Gamification elements in tracking applications

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Mobile phones are highly effective to develop mHealth applications. The mHealth is the use of mobile communication for health services. There are various types of mHealth applications, one of which is the tracking application. The main feature of tracking applications is the process of tracking data. Users of tracking applications need to track data on a mobile phone repeatedly which can be monotonous. To solve such issue, gamification, the use of game elements in non-game context, can be included in tracking applications to convert a repetitive task into a more engaging one. A prototype of gamified tracking application has been developed to examine the effectiveness of gamification in mHealth tracking applications. The prototype includes three gamification elements, which are avatar, story and feedback. Two usability systems have been adapted to support the analysis of the usability of the prototype which are Mobile Application Rating Scale (MARS) and Jakob Nielsen's heuristics. The MARS system contains twenty-three items and four of the items have been adapted to analyze and Jakob Nielsen's heuristics contains ten heuristics and three of which have been adapted. Three interviews were conducted to validate the usability of the prototype. The result of the research shows that the MARS total score for the prototype was three and they have little impact on the application’s usability.

Key words and terms: Gamification, tracking application, usability, mHealth.

Contents

1. Introduction

Mobile phones are an attractive subject to health services because their technical capabilities are increasing by time and they are ubiquitous. The portability of mobile phones provides access to health information at any time and in any context. (Akter & Ray, 2010) Also, mobile phones have collections of personal data such as GPS locations of the user which might be useful for health services. The data can be analyzed by a doctor and provide insights about a person or society (Patrick, et al., 2008). Mobile phones have become nearly universal and their market is leading to more powerful and computationally sophisticated devices which can more easily access the internet. This factor makes the mobile phones engaging and widely applicable for health applications. A study from Stoyanov et al. (2015) found that between 2013 and 2014 the global use of mobile phones increased by 406 million, reaching 1.82 billion devices (up 5% in a year), and Internet usage via mobile devices has increased by 81% in one year. The accessibility of mobile phones makes healthcare services more useful in emergency situations or normal situations. Mobile phones are an essential part of a person's routine hence they can integrate health educations such as educational support of a health topic such as AIDS or other forms of health promotion. (Klasnja & Pratt, 2012) They can also help users to improve their health and well-being by tracking their physical activities.

Modern mobile phones contain features that are highly useful for mHealth applications. A mHealth application is defined as using mobile communications for health services and information (Akter & Ray, 2010). For example, Migraine Buddy[1] is an application to track migraine headaches and helps users record and identify migraine triggers. Data such as tracking health-related activities, physiological states, symptoms, and other health-related can be used in many ways. And it can provide benefits including increase desire for healthy behaviors or decrease the frequency of the undesired behavior. A user of tracking applications rarely manages to keep up with using the application for a long period. (Klasnja & Pratt, 2012) This might be the reason why the number of user downloads of mHealth applications is growing slowly as reported by Research 2 Guidance on 2016[2].

[1] http://www.migrainebuddy.com/

[2] http://research2guidance.com/product/mhealth-app-developer-economics-2016/

Gamification is to add game-like elements into a non-game application to improve user experience (UX) and user engagement (Deterding et al., 2011). It is a potential method to increase the usability of an application. However, if the services offered by an application are different from a user's goal that is connected to the interest or passion of the user, adding gamification elements might not have a positive effect on the usability (Groh, 2012). Usability is "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use" (ISO 9241-11, 1998). Lister et al. (2014) address that true benefits of gamification on mHealth applications are not clear and there is a need for further research. Therefore, this thesis deals with the question "How gamification elements can be included in tracking applications to improve their usability?".

The question is studied in three phases. The first phase is to understand the problem domain and the practice of implementing gamification into mHealth applications. Generally, the literature is divided into three groups: usability, mHealth applications and gamification. The background knowledge of usability and mHealth applications is reviewed. In the reviewed literature, a usability issue was identified for tracking applications. The issue arises from the repetitive tasks that tracking applications contain. Gamification is an interesting method to convert the repetitive task into more engaging ones (Martí et al., 2012). Although there were many articles about gamification and mHealth applications, the impact of the gamification implementation on the usability of mHealth applications was not thoroughly discussed in those articles. Therefore, it has been decided to develop a tracking prototype with gamification elements to evaluate their usability, which forms the second phase of the thesis. The thesis author implements gamification elements into the application and evaluates and tests gamification elements. The third phase is to analyze the usability of the gamified prototype. To achieve it, interviews are conducted to collect comprehensive information and feedback from users on the use of the prototype. The interview provides a solid basis for analysis of the usability of the prototype.

2. Mobile Communications based healthcare (mHealth)

Health services are not accessible or affordable in the developing world. They are often dysfunctional, low in quality, and unresponsive to the needs of clients. Mobile communications based on healthcare (or mHealth) can change healthcare services by providing the correct information to a specific person at the right time. Phones facilitate the healthcare service delivery around the world by improving the health services and changing overall patient care. It is an interactive and personal service and the goal of it is to provide ubiquitous access to medical information and service to any users at any time over mobile phones. Akter & Ray (2010) suggest that "a mobile platform is the newest mass media based on some unique attributes which can be leveraged to empower patients and healthcare service delivery" and report that "mHealth alone has all the potentials to automate and speed up healthcare delivery processes, reduce costs, facilitate service delivery, relate more closely to their patients and offer them more convenience and appeal to this new service". (Akter & Ray, 2010)

The mHealth is an umbrella term that covers many areas, namely, networking, mobile computing, medical sensors or other communication technologies within healthcare (Liu et al., 2011). Currently, two major platform providers have centralized application stores, and they are Apple Store and Google Play. Apple Store classified applications into twenty categories and mHealth applications are distributed in categories of Medical or Healthcare & Fitness. Additionally, Microsoft with Windows mobile OS family and LiMo Foundation with Linux Mobile operating system provide mHealth related applications. mHealth applications have features of remote data collection, remote monitoring, and improved living standards for patients (Akter & Ray, 2010). Researchers and developers use technical capabilities of mobile phones to develop varieties of mHealth applications. Some applications are relatively unsophisticated while others are more complex in terms of strategies or technologies implementation. Many applications developed to help users gather and familiarize and manage their behavior or activities such as weight management or recovering from alcohol or drug addictions (Patrick et al., 2008). Studies suggested that these mHealth applications provide positive effects on users' health (Klasnja & Pratt, 2012). The categorization of mHealth applications given

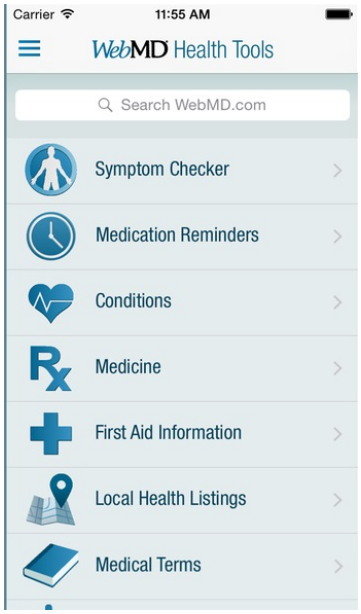
by the study of Liu et al. (2011) is listed below. In this categorization, mHealth applications are divided into seven categories, as follows.

Drug / medical information database applications provide information such as shape, function, color, and code about drugs or other medical information in the application's database (Liu et al. 2011). For example, WebMD[3] is an application that helps people check their symptoms, treatment information, access drug information, and first aid essentials. It consists of five components that are symptoms, conditions, drugs and treatments, first aid information, and local health listing. WebMD helps the user to create and sustain healthy habits by connecting to sensors such as an activity tracker, a blood pressure monitor, a glucometer. A user can collect all information from these sensors and the application can give insights about their conditions. Figure 1 (a) shows the services such as symptom checker, medication reminders, conditions, medicine, first aid information, local health listing, and medical terms.

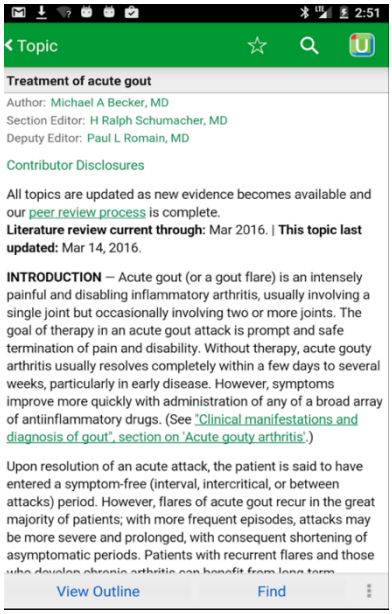
Medical information reference applications provide medical information such as medical articles or websites or journals (Liu et al. 2011). For example, UpToDate[4] is an application designed for medical students, medical professionals, or a person interested in medical articles. It gives information about medical advancement or news and provides headline news, videos articles about new medical information or the user can search for medical information. Figure 1 (b) is the screenshot of the application showing information regarding treatment of acute gout.

[3] http://www.webmd.com/

[4] http://www.uptodate.com/home

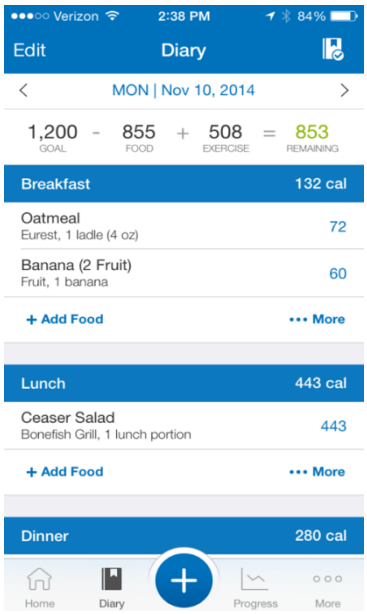


(a) The initial screen of WebMD for Android application version 4.2.

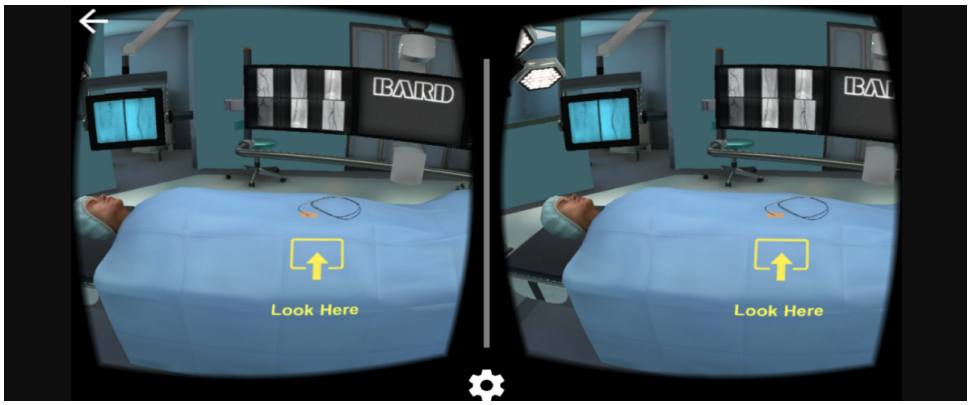


(b) The treatment screen of UpToDate for Android version 2.22.1.

(c) The home screen of Migraine Buddy version 23.7.2.



(d) The initial screen of Calorie Counter – MyFitnessPal version 7.16.



(e) The surgery screen of Bard VR version 2.0.0.

Figure 1: The screenshots of mHealth applications.

Decision support applications are designed for medical professionals such as physicians, surgeons, and nurses to giving professional information toward a medical condition (Liu et al. 2011). For example, Migraine Buddy[1] is designed by neurologists and data scientists to track migraine headaches. This application helps users with migraines to record and identify triggers, symptoms, medications, frequency and duration, pain intensity and location, and other lifestyle factors so users can improve their migraine condition. Figure 1 (c) shows how many days the user is a migraine free.

Educational tools applications are designed for students or other people who want to learn about medical science and it has educational purposes (Liu et al. 2011). UpToDate[4] is also an educational application and to provide medical students articles, videos, or other medical information.

Tracking tools applications are designed to track data such as diabetes factors, blood pressures, food calories followed by the visualization of metrics (Liu et al. 2011). Calorie Counter & Diet Tracker from MyFitnessPal[5] is an example focusing on tracking diets and workouts. This application tracks information such as user's diet, weight change, and workout to help people stay healthy. In this application, there is a food database for checking the calories or other metrics of the foods and it has the largest food database of over 5,000,000 foods. Calories breakdowns are updated with user's input that is the number of calories gained by foods or consumed by workouts. Tracking data of this applications are calories, fat, protein, carbs, sugar, cholesterol, and more. Figure 1 (d) represents the number of calories gained by foods (855) and reminding calories and each food consumed throughout the day.

