1
9									-	-	1	-	-
10										-	-	-	-

11							-	-				-
12								-				-

Table 2.2: Game element cooccurrences. The rightmost column denotes the number of times the game element was the only one used. See Table 2.1 for the mapping of numbers to elements.

2.5.3 Analysis of Results

The overall result of the 25 studies was rather positive, with nine papers reporting only positive observations throughout the whole process. 13 studies found mostly positive results, with some hypotheses failing to be confirmed. Three papers did not report their findings as they were of a preliminary nature, serving as a basis for further research, but still provided valuable insight. However, to reiterate the criticism of J. Hamari, J. Koivisto, and Sarsa (2014), comparing and compiling a list of results is barely possible, as no standardized evaluation method exists.

2.5.4 Unique Feature of this Work

As Table 2.3 showcases, quite some studies that measured the actual effect of gamification on user motivation and performance have been conducted. While some of the studies investigated correlation between player types and preference of game elemenents, none of them took a step outwards from player personalities and looked at a correlation of game elements preference and general personality of a user, determined by a standardized BFI-10 personality test (Rammstedt and John, 2007), as the experiment presented in Chapter 6 does. Additionally, only few studies have conducted an A/B experiment with a gamified version being compared to a functionally equivalent non-gamified version.

2.6 Summary of the Chapter

Going from the basic definition of gamification and serious games, their similarities and differences, over the importance of player types, to a list of commonly encountered game elements, this chapter provided insights into the evergrowing domain of gamification. Additionally, research on the evaluation of gamification was presented, as well as a short introduction of behavioral change theory and a study on its usage in gamified applications. Lastly, 25 studies investigating the effect of gamification in either laboratory or field settings were collected and analyzed with respect to their method and results, as well as a survey of popular combinations of gamified elements.

Elements	System	Evaluation setup	N	Method	Result	Domain	Reference
1	Peer-to-peer trading service	Online A/B testing	2989	Quant.	Mostly positive	Interaction	Juho Hamari (2017)
1,2,3	Image tagging tool	Online between-subject test	295	Quant.	Positive	Productivity	Mekler et al. (2013)
1, 2, 4, 7	Exercise tracking	Online questionnaire	107	Quant.	Mostly positive	Health	Juho Hamari and Jonna Koivisto (2013)
1, 2, 12	Language course	Usage data analysis	2000	Quant.	Positive	Education	Huynh and Iida (2017)
5	Fictional hero narrative	Usage data analysis, survey	251	Quant.	Positive	Health	B. A. Jones, G. J. Madden, and Wengreen (2014)
8	Blood glucose reading	Usage data analysis	20	Mixed	Positive	Health	Cafazzo et al. (2012)
2, 10	Asthma care	Survey	9	Qual.	Positive	Health	Elias et al. (2013)
7	Exercise group interaction	On-site user study	36	Quant.	Positive	Health	Chen and Pu (2014)
4	Course recommender system	Usage data analysis	171	Quant.	Mostly positive	Productivity	Farzan and Brusilovsky (2011)
2, 3, 10	Doc. relevance assessment	Online experiment	795	Quant.	Positive	Productivity	Eickhoff et al. (2012)
1	Question and answer site	Usage data analyis	-	Quant.	Positive	Productivity	Anderson et al. (2013)

2, 3, 6	Quiz tool	Experiment, questionnaire	76	Quant.	Mostly positive	Education	C. Cheong, F. Cheong, and Filippou (2013)
1	Social learning tool	Experiment, questionnaire	1031	Quant.	Mostly positive	Education	Denny (2013)
1, 3	Learning tool	Experiment, questionnaire	195	Quant.	Mostly positive	Education	Dominguez et al. (2013)
4, 5, 6	Learning tool	Interviews	11	Qual.	-	Education	Dong et al. (2012)
1	Information platform	Experiment, questionnaire	26	Quant.	-	Productivity	Fitz-Walter, Tjondronegoro, and Wyeth (2011)
4, 5, 6, 8	Calibration tool	Survey	12	Quant.	Mostly positive	Productivity	Flatla et al. (2011)
1	Online learning tool	Experiment	281	Quant.	-	Education	Hakulinen, Auvinen, and Korhonen (2013)
9, 11	Group collaboration tool	Experiment	260	Quant.	Mostly positive	Productivity	Jung, Schneider, and Valacich (2010)
5, 6, 8	Tutorial system	Usage data analysis, interviews	14	Mixed	Mostly positive	Education	Li, Grossman, and Fitzmaurice (2012)
1, 3, 4	Company social network	Experiment, usage data analysis	3486	Quant.	Positive	Productivity	Thom, Millen, and DiMicco (2012)

1, 2, 3	Programming course	Experiment, usage data anasysis, interviews	22	Mixed	Mostly positive	Education	Ibanez, Di-Serio, and Delgado-Kloos (2014)
1, 2, 3	Class activity	Eperiment	62	Quant.	Mostly positive	Education	Laskowski, Badurowicz, et al. (2014)
1, 2, 3, 5, 7	Storage depot simulation	Online experiment, usage data analysis	419	Quant.	Mostly positive	Mental Health	Sailer et al. (2017)
1, 7, 9	Fitness tracker	Field experiment, interviews	23	Mixed	Mostly positive	Health	Munson and Consolvo (2012)

Table 2.3: This list is comprised of 25 papers which investigated the effect of gamification on players in the context of either self-implemented or existing systems. See Table 2.1 for the mapping of the game elements in the first column.

3 Design and Requirements

The present chapter lays out the requirements of the cross platform mobile application that has been implemented alongside this thesis. To validate the research question of whether gamification can help users positively change their health behavior, two versions of the application are developed, one with gamification elements and one without. Apart from the obvious lack of game elements in the non-game version, the two applications offer the same content and functionality. After introducing the motivational constructs that guide the users behavior change, identified requirements for both these constructs and the included gamification elements are presented. The chapter concludes with a list of design decisions that were taken while conceptualizing the application.

3.1 General Application Objective

The application is a motivational tool that helps users change their health behavior towards a healthier lifestyle, be that in terms of exercising or eating. By teaching users about the core principles of a behavior change process that has been used by a professional mental coach for more than a decade, users are given the knowledge to start their behavior change process. Using these principles and constructs, together with gamification elements, users can overcome their *weaker selves* and live a healthier life. To ensure that users are given the best possible tools, a list of functional and non-functional requirements has been identified.

3.2 Functional Requirements

The list of functional requirements is kept rather superficial, as going into too much detail would exceed the scope of this thesis. As such, only main functionality is described here, without focusing on specific user interface specifications. The available motivational constructs are laid out, along with a specification of the game elements that are employed to increase the users commitment to the application.

3.2.1 Motivational Constructs

The constructs and principles for raising user motivation and eventually incorporate new health behavior into their everyday life are kept simple on purpose. It starts out with helping users figure out their ultimate goal, from now on called mission, like getting fit for a specific event like the Vienna City Marathon, or fitting into a dress for a wedding. For reaching their mission, users also have to figure out why exactly they want to achieve it. By exploring these motives, setting smaller goals along the way and learning how to deal with one's weaker self, users are given the tools for starting their behavior change process. The concept of a weaker self in terms of health behavior is not acting on the knowledge of what would be best, but what would be most convenient. In the German language, the term of *"Innerer Schweinehund"* is used to describe exactly this phenomenon. In this thesis, the unusual, but direct translation of *"inner pigdog"* is used, as it better captures the concept than *weaker self*. The conceptual relationship between the motivational constructs can be studied in the overview diagram in Figure 3.1.

Mission

A users mission is the actual reason for why they desire a healthier lifestyle. It thus takes a central role in the behavior change process and should be prominently featured in the application. Within the motivational ecosystem, missions can take a variety of forms:

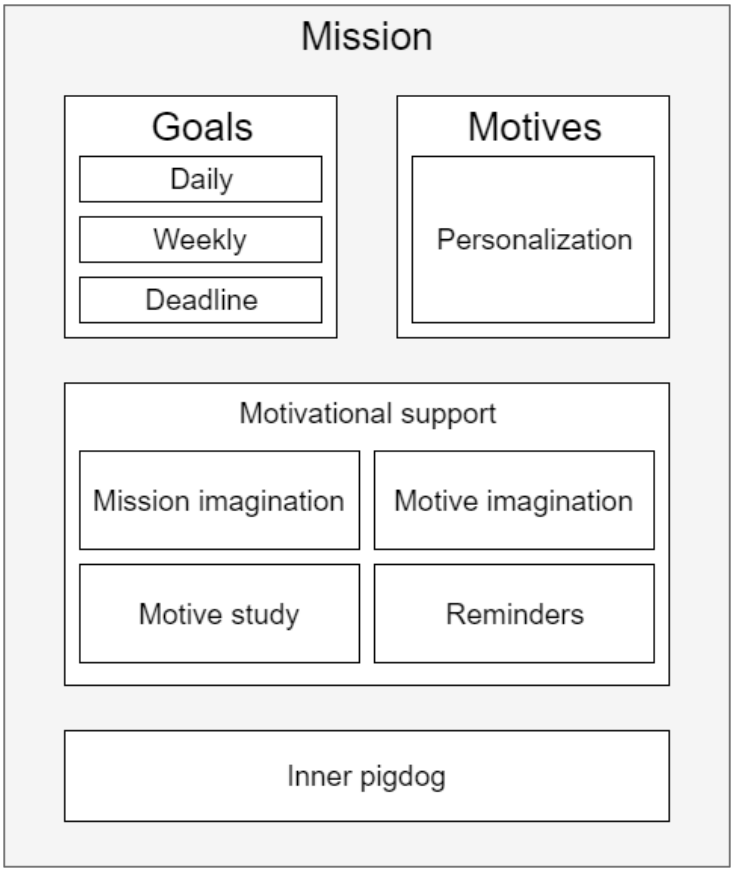


Figure 3.1: Conceptual diagram of motivational constructs and support in the application. The mission is located at the highest level. Contained in the mission are goals, motives and the "inner pigdog". Additionally, motivational support mechanisms are available.

- **Defining Events**: This type of mission is accomplished when a specific event happens for or is made happen by the user, like running a marathon at a defined date or climbing a difficult mountain until the end of the year.
- **Certain Status**: Other than a mission bound to an event, the accomplishment of this type of mission cannot be pinpointed to a single happening, but -as the name suggests- to a status of the user or some element of their life. Examples for this type would be things like reaching a certain weight or being able to do ten pull-ups. Usually, no deadline date is necessary, as no schedule that needs to be kept is present.
- **New Habits**: The two types of missions presented so far both have easily countable requirements. The last type of mission is harder to quantify, as it generally deals with new habits that will be developed along the way. A typical example for this would be the intent of eating healthier. While everyone has some idea of healthy food, actually measuring the healthiness of ones diet is a rather subjective matter.

Motives

Being aware of why one wants to improve their health behavior is highly beneficial for progressing towards it. Writing down the reasons for wanting to reach ones missions may help in realizing why the mission is actually important. These reasons are called motives in the application and form another cornerstone of the motivational constructs, by supplementing both the mission and the goals. Again, as with the mission itself, there are distinctions to be made:

- **Short Term versus Long Term Motives**: Motives are either scoped to a finite time span (short term) or apply to a general status (long term). Looking at a weight loss goal, a short term motive would be fitting into a dress for a wedding that will take place in two weeks, while the health benefits of maintaining a lower weight would be long term motives.
- **Extrinsic versus Intrinsic Motives**: Extrinsic motives are powered by influences that lie outside of the users control. In their book, Sansone

and Harackiewicz (2000) describe extrinsic motivation as a desirable outcome that can be achieved by performing a certain behavior. With intrinsic motivation, rewards are inherent to the performed activity and are self-sufficient. Similar to this definition, intrinsic motives are based on needs and wants the user has volitional control over.

Goals

The highest importance on a users way of reaching their mission is attributed to goals. These goals are the smaller steps that are necessary to reach the mission. Once users perform the action they specified in their goal, they can check it in the application. Goals can require up to 99 checks to be completed for a given time frame and come in three types, distinguished by that time frame:

- **Daily Goals**: These are rather small steps or actions that take no longer than a few seconds, maybe minutes to complete, but should be done every day - like taking the stairs instead of the elevator, or having no more than one sweet meal or snack a day. Constant repetition is helpful for building habits that can help reach the mission. Having a daily goal that only exists for one day would not make much sense, so daily goals can be repeated for a configurable number of weeks.
- **Weekly Goals**: Routines are built into humans, or at least taught from a very young age onwards. Making use of this, goals that follow a weekly schedule from Monday to Sunday should make up the majority of goals users set themselves. This also allows for a quick review of each weeks accomplishments on a short notice. Of course goals can stretch over more than one week, but each new week, the counter is reset to zero for a fresh start.
- **Goals with Deadlines**: Some real life chores or tasks have hard deadlines attached to them. The application allows entering such goals by providing users with the option of creating goals with arbitrary deadlines. While daily and weekly goal cycles both end on Sunday midnight, any day in the future can be selected as end day for deadline goals.

Users should be guided in goal creation, as setting the right goals is paramount to the success of the behavior change. Generally, they should have a measurable outcome, be formulated in a positive way and promote the users progression towards their mission. An important distinction has to be made here: A goal in the context of the application is not a gamification element, such as the ones presented in Section 2.1.5, but a motivational construct in the context of the induced behavior change.

The "Inner Pigdog" (Der "Innere Schweinehund"")

Technically, the "inner pigdog" is a concept that diminishes motivation, as it is a manifestation of the users weaker self, keeping them from reaching their goals and thus, ultimately their mission. However, learning to accept its presence and the fact that it will never fully go away is an important step towards reaching better health behavior. By studying ones own behavior and identifying situations in which laziness is especially prominent, strategies against the "inner pigdog" can be developed. Usually, such strategies consist of readymade strands of thought that should be called back into memory once users find themselves in a situtation where they are about to follow their "inner pigdog" and take the momentarily easier, but in the long term less rewarding route.

3.2.2 Requirements for User Input and Session Handling

The following enumeration lists the requirements for the handling of user input and general session handling.

1. Users can sign up to the application using a valid e-mail address and a password.
   1.1. In case of invalid inputs, the corresponding field is highlighted.
2. Users stay logged in as long as they do not log out explicitly.
3. Users can log in to the application after logging out, using the previously provided credentials.
   3.1. In case of invalid inputs, the corresponding field is highlighted.

4. Users can log out of the application.
5. Users can set their name in the application.
   5.1. Their name can be set during the introduction process after signing up.
   5.2. Their name can be changed later at any time.

3.2.3 Requirements for the Use of Motivational Constructs

Creation and use of missions, goals and motives is possible in the application. Users are provided with the necessary information to create high quality content, enabling them to get help in their health behavior change by practicing with the application. For missions and motives, motivation techniques like audio assisted imagination are provided. Goals can be created with daily, weekly and custom time schedules and checked in a straightforward manner. Additionally, native notifications are delivered as reminders for checking goals when the scheduled end approaches. The following list of functional requirements concerning motivational constructs has been identified:

1. Users can make use of their mission.
   1.1. Users can create their mission after signing up.
      1.1.1. Users have access to information about setting the right mission.
      1.1.2. Users are given suggestions to inspire their own mission.
   1.2. Users can edit their mission.
   1.3. Users can change their mission picture.
      1.3.1. The mission picture can be deleted.
   1.4. Users have access to a concise summary of their mission.
      1.4.1. References to the users motives are contained in this summary.
      1.4.2. A short statistic about the amount of checked goals is available in this summary.
      1.4.3. Short motivational messages are displayed throughout this summary.

1.5. Users can listen to an audio imagination for their mission.
1.6. Users can only have one mission.

2. Users can make use of their motives.
   2.1. Users can create new motives at any time.
      2.1.1. The title for motives can be chosen freely.
      2.1.2. An additional description can be added.
   2.2. Users can add an arbitrary amount of pictures to a motive.
      2.2.1. Users can choose which picture to use as main picture for a motive.
      2.2.2. Pictures of motives can be deleted.
   2.3. Users can see a list of their motives.
   2.4. Users can listen to an audio imagination for their motives.
      2.4.1. This imagination is available once the first motive has been created.
   2.5. Users can study their motives.
      2.5.1. Each motive is displayed with its main picture.
      2.5.2. Each motive is shown for a set amount of time.
      2.5.3. The motive study cycles through all motives before looping back to the first one.
   2.6. Users can have any number of motives.
   2.7. Users can delete motives.

3. Users can make use of their goals.
   3.1. Goals can repeat daily or weekly, or have a set deadline.
   3.2. Repeating goals are repeated for a configurable amount of weeks.
   3.3. Users can create new goals at any time.
      3.3.1. The title of the goal can be chosen freely.
      3.3.2. The number of required checks can range from 1 to 99.
      3.3.3. The scheduling mode can be chosen from daily, weekly or a set deadline.
      3.3.4. For repeating goals, the number of weeks can range from 1 to 99.
      3.3.5. An icon can be assigned from a preselected set of icons.
      3.3.6. Alternatively, users can choose from suggested goals.
      3.3.7. Before creation, a confirmation is displayed.

3.4. Users can edit their goals.
  3.4.1. Every attribute that was set during creation can be edited.
3.5. Users can check their goals, indicating that they have reached them.
  3.5.1. No limit on the number of daily goal checks exists.
  3.5.2. Users can exceed the required number of checks for a goal.
  3.5.3. Goals can only be checked until their deadline or the end of their schedule.
3.6. Goals are categorized by their schedules.
  3.6.1. Daily, weekly and deadline goals are listed separately.
3.7. Users get reminders about their goals when the deadline or end of schedule apporaches.
3.8. Users can have any number of goals.
3.9. Users can delete goals.