Wearable fitness trackers are applications using wearable devices for tracking data. They are gaining more popularity because of their ambient gathering and analysis of data for customers looking to improve their health (Asimakopoulos et al. 2017). For example, FitBit[6] is a wearable fitness trackers application for tracking all-day activity, workouts, sleep, and heart-rate.

Medical calculator applications provide information about medical calculations, equations, and algorithms (Liu et al. 2011). For example, Medical Calculator[7] is a medical

[5] http://www.myfitnesspal.com

[6] https://www.fitbit.com/iphone

[7] http://www.qxmd.com/

calculation application that provides the calculation of the ideal body weight or formula used in echocardiography or other medical calculations.

Besides, there are other types of applications such as applications about eye charts, medical images, color test tools and timers. For example, Bard VR[8] is a medical application using Virtual Reality (VR) technology to take the user to a virtual catheterization lab and do operations in virtual place. This application brings an innovative and unique way of thinking of using VR technology into future medical applications. Figure 1 (e) shows the screenshot of the application and the two pictures simulate the 3D effect of VR technology.

Based on a report conducted by health research group Research 2 Guidance on 2016[2], the number of mHealth applications increases by 100,000 in 2016, a 57% increase over 2015. The number of health applications in 2016 is estimated to be 259,000 and the majority of new applications are published for iOS platform. The report says the growth is based on three main factors, and they are the growth in the number of mHealth publishers, the increased of multi-platform applications, and the expansion of mHealth application portfolios. In addition, it is mentioned in that report that the growth of user downloads is slow and only a 7% increase from 2015 but the report does not give any reason for slow growth of the downloading number.

[8] https://www.raindropagency.com/

3. Gamification

The term gamification was introduced in 2008. It means the use of game design elements in nongame contexts. In other words, gamification is adding technologies and game-like elements, rewards, motivation into a non-game system or application. (Deterding et al., 2011) Gamification is used in plenty of applications across different domains such as productivity, finance, health, education, sustainability as well as news and entertainment media (Groh, 2012). It can be used in commercial or academic applications to influence the user behavior to strength the desire of healthy behaviors or decreases unhealthy behaviors such as discouraging smoking (Lister et al., 2014). Gamification is a different concept from serious games. The term serious games used to describe full-fledged games to achieve changes in the player such as changes in attitude, knowledge, physical ability (McCallum, 2012) while gamified applications just use of game elements in applications (Groh, 2012).

As Groh (2012) stated, the commercial aspect of gamification mainly differs in two concepts: To increase acceptance of games in everyday life and to promote the motivation of users to be engaged with applications. Gamification increases engagement by providing game elements because they are fun (Rigby, 2015). The game designer Raph Koster (2005) said: "Fun from games arises out of mastery. It arises out of comprehension. It is the act of solving puzzles making games fun. With games, learning is the drug". Solving the mathematic equation in games is fun for people while simultaneously it is not considered as a fun activity in schools (Groh, 2012). Gamification is an effective approach to increase user's motivation and engagement (Morschheuser et al., 2017) and is a popular subject for academic studies (Hamari et al., 2014).

3.1. Gamification Elements

Gamified applications use the game elements in applications (Groh, 2012). Table 1 shows various gamification elements from the work of Reeves and Read (2009), Hamari et al. (2014) and Lister et al. (2014). In Table 1, gamification elements in the same row have the same definition or they are connected to each other. The elements discussed in the work of Reeves and Read (2009) cover the elements addressed by the other two articles. Therefore, they are described in the following subsections. The story element is identical

in Reeves and Read (2009) and Hamari et al. (2014). However, the feedback element branched into points, leaderboards, feedback, progress elements and the ranking element branched into achievement and level elements. In addition, the competition element changed into the challenge elements and the marketplaces and economies element changed into the reward element. The competition element is identical in Reeves and Read (2009) and Hamari et al. (2014). The ranking element altered to the level element. The marketplaces and economies element branched into digital rewards and real-world prizes elements and the team element changed into social and peer pressure elements.

Reeves and Read (2009)	***Hamari et al. (2014)***	***Lister et al. (2014)***
Self-representation with avatars	-	-
Story	*Story*	-
Three-dimensional environments	-	-
Feedback	*Points*	*Leaderboards*
	Leaderboards	
	Feedback	
	Progress	
Ranking	*Achievements/Badges*	*Levels*
	Levels	
Marketplaces and economies	*Rewards*	*Digital rewards*
		Real-world prizes
Competition under rules that are explicit and enforced	*Challenge*	*Competitions*
Team	-	*Social or peer pressure*

Table 1: Gamification elements listed on Reeves and Read (2009), Hamari et al. (2014), Lister et al. (2014) articles.

Groh (2012) mentioned, "if one of these elements are common in one type of game, it could be very unlikely to be found in another kind of game, e.g. avatars and levels are

usually in adventure games but there are rare in real-time strategy games". Gamification elements are expensive to produce and develop in general (Reeves & Read, 2009). Reasons given for the difficulty in gamification elements' development by the research of Morschheuser et al. (2017) are: (1) "The source of innovation; games, are complex, multifaceted, and therefore, difficult to holistically transfer to other environments", (2) "gamification involves motivational information system design which entails understanding a host of (motivational) psychology", (3) "the goal of gamification is commonly also to affect behavior which adds yet another layer into the scope of gamification design". It has been suggested by Reeves & Read (2009) that it would be more efficient to develop gamification elements by smaller batches or by developing only one gamification element at a time. The following subsections are focusing on gamification elements in mobile applications especially in the health domain.

3.1.1. Self-representation with avatars

People have become more actively involved in representing themselves with virtual characters or avatars (Kim, 2010). Avatars are comparable with a puppeteer; users control a personalized character reflecting the user's stand-in within the application. Avatars are customizable in appearance, size, gender, facial feature, dress, and roles they perform. (Reeves & Read, 2009) Therefore, they represent people, gender, race, age, dress, emotional expression and they are available visually and instantly. There is no real-life counterpart to an avatar. Avatars allow users to create and build their own identities in online communities such as video games and virtual environments (Kim, 2010). With avatars, users are not standing outside of the application. They are in the scene and part of the application and can virtually speak to and interact with others. User's interactions with avatars would change next situation of the application. For example, a game story could change when the user feeds his/her avatar. (Reeves & Read, 2009)

The biggest advantage of avatars is the freedom of the physical appearance. With avatars, people communicate with each other without revealing their real physical appearance. (Kim, 2010) Avatars are easy to use once users figure out how to use buttons to interact with the application. This learning process makes avatars more engaging. Much of the human's memory is parsed by how they remember people's attributes. With avatars, users remember attributes such as faces or bodies and the variation of the different body or

facial parts are more apparent. Avatars help to identify and keep tracks of crucial social information of users such as expertise. There is evidence from a result of Stanford University lab that engagements of people with avatars are substantial, even if unconscious, the avatar can dramatically change how people experience media. (Reeves & Read, 2009)

For example, Habitica: Gamify Your Tasks[9] is a tracking tool application. Its objective is to treat the life of users like a game. Users track tasks such as a routine in their life and the application provides rewards for completing tasks. As shown in Figure 2, the avatar is represented by a picture on the top-left corner with attributes such as health status, experience level, the amount of gold, silver and diamond that the avatar possesses and the level of the avatar. Users create an avatar and add tasks such as go to a gym and daily readings. Users can select tasks to be positive or negative. Positive tasks increase avatar's experiences and gold while negative tasks reduce the avatar's health. Tasks are divided into three types: Habits, Daily, To-Dos. Habits are tasks that are accomplished continuously. Daily are tasks that are accomplished once per day. On the other hand, To-Dos occur only one time. With enough experience, players can level up their avatar and that would unlock some features of the application such as drop rate system (a small chance to drop items upon completing tasks). Beside avatars, Habitica is using elements such as the ranking element (Section 3.2.5), the marketplaces and economy element (Section 3.2.6). The ranking element is the level of the avatar. The avatar gets level upon receiving enough experience status. There is a reward system (the marketplaces and economy element, Section 3.2.6) that with collected golds, players can buy equipment for their avatar. The rewards can be in-game rewards or custom real-world rewards made by players. The avatar image updates by accomplished tasks or buying new rewards. To summarize, the avatar helps users by visualization of rewards or accomplished tasks. The avatar provides users a vivid vision about their goals and achievements in the application.

[9] https://habitica.com/static/front

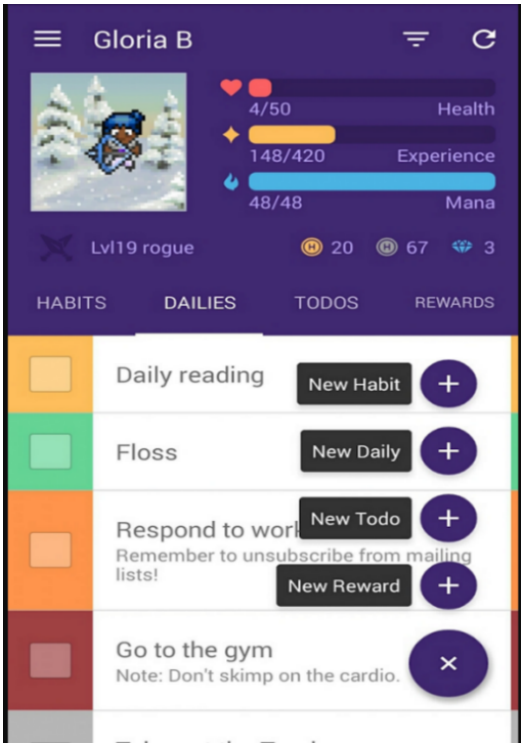


Figure 2: The initial screen of Habitica: Gamify Your Tasks version 1.0.4.

3.1.2. Three-Dimensional Environment

The three-dimensional (3D) environment is an environment user interact with the game and it has physical properties or rules such as gravity that is close to the real world. A virtual world close to the real world is effortlessly understandable because the physical rules such as time, gravity and distance are familiar to users. (Reeves & Read, 2009) Designers create a virtual world that is explorable by users (Nicholson, 2015). They can create virtual 3D environments with rich details. Three-dimensional environments made by rendering 3D graphical objects into a 2D screen similar to a perspective drawing on a (2D) paper that simulates depth (Reeves & Read, 2009). In a three-dimensional environment, avatars can be represented by three-dimensional representations (Sailer et al., 2017).

Three dimensional environments allow people to understand the virtual space in the same way as the real world. Users have a sense of immersion as they are trying to move the avatar through the virtual space. Places have meanings same as the real world. Users easily remember the location of objects or avatars because they can organize their virtual environments (e.g. offices, living rooms in the application). (Reeves & Read, 2009)

Three-dimensional environment can be used in simulation (such as flight simulation) applications (Groh, 2012). As shown in Figure 1 (e), Bard VR[8] is an educational mHealth application with the three-dimensional environment element. It shows a 3D environment that users can explore and do surgeries on it. A 3D environment helps to educate students about medical surgeries with the virtual reality technology by providing users a virtual operating room. Also, users get acquainted with new medical devices represented by 3D objects.

3.1.3. Story

"A story can be communicated by a game's title or by complex storylines typical of contemporary role-playing video games" (Sailer et al., 2017). Stories are important for thinking, emotional experiences, and social expertise (Reeves & Read, 2009). Stories supply a meaning beyond the mere quest for points and achievements (Kapp, 2012). In games, stories are usually created by the design team (Cheong et al., 2013). People like to hear and tell stories to each other and they know their relative roles to others. They know how their current activity fits together. They know how pieces of a story that are linked to their action in a game are linked. This makes it easy to understand why they are doing something right now as well as making people eager to find out how 'what they are doing' will affect what happens next. Usually, stories contain conflicts and people focus on the story until conflicts are resolved and this keeps players tuned in. (Reeves & Read, 2009) Also, stories in applications used by wrapping a story around an activity with suitable visuals (Groh, 2012). Therefore, stories can change the meaning of real-world activities (Sailer et al., 2017)

Several psychological advantages can be gained from stories to keep the user engaged. Game stories are designed as an unfinished framework where players complete it by living in it. Why are good stories important? Because they provide excitements or tensions while sustaining the involvement of users also focuses on the user's resolution. Stories might contain uncertain circumstances or situations. This uncertainty flows with the story to arouse users physically as well as mentally. "Hearts beat faster, skin becomes moist, and brain centers that regulate emotion slowly increased activation, especially during those times when uncertainty about outcomes in highest". In addition, stories influence user's memories. Memories provide a sense of control over the information and

remembering information is easier when it is in a narrative format rather than a random order. (Reeves & Read, 2009)

For example, Burn Your Fat with Me!![10] is a tracking tool application using the story element. As shown in Figure 3, the application contains a visual novel that is describing the story to users with arts and voices. Players advance the story by clearing fitness goals such as performing ten sit-ups. The story of the application is about the relationship with the player's childhood friend. Users track their fitness level such as push-ups, squats and the application's story continues after progress in fitness. This story increases user's motivations for working out.

Figure 3 The screenshot of Burn your fat with me!! version 5.1.3.

3.1.4. Rankings

[10] http://nensho.net/nensho/index_en.html

For centuries, rankings have been used to change user's behaviors (Nicholson, 2015). For example, soldiers were ranked up for their achievements. Users have ranks available for public and hard to spoof. They are comparable to a spreadsheet that has users as their rows and metrics such as health, mana, experience as their columns and continuously synchronize rows and columns in time intervals of seconds, minutes, hours, etc. Ranks show the user's current state such as competencies, talents, achievements, and special experiences in the game hierarchy. (Reeves & Read, 2009) Ranks shall be accurate, up-to-date, and accessible to every user.

Digital ranks such as ranks of sellers in eBay[11] are user-friendly and influential in an online commerce (Reeves & Read, 2009). Users might leave the application if they acknowledge ranks do not present benefits or meaningful content (Groh, 2012). For example, stackoverflow[12] is a website for the purpose of questions and answers and it has a meaningful content even after removing the ranking system. Users have a desire to possess rankings and more importantly display their possessions. Virtual worlds are more transparent than the real world because the application's interface and design contain more information in virtual worlds. Rankings shall be designed to be transparent and not cheatable or at least difficult to cheat so the game would be trustable. In some applications, a system is designed behind the scene seeking cheaters who demand to achieve ranks unfairly. (Reeves & Read, 2009) The communication between people is established based on the common ground in a conversation and it is important to connect users to a meaningful community with the same interests. Ranks are cited common ground. Therefore, they accelerate social interactions. Many applications use gamification as a software service layer of ranking systems. (Groh, 2012) For example, Fitocracy-Fitness Community & Personal Coaching[13] is a tracking tool application incorporating social and rank aspects. After completing an exercise, users receive badges and achievements. In Figure 4, the user received the Top Of The Bar achievement and it means the user performed 5 pull-ups in a single set successfully. Achievements depict the user's rank. Achievement systems increase user's motivations for fitness by users

[11] www.ebay.com

[12] http://stackoverflow.com/

[13] https://www.fitocracy.com/

demand better achievements. Each user has a level and they can level-up when they are accumulating enough points.

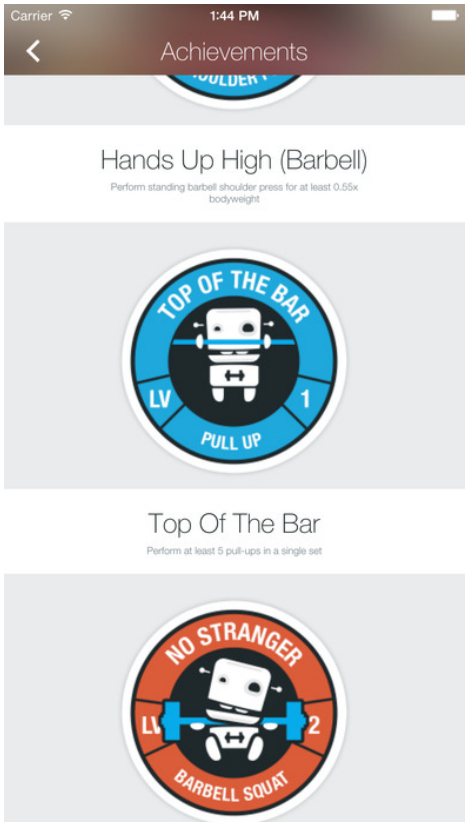


Figure 4: badges and achievement system in Fitocracy-Fitness Community & Personal Coaching version 3.5.3.

3.1.5. Team

Teams are defined as forming groups of users working together towards a shared goal (Sailer et al., 2017). The popularity of games using teams in multiplayer games as a gamification element is more compared to solo games. The era of multiplayer games has been started with games over local area network (LAN) allowing players to connect game consoles only with a limited number of people. After LAN with a ubiquitous and affordable network, most top-selling video games nowadays allow team experience to engage or against with other players. (Reeves & Read, 2009) Teammates, whether real players or virtual non-player characters (NPCs), might induce conflict or competition or cooperation (Kapp, 2012). Users of the application might have a conflict with another one after they spend times to learn application's mechanics and it makes the application more engaging. Competitive systems encourage some people to put more effort into the

system to do better than others, or they can discourage others. However, cooperative systems are about bringing players together. “These systems can tap existing friendships and social networks to encourage players to recruit others whom they already know, and allow friends to work together as a team in the system”. (Nicholson, 2015) Games try to engage interactions between players such as yelling at other players or showing a specific personality. The subjects of team conversations are usually the game or experiences of the game. However, games create an environment that is enjoyable for other conversations. These conversations create a social bond and keep players engaged with each other. (Reeves & Read, 2009)

For example, Keas[14] is a tracking tool application using teams. The user monitors their fitness and dietary goals, and earn new badges upon completing them.[14] Keas has many gamification elements including leaderboards, points, and team challenges. As shown in Figure 5, a user can join a team to solve team challenges and they have a team ranking. Team challenges are tasks such as eating less and completing them increase team's challenge points. Team rankings are based on challenge points. Team ranks would increase user's motivations toward fitness program by providing enthusiastic feelings for having a better rank.

[14] https://itunes.apple.com/us/app/keas/id432425118?mt=8

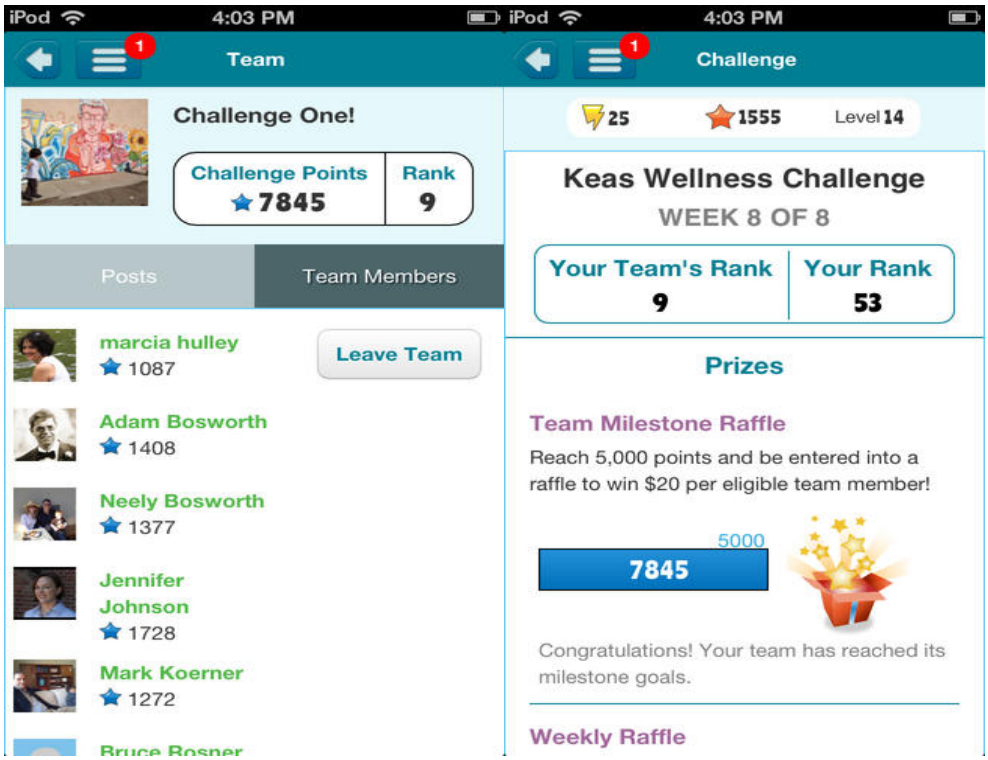


Figure 5: Team and Ranking system in Keas version 1.5.3.

3.1.6. Marketplaces and economies

A synthetic currency and marketplace is one important feature of multiplayer games. Currency systems allow users to trade in the same way as the real world. Most trades are for application-relevant objects such as a sword for the avatar. In addition, information such as tag ideas, or auction resources can be the source of trades. Researchers disclosed trading virtual currency affects the brain in the same way as real money. Game economies increase the player's motivation to play the game. (Reeves & Read, 2009) It is essential for users to have a sense of autonomy in the virtual world. Therefore, if players perceive they receive conditional rewards, meaning if a condition triggers then a reward appear, they might contemplate that they are being controlled and losing their autonomy which leads to a de-motivating experience of the application (Groh, 2012). Many applications use economic systems with a virtual currency system. For example, the currency system in Habitica: Gamify Your Tasks[9] contains golds, silvers, and diamonds (that are 20, 67, 3 respectively in Figure 2). Completing tasks provide currencies that allow users to buy or sell rewards. For example, the reward can be a sword that can customize the user's

avatar. The currency system increases user's motivations same as in the real world by providing items to buy or sell and as it is mentioned because the virtual economic increases motivations.

3.1.7. Competition under rules that are explicit and enforced

The works of Reeves & Reads (2009) mentioned that players play to win the game because it feels good to win. They also mentioned that explicitness of competitions is under-rated and fundamental aspect of games that can help non-games applications. Competitions can encourage some people to put more effort into the game to do better than others, but it discourages others (Nicholson, 2015). Rules are required for competitions. Game rules are the fundamental ingredient allowing competitions to work properly. Gamers swiftly accustom to the game rules as they follow them. Discovering of the rules is an entertaining part of games. Once the rules are discovered, it makes the game trustworthy and players identify winning conditions. However, there aren't many rules to be discovered in applications. Players know they can control a game as they oversee it even if they believe their actions in the real world are guided by fate, luck, or other external circumstances. It is psychologically healthy to believe in the internal control over actions. Because people don't want to think that with their best efforts other factors determine their success. There is good evidence that internal orientation that means people believe their actions are caused by their personal decision can be thought by games. (Reeves & Read, 2009) For example, the competition system between teams in Keas[14]. Each team in this application has a rank (Figure 5) which makes teams compete for having a better rank that leads to increasing user's motivations. Each team has a score (challenge points in Figure 5) and when users accomplish tasks, they increase their team score.

3.1.8. Feedback

A feedback system for people to track their progress is one of the main components of games (Matallaoui et al., 2017). Feedback is a set of progress bars, numbers, statuses, etc. in a well-organized dashboard that clarifies being acquainted with users' current state of the game. For example, a number indicating the health of a player, the time left before an

attack, number of acquired golds. Users learn if an action is right or wrong from derived feedback. Feedback is highly valuable for a person who wants to progress. Users constantly seek positive reinforcement and receptive to negative feedback. (Reeves & Read, 2009) In contrast to real-life, users have the possibility of getting feedback at any given time (Groh, 2012). Therefore, time scales of the feedback can be contrasting. Time scales can be in seconds, minutes, hours, days, weeks, or months. Beside different time scales, the feedback can be given from multiple sense and signals. (Reeves & Read, 2009) For instance, the health updates when a signal happens.