3.2.4 Gamification Elements

This section applies to the gamified version of the application only. Gamified elements should be coherent and meaningful. Several elements and concepts are exposed to the user. To keep in line with common terminology of gamification, users are referred to as players for the rest of this enumeration.

Weekly competition Against the "Inner Pigdog"

The central part of the gamification is the weekly battle of the player against their "inner pigdog". By default, 50 points are required to defeat the "inner pigdog" for a week. These 50 points must be earned before Sunday midnight. Players can change the required number of points to make the battle easier or harder, depending on the time which can be spared to work with the application. Players earn points for every action that brings them closer to accomplishing their mission:

- **Starting Points**: To avoid having players start their journey with empty hands, 20 points are rewarded upon finishing the introduction in which a players name and their mission have been queried.
- **Creation of Motives**: Every motive that is created rewards the player with seven points
- **Creation of Goals**: After setting themselves a new goal, players are rewarded with three points.
- **Checking of Goals**: Once setup is completed and some motives and goals have been created, this is the task players will be performing most often. Five points are rewarded upon checking a goal.
- **Uploading of Pictures**: For the mission and for each motive, players can upload pictures for better personalization. Each new picture is worth two points against the "inner pigdog".
- **Audio-assisted Mission Practice**: The application offers a guided audio practice for imagining the mission. Listening to this audio guide is worth five points.
- **Audio-assisted Motive Practice**: Similar to the guided mission imagination practice, players are assisted with imagining their motives. The point reward is the same as for mission practice.
- **Studying Motives**: A nice graphical representation that cycles through a players motives is helpful for keeping those motives in mind. Looking at the motives gives the players three points in their battle against the "inner pigdog".
- **Daily Login**: As seen in many online games, a login reward of 3 points is given to players when they open the application for the first time on a day. Subsequent uses on the same day do not trigger this point reward repeatedly. The intention behind these points is to encourage the player to pick up their phone and occupy themselves with their behavior change process every day, even if only for a short while.

By winning subsequent weekly battles against their "inner pigdog", players build a streak of wins. If the required points are not reached in a week, the week is lost and the current streak is reset to zero.

The dangers of this system being gamed and exploited by the players is mitigated slightly by some tasks rewarding less and less points the more often they are performed on a single day. However, eventually, if a player decides to game the system, they will do so. The complete freedom of self

defined goals makes it impossible for the application to actually verify if the goal has really been reached when the user checks it. Outside of the system, no gain is made a by player for untruthfully accumulating points. For working with an application that offers support for a health behavior change, a certain level of honesty with oneself is required of a player. As there are no real life rewards or bragging rights among peers attached to winning against the "inner pigdog", the incentive for cheating should be rather low.

Badges

Certain actions which can be performed by users also reward badges. These actions are similar to the ones which reward points against the "inner pigdog", but badges are of a more permanent nature than the points which are reset every week. Every badge has a progression system built in, with each new level being increasingly harder to attain by requiring more actions. They are awarded for the following actions:

- **Creation of Motives**: This badge progresses every time a new motive is created.
- **Creation of Goals**: Unlike motives which do not contain any timing information, goals are not permanent and disappear after either a configurable number of weeks or on a certain deadline date. Therefore, this badge can also be used to keep track of the total number of goals a player has set while using the application.
- **Checking of Goals**: Goals usually require several checks to be completed within their time frame. This badge simply tracks the total number of times a player has checked one of their goals.
- **Winning Against the "Inner Pigdog"**: Every single week that is won by the player adds to this badge. In contrast to the streak that is reset once the player fails to win a week, this badge only tracks the wins, independently of them being consecutive.
- **Daily Logins**: Every time a a player opens the application for the first time on a given day, this badge progresses.

Player Level

While the points of the battle against the "inner pigdog" are reset to zero at the start of each new week, each point earned from the actions in the list of Section 3.2.4 also goes towards the players level as experience points. Experience points do not reset at any point in time. Currently, the level is no more than a rough indicator for the time the player has spent with the game, but Chapter 9 provides some more possible use cases.

Simple Interaction with the "Inner Pigdog"

As a simple, fun way of interacting and getting used to "inner pigdog" in the game, players can tap it on the home screen of the application. The "inner pigdog" is then animated and blurts out a grunt. While not connected to the main game of beating the "inner pigdog", such small interactions are entertaining - nothing more, nothing less.

3.2.5 Requirements for Gamification Elements

The following enumeration summarizes the functional requirements for all gamification elements and concepts in the application:

1. Users engage in a weekly competition with their "inner pigdog".
   - 1.1. The required points to win the competition must be gathered before Sunday midnight.
   - 1.2. Every action that is beneficial to their health behavior and application usage gives a point reward.
     - 1.2.1. 20 starting points for setting the mission to avoid an empty bar
     - 1.2.2. Seven points for each new motive
     - 1.2.3. Three new points for each new goal
     - 1.2.4. Five points for checking a goal
     - 1.2.5. Two points for uploading a picture

1.2.6. Five points for listening to a motive or mission imagination, each once a day
1.2.7. Three points for studying motives, once a day
1.2.8. Three points for opening the application, once a day

1.3. Any point reward is shown clearly to users.
1.4. The point value resets to zero on Sunday midnight.
1.5. Users get reminders about the competition outside of the application.
1.6. Users see their winning streak against "inner pigdog".
1.6.1. Winning a weekly competition increments the streak counter.
1.6.2. Losing a weekly competition resets the streak counter to zero.
1.7. Users can change the required number of points required to win against their "inner pigdog".
1.7.1. The change becomes active in the following week.

2. Users earn badges throughout the application.

2.1. Badges are used for tracking the following actions:
2.1.1. Users create a motive.
2.1.2. Users create a goal.
2.1.3. Users check a goal.
2.1.4. Users win the weekly competition against their "inner pigdog".
2.1.5. Users open the application for the first time on a given day.
2.2. Each badge has two or more levels.
2.2.1. The level of a badge is characterized by the required amount of actions.
2.3. Performing one of the selected actions progresses the corresponding badge.
2.4. Each badge has two or more levels.
2.4.1. If a new level on a badge is reached through that action, attainment of that badge is shown clearly to users.
2.5. Users see a list of their attained badges.
2.5.1. Users see how many actions are required for reaching the next level of a badge.
2.5.2. For completed badges, users see the completion date.

3. Users have a level.
   3.1. Every point reward from the weekly competition also contributes to the users level as experience points.
   3.2. Experience points do not reset.
   3.3. Users' levels serve as an indicator of the time spent with the application.
4. Users can interact with their "inner pigdog".
   4.1. A simple interaction is available upon clicking an avatar of the "inner pigdog".
   4.2. No point or badge reward is gained from this.

3.3 Non-functional Requirements

Any requirements that do not describe an actual functionality of the application are non-functional. As this application is at its core a pervasive system, usability is vital. Additionally, scalability and flexibility of the system to allow possible extensions at a later time as well as scaling to a potential larger number of users are also important. All in all, the following list of non-functional requirements was identified:

- **Usability**: As postulated in Section 2.2.2, every persuasive system should provide a great user experience and good usability. Based on the short list of Nielsen (2003), this means that:
  - learning to use the system should be as easy and fast as possible.
  - once proficient, users can perform their tasks swiftly.
  - when returning from an abstinence period from the system, users can quickly pick things back up.
  - errors should be sparse and recoverable.
  - the system should be pleasant to use.

  In the case of the implemented application, special focus should be put on an easy onboarding process that helps users get started. Additionally, the user interface for different pages should still stick to a common baseline, as this will allow users to quickly pick up any

functionality. The presented requirements apply to a standalone application that helps users with their behavior change process by handing them the required tools and keeping them motivated to work with these tools.
- **Performance**: The application should offer an uninterrupted experience without waiting times. No blocking actions should be performed, instead operations that might take a little longer should be executed asynchronously.
- **Scalability**: Larger numbers of concurrent users should be handled automatically, without making single users notice the heavier system load.

To summarize, the application should provide a great user experience by being performance-oriented, well usable and scalable. In addition to these system attributes, technical requirements also belong to non-functional requirements. The following section shortly discusses any technical requirements that have been identified.

As with the application requirements, the technical requirements are summed up in a concise manner. The general architecture of the application is seen in Figure 3.2. A clear separation between the front-end and the back-end of the application is ensured. This is especially helpful if more than one front-end implementation exists, which is the case even with this thesis, as a gamified and a non-gamified version are implemented for evaluation. The mobile application should be cross-platform to ensure maximum compatibility with as many devices as possible. Up-to-date tools and frameworks should be employed to implement the application. All user data is stored in the back-end. Only data that is specific to a device, not to a user, must be stored in the front-end. An example for device specific data is the identification token which is used for authenticating requests with the back-end. Concerning security and safekeeping of sensitive user data, all communication between the front-end and the back-end should happen over a secure protocol like HTTPS. For hosting the back-end, which in turn stores the user generated data, a proven, reliable infrastructure provider with automated scaling and easy configuration can help mitigate many possible errors and security risks.

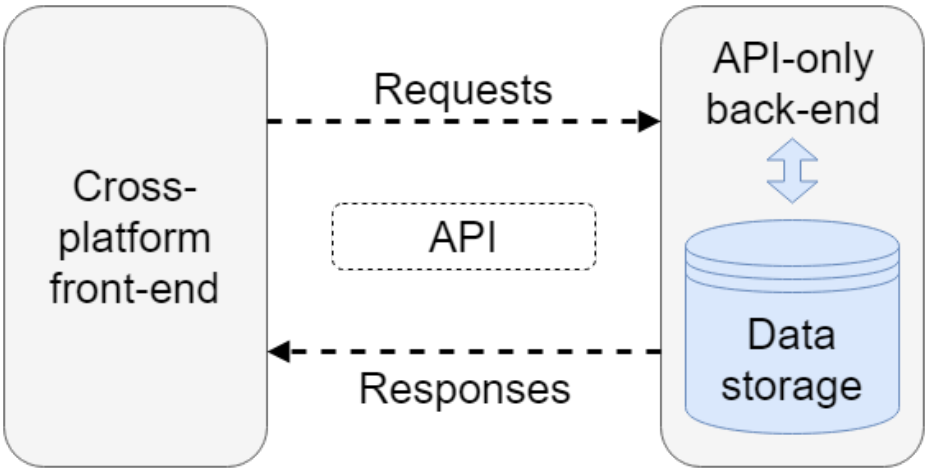


Figure 3.2: The application is cleanly split into a front- and back-end, connected via an Application Programming Interface (API) for exchanging data in between.

3.4 Evolution of Requirements

A shift of the focus of the application during development brought about a change of requirements. The largest change was from being a companion application to real life workshops about getting motivated to improve ones health behavior to being a standalone health behavior change tool. The change in requirements that was induced by this new focus will be discussed in the following sections, followed by an overview of the concept of the outdated version.

3.4.1 Companion Application for Motivational Workshops

Initially, the very first version of the application was planned as a companion for participants of real life motivational workshops that were led by a professional psychologist, who will be referred to as facilitator from now on. The whole ecosystem was designed in the following way: Over the course of five weeks, participants would visit a weekly workshop at which they would learn increasingly advanced concepts and tricks about motivation, and how to apply these concepts to better their health behavior. The application

would fit in seamlessly with the presentation of the facilitator and prompt the participants to enter required data like their mission once the facilitator would ask them to. Each workshop would be dedicated to one topic, like missions or motives. After having learned about that topic in the workshop with the facilitator and the help of the application, participants would be able to practice and employ the freshly learned concepts in the week until the next workshop. This version was implemented for one evaluation series of workshops that took place in the summer of 2017 and already contained some gamification elements. Evaluation for this version can also be found in Chapter 6.

Difference in Game Elements

The major difference in terms of gamification between the application in its current state and the first version was the presence of an in-game antagonist to the “inner pigdog”. This antagonist was called the ”Master” (”Meister”) and helped users find their footing in the app and guided them in their battle against their “inner pigdog”. The master and an earlier version of the “inner pigdog” are depicted in Figure 3.3. Generally, less gamification elements were available: Badges, points and the weekly battle against the “inner pigdog” were not contained in this version. However, more storytelling was contained.

Workshop Contents

The first workshop was used to let the participants familiarize themselves with the application and the facilitator. Once that was done, the main topic for the workshop was finding ones mission. Missions are explained in more detail in Section 3.2.1. Also, a first goal with a time frame of one week was declared by each participant. Both the mission and the first goal were already entered into the application. In the second workshop, participants learned about their motives, the reason behind the desire to change ones health behavior. After being taught about the different types of motives, the facilitator engaged the participants in a short experiment to help them find out what types of motives worked best for each of them. As with the

Figure 3.3: The "Master" character that was included in the first version of the application and later dropped is displayed on the left. On the right side, an earlier version of the "inner pigdog" is depicted.

first workshop, a simple, one week long goal was also entered by each participant to keep them involved until the next workshop. A much closer look at the intricacies of goals was the topic of the third workshop. Correct wording of goals, the different types of goals with respect to their time frame and the importance of goals was taught to the participants. At the end of this workshop, the participants had access to their mission, their motives and advanced ways of goal setting. The creation of a new goal was not mandatory at the end of this workshop, as users now had the tools to create goals of any type at any time at their disposal. After being introduced shortly in the first workshop, the "inner pigdog" as player antagonist within the app stood in the limelight of the fourth workshop. Users now had access to a quiz for learning to deal with weak excuses for not exerting the desired, but hard to achieve, healthier behavior. Again, as participants had learned about goals in more detail in workshop three, no goal was mandatory at the end of this workshop. The fifth workshop was used as an opportunity for recapping the road so far, giving feedback and learning about advanced motivational techniques that were not part of the application anymore.

3.4.2 Switch to Standalone Health Behavior Change Tool

When attempting to organize a second series of testing workshops, no participants could be found despite several attempts and following postponements. The decision to drop the workshops and transfer all their content into the application had to be made, as apparently weekly attendance over the course of five weeks was too time consuming for participants. Transferring the content which was supplied by the workshop conductor, special care had to be taken to not leave out important information. Originally, the concept of workshops was planned to be kept in the application and used to unlock new content every week, until all functionalities would be available at the fourth week. This idea was dropped rather soon in favor of having all content available right from the start, as four weeks were too long of a period, and users might have been prone to uninstalling the application if they felt some parts were missing or not worth the wait.

3.5 System Design Decisions

Having discussed requirements for both the motivational constructs and the gamification elements, the conceptual diagram in Figure 3.4 plots the connections between the two integral components of the application. All motivational constructs, namely mission, motives, goals and the "inner pigdog" are integrated into the competitive aspect of the gamification, either via actions or as the antagonist. Performing these actions, like creating and checking goals, allows users to earn point points in the weekly competition against their "inner pigdog". Some of the actions, as well as victories over the "inner pigdog" are also tracked via badges. In Figure 3.5, an analytical class diagram of the relationship between the user, the motivational constructs and the contained gamification elements can be found.

For the motivational constructs and gamified aspects, several design decisions concerning their functionality and interplay had to be made. The following list discusses any decision that was taken, possible alternatives and the reason for making that decision.

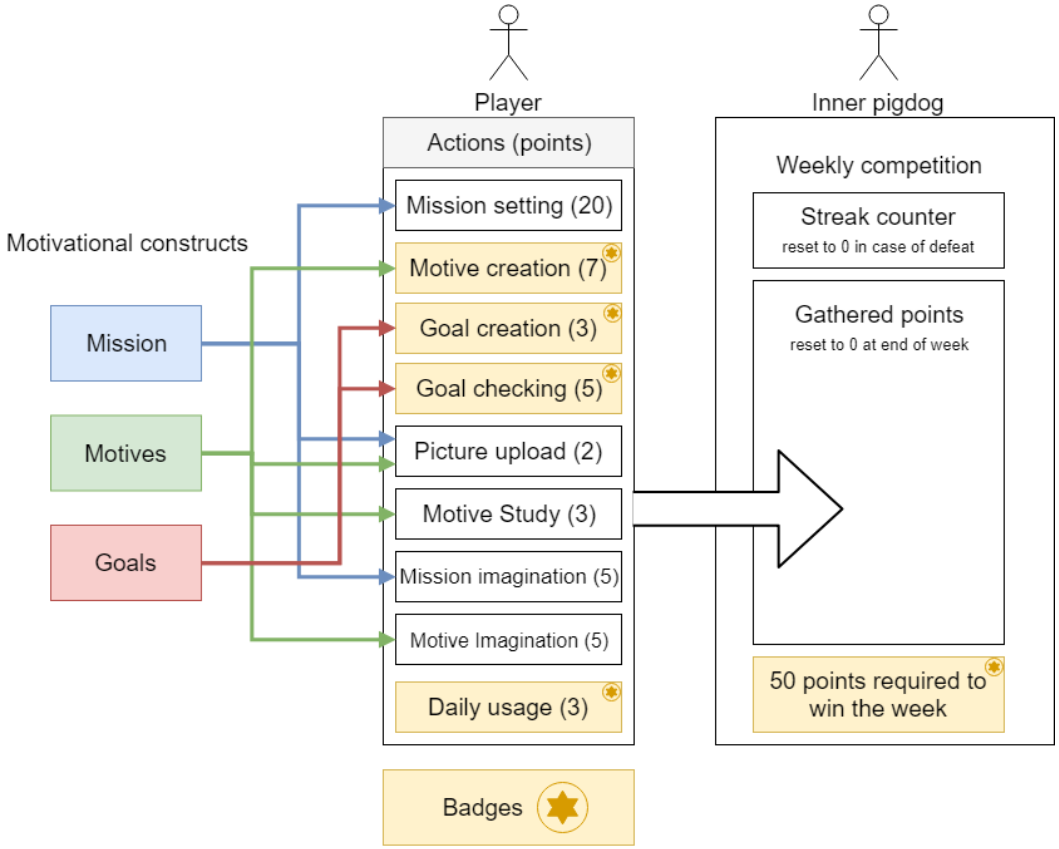


Figure 3.4: Conceptual diagram of the connection and interaction between motivational constructs and gamification elements. Any action or concept with golden background has a corresponding badge.