In psychology, one of the most enduring principles is feedback changes behavior. The feedback often effects in terms of control. For example, a boss can influence performance by issuing the right feedback (positive or negative) at the right time. People who receive this feedback are viewed as passive participants (Reeves & Read, 2009) because they do not know they are being monitored. Constantly giving a personalized feedback to user's activities improves the system engagement and raises the user's motivation (Amriani et al., 2013). Feedback can be given by another user or from a computer-controlled (Artificial Intelligence) character that is programmed to give feedback. In both cases, the feedback is called extrinsic and it means it came from the social actor. Another form of feedback is intrinsic rewards, as Reeves & Reed (2009) mentioned: “Intrinsic rewards are primitive, unconscious, and can have physical consequences”. For example, a small success in the game can cause dopamine release in the brain that acts as a powerful stimulant and increases the possibility of similar actions. (Reeves & Read, 2009)

For example, Super Better[15] is a tracking tool and decision support application. The purpose of this application is to improve moods and reduce anxiety and depression.[15] As shown in Figure 6, users receive quests or power-ups. Quests are preformed tasks by users such as quit caffeine. Users have four attributes: Physical, Mental, Emotional, Social and they are shown with red, yellow, blue, purple colors respectively in Figure 6. Users collect relevant attribute’s points from accomplished tasks. For example, drinking a glass of water boosts Physical and Mental attributes. Figures and numbers showed in Figure 6, is the feedback element. As it is described by Reeves & Read (2009), the

[15] https://www.superbetter.com/

feedback would release dopamine in the brain that causes raising user's motivations for using the application.

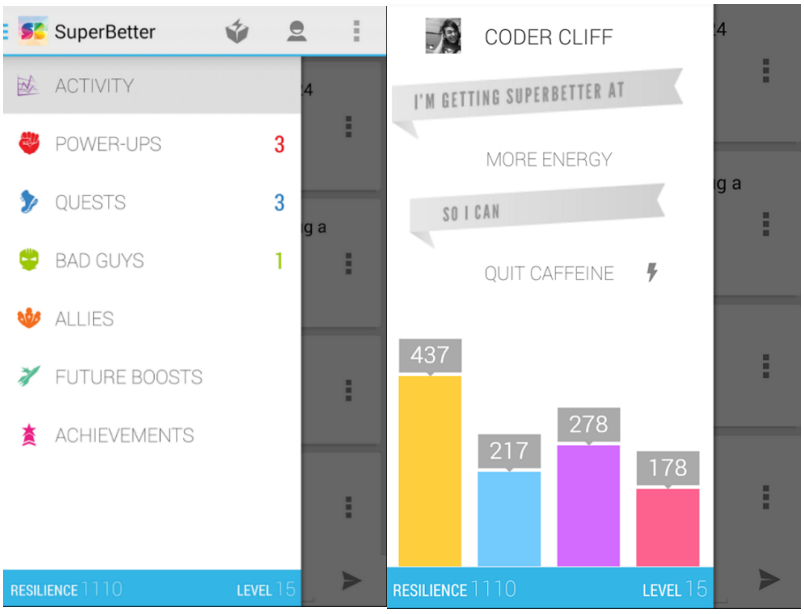


Figure 6: Power-Ups and Quests in Super Better version 1.1.2.

3.2. Gamification in mHealth applications

An analysis of gamification elements used in mHealth applications was conducted among top 50 applications in Apple App Store in the Health & Fitness category[16] in 2017. 70% of the applications contain at least one gamification element. 14% of the applications contain the self-representation with avatars element. 2% of the applications contain the three-dimensional environments element. 54% of the applications contain the feedback element. 24% of the applications contain the ranks element. 9% of the applications contain the competition under rules that are explicit and enforced and 6% applications contain the team element. The marketplace and economy element and the story element are not visible in the applications (0%). (The top 50 applications with their gamification elements are listed in Appendix A.)

Gamification has been used in many mHealth applications. Lister et al. (2014) estimated that gamification elements are visible in 60% of health initiatives and the use of

[16] https://itunes.apple.com/us/genre/ios-health-fitness/id6013?mt=8

gamification in mHealth applications is increasing over the time. Gamification is effective at increasing popularity of the applications. (Lister et al., 2014) Knowingly or not, video games developed to motivate user's behaviors (King et al., 2013). The behavioral intervention is “interventions designed to affect the actions that individuals take with regard to their health”. Changing personal behavior is the key and goal of the behavioral intervention. (Bulatao et al., 2004) There are two types of behavioral changes, long-term behavior changes and short-term behavior changes. Short-term behavioral changes behaviors of a user for a short period and it is a temporary change. On the other hand, long-term behavioral changes are permanent ones. Temporary effects of gamification might help healthy behaviors, but they are not sustainable. Health professionals are researching how to change behavior with gamification or with other methods. (Lister et al., 2014) However, this behavioral change can cause an effect known as overjustification. Overjustification means “intrinsic motivation is shifted towards the extrinsic incentives” (Lepper et al., 1973). An example of it found on one of the studies that children will draw more low-quality pictures if they are paid for it and after they had stopped being paid, they did not like drawing pictures as much as before. Similarity the overjustification effect can be caused by using points, badges, and leaderboards on everything. (Groh, 2012) Therefore, the motivation needs to be more intrinsic.

4. Usability

There are principles a mobile application should follow to improve the user interface (UI) and the user experiences (UX) given by the application's provider. However, it is difficult for users, health professionals, and researchers to assess the quality of mHealth applications, due to the reasons that (1) mobile applications are in a rapid proliferation, (2) little information is available for the application's quality, (3) application's reviews on the retailers' web page are subjective by nature and may come from unreliable sources. (Stoyanov et al., 2015)

4.1. Definition

Usability is “the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use” (ISO 9241-11, 1998). It refers to multiple concepts such as performance, user satisfaction, and ease of learning. The usability has not been defined consistently either by researchers or others (Abran et al., 2003). Different systems have been developed to assess the usability of mHealth applications such as the mHIMSS system from Health Care Information and Management Systems Society (HIMSS). This system consists of guidelines to evaluate the usability of mHealth applications. These guidelines have different usability's criteria with “Strongly agree” to “Strongly disagree” scale points to rate each criterion. The issue of this system mentioned by Stoyanov et al. (2015) is “no criteria for rating information quality were included”. However, in this thesis, two systems that are Mobile App Rating Scale (MARS) system and Jakob Nielsen's Heuristics for evaluating the gamified prototype's usability are adapted. Because in other systems attempting to evaluate criteria for the mHealth application's usability are often either too complex or specific to a health domain, it might make the evaluation scheme more complex and time-consuming or unrelated to the evaluating application. (Stoyanov et al., 2015)

4.2. MARS System

Stoyanov et al. (2015) developed a system for the usability assessment of mHealth applications, MARS. The MARS criteria were clustered into five subscales: engagement, functionality, aesthetics, information quality, and subjective quality. Stoyanov et al. (2015) conducted a literature search for articles between 2000 and 2013 containing the web or app quality rating criteria. Extracted criteria were refined into twenty-three items[17] and they are categorized into the following subscales. (Stoyanov et al., 2015) Also in the MARS system, there is an App-Specific section that contains items concerning health behavior changes. However, the objective of this thesis is to analyze the usability of tracking application and it is not focusing on behavioral changes. Therefore, this section has been excluded. The description of each MARS items and their relevance to the research questions with their evaluation scales are given in the following subsections.

4.2.1. The Engagement Subscale

Engagement is to voluntarily use application that involves multiple interactions and each one spanning for longer than a few minutes (Febretti & Garzotto, 2009). Chapman (1997) mentioned that "something that 'engages' us is something that draws us in, that attracts and holds our attention". Engagement is a dimension of measuring fun of a system (Read et al., 2001). It is influenced by the enjoyment users derived from using an application and their first impression of it. (Quesenbery, 2003) In the MARS system, the engagement subscale includes items relevant to entertainment, interesting, customizable, interactive and well-targeted aspects of the application. They are discussed as follows.

Entertainment measures if an application is engaging and pleasant to use. The entertainment of an application could be enhanced by properly adding extra components such as gamification, well-designed graphics, videos or other different activities. The entertainment component shall be given at the right time and shall match the proper functionality of the application and the users' goal. For example, Ray's Night Out[18] is an application developed by the Queensland University of Technology that is designed to

[17] http://mhealth.jmir.org/article/downloadSuppFile/3422/14733

[18] https://itunes.apple.com/us/app/rays-night-out/id978589497?mt=8

educate people about alcohol and teaches safe drinking strategy and alcohol abuse. As shown in Figure 7, the application contains entertainment components such as gamification and abundant graphical design making the application more entraining and not stigmatizing. The gamification elements implemented in this application are feedback, avatar and marketplaces.

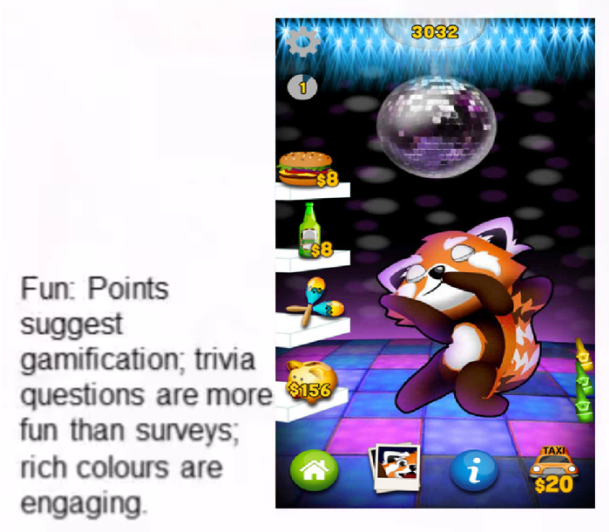


Figure 7: Entertainment components in Ray's Night Out application.[18]

Interest measures how interesting application is and does the application use any strategies to increase user engagement by presenting the content in an interesting way. To distinguish between entertainment and interest items the following example should be considered. A documentary about cancer might be very interesting while it is not entertaining. The interesting component can be improved by replacing texts in the application with animations or images or sounds.

Customization explores whether applications could be modified to suit user's preferences. Generally, the majority of applications provide customizable settings such as sounds, color customization, timer, alarm settings, etc. However, some applications are more customizable by providing extra settings that are not essential for the basic functionality of the application. For example, a music application can provide additional settings such as adjusting sound volume, random shake, auto lock and sound animation that improve the customization component.

Interactivity measures the application's features such as allowing user input, providing feedback, containing prompt, etc. Customization measures application's settings while interactivity measures application's features. For example, a fitness application might provide a variety of features such as the in-app community, allows sharing with others, has nutrition information. Features increase the engagement by enabling users to select the options they enjoy. It is valuable to allow customizations.

Target group evaluates the target audience of the application. It is important to measure who is the target audience and how they affect the application. For example, an application with a complex language might be irrelevant to young people because it is undesirable for them. Some applications such as Facebook[19] is designed to be appropriately used by any generation.

4.2.2. The Functionality Subscale

Functionality is an aspect of the system's evaluation and it measures the usefulness of features, maintainability, and reliability of the system (Mcnamara & Kirakowski, 2006). Functionality can determine the usability and a system is not usable if the provided functions do not match task requirements. Providing extra functionality is not enough, users must understand how to use functions and what they do. (Goodwin, 1987) In MARS, the Functionality subscale includes items related to application's functioning, easy to learn, navigation, logical flow, and gestural design.

Performance measures how accurately and fast application's functions and components (such as buttons or menus) work and if the application works overall. Application's functions shall work properly and therefore users will be satisfied with the application. Also, the response to user's request shall be fast.
Ease of use measures how easily users can learn to use the application. Application's menus, labels, icons, or instructions shall be apparent and concise to users. Also, applications shall provide proper tutorials. The workflow of applications shall be modified to improve the ease of use item.

[19] https://www.facebook.com/

Navigation measures if moving between screens is logical, accurate, appropriate, and uninterrupted. It measures if all the screens link correctly and if the application prevents users from a proper access. For example, ReThink[20] application in Figure 8 contains no register button to register users. Therefore, it doesn't allow new users to use the application.

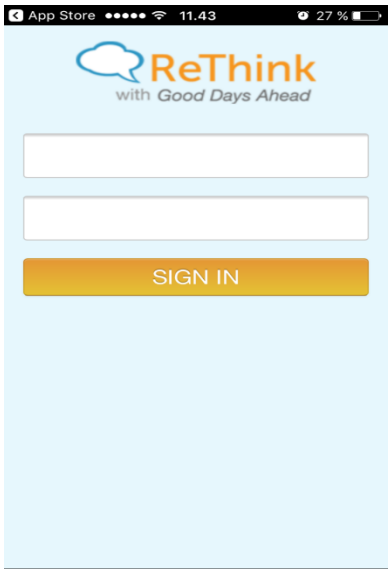


Figure 8: Navigation example. There is no register button in ReThink application.

Gestural design measures if user's gestures or interactions are consistent and intuitive across all components or screens. The developer of applications provides the opportunity for expanding user's gestures such as taps, swipes, pinches, and scrolls within the application. Developers can also create a new gesture such as triple taps on a button.

4.2.3. The Aesthetics Subscale

The Aesthetics subscale generally focuses on the visual appearance of applications. Items are related to the graphical design and overall visual appearance of applications. Additionally, it measures application's colors and styles.

[20] https://itunes.apple.com/us/app/rethink/id634531935?mt=8

Layout measures accessibility and appropriability of application's components such as buttons, icons, menus, contents. The components shall be accessible, appropriate and zoomable if needed. For example, a button in the application that is not clickable or not appropriately represented icons shall be modified within the application to improve this item.
Graphics is mainly evaluating the resolution of applications and the graphics used for buttons, icons, menus, content. Also, the professionalism of the application's design. The application's resolution shall be selected appropriately. The design and components of the application shall be appealing to users and professionally selected.
Visual appeal mainly measures the colors of applications and whatever colors look appealing. Colors are the important aspect of applications and need to select carefully to represent and correct the content. Many color scheme patterns exist for designers and shall select the appropriate one.

4.2.4. The Information Quality Subscale

The Information subscale focuses on high-quality information (e.g. text, feedback, measures, references) from a credible source. It measures items related to the accuracy of the application's description or information and credibility of the information. Additionally, it measures the application's goals and quality or quantity of information.

The accuracy of application's description measures if the application contains what it is described. The description of applications could be inaccurate or misleading. They could make promises that the application is not capable of achieving. Outstanding descriptions would contain quality information of the application, legitimately explaining components of the application, information about the developers and where to get supports when a problem encountered.
Goals measure the application's goals and if they are achievable or contain proper components to achieve them. Applications need to have a specific goal (or multiple goals) that is measurable and achievable. The goal needs to be specified with the description in the application store or within the application.
The quality of information measures if the information that the application provides is relevant, competent, appropriate and not potentially harmful to users. The application's

content shall be corrected and well-written. Additionally, it needs to be relevant to the application's goal or topic.

The quantity of information evaluates if amounts of the information contained within the application are appropriate, comprehensive and concise. The amount of information must be enough and appropriately present to users.

Visual information measures the readability of application's visual concepts such as charts, graphs, images, videos and if they are clear, logical, and correct. If the application contains visual concepts, they need to be readable and clear, logical and correct to users.

Credibility measures the legitimacy of the application and who provides the application's description and if they are experts in the field. The application shall be provided by legitimate developers or institutions and the developers require to be experts.

Evidence base measures if the application has been tested. The test must be verified by evidence in a published scientific literature. The application shall be tested by developers to prevent bugs within the application and check if the application's goals are achievable.

4.2.5. The Subjective Quality Subscale

The Subjective quality subscale lists several components that might be relevant to the subjective use. The items contain the subjective use of the application such as application's recommendation or application's usage and if users would pay for it also the overall rating of the application.

Would you recommend this application to people who might benefit from it? The item measures if users recommend the application. For example, a user might not recommend an application about eating disorders to every person. The recommendation shall be given to people have the disorder and benefits from the application.

How many times do you think you would use this application in the next 12 months if it was relevant to you? The item measures if the application's usage seek continuously or it would be used only for several times before it becomes repetitive.

Would you pay for this application? The item measures the business value of the application and if users would pay for it.

Overall rating of the application? The item measures if the rating a user is given to the application reflects the quality of the application.

4.2.6. MARS evaluation

Items evaluate with a 5-point scale score: 1-Inadequate, 2-Poor, 3-Acceptable, 4-Good, 5-Excellent. Acceptable is the medium level. Generally, in the lower levels (poor and inadequate) the application lacks important components while in the upper levels (good and excellent) extra component has been developed to promote the usability. The average score of items in a subscale equals to the subscale score. Total app quality score calculates with the average scores of subscales. Therefore, MARS total score also represents with 5-point scale score. MARS total score describes the overall evaluation of the quality of an application. (Stoyanov et al., 2015)

4.3. Jakob Nielsen's Heuristics

Jakob Nielsen's 10 heuristics for interaction design are listed below. The reason for calling them heuristics is because they are broad rules and not specific usability guidelines (Nielsen, 1994). Unlike MARS, heuristics are not specific to mobile or mHealth applications. Therefore, they have been adapted to deliver extra information regarding the usability of gamification elements. Heuristics are unrelated to criteria presented by MARS and they do not target only mobile or health applications.

1. Visibility of system status

All the time the system should keep users informed about what is happening with providing appropriate feedback on reasonable times. The application should give feedback hence the user is aware of the system. For example, when the network connection is not available the application should provide feedback about it. (Nielsen, 1994)

2. Match between system and the real world

The system's feedback should speak the user's language, with the words, phrases, and concepts known to the user, instead of system-oriented terms. The order of system' feedback shall follow real-world convention, in a natural and logical order. Symbols or

graphical objects shall be carefully chosen and they must be related to real-world counterparts. (Nielsen, 1994)

3. User control and freedom

Users should have the freedom in the application and if the user chose a function by mistake and there should be clearly marked “emergency exit” for the user without going through an extended dialogue, also the application should support undo and redo. (Nielsen, 1994)

4. Consistency and standards

The system should follow platform conventions. The system should work in a consistent way and different words, situations or actions shall mean the same thing. The system should keep the standards and the meaning of those standards consist in the application. (Nielsen, 1994)

5. Error prevention

Before the error happens and thinking about good error messages, the error shall be prevented with a careful design that prevents it from occurring in the first place. If the error is happening to the user, this error should be explained with a confirmation option and the explanation should be understandable to the user. (Nielsen, 1994)

6. Recognition rather than recall

Could be explained by minimizing user memorizing by making icons, actions, objects, and other options more visible. The user shall not have to remember actions, objects, etc. also instruction of system usage should be retrievable and visible whenever appropriate. (Nielsen, 1994)

7. Flexibility and efficiency of use

Could be defined as the system should enable expert users to use the application as well as inexperienced users. This system shall cater for both inexperienced and experienced user instead of making the application easy for all the users. (Nielsen, 1994)

8. Aesthetic and minimalist design

The dialogues and information in the system should not contain unnecessary information. (Nielsen, 1994) An extra unit of information in a dialogue diminishes their relative visibility and competes with related units of information. (Nielsen, 1994)

9. Help users recognize, diagnose, and recover from errors

Error messages should not be codes and should express in a plain and understandable and precise language, the user understands the problem precisely and suggest a solution for fixing the problem. (Nielsen, 1994)

10. Help and documentation

Although the system can be developed without documentation, providing information to the user might be necessary. Documentation and help instruction should be easy to search, focused on user's task, the list of precise steps to be followed, and should not be too large. (Nielsen, 1994)

For this thesis, parts of Jakob Nielsen's heuristics would be analyzed in the research. Open questions are included to analyze heuristics. Heuristics relevant to documentations, help, and bugs and error are not included in the research because they are not the objective of the research. Relevant heuristics are listed below:

1. Visibility of system status analyzes the visibility of gamification elements and their related feedback. Related questions to be asked in the interview include: Are gamification elements shown at the appropriate time? Is the feedback of gamification appropriate?
2. Match between system and the real world analyzes the feedback of gamification elements on communication and language levels. Related questions to be asked in the interview include: Is the communication between the feedback of gamification element and a user clear? Are gamification elements clearly displayed? Is there any way to improve it?
3. Flexibility and efficiency of use analyze if experienced and inexperienced users can use the application. Gamification elements in this thesis are designed for the public. Therefore, experienced and inexperienced users shall understand it. Related questions include: Can everyone perceive the implemented gamification elements in the same way? Do experts have more advantages than non-experts?

5. Tracking Applications

Tracking data is the process of collecting and saving data (Klasnja & Pratt, 2012). Examples of the data include the number of calories, the amount of time of exercises, the current weight of users, etc. In some mHealth applications, users track a set of pre-defined data. For example, A tracking application might aim to track physical activities and control the weight of a user (Turner-Mcgrievy et al., 2013). Also, mHealth applications such as Migraine Buddy[1], Calorie Counter & Diet Tracker[5] can be acknowledged as tracking applications because they have a feature to track the time of migraine headaches and the number of calories respectively. The benefit of the process of tracking is to increase the engagement of desired behaviors and to perceive a health-related behavior (Klasnja & Pratt, 2012). Features of tracking applications differentiate from each other and are related to their goals. For example, features of a fitness application are tracking frequency, intensity, time, and type of the fitness activity (Turner-Mcgrievy et al., 2013). Tracking data can be categorized into two types, i.e. automatically trackable data and manually trackable data. Automatically trackable data can be synchronized automatically with sensors. Such as the step counting from a pedometer embedded in a phone. Manually trackable data is what users shall put on phones such as the time of migraine headaches, food consumptions.

5.1. Issues of Tracking Applications

Tracking applications may have deficiencies and limits. For example, users might not benefit from a service of an application if the offered function cannot match with a user's goal, or it is difficult to engage users with applications. Generally, interactions in applications require substantial effort. (Boulos, et al., 2014) In tracking applications, the substantial effort is to engage a user in the tracking process. Studies show that a user of tracking applications rarely manages to keep up with using the application for longer than a few weeks. (Klasnja & Pratt, 2012) Users need to track data on a mobile phone repeatedly and the process can be monotonous. The issue arises from the boredom that these repetitive tasks provide without any amusing element (Martí et al., 2012). The repetitive task in tracking applications is to track data manually by users continuously.

This occurs only in manually trackable data. Therefore, this thesis is focusing on manually trackable data.

A solution has been suggested for this issue in Klasnja & Pratt (2012) article, “to use sensors and connected measurement devices to automate logging of at least a subset of relevant activities and states”. However, it only targets automatically trackable data. For manually trackable data, improving the usability of the data input process shall be taken into account. It can help users gain motivation and to interact or understand the application (Asimakopoulos et al. 2017). Improving the usability of applications is related to improving user's satisfaction or the efficiency of the applications. Gamification is a potential method to increase the usability of an application, convert a repetitive task to a more appealing one (Martí et al. 2012) (Flatla et al. 2011) and it keeps users engaged to the application (Iacovides et al. 2013). Top 50 applications of Apple App Store in the Health & Fitness category were analyzed to identify if they are using manually or automatically trackable data. Thirty-two applications were identified as tracking applications. Twenty applications were using manually trackable data and eleven applications were using automatically trackable data. The data used in these manually trackable data applications are food, fitness and fertility related data. Among these applications, fifteen applications used the feedback element. Two applications used the competition element. Six applications used the ranking element. One application used the team element. Three applications used the avatar element and three applications did not use any elements.

5.2. Adapting the MARS items

MARS includes 23 items to evaluate the usability of applications and this thesis will investigate the potential impact of the selected gamification elements by adapting the items. Four MARS items have been adapted as follows. *Entertainment* evaluates gamification as well as other graphical components within the application. This item is the major part of the research question and has been considered for the interview. The avatar element can increase user's engagement and therefore the entertainment component of the application might be influenced by it. The story element shall be appealing to users to impact this item. The feedback element could potentially change this item because users can read them effortlessly. *Interest* measures if the application is

interesting to use. The interesting aspect inspects if gamification elements could increase application's interest. Therefore, this item has been included for analyzing gamification elements to check if elements could increase interest. The potential impact of the designed elements would be the same as the entertainment item. *Graphics* measures the visual beauty of the application. Gamification elements are considered as graphical components and need to be evaluated in this thesis. Because the avatar represents an image or a 3D object, therefore, the item might be affected by it. The story element commonly represents in a textbook format and would not increase this item. The feedback element might impact this item because it could increase the application visual appearance. *The application's usage* item measures if users would continue to use the application in the next 12 months if the application was relevant to them. This item is an important aspect of the research question and the potential impact of the designed gamification elements would be they can increase the application's usage because they would alter the repetitive task into a more engaging task.