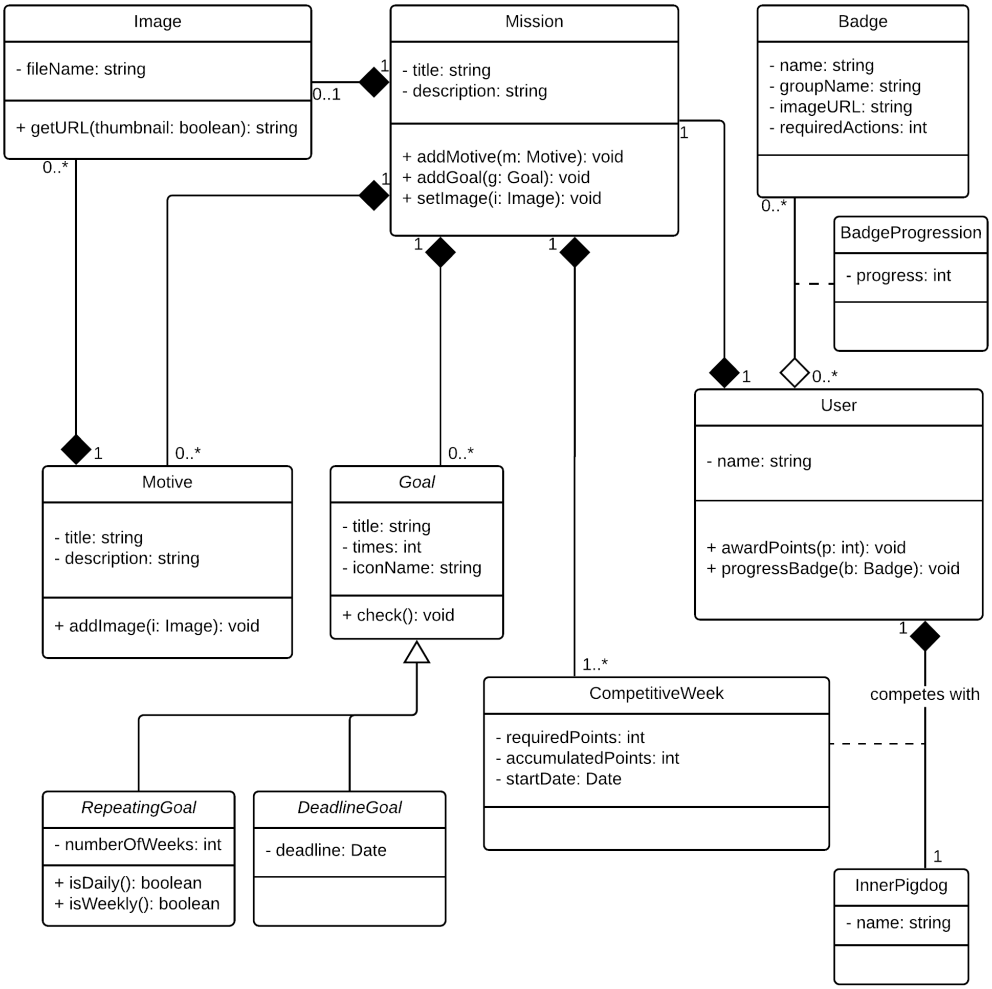


Figure 3.5: A class diagram of the motivational constructs and gamification elements at analysis time.

- **Users have only one mission**:
  By restricting users to one mission, the application is easier to operate. Additionally, allowing users to have more than one mission might overwhelm them and distract them from their one mission they actually want to pursue.
- **Every motive is worth the same amount of points**:
  Basing the point rewards of motives on text length or text content is neither viable nor useful. The alternative of letting users choose the worth of their motives is not realistic either, as users start out inexperienced and do not have a frame of reference.
- **Every goal and goal check is worth the same amount of points**:
  Similar to the point reward of motives, basing the points on length or content is not viable. A meaningful alternative would have been setting an arbitrary number of total points for all hypothetical checks of a goal, then have each check be worth the corresponding fraction of that. In this manner, the user would get the same amount of points for reaching a goal, regardless of the number of times it requires checking. The decision was made against this solution, as the goal of the application is not to judge the hardness of the behavior the user actually performs in real life and give points based on that, but to keep the behavior change process in the users mind. Giving out a set amount of points for each goal and goal check was therefore the chosen solution.
- **Users only get points for creating the first three goals each day**:
  To counteract users creating a too high number of goals which might lead to them being frustrated, only the first three goals that are created on a given day give a point reward. Other actions are not affected by this.
- **Users can check their goals more often than required**:
  Allowing users to check their self-set goals more often than specified reduces frustration. It would be demotivating to actually perform a healthier behavior more diligently than required and not be able to track it.
- **Checking of goals cannot be reverted**:
  Following the principle of keeping it simple, checking a goal cannot be reverted. To prevent accidental checking, exactly two clicks should be necessary for performing it.

- **Goals cannot run for an infinite amount of time**:
  To allow users to have a sense of accomplishment on their way to reach their mission, goals have a defined end and cannot be continued indefinitely.
- **The competition against the "inner pigdog" is the main gamification element**:
  The weekly competition, as well as maintaining the streak of winning was designed as the core concept of gamification. An alternative would have been badges, but they carry no inherent relationship to motivational issues, like the "inner pigdog" does. By overcoming their "inner pigdog" and thus their weaker selves, users participate in a game environment that is modeled after a known concept.
- **Badges progress through several levels**:
  Each badge has at least two levels for the user to progress through. The alternative would have been having one-off badges that are awarded for smaller, offbeat actions. Instead, badges were chosen to be supplemental to the core gamification concept of competing against the "inner pigdog", by tracking actions related to this competition.
- **Users can see all available badges**:
  Instead of being surprised by a new badge, users are always aware of their progress on badges, as well as the existence of any badges on which they may not have made any progress yet. As badges are useful even for steering application usage into certain directions, this decision was made to keep users informed about their status in the application at any time.

3.6 Summary of the Chapter

First giving a general description of the application objective, this chapter then went over the functional requirements. These were focused on the motivational aspects of the behavior change affordances as well as the gamification elements and the way a meaningful connection between these two most important aspects of the application. As such, the list of presented requirements was restricted to functionality related to either motivational constructs or gamification elements. In addition to the list

of functional requirements, the non-functional requirements were shortly presented. Stemming from a shift of focus concerning the application objective, a change from an earlier version of the application to its current state has been discussed, both in terms of functionality and gamification elements. The design of the system, especially the connection between the motivational constructs of mission, motives and goals and the gamification elements was presented next. An important attribute of the gamified areas of the application is that each one is tied to the actual motivational content creation options. All badges, except for the one tracking wins in the weekly competition, are also supplemental to the motivational constructs. Finally, a class diagram giving an overview on the relationships of components in the application was presented before going into detail about design decisions that were made during development. With the requirements and design decisions for the motivational constructs and gamification elements in mind, the next chapter discusses details of the actual implementation of the application as a cross platform mobile app.

4 Implementation Details

This chapter will go into detail about the implementation of the cross-platform mobile app that was developed alongside this thesis. Before following the common theme of focusing on motivational constructs, gamification elements and their interplay, the general system architecture, spanning both front-end and back-end is discussed, with an emphasis on handling persistence of entered values. Then, code samples from both client and server and implementation level diagrams are provided for any major functionality groups of the application. Afterwards, the solution for information exchange between the front-end and back-end implementation is presented and discussed. In addition to showcasing code samples and solutions, short insights into any used frameworks are given.

4.1 System Architecture

The system is cleanly split into the front-end and the back-end. The first is a cross-platform mobile app built with the Ionic[1] framework, installed on a device, while the second is an API-only application, built with Ruby on Rails[2] and hosted on a server. Figure 4.1 shows an overview of the components of the whole system. The cross-platform app is built from pages, which in turn use components. Actually, pages are components themselves, but fulfill the special role of navigation handling and have thus been drawn separately. Providers are injectable, singleton classes that either perform synchronization between components and pages, or offer wrapper for native functionalities like playing audio or setting up notifications. Data

[1] `https://ionicframework.com/about` (Ionic, 2018b)

[2] `https://www.ruby-lang.org/en/about` (Community, 2018)

storage on the front-end is actually non-persistent and is handled by the models. For persisting the data, a service issues a request to a controller on the back-end, which in turn makes use of the corresponding model implementation to persist the desired values into the database. The return value of a server call is serialized into a JavaScript Object Notation (JSON) string and sent back to the service, which returns an `Observable` object to the controller that called it. Thanks to the usage of such observables, all server calls are non-blocking and responses are handled asynchronously. An exemplary asynchronous handling of such a response can be seen in Listing 4.4. On line 16, the controller of the introduction page calls the `create()` method of the `MissionService`. In turn, this method makes an HTTP POST request, as seen on line 30. Line 42 through 62 depict the creation and storage of the actual data in the back-end. The return value of this method is a `Mission`, which is automatically serialized to a plain object by the framework before being sent back. The aforementioned `create()` returns an `Observable`. With the subscription to this observable on line 16, the code on lines 17 to 21 is called once the server call returns with the response which is passed as the value parameter of the anonymous arrow function on line 17. The response is automatically parsed into a JSON object and used further to set the values of the users mission.

To verify the authenticity of a request for a resource on the back-end, each request sends along a so called JSON web token. This token is a digitally signed hash of the users email address and password. In contrast to any other data created in the application, this token is stored only in the front-end. Because of this, the cross-platform app requires a persistent storage mechanism. Listing 4.1 shows the two main functions of a local storage provider which builds upon a device-agnostic storage mechanism of the underlying framework. As with observables for communicating with the back-end, access to this storage is done in an asynchronous manner using a `Promise`, a wrapper for callback functions.

The creation of the token is done by the back-end, the request for such a token is seen in Listing 4.2. Having obtained that token, it is then stored using the `set()` method of the local storage provider and subsequently sent along with every request that is made to the back-end, for example seen on line 4 in Listing 4.3. Another practical effect of this is the existence of a `current_user` method on every controller in the back-end, as the user needs

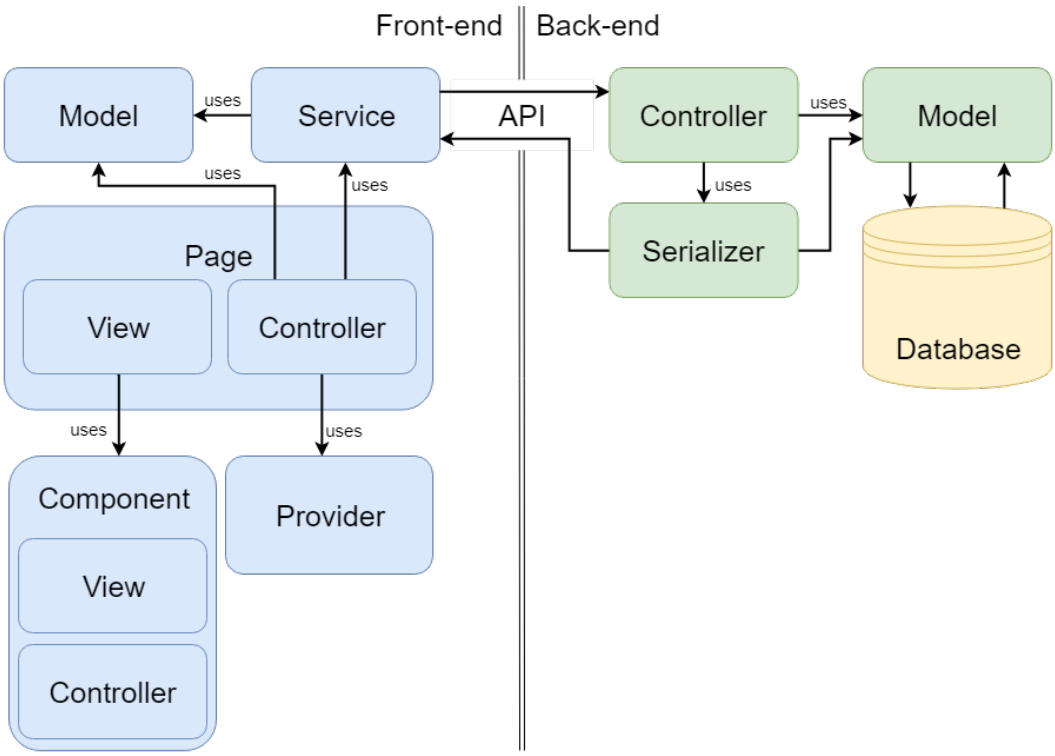


Figure 4.1: In this architectural diagram of the system the connection between the different parts are shown. The only connection between the two front- and back-end exists between services on the front-end and the controllers (via serializers) on the back-end.

```
@Injectable()
export class LocalStorageProvider {

  public get<T>(key: string,
    decodeJSON: boolean = false):Promise<T> {
    return this.storage.ready().then(
      () => {
          return this.storage.get(key);
      }
    );
  }

  public set(key: string, value: any,
    encodeJSON: boolean = false): Promise<any> {
    return this.storage.ready().then(
      () => {
        return this.storage.set(
          key,
          encodeJSON ? JSON.stringify(value) : value
        );
      }
    );
  }
}
```

Listing 4.1: Excerpt of the persistent storage provider for the cross-platform mobile application

```
POST /auth HTTP/1.1
Host: example.motime.com
Accept: application/json; version=1
Content-Type: application/json
Cache-Control: no-cache

{
  "auth": {
    "email": "user@example.com",
    "password": "foobar123"
  }
}

// response
{
   "jwt": "some-token-string"
}
```

Listing 4.2: Exemplary HTTP request and response for an authorization token. As the password is sent along, HTTPS would of course be mandatory in a production environment.

to be validated for every request, given the stateless nature of the HTTP protocol.

4.2 Motivational Constructs

The implementation for the creation and general usage of the three motivational constructs of mission, motives and goals is rather similar, especially concerning the way the communication and synchronization between the front- and back-end is realized. Because of this, for each construct, one aspect is described in a short case study and explained with code samples. For missions, the creation will be looked at in more detail, motives will deal with the implementation behind the motive imagination and the section about goals will be focusing on checking them.

```
1  POST /users/5/missions/12/pictures HTTP/1.1
2  Host: example.motime.com
3  Accept: application/json; version=1
4  Authorization: Bearer some-token-string
5  Content-Type: application/json
6  Cache-Control: no-cache
7
8  {
9    "mission_picture": {
10     "image_file_name": "image.png",
11       "text": "some random text",
12       "image": "data:image/jpeg;base64/-cut-
13   }
14 }
```

Listing 4.3: An exemplary authenticated HTTP request. Line 4 is the authorization header of the request, bearing a previously requested JSON web token.

4.2.1 Mission

The mission is the users overarching objective. As such, users have only one mission, and add goals and motives to that mission. To enable a clean split of the front-end and back-end sides of the application, any data that is not related to the users session is stored in a database that is accessed by the back-end only. As seen in Figure 4.2, the class `Mission` implements an interface that has exactly the same members as the `Mission` class on the back-end. The existence of attributes on an interface may seem surprising, but interfaces in TypeScript are not interfaces in the classic object oriented way, but more general specifications on the form of a JSON object. Having the same attributes on a `Mission` object on both front- and back-end, synchronization becomes a lot easier. For a users mission, a closer look will be taken at its creation.

Case Study: Creation of a New Mission

On the front-end side of things, creating the mission requires only its title. This value is then wrapped into a JSON object and sent to the back-end via an HTTP POST request, as seen on line 26 in Listing 4.4. In the back-end,

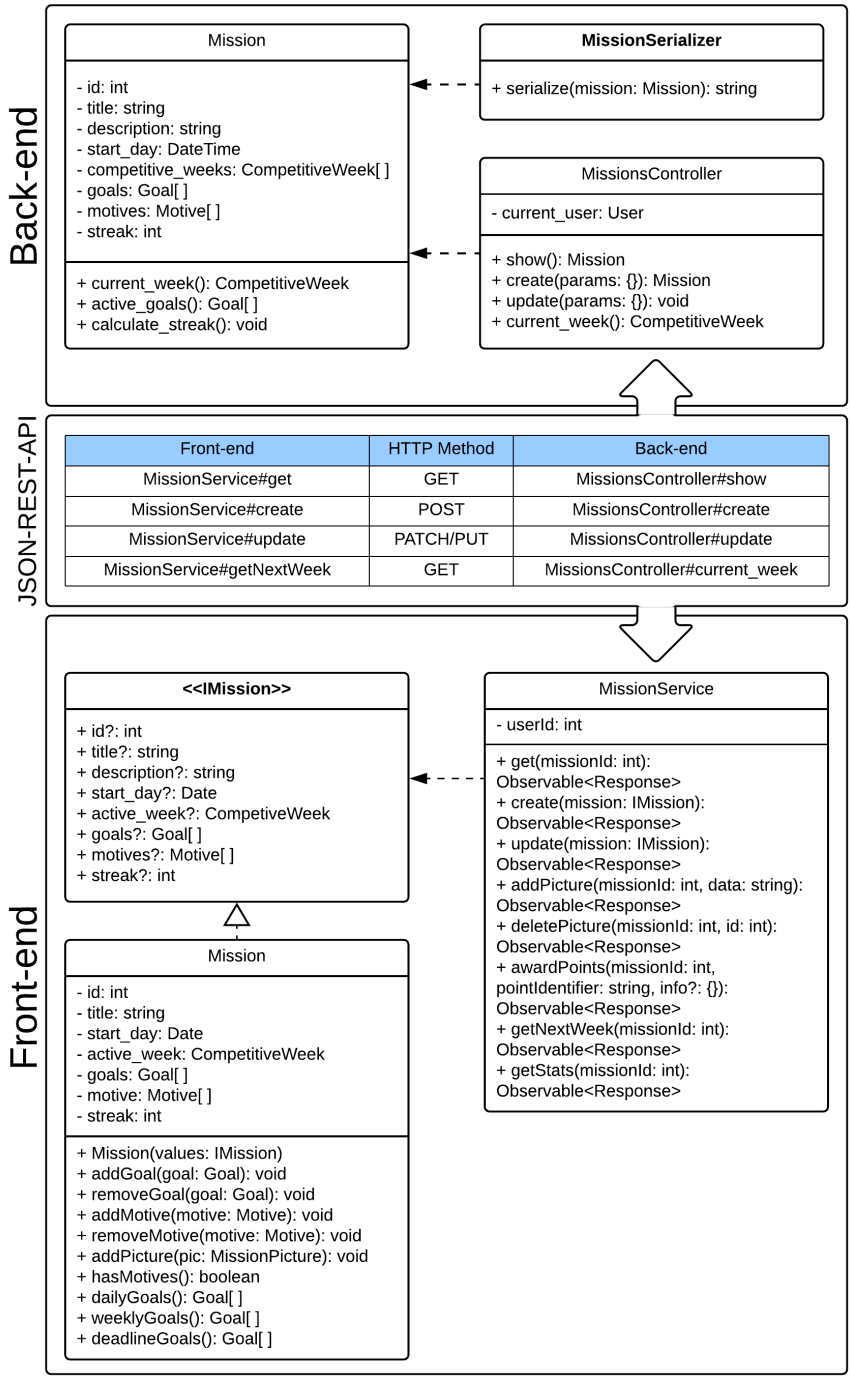


Figure 4.2: Architectural class diagrams of the implementation for the usage of the users mission on both the front- and back-end. The interface `IMission` in the front-end is actually just a descriptor for possible fields in a JSON object. A question mark indicates optionality of an attribute.

the mission is created and stored into the database. as detailed in Listing 4.5. The new mission is then serialized into a JSON object and sent back to the front-end. These two listing shows all code parts which are relevant to the creation of a mission. The markup at the top of Listing 4.4 shows the usage of a custom `mg-input` component which is responsible for receiving and validating the mission title. The actual user interface for this functionality can be found in screenshot A of Figure 5.1 in Chapter 5.

4.2.2 Motives

As with the mission, motives exist on both the front-end and the back-end in similar fashions. The diagram in Figure 4.3 gives an overview of the implementation details of motives on both ends of the system. The points presented in Section 4.2.1 apply as well, as the interface `IMotive` allows for easy synchronization between the cross-platform app and the server-hosted back-end. A study of the implementation of the motive imagination follows.

Case Study: Motive Imagination

The audio assisted motive imagination is implemented with the help of a device-agnostic audio provider which makes use of the `HTML5AudioElement`, as seen in the interface definition on line 24 of Listing 4.6. Clicking the button in the view calls the controllers `togglePlayback()` method, which - through the underlying frameworks data-binding - also changes the icon of the button. The required audio file is bundled with the application and preloaded into memory when the imagination page is first visited. This eliminates any delay when clicking the button, allowing the playback to start right away. The controller of the page handles only the logic of playing and pausing, any actual playback is handled by the aforementioned provider.

```
1  <!-- introduction.html -->
2  <mg-input formControlName="mission"
3    [activeErrors]="missionForm.errors('mission')"
4    [data]="missionForm.controlData('mission')"
5    iconButton="ios-help-circle-outline"
6    (iconButtonClick)="showMissionPopover()"
7    type="text">
8  </mg-input>
9
10 <button (click)="saveMission()">Weiter</button>
11
12 // introduction.ts
13 private saveMission() {
14   // calls back-end controller code
15   this.missionService.create(this.mission).subscribe(
16     value => {
17       this.session.user.addMission(
18         new Mission(value as IMission),
19         true
20       );
21     }
22   );
23 }
24
25 // mission-service.ts
26 public create(title: string): Observable<Response> {
27   return this.api.post(
28     this.routes.getMissionsUrl(this.userId),
29     {
30       'mission': { 'title': title }
31     },
32     true
33   );
34 }
```

Listing 4.4: Simplified code excerpts for creating the users mission on the front-end. The method `create()` on line 26 is used for synchronization to the back-end.

```
1  def create
2    @mission = Mission.new(create_params)
3    @mission.start_day = Time.zone.now
4    @mission.user = current_user
5
6    if @mission.save
7      week = CompetitiveWeek.create(
8        points_accumulated: 0,
9        points_required: @mission.points_goal,
10       starts_at: Time.zone.now.at_beginning_of_week,
11       mission: @mission
12     )
13     week.save
14
15     @mission.calculate_attributes
16     render json: @mission, status: :created
17   else
18     render json: @mission.errors,
19       status: :unprocessable_entity
20   end
21 end
```

Listing 4.5: Simplified code excerpts for creating the users mission on the back-end. The mission is created and a competitive week is assigned to it. The whole object is then serialized to JSON and sent back to the front-end.

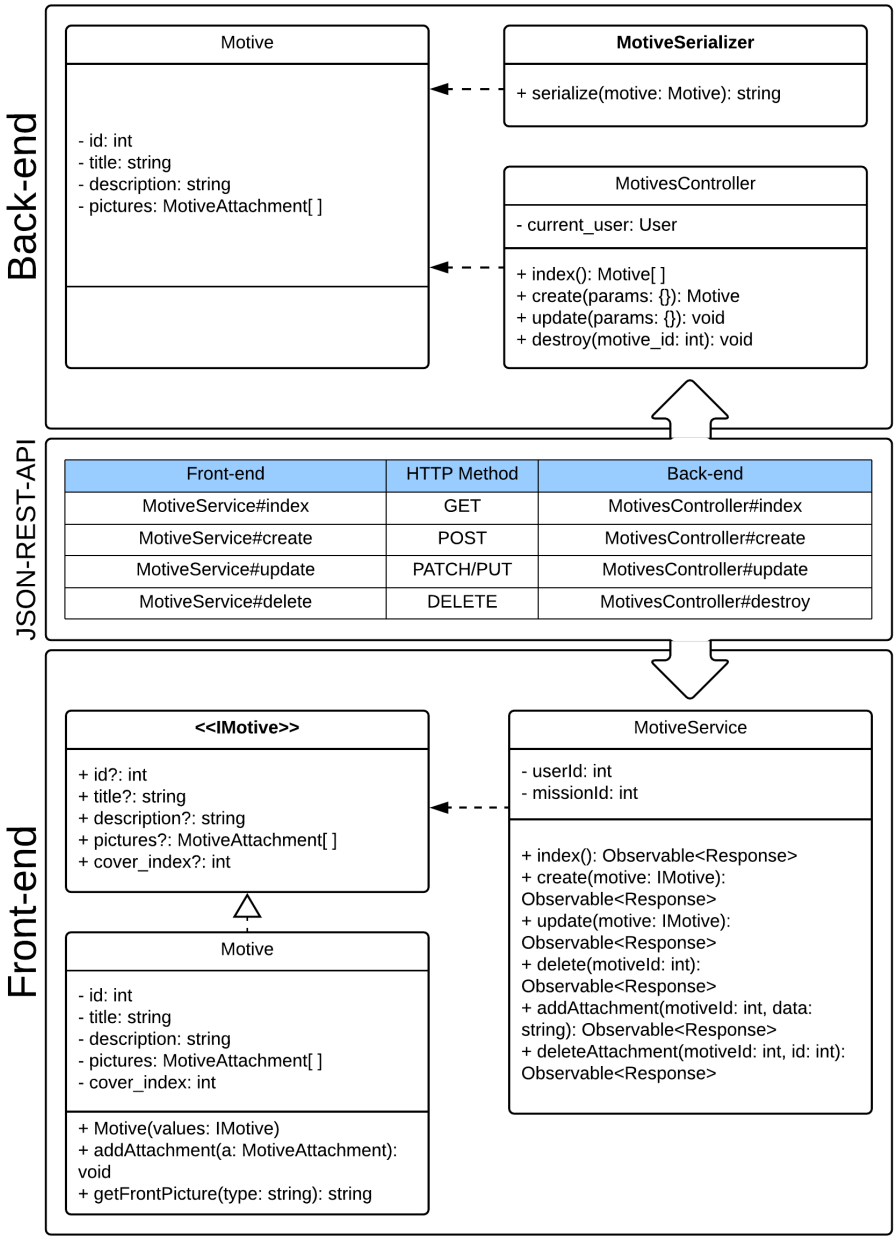


Figure 4.3: Architectural class diagrams of the implementation for the usage of the users motives on both the front- and back-end. The interface `IMotive` in the front-end is actually just a descriptor for possible fields in a JSON object. A question mark indicates optionality of an attribute.

```
<!-- imaging-motives.html -->
<button (click)="toggleMotivePlayback()">
  <ion-icon name="play" *ngIf="!active"></ion-icon>
  <ion-icon name="pause" *ngIf="active"></ion-icon>
</button>

// imaging-motives.ts
public toggleMotivePlayback(): void {
  if (this.active) {
    this.audio.pause(this._audioKey);
    this.active = false;
  } else {
    this.audio.play(this._audioKey);
    this.active = true;
  }
}

// in constructor
this.audio.preload('imagine motives',
  'assets/audio/imaginations/motives.mp3');


// smart-audio.ts
interface AudioDescriptor {
  key: string,
  asset: string,
  audioObject: HTMLAudioElement
}
```

Listing 4.6: Simplified code excerpts for listening to the motive imagination.

4.2.3 Goals

As with the mission and motives, goals have the same specification on both ends of the application. Figure 4.4 shows the specification for both sides, as well as the routing from service methods on the front-end to controller methods on the back-end. The Representational State Transfer (REST) nature of the API can be seen in the table in the center of the diagram, as each of the four requests is directed to the same URL, but with different HTTP methods.

Case Study: Checking of Goals

Checking goals is probably the most used functionality when it comes to the motivational constructs. Due to this, performance, usability and reliability are of utmost importance. Users see their goals in three lists, determined by the scheduling information of each goal. Clicking on a goal in a list brings them to a detail page, where the button for checking the goal is located at the bottom. Screenshots for the three lists and the detail page are found in screenshots A and B of Figure 5.3 in Chapter 5. Making the connection to the gamification in the application, Listing 4.7 includes the asynchronously executed anonymous function that rewards the user with points, as well as the display of the point reward in the interface. In Listing 4.8, the back-end code creating the `GoalCheck` and persisting it to the database is shown. The aggregation of the number of checks for display in the front-end is performed on the front-end as well, as operations such as this one would only put strain on the back-ends computing resources if they had to be performed for every user.

4.3 Gamification Elements

This section will focus on the integration of gamified elements into the application. On the back-end, any point or badge related functionality is handled by the `CompetitionController`, while on the front-end, the `PointsProvider` is the main gamification container.

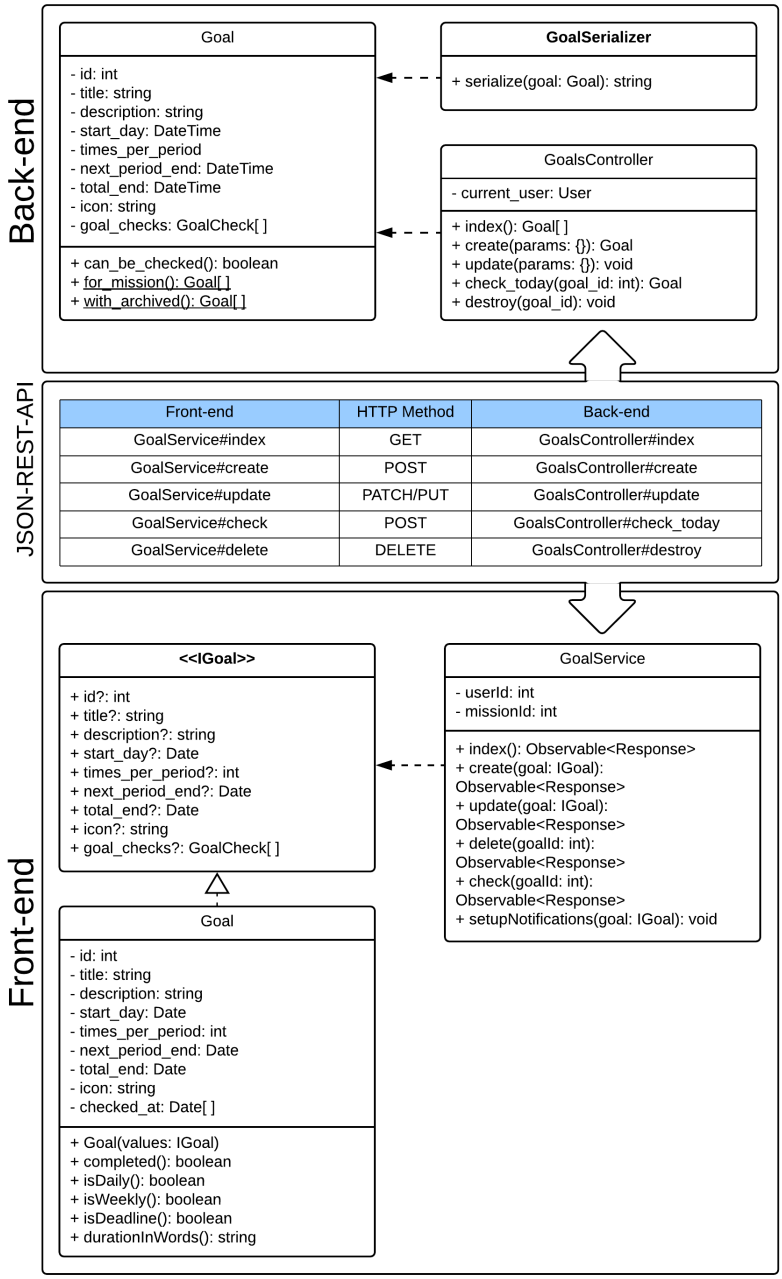


Figure 4.4: Architectural class diagrams of the implementation for the usage of the users goals on both the front- and back-end. The interface `IGoal` in the front-end is actually just a descriptor for possible fields in a JSON-Object. A question mark indicates optionality of an attribute.

```
1  private checkGoal(): void {
2    this.goalService.check(this.goal.id).subscribe(
3      value => {
4        this.session.user.activeMission.goals[this._index] =
5              new Goal(value as IGoal);
6        this.session.user.incrementStat(userStatKeys.totalGoals);
7        this.pointsProvider.awardPoints(Action.CHECKEDGOAL).then(
8          pointInformation => {
9          const ishBeaten: boolean = pointInformation[1];
10         const awardedPoints: number = pointInformation[0];
11
12         this.viewCtrl.onDidDismiss(() => {
13           this.popover.addAndShowPopover({
14             page: 'GoalCheckedPage',
15             pageData: {
16               'goal': this.goal,
17               'points': awardedPoints
18             },
19             dismissCallback: () => {
20               if (pointInformation[2]) {
21                 this.pointsProvider.showBadgeProgress(
22                     pointInformation[2]
23                   );
24               }
25             }
26           });
27         });
28         this.navCtrl.pop();
29       }
30     }
31   );
32 }
```

Listing 4.7: Simplified code excerpts for checking a goal on the front-end. Any error handling has been omitted. The asynchronous nature of the application is clearly visible, as every function that may not execute instantly is wrapped in a callback.

```
1 def check_today
2     check = GoalCheck.new()
3     check.goal_id =  @goal.id
4     check.save
5     @goal.calculate_attributes
6     render json: @goal, status: :created
7   end
8 end
```

Listing 4.8: Simplified code excerpts for checking a goal on the back-end. Any error handling has been omitted.