19 MARS items have been excluded from the research and the reasons are given as follows. *Customization* measures the application's customizability. Although gamification elements such as avatar could be designed to be customizable but adding the element per se would not increase the total customizability of the application without the gamification element. Therefore, it has been excluded. Same reason as customization, other items such as *Interactivity, Ease of use* has been excluded. *Target group* focuses on the target audience of the application. No specific target group is selected for the research question of this thesis because the target group of tracking applications varies between different application's goals. Therefore, it has been excluded. *Performance* measures the application performance. Although the application's performance is the key to measure the application's usability, it is not the focus of this thesis and is not included in the research. *Navigation* evaluates the navigating between screens. This item is also excluded because the research question is not focusing on the navigation between screens. *Gestural design* evaluates users' interactions. This item is not relevant to the research question of this thesis. *Layout* is also excluded because it measures the arrangement of the application's contents and it is not relevant to the research question. *Visual appeal* focuses on application's colors and styles. The color choice of the application is not relevant to the research question. The MARS information quality subscale is excluded from the

research because it focuses on the application's description and that is not relevant to the research question of the thesis. In addition, as mentioned only the application's usage item from subjective quality subscale has been relevant to the research question. Other items were regards the subjective quality of the application and have been excluded.

6. Prototype mHealth application

Following the issue mentioned in Section 5-1, this thesis is prototyping a tracking application with gamification elements to resolve it. The prototype is an incomplete application to show the concept of gamification elements in tracking applications. The incomplete state of the prototype is in the design of the application and not in the gamification concept. However incomplete design might affect the usability evaluation. Gamification is an interesting method to convert the repetitive task into more engaging ones (Martí et al., 2012). Gamification elements have been developed as a method to analyze if it can convert a repetitive task to a more engaging task and causes usability improvements. Most of the gamification implementations fail because of the poor understanding of gamification elements (Morschheuser et al., 2017). It has been suggested by Reeves & Read (2009) that it would be more efficient to develop gamification elements by developing only one gamification element at a time. Therefore, for the efficiency of the prototype and to show the concept of gamification elements clearly to the audience (interviewee) and to focus more on the concepts, three gamification elements are used in the prototype. These elements are: Self-representation with Avatar (Section 3.2.1), Feedback (Section 3.2.8), Story (Section 3.2.3). The reason for selecting them is given as follows. The story element was not identified in the top 50 applications mentioned in Section 3.2. However, it might have an impact on the application's usability and the developers might not be aware of it. To research it, this item has been selected for the prototype implementation. Feedback and avatar elements can show users their progress in the application which can increase application's usability. For analyzing gamification elements separately and emphasize them, three sections are constructed for each of the target gamification elements. The Android OS is selected as the target OS of the prototype. As Reeves & Read (2009) discussed, the gamification elements might have an enormous impact on the usability of an application. However, it corresponds to how they integrate into applications. The prototype is implemented following the research question and to support the analysis process. The prototype aims to develop a tracking application that contains a feature to track data. To provide a clear vision to the interview participants, the prototype has been introduced as a diet tracking application. The reason for selecting a diet tracking prototype over others is because they are popular in the market and therefore users are familiar with them. In 2013, more than 10,000 applications targeted diet and weight loss functionalities (Azar

et al., 2013). The prototype is comparable to tracking applications that are focusing on weight managements such as Calorie Counter MyFitnessPal[5]. The features of the prototype are collecting and saving calories information provided by users and visualize them by graphs and gamification elements. The UML diagram of the classes and their attribute and functions is visible in Figure 9.

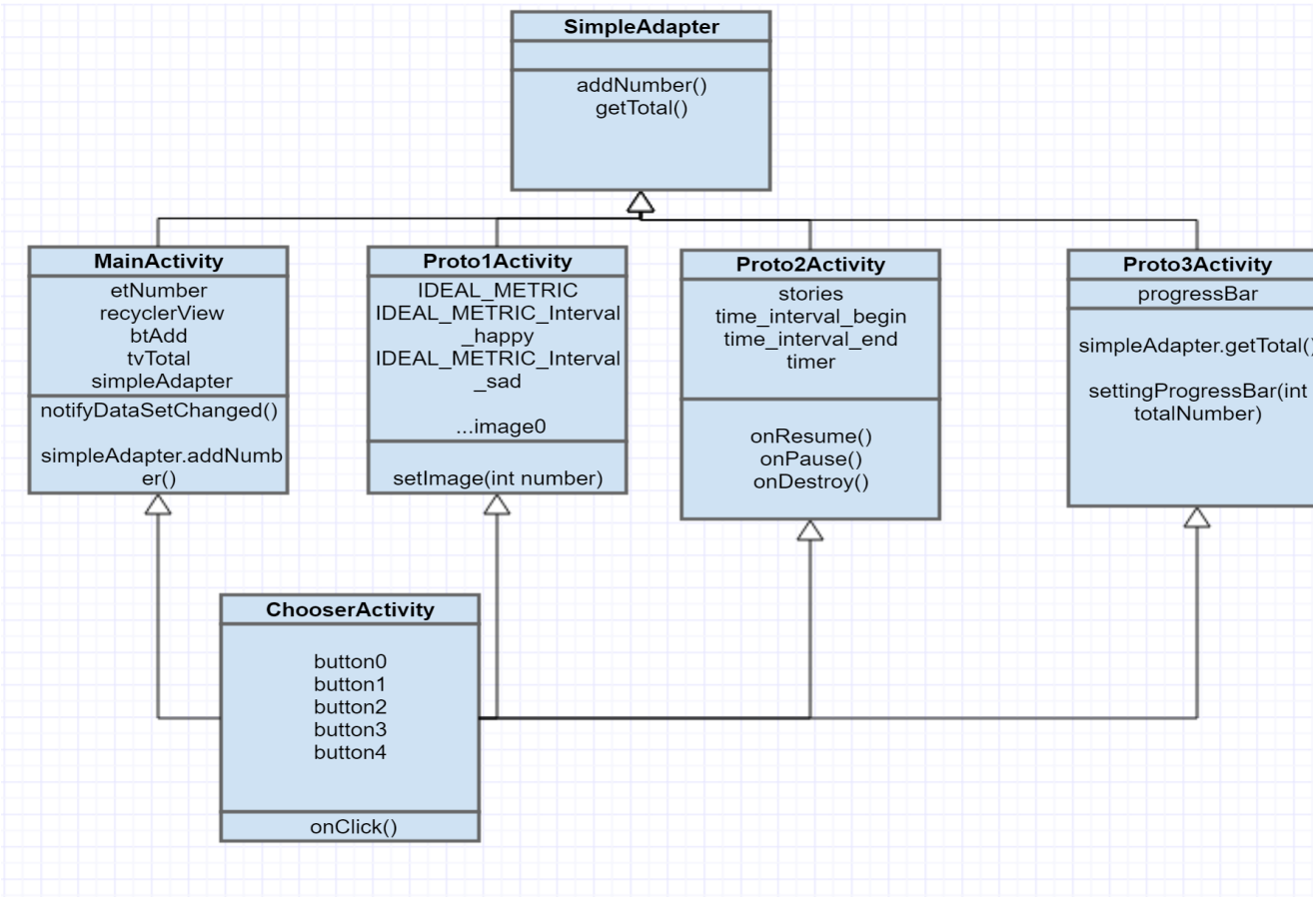


Figure 9 The UML diagram of the prototype

The prototype starts with Chooser Activity that is a screen for selecting the designed gamification elements. The prototype narrows down to four sections. Section 0 (MainActivity Class), Section 1 (Proto1Activity Class), Section 2 (Proto2Activity Class) and Section 3 (Prototype3Activity Class) and they are connected to SimpleAdapter. SimpleAdapter carries data. In Section 0, a tracking application without any gamification elements has been designed. As described, the prototype is introduced as a diet tracking application. Therefore, the data is considered as calories of the food consumed by a user. Three gamification elements have been included in other sections. Sections 1 to 3 have the tracking functionality of the Section 0 but with a gamification element. Section 1

contains the avatar gamification element. The avatar displays with an image and it is corresponding to the user's goal. Section 2 contains a story gamification element. A list of texts has been designed for the story element. The story appears when users reach their goals every day. Section 3 contains the feedback gamification element. The feedback is an incremental progress bar from 0 to 100 percent to reach the user's goal and it will decrease from 100 to 0 percent when users keep inserting calories after they reach their goals.

The effects of designed elements on the four adapted MARS items are discussed as follows. Generally, gamification elements shall increase entertainment and interest items because of their high level of interactivity (Kapp, 2012) and engagement. However, the interest item is opinion oriented. A group of users might not be interested in a design of particular elements such as a humanoid avatar or promotional health text or the design of the feedback. The prototype followed the principles of material design to influence the graphics item. Material design is a set of principles that an application shall follow to have a valuable design.[21] The application's usage item would be influence by designed elements because gamification elements increase user's engagement (Iacovides et al., 2013).

6.1. Section 0

In this section, a tracking prototype has been developed without any gamification elements. To show concretely the functionality of the tracking prototype to the participants of the interview, the prototype has been introduced as a diet tracking prototype. There are three features in the prototype. The first feature is to track data. The data is the number of the calories consumed by a user. In Calorie Counter MyFitnessPal, users search for the food's name that is in the database and the application calculates the corresponding number of the calories. However, in the prototype users insert the calories number directly because the application lacks a database containing food's details. Calories are represented by numerical values which are provided by users when the add button is pressed (Figure 10). This feature is the mentioned repetitive task because

[21] https://material.io/

calories need to be added continuously. Users lose their interest in the application because of this repetitive task (Klasnja & Pratt, 2012) and they might lose their motivation for using the application. The second feature is to save the data locally in the application. The data saves on the SimpleAdapter when users press on the end day button (Figure 10). The third feature is to visualize the data by showing the number of calories on a list and the sum of the numbers in a text field. The end day button has been designed and users will redirect to the chart screen (Figure *11*) by clicking on it. Users can compare their daily calories consumption in the chart screen. In Figure *11*, the calories consumptions are 20, 100, 140 for day 0, 1, 2 respectively.

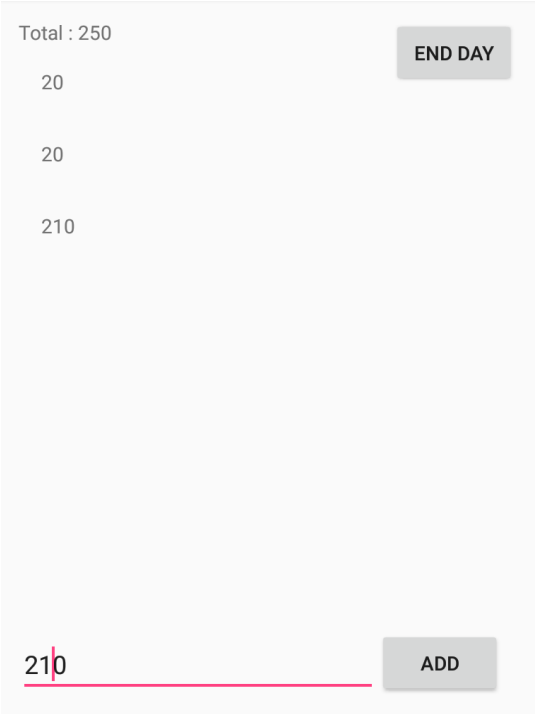


Figure 10: the screenshot of Section 0

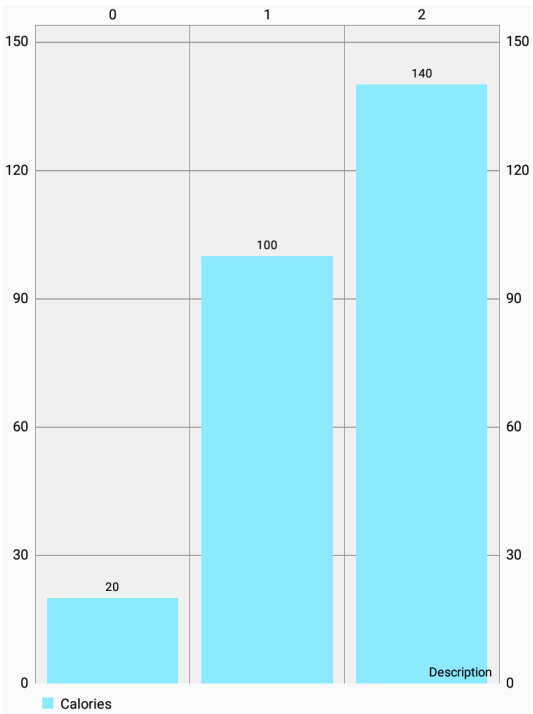


Figure 11: the chart represented calories per day

6.2. Section 1, Self-representation with Avatars

In this section, the avatar element appends to the tracking prototype. The data in the prototype is defined as calories in the form of numerical values. In tracking applications, data is usually in the form of numbers, figures, and names, videos, sounds, etc. It is demanding to make comparisons or to communicate with data in those forms. Because avatars are usually in the form of human creatures, the communication between users and avatars are less demanding and more engaging (Reeves & Read, 2009). As mentioned in

Section 0, users perform a repetitive task without any entertainment components within the application. With avatars, an engaging communication would settle because the communication is less demanding. Therefore, an increase in the application's usability might occur. In the prototype, the avatar's role is to visualize data in the form of humanoid creatures and the goal is to eliminate the boredom of repetitive tasks and transfer it into an engaging one. Users usually customize an avatar at the beginning of the application or a default avatar is given to users. The avatar's appearance updates when users achieve a goal such as reaching a fitness goal. Updating the avatar might correspond to the application's rewards or goals. For adding this element, an image representing the avatar appended to the tracking prototype. In tracking applications, the reward is linked to the user's goal that is an ideal numerical value to reach for users. In diet tracking applications, the goal is to reach the number of ideal calories per day. In the prototype, the ideal calories set to 2000 for the testing purposes. When users reach 2000 calories or near to it, they achieve their goal and therefore they need a reward. Three images represent the avatar's state are happy, neutral, sad. In Figure 12, top of the triangle is the user's goal (a numerical value or 2000 in the prototype). When a user is near to the goal that is between the goal's number and an interval (intervals_happy in Figure 12) then the avatar's appearance updates as a happy state. If the number is between intervals_happy and intervals_sad then the avatar updates with a neutral state. Otherwise, it updates with a sad state. (Figure 13) It is expected that implemented avatar could increase the application's usability and influence users significantly. The number of avatar's states can be increased with the marketplaces and economies implementation (Section 3-2-6-) by providing more rewards. For example, the application can provide a reward with virtual currency such buying a hat and that can update the avatar image with a hat.