4.3.1 Points and Competition

All available actions that let the user gather points must be identifiable on both ends. On the back-end, the available actions are stored in the database, along with their point values and daily limitations. Listing 4.9 shows the setup code with the values that are inserted into the database when deploying the back-end. The same identifiers are available in a constants file on the front-end, seen in Listing 4.10. With this setup, no information on the amount of points an action is worth is stored on the front-end. Listing 4.7 from line 7 and onward shows the asynchronous handling of awarding points to the player. The `PointsProvider` issues a request to the back-end, parses the response and resolves with a `Promise`. Calling `then()` on this promise makes the contained arrow function execute asynchronously once the call has been executed. In this case, the provider passes the number of awarded points, any badges that progressed and a boolean value that indicates whether the required points for this weeks competition have been reached. As a promise can only resolve with one variable, these values are stored in the array `pointsInformation`. By setting up a callback with `onDidDismiss` on line 12, it is made sure that the overlay showing the awarded points is only displayed once the user has returned to the main page, which is done by the `navCtrl.pop()` on line 28. As with any data, a users points are stored in the front-end for display only, the persistent storage happens on the back-end.

```
[
  # name | display name | points | times per day | fractional falloff
  ['misc', '', 0, 0, 0.0], # for miscellaneous point rewards
  ['entered motive', 'Neues Motiv eingegeben', 7, 0, 0.0],
  ['uploaded motive picture', 'Neues Motivbild hochgeladen', 2, 0, 0.0],
  ['uploaded mission picture', 'Neues Missionsbild hochgeladen', 2, 0, 0.0],
  ['looked at motives', 'Motive angesehen', 3, 2, 2.0],
  ['listened to motives', 'Motiv-Imagination angehört', 5, 1, 0.0],
  ['listened to mission', 'Missions-Imagination angehört', 5, 1, 0.0],
  ['ticked goal', 'Teilschritt des Wochenziels abgehakt', 5, 0, 0],
  ['used app', 'App geöffnet', 3, 1, 0],
  ['new goal', 'Neues Ziel erstellt', 3, 3, 0.0],
  ['won week', 'Woche gewonnen', 0, 0, 0]

]
```

Listing 4.9: Setup code containing the values for actions that reward points. All configuration options, such as the maximum number of times a certain action can be awarded in one day are centrally accessible.

```
export class Action {
  static MISC = 'misc';
  static CHECKEDGOAL = 'ticked goal';
  static MISSION_PICTURE_UPLOAD = 'uploaded mission picture';
  static MOTIVES_PICTURE_UPLOAD = 'uploaded motive picture';
  static MOTIVES_VIEWED = 'looked at motives';
  static MOTIVES_NEW = 'entered motive';
  static LISTENED_MOTIVES = 'listened to motives';
  static LISTENED_MISSION = 'listened to mission';
  static USED_APP = 'used app';
  static NEW_GOAL = 'new goal';
  static WON_WEEK = 'won week';
}
```

Listing 4.10: Constants for identifying user actions that reward points. On the front-end, no information about point values or other options is stored. These identifiers match the ones in Listing 4.9.

A B C

Figure 4.5: Badge graphics for creating a new goal (A), checking a goal (B) and winning the weekly competition against the "inner pigdog" (C).

4.3.2 Badges

The badge implementation is tied tightly to the implementation of points and the weekly competition, as every badge except one is tracking actions which also yield points. The one badge for winning the competition is therefore implemented as a special action that rewards zero points, as seen on line 12 of Listing 4.9. Data for all available badges is inserted into the database at deployment, similar to the available actions in the previous listing.

Badge Graphics

As badges are essentially collectibles, they should offer pleasing aesthetics. Being awarded a badge that looks dull is probably way less motivating to users than getting one that is visually pleasing. Of course, preferences are always subjective, but the badges in Figure 4.5 show the effort of consistency between the badges and the system while still being nice to look at.

4.4 Used Frameworks and Technology Stacks

To avoid having to solve known problems and issues of cross platform application development, several frameworks and utilities were used for implementing the system. This section shortly introduces every framework and discusses the reasons for why it was chosen.

4.4.1 Used Framework for the Back-end Implementation

Implementation of the back-end was done with the web application framework Ruby on Rails, commonly and in this thesis from now on called only Rails. Rails is a Model-View-Controller (MVC) based framework that follows both the "Don't Repeat Yourself (DRY)" and "convention over configuration" approaches and makes it simple to write complex database backed web applications. While Rails is usually employed as full stack framework incorporating both views and business logic, a single configuration option allows to strip out all view parts and have the application run in so-called headless mode, only exposing an API to provide access to the backing database. Rails itself is written in the Ruby programming language[3].

Alternatives to Rails

Web application frameworks that offer API-only versions exist in many programming languages and technology stacks. The decision for Rails was made early, however, two contenders were considered: Laravel[4], written in PHP, and Django[5], written in Python. Both frameworks offer configuration options to work in headless mode, exposing only an API for consumption by the front-end and would also have been suitable for implementing the required functionality. Essentially, the decision came down to the simplicity and extensibility of Rails.

[3] `https://rubyonrails.org` (Rails, 2018)
[4] `https://laravel.com/` (Artisans, 2018)
[5] `https://www.djangoproject.com/` (Foundation, 2018)

4.4.2 Used Frameworks for the Front-end Implementation

The cross-platform mobile application was developed with the help of the open source cross-platform development framework Ionic[6]. This framework allows for development of a mobile application that will run on Android, iOS and Windows Phone devices without needing separate codebases for each platform. The Ionic framework itself is based on Angular[7], a Typescript[8] framework from Google and therefore follows the conventions of that framework. Ionic, along with the company behind the framework, Drifty Co., was founded in 2012 by two developers. Their main goal was to give web developers a better way to use their existing skills to create apps for the app stores of Android and iOS. Over the years, millions of mobile applications were built using Ionic, helping the framework make the claim of being the most popular cross-platform development stack[9]. Ionic offers the following development stack to ease the creation of cross-platform applications that only require a single codebase:

- **Angular**: The popular front-end web application framework from Google acts as the foundation of Ionic. This implies that Ionic follows a component-based approach, offers strong, static typing as provided by TypeScript, runtime dependency injection and two way data binding between views and controllers.
- **TypeScript**: TypeScript is a superset of the JavaScript programming language that transpiles (compilation of one programming language to another) to JavaScript.
- **Node Package Manager**: Node Package Manager (NPM)[10] is a JavaScript package manager that can be used to install third-party modules, manage dependencies and publish code. According to its own claim, the NPM repository is the worlds largest collection of free, reusable code.
- **SASS**: Syntactically Awesome Stylesheets (SASS) is a preprocessor for the web's styling language Cascading Stylesheets (CSS). Like CSS

[6] `https://ionicframework.com/about` (Ionic, 2018b)
[7] `https://angular.io/features` (Google, 2018a)
[8] `https://www.typescriptlang.org` (Microsoft, 2018b)
[9] `https://ionicframework.com/about` (Ionic, 2018b)
[10] `https://www.npmjs.com/about` (npm, 2018)

for webpages, SASS is used to apply visual styling to the mobile application, but extends CSS with variables, looping capabilities and more.

Competing Cross-Platform frameworks

At the time of writing this thesis, several cross-platform mobile application development frameworks were available to choose from. All backed by large, well-established companies, the following alternatives were considered:

- **React Native**: Based on Facebooks JavaScript library React[11], React Native[12] extends the framework to the realm of cross-platform mobile application development. The major difference to Ionic, apart from the different underlying frameworks, is the use of actual native controls and widgets for each platform. In Ionic, the entire application is rendered inside a full screen web view, the building blocks boil down to Hypertext Markup Language (HTML) elements. This yields better performance for React Native when the components require little repeated rendering and data exchange with the backed, but may impair performance issues for data-heavy visualizations as every render cycle requires a call over a bridge from the native component to the JavaScript code, resulting in a possible bottleneck for the whole application. However, keeping repeated renderings to a required minimum easily mitigates this potential problem.
- **Xamarin**: Sitting on top of Mono, a platform independent port of Microsofts .NET framework, the Xamarin Platform[13] enables developers to write mobile applications in pure C#. Xamarin form components render as native controls, depending on the platform the application is running on. With a plugin for Microsoft Visual Studio, every step of the development process can be controlled from one point, allowing C# developers to use existing knowledge and toolchains for mobile applications.

[11] `https://reactjs.org` (Facebook, 2018b)
[12] `https://facebook.github.io/react-native` (Facebook, 2018c)
[13] `https://www.xamarin.com` (Microsoft, 2018a)

- **Flutter**: Flutter[14] is the newest of the three presented frameworks, being first released in early 2017. The programming language used by Flutter is Dart, an also relatively new strongly typed programming language that follows a multi-paradigm, object oriented approach. Both Dart and Flutter are maintained by Google. Like TypeScript, Dart can be transpiled to JavaScript using the official transpiler from Google. Other than Ionic that renders the user interface in a web view, Flutter uses a C++ rendering engine developed by Google. Responsiveness and fluidness of an application is the paramount objective of Flutter that promises refresh rates of 120 frames per second. To reach this goal, Flutter builds all widgets and components outside of the native side of the application, thus allowing repeated rendering cycles without ever having to make a call to native endpoints. While this definitely speeds up rendering, the problem of compliance to native components and controls arises. A change of the native widgets and controls of a platform requires incorporation of these changes into the Flutter widget library.

Reasons for Choosing Ionic

Before starting the implementation of the front-end, a minimal working prototype fulfilling easy tasks like parsing and validating values was created with each framework. The three most significant criteria when making the decision in favor of Ionic were:

- **Creating Complex, Custom Components**: Due to extensive documentation and previous experience with web development, creating intricate components that delivered outstanding visual and data processing results proved to be fastest and easiest with Ionic. Being able to use plain HTML in combination with the Angular templating syntax was perceived as a good workflow. The two way data binding implemented by Angular made it easy to have perfect synchronization between a components display (the view) and the logic behind it (the controller).
- **Separation of Logic and View**: In both React Native and Flutter, the code for building the view resides in the same file as the business

[14] `https://flutter.io/` (Google, 2018b)

logic. While still being separated in functionality, this lack of a real templating language favored Ionic and Xamarin that use .html and .xml view templates respectively.
- **Overall Development Experience**: React Native, Flutter and Ionic all provided good, lightweight development experiences. Xamarin, on the other hand felt a bit heavyweight, like being better suited for larger-scale, database-centric enterprise applications. This fact ruled Xamarin out.

The decision for Ionic was made on the points presented, as React Native and Flutter did not provide the cleanest separation between views and controllers. Additionally, Flutter was very new at the time the implementation began, and only few resources apart from the official documentation were available. Xamarin had looked promising at first glance, but the perceived unwieldy development experience made a point against it.

4.5 Summary of the Chapter

Implementing a pure front-end cross-platform mobile application, backed by a server-hosted API-only back-end for persisting the user data required before-hand planning. A conceptual diagram was used to convey the system architecture, focusing especially on the synchronization between the two sides with the help of interfaces to have compliant object structures for data exchange. For each motivational construct, short case studies with UML class diagrams embedded into larger diagrams depicting the interfaces between front- and back-end and code samples were used to present the implementations. One important attribute of the mobile app is its asynchronous nature. To give users a fluid experience, any call that might not return instantly is wrapped by either a `Promise` or an `Observable`. Executing the functions that process the return values of these calls separately from other execution threads, users can carry on using the app uninterruptedly while the call is handled in the background and only becomes prevalent once a response has been received. Concerning the gamification elements, the point reward mechanism and the badge system were explained in more detail, again with a focus on the interplay between the two sides of the

system. Due to the similarity of actions that reward points and actions that promote badge progression, the gamified aspect can be handled by a central class for both sides. As implementing a cross-platform app would have been impossible without a proper framework to base it on, the Ionic framework powering the front-end, and the Rails framework powering the back-end were presented, along with a discussion of why each was chosen.

5 Application Showcase

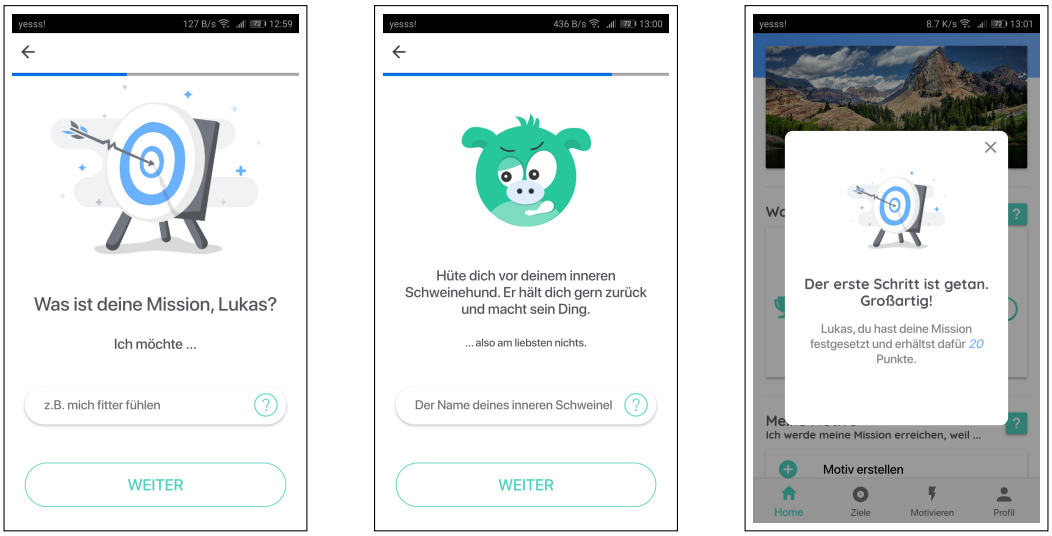
This application showcase depicts the functionalities discussed in the previous two chapters, focusing again on the motivational constructs and the gamified aspect. For a users mission, goals and motives, screenshots of typical usage cases are provided. Concerning gamification elements, both the weekly competititon against the "inner pigdog" as well as the closely related badges are shown in action.

5.1 Introduction and Mission Setup

After signing up with an e-mail-address and password, users first enter their name, then set their mission (screenshot A in Figure 5.1). Getting to know the "inner pigdog" and naming it (screenshot B), users are taken to the home screen where they are rewarded with their first points (screenshot C), to avoid starting out with an empty bar.

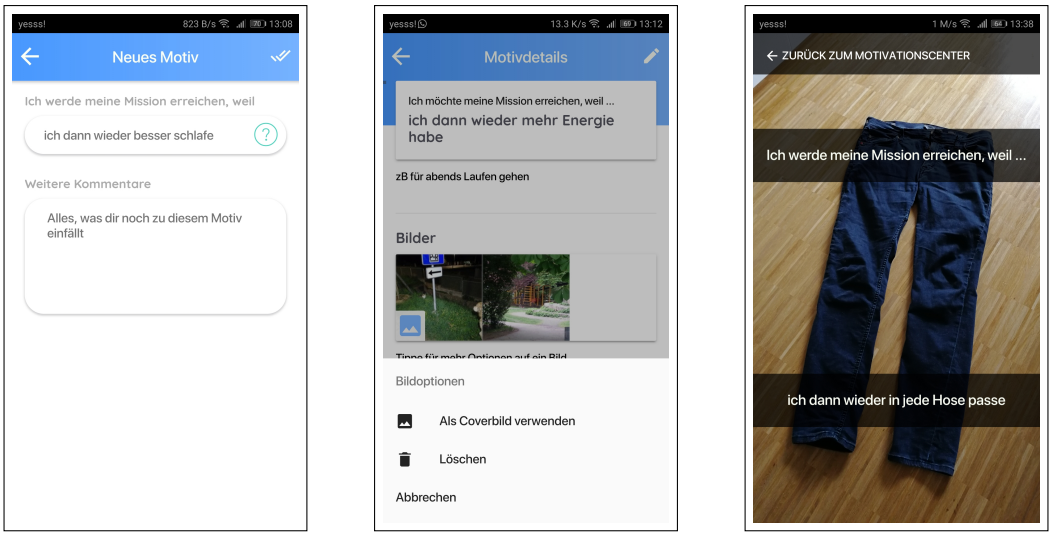
5.2 Usage of Motives

Once users have gone through the introduction process, they have the full functionality of the application at their disposal. The input mask for creating new motives is seen in Screenshot A of Figure 5.2, screenshot B then shows customization options for a motive by uploading one or more images, while screenshot C shows the usage of motives in the motivational support tool of motive imagination.



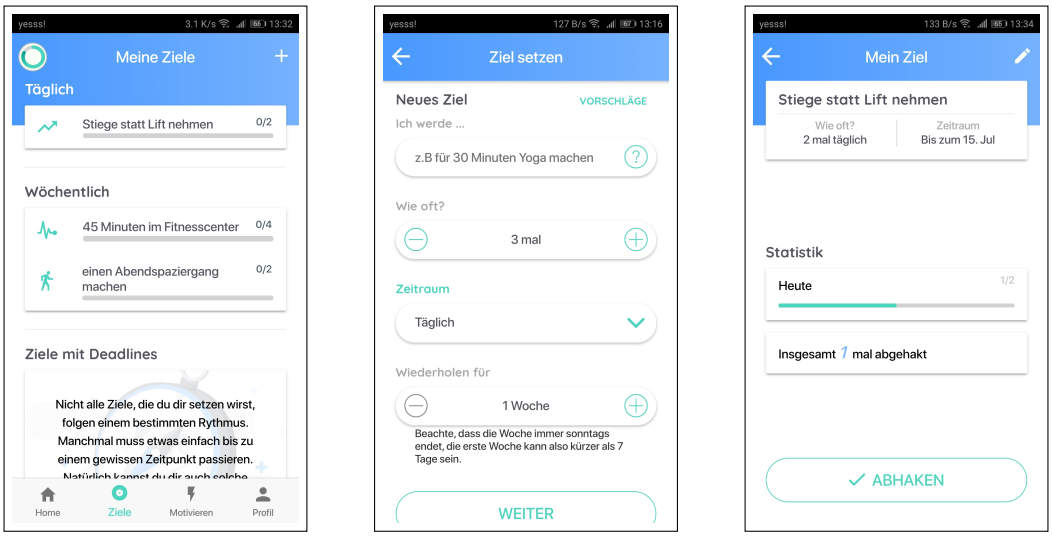
A B C

Figure 5.1: Selected screenshots of the introduction process of the application



A B C

Figure 5.2: Selected screenshots of the usage of motives throughout the application



A B C

Figure 5.3: Selected screenshots of the usage of goals throughout the application

5.3 Usage of Goals

An overview of all active goals, as well as the option to create new goals is available on the goal page, seen in screenshot A of Figure 5.3. In this specific case, one daily goal and two weekly goals have already been created. In the upper left corner of the page, a small indicator for the weekly battle is displayed. Tapping the plus icon in the top right opens the page for creating new goals, seen in screenshot B. In order to help inexperienced users with creating their first goals, some suggestions are available by clicking the button in the top right. As with motives and the mission, tapping the question mark in the first input field presents an overlay that gives guidance on goal creation. As discussed in Chapter 3, three options are available for the time frame of a goal. It can either be daily, weekly or have a set deadline. Tapping a goal in the list on the overview page opens its detail page, seen in screenshot C. Some statistics and the option for editing the goal are available, as well as the button in the bottom that checks the goal.