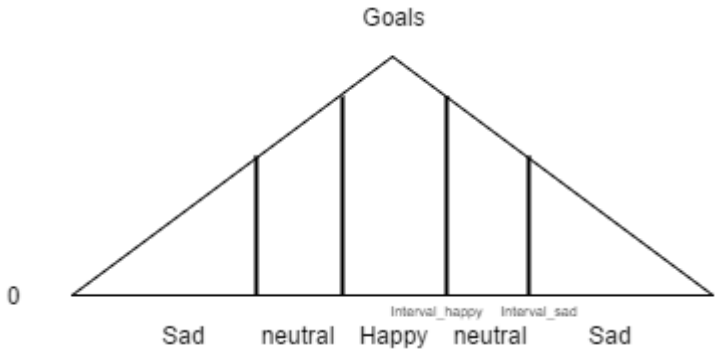


Figure 12: states of the avatar

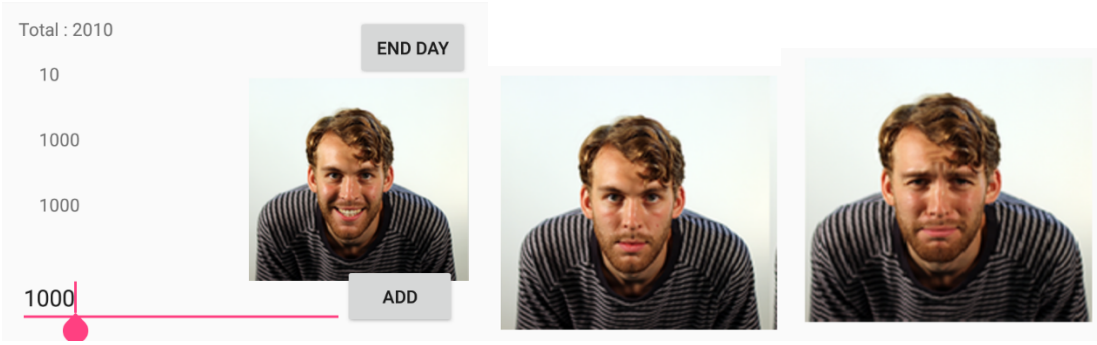


Figure 13: the avatar represented by happy, neutral and sad images.

6.3. Section 2, Story

In Section 2, the story gamification element appends to Section 0. The role of stories in mHealth applications is to promote user's health or to educate them. The purpose of it is to increase the desired behavior or decrease the undesired behavior. In video-games, the story is an unfinished framework and players complete the story by progressing in the game. However, how can a story appear in mHealth applications? The story element did not appear in top 50 applications of the Apple Store and after searching for the application using the story element in the Apple Store, only one application had story element. Burn your fat with me!![10] is an application consist of a visual novel. The visual novel appears when users progress with their fitness goals. In that application, the story is using the same concept as what Groh (2012) stated: A story can include in an application by wrapping a story around an activity with suitable visuals. The activity Groh referring to is the fitness goal in Burn your fat with me!!. The story in the prototype designed to correspond with the progress of the user's goal every day. To implement the story element in the prototype, identifying the prototype's goals and progression of the goals are required. The prototype's goal is to reach a certain number of calories (that is 2000 calories) per day and the progression of the goals appears when end button is pressed. In mHealth applications, the story can appear as texts to promote user's health. In the prototype, a list of texts has been designed to educate users or promote users' health such as the text in Figure 14 educating users about asthma. In the prototype, the goal is to keep the 2000 calories stable and the story appears when users click on the end day button while the goal has been achieved. In the prototype, the goal needs to achieve daily. However, in other applications goals, can be divided into short term goals and long term

goals. For example, users can have a long-term goal of achieving 2500 calories per day within a year. Improving the story element is possible with the implementation of a database containing educational texts or promoting public health texts also with the graphical visualization of the story. It is not clear how can stories affect the usability of tracking applications.

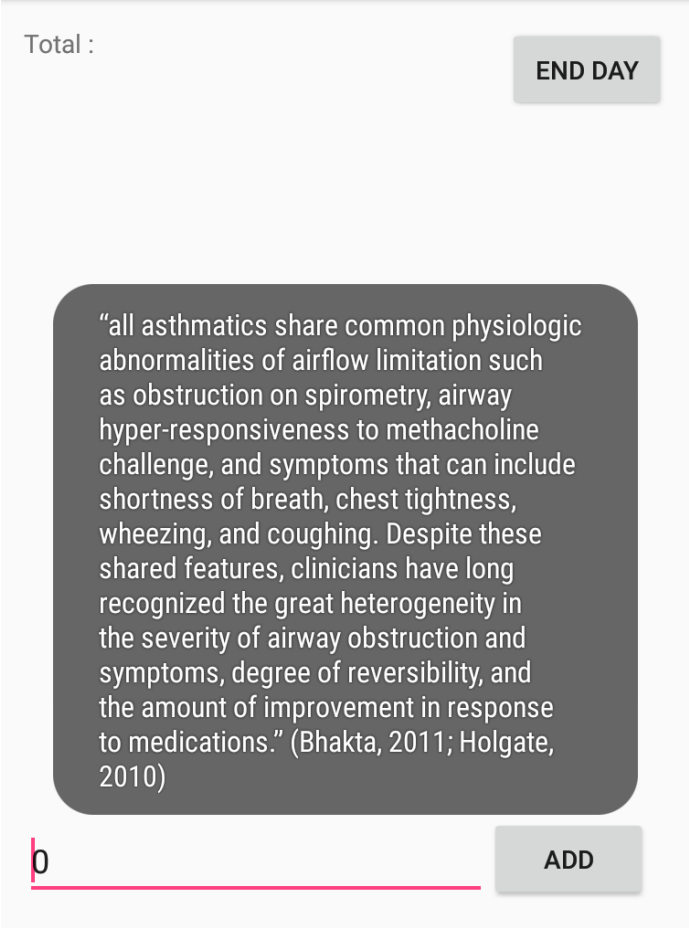


Figure 14: the story element in the prototype showing asthmatic information to users.

6.4. Section 3, Feedback

In Section 3, the feedback gamification element appends to Section 0. The feedback element develops with different approaches in applications. The feedback element used in many mHealth applications in contrast to the story element. In most of the mHealth applications, there are progress bars to visualize data. Super Better[15], Keas[14], Migraine Buddy[1] are applications that are using progress bars. A progress bar that is representing the feedback element has been added to the prototype (Figure 16). The progress bar

updates when the user's current state changes. It occurs when a new calorie inserts to the application. The progress bar states are from 0 to 100 percent. (Figure 15) The progress bar increases from 0 to reach 100 percent when users insert a new calorie. The progress bar will set to 100 percent when it reaches the goal (or 2000 calories). In addition, the progress bar decreases to reach 0 percent when users pass their goal. (Figure 15) Recording the progress bar values in time intervals might increase the usability of the application because the progress of the data is more apparent to users. If an application contains multiple data, comparisons between metrics could provide more meaningful information. With the feedback element, users have a precise vision of their progress. This might affect the user's motivation and therefore increases the usability of the application.

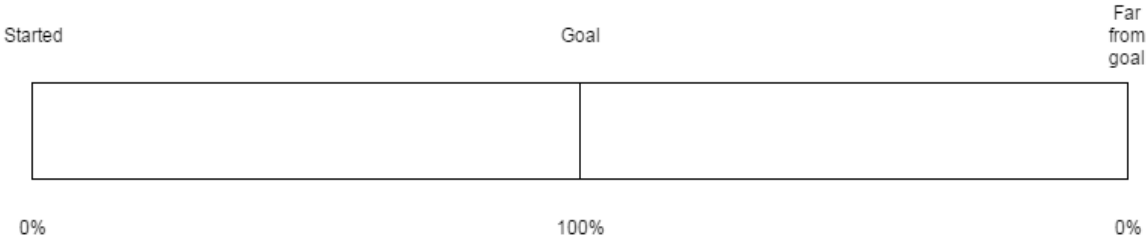


Figure 15: the progress bar states based on the application's goal

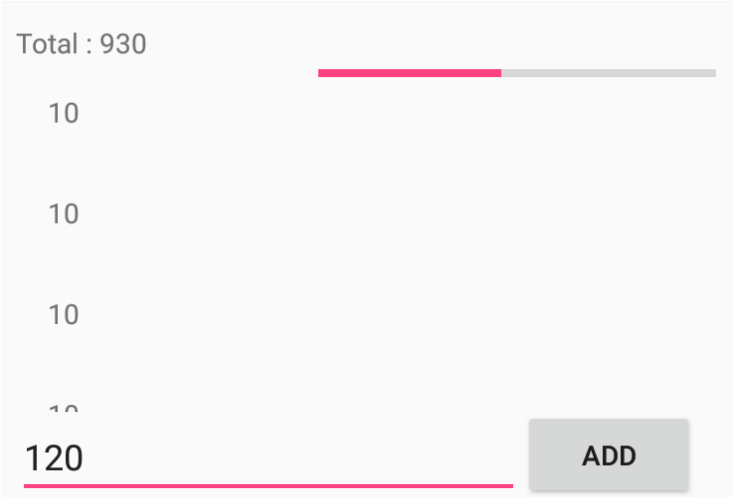


Figure 16 – The feedback element of the prototype

7. The Interview

To analyze the usability of the gamified mHealth application (or the prototype) research methods are required. The research method that is selected for this thesis is the interview. The reason for selecting the interview over other methods is to collect comprehensive information and feedback which provides a solid basis for analysis of the usability of the prototype. It is possible to collect meaningful information by interviewing only a couple of people. The objective of the interview for this thesis is to perceive if the gamification elements used in the prototype improves the usability of tracking applications. Target groups of respondents are people who had working experiences in the gamification field and they are referred to as experts in following sections.

Three interviews were conducted. Interviews were obtained in Finland, Tampere. All interviews were conducted face-to-face and lasted for 30 minutes approximately. The interview was challenging because of the difficulty to find gamification experts and to convince them to participate and to arrange a suitable time with participants. Also, participants might provide "socially acceptable" answers and not the intended answers. Participants information treated confidentially upon their request.

The interview conducted for this thesis includes four phases. In the first phase, the researcher and the research question were introduced to the participants. The designed gamification elements and the tracking applications were described to the participants. Additionally, the issue of tracking application was discussed with the participants. In the second phase, the prototype demonstrated to the participants and they experimented it. They used avatar, story and feedback sections of the prototype respectively. The participants provided comments while experimenting the prototype. The comments were discussed in the interview results section of this thesis. In the third phase, the MARS and heuristics questions were asked from the participants. The questions were usability related questions discussed in Section 4. The questions were modified to be shortened and clearly written and they were customized for gamification and tracking applications. The academic language was avoided during the interview. Seven questions have been prepared for the interview (the questions are listed in Appendix B). Responses were chosen from a scale of 1-5 for MARS questions with open-ended heuristics questions. In the fourth phase, the answers to the usability's questions were precisely collected and the interview ended.

The usability would be calculated with the MARS total score. If the total score of MARS is 4 or 5 score, then designed gamification elements have a potential to improve the usability. If it is below 4 scores, then they have a little impact on it. Furthermore, Jakob Nielsen's Heuristics delivers extra information regarding gamification elements or the usability. Although it is demanding to predict the results of this interview, expected results could be designed gamification elements improve the usability in certain conditions.

7.1. Interview Results

The average MARS total score for the three interviews was three. It indicates that the designed elements have little impact on the usability of the application. The analysis of the questions which were asked from the experts is as follows. The first question was related to the entertainment perspective involved in the designed gamification elements. The participants said that the story and feedback elements are mostly monotonous. The reasons might be because the story element is very opinion oriented and the genre of it attracts a portion of users. The prototype used promotional health texts as the story element. The response to this element would be more positive if the story's texts were connected to each other or animations and sounds were used instead of the plain texts. Additionally, the feedback element might be not considered monotonous if it was analyzed with other designed elements. Participants mentioned the avatar element is satisfactory and one participant mentioned it is highly entertaining. In the second question, the participants were asked to indicate if each designed gamification elements present its content in an interesting way. The result shows that the story and feedback elements are neither interesting nor uninteresting. However, the responses of the avatar element were moderately interesting. It was challenging to improve entertainment and interest items by gamification elements because various users admire different elements or some users might prefer none. The third question was related to the visual appearance of the application after including the gamification elements. All participants said that after the inclusion of gamification elements, the graphics become more seamless and application have the high level of the visual appearance. The fourth question was about the yearly usage of the application if it was relevant to the participants. The answers were diverse, but the average answers were between 10 to 50 times. The diverse answers might

represent that the gamification elements can influence the application's usage for only some users. The fifth question was that if designed gamification elements occur in a reasonable time. The answers of the participants were positive and mostly said yes. The sixth question was that, is the communication between the feedback of gamification element and a user clear? The answers of the participants were positive and mostly says yes. Finally, the interviewer asked the last question about the understanding level of the designed elements by experienced and inexperienced users. The participants answer that it completely depends on the situation. However, the experienced users got the certain advantage. (Appendix C.)

Generally, participants mentioned the application's usage cannot be influenced by gamification elements and only the application's appearance can be influenced by them. However, this statement might not be true because by improving the application's appearance, more users might be attracted to it. Therefore, more users might use the application. It is self-evident that the application's appearance is influential by gamification elements. Therefore, all participants responded positively towards the visual appearance of the prototype. Participants made suggestions about designed elements as follows. One participant mentioned that the story element should be linked to the tracking data. For example, if a user overeats sugar, the application can provide a story about the sugar effect on the body. Linking the story element with the tracking data can be possible through artificial intelligence and it might provide more meaningful information such as the given example. He mentioned that gamification elements cannot improve the application's usability but people might prefer to pick a gamified application rather than a normal application. Another participant mentioned that the story needs to be in a humorous format and the educational text can be embedded inside it. He said the usability evaluation of the designed elements should be done together and not separately for each element because they are linked together in applications. The author agrees with this statement. The usability evaluation of each element has been done separately to analyze and compare elements separately. However, it needs to consider that some elements are linked to other and needs to be analyzed together. For example, the story and avatar can be linked together. The participant also mentioned that users should select their avatar appearance such as female, male, or alien because they would perceive a sense of autonomy which is an important part of SDT (Self-determination theory) and provides users intrinsic motivation. He said the avatar picture should be a comical picture rather

than a picture of a guy. He mentioned gamified applications contained three parts that are mechanics and dynamics and aesthetics. Dynamics is the rules of the game. Mechanics is the mechanic of the game. Aesthetics is the visual appearance of the application. He mentioned gamified applications could influence user's motivations without aesthetics aspect when mechanics and dynamics are designed properly. Another participant mentioned using a humanoid face is entertaining, but the avatar should have more expressions such as an extreme happiness expression might increase entertaining component. This comment is contradictory to the previous participant's comment because he mentioned using humanoid pictures is not entertaining. However, both suggestions might increase the usability of the avatar. She mentioned the story text should be shorter so users can follow them and it should happen in surprise moments rather than every day. In conclusion, participants considered the story element as a weak link of the prototype while the avatar and feedback elements were satisfactory. They provided suggestions to improve these elements which can be beneficial for the future developers or researchers.

8. Conclusion

After identifying an issue with tracking applications, a prototype of a tracking application with three gamification elements has been developed. The issue arises from a repetitive task for manually tracking applications. Gamification is a potential method to convert this task into an interesting one. Three interviews have been conducted to analyze the prototype's usability of the designed elements. The interview questions have been selected from MARS system and Jakob Nielsen's Heuristics. Based on the result of interviews, the designed elements have little impact on improving the prototype's usability. However, the response of the avatar and feedback elements was more positive than the story element. This study aimed to improve the usability of manually tracking applications by implementing three gamification elements described earlier. The results are beneficial for researchers studying the use of gamification elements in tracking applications. In addition, this study contributes to better understanding of designing gamification elements.

The barriers of using mobile phones as a health application are: Mobile phones are expensive to purchase for some individual. Moreover, in a poor-resource geographic region not accessing a good network connection or a signal is experienced by many users. Another barrier is mobile phones have multiple operating systems (OS) such as Microsoft Windows Mobile, Symbian, Blackberry, Palm OS, Mobile Linux, J2ME, and the Android, IOS and this variety of OS makes it difficult for the developer to build mHealth applications. Also, another barrier is to make a large scale feasible. The mHealth application is required to have healthcare model agreements require different stakeholders or organization. From patients' perspective, the barrier can be that they might not prefer mHealth applications and they would like to have a face to face contact and a privacy issues can be caused by shared mobile phones or stole ones. (Patrick et al., 2008) The barriers in mobile phones are: They have limited screen size, processor, power, memory, bandwidth and battery lives and these limitations restrict phones' capacity in applications. The risk of a wrong or missed diagnosis in the application needs to be considered from the inadequate information or for example, corrupt image. (Akter & Ray, 2010) For the developer of mHealth applications, there is a need to understand mHealth

services hence the application's developer could identify suitable technologies and use them more relevantly to the user with better usability (Liu et al., 2011).

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Appendices

Appendix A. – Top 50 applications in Apple App Store in the Health & Fitness category

Id	Application name	Company name	Type	Link
1	Calorie Counter & Diet Tracker by MyFitnessPal	MyFitnessPal.com	Manually tracking app	https://itunes.apple.com/us/app/calorie-counter-diet-tracker-by-myfitnesspal/id341232718?mt=8
2	Ab & Core Sworkit - Free Workout Trainer	Nexercise	Not a tracking app.	https://itunes.apple.com/us/app/ab-core-sworkit-free-workout-trainer/id986540048?mt=8
3	Sound Sleeper: white noise machine for baby sleep	Michael Feigenson	Automatically tracking app (Sound)	https://itunes.apple.com/nz/app/sound-sleeper-white-noise-machine-for-baby-sleep/id507967709?mt=8
4	Fitbit	Fitbit, Inc.	Manually tracking app	https://itunes.apple.com/us/app/fitbit/id462638897?mt=8
5	Nike+ Fuel	Nike, Inc	Manually Tracking app	https://itunes.apple.com/us/app/nike-fuel/id493325070?mt=8
6	Pillow: Sleep tracking & analysis alarm clock	Neybox Digital Ltd	Automatically tracking app (sleep)	https://itunes.apple.com/us/app/pillow-sleep-tracking-analysis-alarm-clock/id878691772?mt=8
7	My Challenge Tracker	Beachbody, LLC	Manually tracking app.	https://itunes.apple.com/us/app/my-challenge-tracker/id1025601254?mt=8
8	Lose It! – Weight Loss Program and Calorie Counter	FitNow	Manually tracking app	https://itunes.apple.com/ca/app/lose-it-weight-loss-tracker-and-calorie-counter/id297368629?mt=8

9	ShopWell - Healthy Diet & Grocery Food Scanner	YottaMark, Inc.	Not a tracking app	https://itunes.apple.com/us/app/shopwell-healthy-diet-grocery-food-scanner/id393422300?mt=8
10	StrongLifts 5x5 Workout	StrongLifts	Manually tracking app.	https://itunes.apple.com/us/app/stronglifts-5x5-workout/id488580022?mt=8
11	Map My Run - GPS Running & Workout Tracker	Under Armour, Inc.	Automatically tracking app (location)	https://itunes.apple.com/us/app/map-my-run-gps-running-workout-tracker/id291890420?mt=8
12	Pillow: Sleep tracking & analysis alarm clock	Neybox Digital Ltd.	Automatically tracking app (sleep)	https://itunes.apple.com/us/app/pillow-sleep-tracking-analysis-alarm-clock/id878691772?mt=8
13	Happy Scale: Weight Loss Tracker, Trend Prediction	Front Pocket Software LLC	Manually tracking app	https://itunes.apple.com/us/app/happy-scale-weight-loss-tracker-trend-prediction/id532430574?mt=8
14	Nike+ Run Club	Nike, Inc	Automatically tracking app (steps)	https://itunes.apple.com/us/app/nike-run-club/id387771637?mt=8
15	Moves	ProtoGeo	Automatically tracking app (steps)	https://itunes.apple.com/us/app/moves/id509204969?mt=8
16	White Noise	TMSOFT	Not a tracking app	https://itunes.apple.com/us/app/white-noise/id289894882?mt=8
17	Weight Watchers	Weight Watchers International, Inc.	Manually tracking app	https://itunes.apple.com/us/app/weight-watchers/id331308914?mt=8
18	Sunshine - A brighter lifestyle	Sunshine Technologies, Inc.	Not a tracking app.	https://itunes.apple.com/us/app/sunshine-a-brighter-lifestyle/id959396618?mt=8
19	Pact: Earn Cash for Exercise and	GymPact	Automatically tracking apps (GPS)	https://itunes.apple.com/us/app/pact-earn-cash-for-exercise-and-healthy-living/id456068701?mt=8

	Healthy Living			
20	Period Tracker Lite	GP Apps	Manually tracking app	https://itunes.apple.com/fi/app/period-tracker-lite/id330376830?mt=8
21	Workout: Gym personal trainer & workout tracker	FITNESS22 LTD	Manually tracking app	https://itunes.apple.com/us/app/workout-gym-personal-trainer-workout-tracker/id1048454034?mt=8
22	WebMD – Trusted Health and Wellness Information	WebMD	Not a tracking app	https://itunes.apple.com/us/app/webmd-trusted-health-and-wellness-information/id295076329?mt=8
23	PumpUp - Health & Fitness Community	PumpUp Inc.	Manually tracking app	https://itunes.apple.com/fi/app/pumpup-health-fitness-community/id573070442?mt=8
24	Relax Yoga Music: Relaxing Sounds Studio & Breathe	iLBSoft	Not a tracking app	https://itunes.apple.com/us/app/relax-melodies-oriental-meditation-white-noise-sleep/id448207365?mt=8
25	Runkeeper - Track Running with GPS	FitnessKeeper, Inc.	Automatically tracking apps (GPS)	https://itunes.apple.com/us/app/runkeeper-track-running-with-gps/id300235330?mt=8
26	Happify — Activities & Games for Stress & Anxiety	Happify, Inc.	Not a tracking app	https://itunes.apple.com/us/app/happify-activities-games-for-stress-anxiety/id730601963?mt=8
27	Think Dirty – Learn Beauty Ingredients, Shop Clean	Think Dirty Inc.	Not a tracking app	https://itunes.apple.com/us/app/think-dirty-learn-beauty-ingredients-shop-clean/id687176839?mt=8
28	Nike+ Training Club	Nike, Inc	Manually tracking app	https://itunes.apple.com/us/app/nike-training-club-workouts-fitness-plans/id301521403?mt=8

	- Workouts & Fitness Plans			
29	First Aid by American Red Cross	American Red Cross	Not a tracking app	https://itunes.apple.com/us/app/first-aid-by-american-red-cross/id529160691?mt=8
30	Breethe - Guided Meditation	OMG. I Can Meditate! Inc.	Not a tracking app	https://itunes.apple.