5.4 Gamification Elements

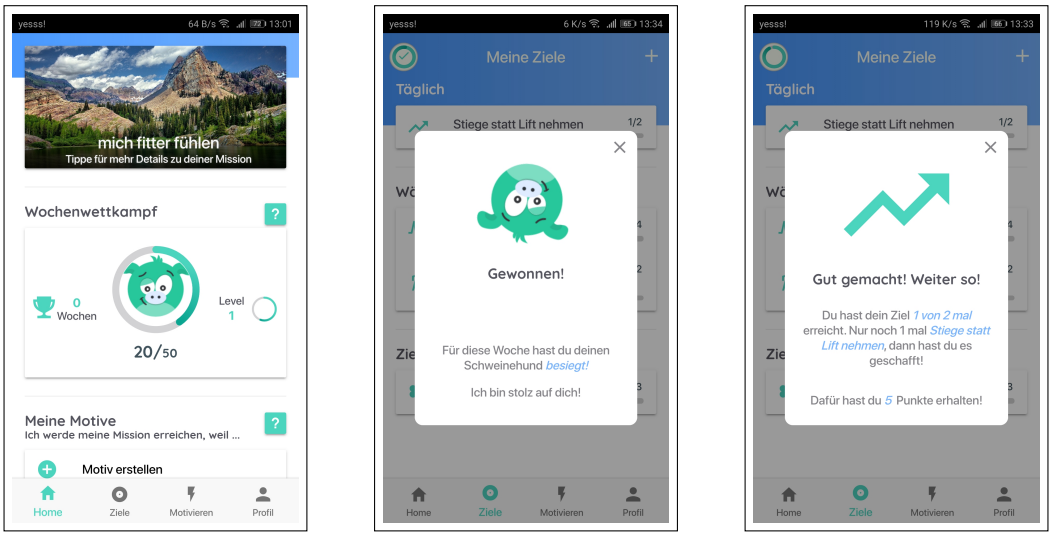
Gamified, persuasive systems should provide a great user experience, which starts with an accessible and appealing user interface. As such, special care has been taken with the implementation of the weekly competition and the badges.

5.4.1 Weekly Competition

The main area of the competition against the “inner pigdog” is located on the main page, seen in screenshot A of Figure 5.4. The question mark icon at the top right corner of the competition area opens an overlay that recapitulates the weekly competition. A smoothly animated round bar around the avatar of the “inner pigdog” fills up as users gather points. Once enough points have been gathered to ”defeat” it, an overlay (screenshot B) is shown, in which the “inner pigdog” spirals out view, as an indication for being gone for the rest of the week. Until the start of the next week, the face inside the circle is grayed out. An exemplary point reward is shown in screenshot C, where the user just checked a goal and is informed about their gain of five points.

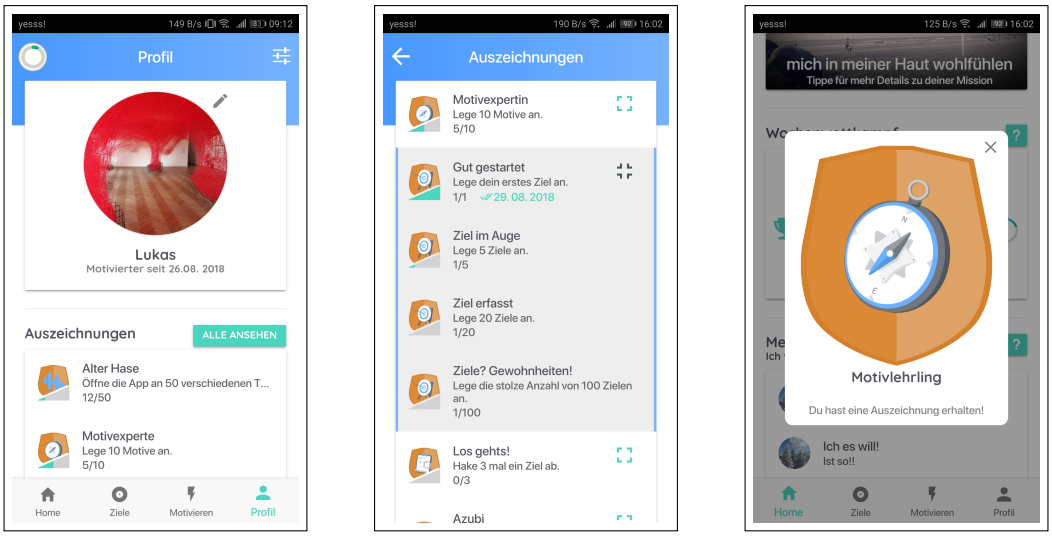
5.4.2 Badges

The last item in the bottom tab bar is the users profile (screenshot A in Figure 5.5). Apart from an option to change the avatar image and viewing some statistics, the list of attained badges is situated here. Tapping the button above the badges takes users to the overview of all available badges and all their progression steps, attained or not. Originally, only the badge level that is active is visible in the list. Tapping the icon to the right of each badge expands the list to show all progression levels of that badge (screenshot B). When users complete a progression level of a badge, they receive a congratulatory overlay (screenshot C).



A B C

Figure 5.4: Selected screenshots of gamification elements belonging to the weekly competition.



A B C

Figure 5.5: Selected screenshots of gamification elements belonging to the implemented badge system.

5.5 Summary of the Chapter

With the help of an ample array of screenshots, the implemented application was showcased in its gamified version. Generally, the application aims to be assessable in its behavior, not surprising users when they do not expect it. The application as it is shown here was used in an A/B on-site experiment for answering the two research questions. Setup and results of this experiment are discussed in the next chapter.

6 Evaluation

For evaluating the effect of the included gamification on the users commitment to using the application, an A/B experiment of both qualitative and quantitative nature was conducted. This chapter discusses the design and results of this experiment and attempts to answer the research questions. Overall, a positive effect of the gamification on the users' commitment to the application was measurable and could be validated by interviews and open-ended questions. A concise evaluation of an earlier iteration of the application with different requirements and focus is also discussed.

6.1 Experiment

To verify or reject the two hypotheses stated in Chapter 1, a both qualitative and quantitative on-site A/B experiment with 12 participants was conducted. To recapitalize, the two hypotheses are:

- H1 Gamification measurably increases user commitment to their health goals, by keeping users motivated to use a behavior change application.
- H2 Personality and preference for gamification elements show some sort of correlation.

6.1.1 Experiment Design and Setup

The experiment was conducted individually for each tester, having them test the non-gamified (ordinary) version before the gamified one, therefor every tester gave their opinion on both versions. The decision of starting with the

non-gamified version was made because of possible bias on the evaluation of the non-gamified version. As this version is basically a slimmed-down version of the full gamified version, testing it after having seen the full application might have yielded worse results in relation to the gamified version, skewing the results in favor of the gamified version.

Non-gamified Version

To have a baseline that the gamified version could be compared to, a non-gamified version was developed by trimming out all gamified content of the finished application. Therefore, while any game-related functionality or reference was removed, all motivational constructs and other functionalities were left untouched by this reduction.

Used Tools

For reasons of simplicity, the Ionic DevApp[1] was used for running the application on a smartphone for the experiment. This testing platform allows for an Ionic application to run natively on a device without requiring an actual native build. For the questionnaires, the open source online survey tool LimeSurvey[2] was employed.

6.1.2 Test Procedure

Upon entering the test room, testers were first greeted and thanked for their participation. They were then filled in on the general procedure of the experiment. Before starting to explore the non-gamified version of the application, testers were first asked to fill in a short background questionnaire and a standardized personality test. Having finished these two questionnaires, they were then handed a smartphone on which the non-gamified version of the application was already running and greeted them with a welcome

[1] `https://ionicframework.com/docs/pro/devapp/` (Ionic, 2018a)
[2] `https://www.limesurvey.org/` ("LimeSurvey", 2018)

screen. The only task given to them for this version was to sign up within the application, using either self-chosen credentials or suggested ones they could copy from a slip of paper on the testing table. Afterwards, they were free to explore at their own pace for at least ten minutes. Immediately after putting down the smartphone, three questions were asked and recorded. As the whole experiment was conducted in German, these have been translated accordingly:

1. How was it?
2. Was there anything you particularly liked?
3. Was there anything you particularly disliked?

After answering these question, a system usability scale questionnaire and a self-designed questionnaire about the application and its perceived usefulness was filled in by the testers. Next, they were handed the smartphone again, this time with the gamified version up and running. Again, the first task was to sign up and explore for 10 minutes. The testers could reuse their credentials from the previous version, as the testing environment was reset each time as the version switch happened. Having familiarized themselves with the gamified aspects of the application, they were given four more tasks. Translated from German, these tasks were:

1. Create two goals
   - **Climb the Schöckl**[3] three times, until the 31st of Dec. 2018.
   - **Take the stairs instead of the elevator** two times daily, for four weeks.
2. Check the second goal you just created two times.
3. Create a motive with the title "**I want to feel more energized**" and add one or more pictures to it. Afterwards, head over to the motivation center and fully listen to the motive imagination.
4. Log out of the application.

Testers were told that if they felt they had already completed an action similar enough to a given task, the corresponding task could be skipped, as the experiment was not about performing these certain tasks, but getting an impression of the application. These tasks were assigned to make sure

[3] A Styrian mountain

testers get to see the core parts of the application. Having had their look around and completed the tasks, testers were once again asked the three questions already stated above: how it was in general, and if there was something they liked or disliked in particular. Again, all answers were recorded for evaluation. In accordance with the first version and to create a measurement of comparison, the same two questionnaires were then filled in by the testers, before they filled in the final one, asking about their gamification preferences and their opinion on the usefulness of the gamification in the application. Having answered the final questionnaire, the testers were thanked again before being bid farewell.

6.1.3 Participants

The twelve participants (five female, seven male) were aged 24 to 62 ($M = 31.75, SD = 9.58$). Eleven of them reported high or very high confidence in their ability to handle a smartphone, one participant reported average confidence in that proficiency. Eight of them used their smartphone for gaming, and six reported that they used one or more health related apps that they had installed on their phone.

6.1.4 Materials

Overall, 64 questions split across five questionnaires were answered by each participant. Six of these were open-ended, eight were using yes/no or similar answer schemes and 50 used a Likert-scale between **1** (strongly disagree) and **5** (strongly agree). As indicated in the procedure description, participants first filled in a background questionnaire, querying age, sex, education and information about smartphone usage concerning general proficiency as well as games and health related apps.

Big-Five-Inventory-10

For answering the second research question of correlation between personality and gamification element preference, a standardized Big-Five-Inventory

personality test, as presented by Rammstedt and John (2007) was used. The so called big five are dimensions of personality: extraversion, agreeableness, conscientiousness, neuroticism and openness.

System Usability Scale

As an easy way of gauging the overall usability, a system usability scale questionnaire, developed by Brooke et al. (1996), was used. With ten Likert-scale questions, general usability indicators like efficiency and user satisfaction are aggregated into a score, ranging from zero to 100. Scores above 70 are considered satisfactory.

Application Likability

To assess the participants general impression, as well as gain comparable data for the two versions, a questionnaire with 4 Likert-scale items and two open-ended questions was developed. The four rating items dealt with perceived motivational influence and usefulness of the application, while the two open-ended questions allowed participants to put their experience into words.

Gamification Assessment

The post questionnaire consisted of nine Likert-scale items, one yes/no question and two open-ended questions and served the assessment of the participants experience with the gamification elements in the gamified version. Additionally, interest in possible additional gamified functionality was assessed. The final three questions explicitly queried the participants preference concerning the two tested application versions.

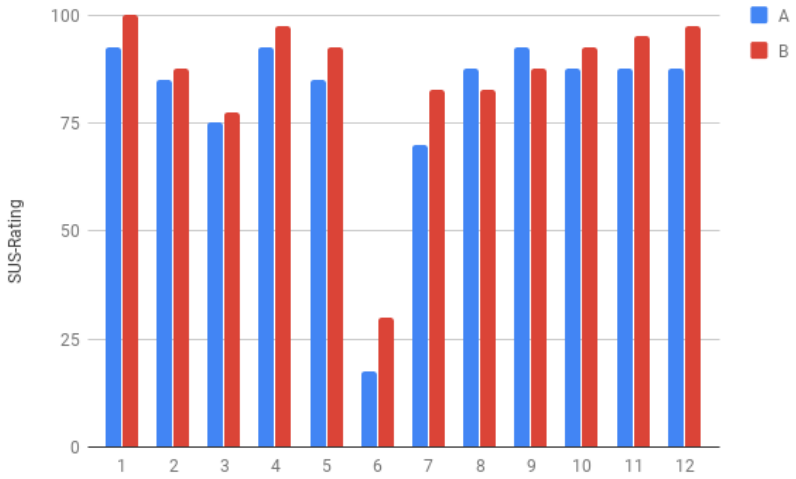


Figure 6.1: System Usability Scale results for both versions of the application.

6.1.5 Results

This section presents and discusses both the quantitative findings from all questionnaires, as well as the qualitative evaluation supported by open-answer questions of the questionnaires. While no technical problems occurred during the experiments, half of the participants reported difficulties with using the pop-up keyboard on the test smartphone. Results for the ordinary, non-gamified versions will be labeled with a capital A, a capital B denotes the gamified version.

System Usability Scale

The scores of the system usability scale for the both version were computed for each participant individually. The mean score of the ordinary app was 80 (85.68 without an outlier of 17). The gamified version scored 85.20 (90.22 without an outlier of 30). Both of these scores indicate good usability, as required by a persuasive system. While the gamified version scored slightly higher, the difference is too small to carry further meaning and may be owed to the bias discussed above. Concerning the one extreme outlier for each

#	Question	M (A)	SD (A)	M (B)	SD (B)
1	The application can help me reaching my health goals.	3.50	0.80	4.25	0.75
2	With the help of the explanations in the application, I felt prepared for using it.	3.50	1.24	4.17	0.58
3	I enjoyed using the application.	3.67	1.15	4.42	0.79
4	I feel motivated by the application.	3.08	1.15	3.83	1.11

Table 6.2: Results of the questionnaire for general application likability.

version, they stemmed from the same participant. Including that outlier, a noticeable standard deviation of $(A : SD = 20.83; B : SD = 18.72)$ was measured. Without it, standard deviation was expectedly lower $(A : SD = 7.16; B : SD = 7.28)$. An overview of the SUS rating of every participant is available in Figure 6.1. Notably, only two participants perceived the gamified version as less usable.

Application Likability

Both versions of the application were deemed useful for supporting the participants in reaching their health goal. The introductory process and explanatory content was also rated helpful. Measuring a general feeling of being motivated by the application produced a middle-ground score for the non-gamified version, and a slightly better score for the gamified version. A mean value and standard deviation for each question is located in Table 6.2. The answers to the two open-ended questions have been aggregated in the list below:

- **Liked aspects of the non-gamified version**:
  - explanations about motivational constructs
  - mission detail overview
  - ease of use
  - three different types of goals
  - beautiful user interface

#	Question	M	SD
1	Winning against my “inner pigdog” would give me a sense of accomplishment.	4.17	0.83
2	Losing against my “inner pigdog” would bother me.	3.67	0.98
3	Losing against my “inner pigdog” after a winning streak of three weeks would bother me.	4.25	0.75
4	I like collecting achievements in games.	3.58	1.51
5	I would like to pursue goals alongside other users.	3.00	1.41
6	I would like to compete with other users.	2.33	1.56
7	Getting point rewards in the app motivated me.	3.50	1.51
8	Seeing my progress in games is important to me.	4.00	1.28
9	I feel motivated by the gameful elements in the app.	4.17	0.83
		Yes	No
10	I prefer the gameful version of the app.	12	0

Table 6.4: Results of the questionnaire for the assessment of the included gamification as well as game element preferences.

- **Disliked aspects of the non-gamified version**:
  - lack of guidance for mission and goal creation
  - no clear purpose of the application discernable
  - usefulness of audio imaginations
  - no reversibility for the checking of goals
- **Liked aspects of the gamified version**:
  - “inner pigdog”: naming, interaction, competition, look
  - badges: look and collecting
- **Disliked aspects of the gamified version**:
  - fixed point rewards of goals

As the gamified version is a functional superset of the non-gamified one, it is safe to assume that liked aspects that were stated for the non-gamified version apply to the gamified one too.

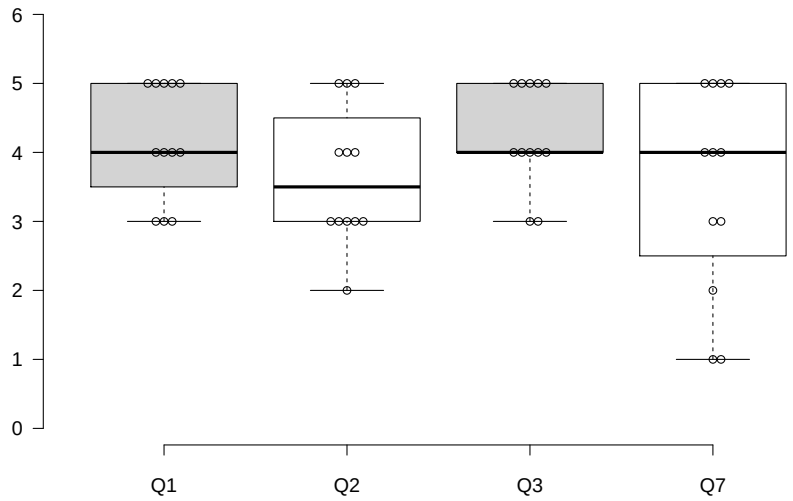


Figure 6.2: Likert-scale ratings for items 1, 2, 3 and 7 of Table 6.4. Due to the small sample size of 12, individual results have also been plotted.

Gamification Assessment

The results of the final questionnaire are found in Table 6.4. Participants responded very positively to the addition of gamification to the application, with every single participant preferring the gamified version over the ordinary one. All items belonging to the weekly competition also achieved high ratings. Eleven participants experienced the gamified version as fun, encouraging and entertaining. The four questions related to the weekly competition received generally high ratings, with the point rewards themselves scoring slightly lower than the competitive elements, as seen in the boxplot in Figure 6.2.

Comparison Between Versions

The gamified version achieved better ratings for every tested aspect. Nine participants explicitly mentioned their preference for it in their post-testing interview. As discussed above, it also achieved a higher SUS rating throughout all experiments, but a slight bias after having learned to use the similar

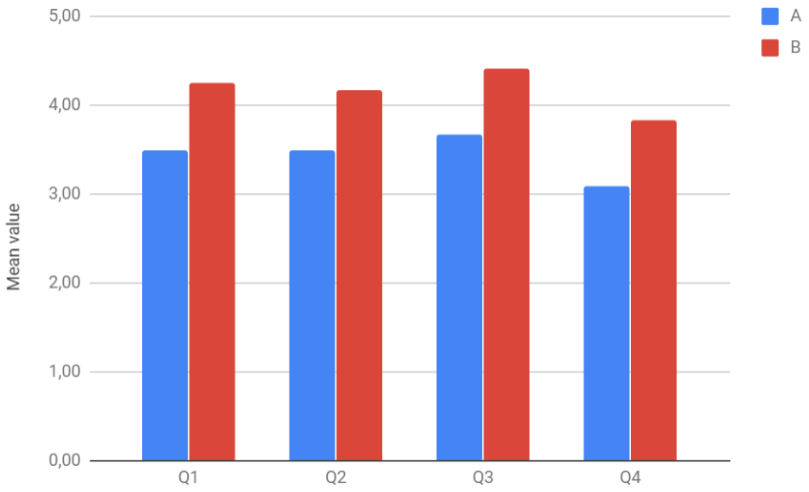


Figure 6.3: Comparison of Likert-scale questions that were answered for each version of the application. Refer to Table 6.2 for questions Q1 through Q4.

ordinary version may be present in this case. The four Likert-scale questions asked after each version, translated from German, are found in Table 6.2. In Figure 6.3, mean values for the results of these questions are plotted in a bar chart. On average, the score of the gamified version was higher by 0.73.

6.1.6 Discussion

Looking at the results, the evaluation was very successful. All but one participant seemed to enjoy working with the applications, even more so for the gamified version. *"I enjoyed the playfulness"*, *"I feel motivated by the game elements"*, *"It was just more fun than the first application"* and similar answers indicate a meaningful and successful inclusion of gamification. As discussed above, every aspect of the "inner pigdog" was very well received. Participants stated that while winning against their "inner pigdog" would give them a sense of satisfaction, losing one week would not bother them too much. When asked about losing a winning streak of three weeks, the rating went up to 4.25 on a Likert-scale. Concerning community features like cooperative goals and competition with other users, the participants showed

moderate interest, especially comparing with other users was rated rather low. While using the gamified versions, several users laughed when being introduced to their "inner pigdog", and several were delighted when they discovered the simple interaction on the main screen. Nine participants first mentioned the "inner pigdog" when asked about an aspect they particularly enjoyed about the gamified version.

Answering Research Questions

Having the positive remarks about the implemented gamification in mind, the experiment indicates validation of the first hypothesis, especially the unanimous preference for the gamified version. An experiment spanning several weeks would be supplemental to this claim. Concerning the claim of correlation of personality and game element preference, the results of the BFI-10 questionnaires were compared with metrics gathered from Likert-scale questions and answers given on open-ended questions and in the interviews.

With all participants rating the competitive aspect of the application highly, no obvious conclusion concerning a possible correlation of that element and the participants' personalities could be made. When looking at feedback about the badges, apart from one outlier at 2.5, each participant that explicitly mentioned them as a positive aspect in open-ended questions or interviews was ranked at 4 or higher for conscientiousness in the BFI-10. This might indicate a general sense of satisfaction once something - in this case a collection of badges - has been completed. Concerning the prospect of community functions that are integrated into existing functionalities, a slight correlation between the ratings for extraversion on the BFI-10 and an aggregated mean of questions that dealt with these community features was discernable, as participants that had low scores of extraversion were not interested in the addition of community features. Overall, results for these correlations should be understood as tendencies only, as the rather small sample size and limited number of relevant questions make it hard to discern definite results without relying on observations made while conducting the experiment. With this being said, Table 6.6 summarizes the answer to the research questions.

Hyp.	Result
H1	The included gamification measurably increased the users dedication to using the application, longer testing cycles required to validate the desired behavior change.
H2	Only weak correlations were discovered, larger sample size and and more focused questionnaires would be required.

Table 6.6: Discussion of the two research hypotheses.

6.1.7 Limitations

With only 12 participants, the results of the present study are to be seen with the right amount of scrutiny. While certain trends are definitely measurable, confirmation of the observations would have to be made with higher user numbers. As stated above, the study in its present form is not able to actually measure the induced behavior change process, as a duration of several weeks would have been required to do this.

6.2 Evaluation of Early Companion App

The evaluation of the first iteration of the application was carried out rather informally. After each workshop, attendees were asked to rate six items on a scale of 1 (not satisfied at all) to 10 (completely satisfied) on a questionnaire, with the additional option of answering open-ended questions about possible improvements. These six items stayed the same throughout all workshops, therefore allowing to monitor their progress as development of the application continued. As all workshops were held in German, the six evaluation items were German too and have been translated accordingly:

(I1) **Information Content of Workshop** (Information im Workshop)
(I2) **Experience During Workshop** (Erlebnis im Workshop)
(I3) **Experience with the Application** (Erlebnis mit der App)
(I4) **Meaningfulness of the Application** (Sinnhaftigkeit der App)

(I5) **Fun While Working with the Application** (Spaß am Arbeiten mit der App)
(I6) **Functionality of the Application** (Funktionsweise der App)

6.2.1 Results

As only items (I3) to (I6) are connected to the application, detailed results are provided for these four only. Generally, each item has been rated at each workshop, from the first to the fourth workshop. The highest number of attendees for a workshop was ten people, attained at the first and third workshop. The second workshop was visited by nine people, eight people attended the fourth.

Evaluation of Workshops (I1) & (I2)

On a scale of 1 to 10, as described above, items (I1) and (I2) achieved an average of 8.78 and 8.00 respectively, summarized over the course of the 4 weeks. Standard deviation for (I1) was as low as 0.2, while it was at 0.86 for (I2). These numbers indicate a general satisfaction with the workshops themselves, especially with the information that was provided in each workshop.

Experience with the Application (I3)

Results for the evaluation of the general experience with the application are plotted in a boxplot in Figure 6.4. Workshops one, two and four have been rated well in this aspect, receiving some top marks of 10, as well as relatively small standard deviations. The best application experience was obviously delivered in the second workshop, with two low outliers. In the third workshop, participants were split about the application experience, with many high and low marks and few in between. The reason for this might have been the longer duration of the workshop that took its toll on the participants perseverance and patience. Overall, the results were adequate, given that the application was still in active development.

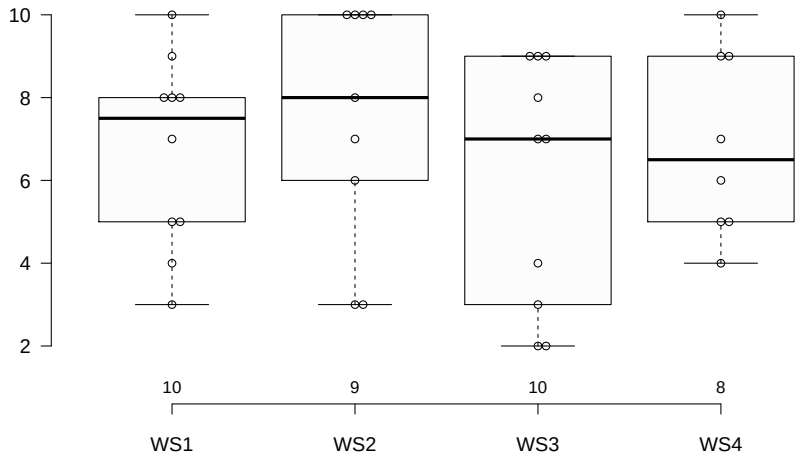


Figure 6.4: Boxplot for item (I3). Labels WS1 to WS4 denote workshops one through four. Due to the small sample sizes of 10, 9 and 8, the individual values have been plotted as well.

Meaningfulness of the Application (I4)

The first workshop delivered outstanding ratings for the meaningfulness of the application. From the second one onwards, the results declined overall, with a slight recovery at the fourth workshop. Again, the third workshop revealed a wide scattering of ratings. A boxplot is found in Figure 6.5

Fun While Working with the Application (I5)

Ratings for this item are of particular interest, as fun is an attribute that is commonly attributed to games. The plot in Figure 6.6 shows high levels of scattering throughout all workshops, probably indicating that the narrative element which was the major part of the gamification did not appeal to every participant. The particularly low score of the third workshop may again be attributed to its lengthiness, which may have been straining for the participants and therefore affected their rating for enjoyment and fun.

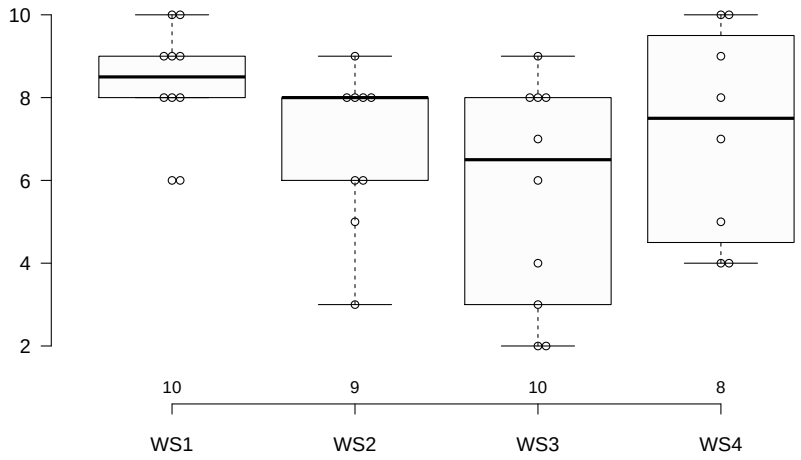


Figure 6.5: Boxplot for item (I4). Labels WS1 to WS4 denote workshops one through four. Due to the small sample sizes of 10, 9 and 8, the individual values have been plotted as well.

Answers to open questions suggested that some people simply did not like the way the master was portrayed and incorporated in the app.

Functionality of the Application (I6)

The results of this items evaluation are plotted in a boxplot in Figure 6.7. Unsurprisingly, given that the application was in active development during the time the workshops were held and more functionality was added every week, the first workshop scored mediocre in this department. The second and fourth attained similarly acceptable scores. Workshop three again had the participants split: while some rated the functionality highly, a technical problem that occurred during the workshop probably caused this item to receive the bottom score of 1 once.

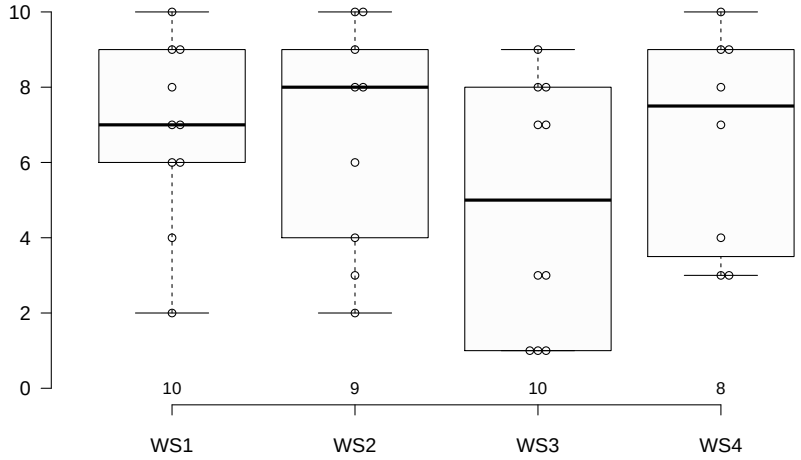


Figure 6.6: Boxplot for item (I5). Labels WS1 to WS4 denote workshops one through four. Due to the small sample sizes of 10, 9 and 8, the individual values have been plotted as well.

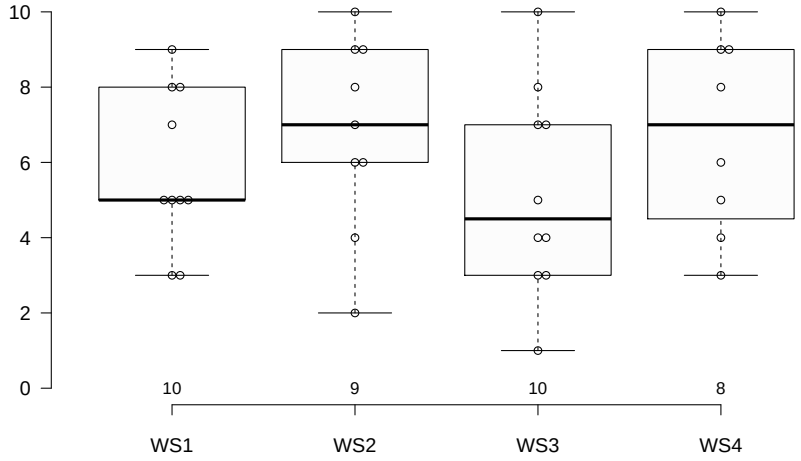


Figure 6.7: Boxplot for item (I6). Labels WS1 to WS4 denote workshops one through four. Due to the small sample sizes of 10, 9 and 8, the individual values have been plotted as well.

6.2.2 Discussion

Grouping items (I3) to (I6) by workshops, the application was generally received well during the first, second and fourth workshop. The third workshop was both the longest by a large margin and many participants experienced a technical problem. Both of these factors may have added to their discontent. However, grouping by participants, it is revealed that those who rated the entertainment item (I5) the lowest generally also gave the lowest scores to other items, indicating that the personal preference for game elements influenced the overall experience with the application. Another interpretation of this observation is that gamification does not help in improving the user experience if it is already perceived as subpar on its own. Given the informal nature of the questionnaire and the small sample sizes, these results should be viewed scrutinizingly.

7 Lessons Learned

During the conceptualization and implementation of the application, several insights were gained. Along with the lessons learned when writing this thesis, these insights will be discussed in this chapter.

7.1 Literature and Theory

When conducting the literature research, a wide variety of research body was discovered rather quickly. While the breadth of the available literature on gamification was definitely satisfactory, the available depth on some aspects still leaves to be desired. An interesting observation was that even though the concept of persuasive system design and gamification are similar in many aspects, not many papers acknowledge and draw from this similarity. The lack of a standardized evaluation for gamification, especially in the health domain, might be mitigatable by adapting concepts and research from the domain of persuasive systems.

7.2 Development Process

Implementation of the application started out in a prospective start-up. The version of the application as laid out in the end of Chapter 3, along with the real-life workshops, was the service this start-up intended to offer. Financial issues brought about the end of these plans and enforced a change of scope for the application and connected thesis. Even though many features that had already been developed at this point were not included in the present version of the application, the experience gained proved invaluable. As

the application had been conceptualized with a commercial background, an extensive thought process had gone into the system architecture and setup to ensure the best performance, compatibility and scalability. All these attributes proved beneficial as development was picked up anew, this time with the list of requirements and design decisions presented in this thesis.

The overall objective of the application, as well as the main gamified aspects were defined at the start of development. The fine-grained details however, were iteratively designed and improved as the application took shape. The development experience with the two frameworks for the front- and back-end was more than satisfactory, owing mostly to the great third-party package availability for networking, authentication and native device functionality access.

7.3 Evaluation Phase

Using the SUS and BFI-10 standardized questionnaires for the evaluation enabled a quick start, but the lack of gamification assessment frameworks made it necessary to complement the evaluation with self-designed domain specific questions to have a comparison base between the non-gamified and gamified version. Learning from the experience gained while conducting the experiment, more specific questions about certain elements and aspects of the usage experience for each version would have been interesting. That being said, the overall result of the evaluation indicates that the objective of implementing a user-friendly behavior change application with meaningful gamification has been achieved. Conducting the experiment in a remote setting by sending the participants download links for the application would have had its advantages and drawbacks. The biggest advantage would have been the possible higher number of responses, as no supervision would have been necessary and testing results may have been more natural. At the same time, this fact could have been the biggest drawback, as the controlled environment of the on-site experiments allowed the enforcement of the same procedure for every participant, making sure that results from different sessions can be compared.

8 Suggestions for Future Work

Drawing from the results of the evaluation as well as early discussions of possible functionality, extension of the implemented application could happen in many places. Additionally, further evaluation of the application could be pursued in several meaningful approaches.

8.1 Additional Functionality

Given the good usability rating and general acceptance the application received during evaluation, not many suggestions for possible extensions could be gathered. However, several improvements were identified during a review of the existing requirements.

8.1.1 Evaluation results

The suggestion most often mentioned during evaluation was the addition of an extended introduction process, guiding the user through all areas of the application and not leaving them on their own once the weekly competition had been explained. A self-set number of points for checking a goal was also recommended twice. No remarks were made concerning performance.

8.1.2 Further Improvements

Based on requirements analysis at an earlier stage, the implemented application offers room for improvement in many areas. First and foremost, a community system would be of interest, where players can share their

progress, look at other players' profiles and maybe even record short motivational talks for each other. Of course, any functionality implemented for a community could also be gamified. Badges for community-related activities come to mind, but also challenges that can only be done in teams of two or more would be an interesting option. Alongside with community features, extending the application to include a sort of coaching platform where users can request advice from professionals could also greatly benefit each user. Naturally, once interaction with other players becomes possible, special care would have to be dedicated to privacy and security concerns.

Customizability of the "Inner pigdog"

Appealing to any players who like tailoring applications to their preferences, a customizable "inner pigdog" could be implemented. Taking inspiration from Duolingos[1] Duo, an owl that guides the player in their learning progression, outfits or even entire new types of "pigdogs" could be purchased or unlocked at certain levels. Another part of the application that could be customized is the length of the battle against the "inner pigdog", allowing time ranges from as short as one day to maybe even a month.

Virtual Currency

If the purchasing approach were to be taken for customization, a virtual currency would have to be introduced to the games ecosystem, adding yet another type of point metric. While successfully used in many games, one needs to be careful not to overload the experience by just adding more and more gamification elements.

Introduction of Machine Learning

While a rather far fetched idea, machine learning could actually fit in many places in the application. By building a model of the motivational profile of

[1] `https://www.duolingo.com/` (Duolingo, 2018)

a user with the help of domain experts like psychologists and motivational coaches, users could be shown just the right motivational messages at the right times, or get personalized suggestions for their next goals.

8.2 Further Evaluation and Research

Given the fact that the main element of the included gamification is based on a weekly cycle, a study spanning two or more weeks of continued usage would be of interest, but was not conducted due to time and resource limits. Having studied the possible effect of gamification on a users behavior change, as well as correlation between personality and preference of gamification elements, an evaluation that is more focused on measuring the actual behavior change outcome of using the application would also be beneficial.

Generally, research on gamification exists in wide variety of studies, surveys and theoretical papers. One aspect that is really lacking is a standardized evaluation approach for popular gamified elements, such as leaderboards and point metrics. While gamification frameworks exists, none has yet reached a status that makes it considered a standard, go-to solution, especially for the assessment of existing gamified systems. Similar to the way the DPE framework extends the MDA framework to the domain of serious games, an extension or adaption to the domain of gamification would be beneficial for future research in gamification theory.

9 Summary and Outlook

Guiding people through a health behavior change process is a multi-faceted undertaking. Many times, they have neither the knowledge nor the tools for improving their health behavior at their disposal. With the application presented in this thesis, users get a tool that attempts to provide both. Gamification is included in this tool as means to an end - keeping users motivated to use the application, which in turn motivates them to pursue their objective of living healthier. Building on three blocks - the mission, the motives and the goals - users then face a part of themselves in a weekly competition. That part is their weaker self, colloquially called "innerer Schweinehund" in German. Every action that keeps users aware of their behavior change is rewarded with points that accumulate in a counter. Once users have gathered a certain amount of points within a week, they have defeated their weaker selves for that week. Winning subsequent weeks build up a streak counter.

This thesis presented the design, requirement analysis, implementation details and an evaluation of a gamified cross-platform mobile application for supporting health behavior change, along with providing background information and literature on the domain of gamification and behavior change. To make persuasion of users possible, special focus was put on delivering a great user experience as well as the required information to use the application to its full extent. A high usability rating and almost unanimously positive written and verbal feedback received during an evaluation phase outlined the success of these efforts. The meaningfulness of the included gamification was also validated unanimously by developing a second version without any gamified aspects and comparing evaluation results for these two functionally identical versions.

Looking at a statistic[1] published by eurostat, positive health behavior and lifestyle changes could have prevented as many as 517.000 deaths throughout the European Union in 2015. While the implemented application is by no means a certified health care tool, these numbers indicate that higher awareness of ones health behavior is beneficial at all times. With this in mind, overcoming the "inner pigdog" should not only happen in a competition inside a gamified application, but in everyday life too.

[1] `https://ec.europa.eu/eurostat/statistics-explained/index.php/Amenable_and_preventable_deaths_statistics` (eurostat, 2018)

Appendix

Glossary

API Application Programming Interface. 65, 74, 86, 92, 96

CSS Cascading Stylesheets. 93, 94

DPE Design, Play, Experience. viii, 11, 13–15, 35, 125
DRY Don't Repeat Yourself. 92

HTML Hypertext Markup Language. 94, 95

JSON JavaScript Object Notation. 75, 79, 81, 83

MDA Mechanics, Dynamics, Aesthetics. 11–15, 125
MUD Multi User Dungeon. 16, 18
MVC Model-View-Controller. 92

NPM Node Package Manager. 93

REST Representational State Transfer. 86

SASS Syntactically Awesome Stylesheets. 93, 94

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Questionnaires

Hintergrund

Bitte füllen Sie den folgenden Fragebogen zu Ihrer Person aus. Sämtliche Angaben in diesem und weiteren Fragebögen werden selbstverständlich anonym behandelt. Vielen Dank für Ihre Mithilfe!

[]Alter *

Bitte geben Sie Ihre Antwort hier ein:

[]Geschlecht *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ weiblich
- ○ männlich

[]Benötigen Sie eine Sehhilfe (Brille, Kontaktlinsen, etc...)? *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ Ja
- ○ Nein

[]Berufsstand *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ Schüler/Student
- ○ Arbeiter
- ○ Angestellt
- ○ Selbstständig
- ○ Arbeitslos
- ○ Sonstiges

[]Studienrichtung / Berufsbezeichnung *

Bitte geben Sie Ihre Antwort hier ein:

[]Höchste abgeschlossene Ausbildung *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ Fachhochschule / Universität
- ○ Kolleg
- ○ BHS
- ○ AHS
- ○ Lehre
- ○ Pflichtschule
- ○ Sonstiges

[]Ich fühle mich routiniert und kompetent bei der Nutzung von Smartphones. *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... ganz und gar nicht
5... absolut

[]Ich nutze mein Handy zum Spielen. *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ Ja
- ○ Nein

[]Ich benutze Fitness- und/oder Gesundheits-Apps auf meinem Handy. *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ Ja
- ○ Nein

[]Welche Fitness- und/oder Gesundheits-Apps nutzen Sie bereits?

Beantworten Sie diese Frage nur, wenn folgende Bedingungen erfüllt sind:
Antwort war 'Ja' bei Frage '9 [BG_otherapps]' (Ich benutze Fitness- und/oder Gesundheits-Apps auf meinem Handy.)

Bitte geben Sie Ihre Antwort(en) hier ein:

1: _____
2: _____
3: _____
4: _____
5: _____

Sollten Sie mehr als 5 Fitness- und/oder Gesundheits-Apps nutzen, geben sie bitte ihre 5 meistgenutzen an.

BFI-10 Persönlichkeitstest

Beantworten Sie die folgenden 10 Fragen, indem Sie jede Aussage auf einer Skala von **"(1) trifft überhaupt nicht zu"** bis **"(5) trifft voll und ganz zu"** bewerten.

[]Ich bin eher zurückhaltend, reserviert. *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... trifft überhaupt nicht zu
5... trifft voll und ganz zu

[]Ich schenke anderen leicht Vertrauen, glaube an das Gute im Menschen. *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... trifft überhaupt nicht zu
5... trifft voll und ganz zu

[]Ich bin bequem, neige zur Faulheit. *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... trifft überhaupt nicht zu
5... trifft voll und ganz zu

[]Ich bin entspannt, lasse mich durch Stress nicht aus der Ruhe bringen. *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... trifft überhaupt nicht zu
5... trifft voll und ganz zu

[]Ich habe nur wenig künstlerisches Interesse. *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... trifft überhaupt nicht zu
5... trifft voll und ganz zu

[]Ich gehe aus mir heraus, bin gesellig. *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... trifft überhaupt nicht zu
5... trifft voll und ganz zu

[]Ich neige dazu, andere zu kritisieren. *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... trifft überhaupt nicht zu
5... trifft voll und ganz zu

[]Ich erledige Aufgaben gründlich. *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... trifft überhaupt nicht zu
5... trifft voll und ganz zu

[]Ich werde leicht nervös und unsicher. *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... trifft überhaupt nicht zu
5... trifft voll und ganz zu

[]Ich habe eine aktive Vorstellungskraft, bin fantasievoll. *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... trifft überhaupt nicht zu
5... trifft voll und ganz zu

App-Gebrauchstauglichkeit (A)

Bitte beantworten Sie die folgenden Fragen zu der App, die Sie gerade getestet haben.

[]
Ich denke, dass ich die App gerne häufig benutzen würde.
***

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... Stimme überhaupt nicht zu
5... Stimme voll zu

[]
Ich fand die App unnötig komplex.
***

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... Stimme überhaupt nicht zu
5... Stimme voll zu

[]

Ich fand die App einfach zu benutzen.

***

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... Stimme überhaupt nicht zu
5... Stimme voll zu

[]

Ich glaube, ich würde die Hilfe einer technisch versierten Person benötigen, um die App benutzen zu können.

*

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... Stimme überhaupt nicht zu
5... Stimme voll zu

[]
Ich fand, die verschiedenen Funktionen in dieser App waren gut integriert.

*

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... Stimme überhaupt nicht zu
5... Stimme voll zu

[]
Ich denke, die App enthielt zu viele Inkonsistenzen.

*

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... Stimme überhaupt nicht zu
5... Stimme voll zu

[]Ich kann mir vorstellen, dass die meisten Menschen den Umgang mit dieser App sehr schnell lernen. *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... Stimme überhaupt nicht zu
5... Stimme voll zu

[]Ich fand die App sehr umständlich zu nutzen. *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... Stimme überhaupt nicht zu
5... Stimme voll zu

[]
Ich fühlte mich bei der Benutzung der App sehr sicher.

***

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... Stimme überhaupt nicht zu
5... Stimme voll zu

[]
Ich musste eine Menge lernen, bevor ich anfangen konnte die App zu verwenden.

***

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... Stimme überhaupt nicht zu
5... Stimme voll zu

Wirkung der App (A)

[]Die App kann mir helfen, meine gesundheitlichen Ziele zu erreichen. *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... Stimme überhaupt nicht zu
5... Stimme voll zu

[]Ich fühlte mich durch die Erklärungen in der App gut vorbereitet. *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... Stimme überhaupt nicht zu
5... Stimme voll zu

[]Die App hat mir persönlich gut gefallen. *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... Stimme überhaupt nicht zu
5... Stimme voll zu

[]Ich fühle mich durch die App motiviert. *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... Stimme überhaupt nicht zu
5... Stimme voll zu

[]Besonders gut hat mir folgendes gefallen:

Bitte geben Sie Ihre Antwort hier ein:

[]Wenn ich etwas an der App ändern könnte, wäre das:

Bitte geben Sie Ihre Antwort hier ein:

App-Gebrauchstauglichkeit (B)

Bitte beantworten Sie die folgenden Fragen zu der App, die Sie gerade getestet haben.

[]
Ich denke, dass ich die App gerne häufig benutzen würde.
*

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... Stimme überhaupt nicht zu
5... Stimme voll zu

[]
Ich fand die App unnötig komplex.
*

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... Stimme überhaupt nicht zu
5... Stimme voll zu

[]

Ich fand die App einfach zu benutzen.

*

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... Stimme überhaupt nicht zu
5... Stimme voll zu

[]

Ich glaube, ich würde die Hilfe einer technisch versierten Person benötigen, um die App benutzen zu können.

*

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... Stimme überhaupt nicht zu
5... Stimme voll zu

[]
Ich fand, die verschiedenen Funktionen in dieser App waren gut integriert.

*

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... Stimme überhaupt nicht zu
5... Stimme voll zu

[]
Ich denke, die App enthielt zu viele Inkonsistenzen.

*

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... Stimme überhaupt nicht zu
5... Stimme voll zu

[]Ich kann mir vorstellen, dass die meisten Menschen den Umgang mit dieser App sehr schnell lernen. *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... Stimme überhaupt nicht zu
5... Stimme voll zu

[]Ich fand die App sehr umständlich zu nutzen. *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... Stimme überhaupt nicht zu
5... Stimme voll zu

[]
Ich fühlte mich bei der Benutzung der App sehr sicher.

***

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... Stimme überhaupt nicht zu
5... Stimme voll zu

[]
Ich musste eine Menge lernen, bevor ich anfangen konnte die App zu verwenden.

***

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... Stimme überhaupt nicht zu
5... Stimme voll zu

Wirkung der App (B)

[]Die App kann mir helfen, meine gesundheitlichen Ziele zu erreichen. *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... Stimme überhaupt nicht zu
5... Stimme voll zu

[]Ich fühlte mich durch die Erklärungen in der App gut vorbereitet. *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... Stimme überhaupt nicht zu
5... Stimme voll zu

[]Die App hat mir persönlich gut gefallen. *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... Stimme überhaupt nicht zu
5... Stimme voll zu

[]Ich fühle mich durch die App motiviert. *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... Stimme überhaupt nicht zu
5... Stimme voll zu

[]Besonders gut hat mir folgendes gefallen:

Bitte geben Sie Ihre Antwort hier ein:

[]Wenn ich etwas an der App ändern könnte, wäre das:

Bitte geben Sie Ihre Antwort hier ein:

Spielerische Elemente

[]Es würde mir ein Gefühl der Genugtuung geben, meinen inneren Schweinehund zu besiegen. *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... Stimme überhaupt nicht zu
5... Stimme voll zu

[]Es würde mich stören, gegen meinen inneren Schweinehund zu verlieren. *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... Stimme überhaupt nicht zu
5... Stimme voll zu

[]Es würde mich stören, eine dreiwöchige Siegesserie gegen meinen inneren Schweinehund zu verlieren. *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... Stimme überhaupt nicht zu
5... Stimme voll zu

[]Ich sammle gerne Auszeichnungen in Spielen. *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... Stimme überhaupt nicht zu
5... Stimme voll zu

[]Ich würde gerne mit anderen Nutzern gemeinsame Ziele setzen und verfolgen. *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... Stimme überhaupt nicht zu
5... Stimme voll zu

[]Ich würde mich gerne mit anderen Nutzern messen. *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... Stimme überhaupt nicht zu
5... Stimme voll zu

[]Es motiviert mich, Punkte für Dinge, die ich in der App mache, zu bekommen. *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... Stimme überhaupt nicht zu
5... Stimme voll zu

[]Es ist mir wichtig, meinen Fortschritt in Spielen zu sehen. *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... Stimme überhaupt nicht zu
5... Stimme voll zu

[]Ich fühle mich durch die spielerischen Elemente motiviert. *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

1... Stimme überhaupt nicht zu
5... Stimme voll zu

[]Ich bevorzuge die Version mit spielerischen Elementen. *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ Ja
- ○ Nein

1... Stimme überhaupt nicht zu
5... Stimme voll zu

[]Warum gefällt Ihnen die Version MIT Spielelementen besser?

Beantworten Sie diese Frage nur, wenn folgende Bedingungen erfüllt sind:
Antwort war 'Ja' bei Frage '62 [G_010]' (Ich bevorzuge die Version mit spielerischen Elementen.)

Bitte geben Sie Ihre Antwort hier ein:

[]Warum gefällt Ihnen die Version OHNE Spielelemente besser?

Beantworten Sie diese Frage nur, wenn folgende Bedingungen erfüllt sind:
Antwort war 'Nein' bei Frage '62 [G_010]' (Ich bevorzuge die Version mit spielerischen Elementen.)

Bitte geben Sie Ihre Antwort hier ein: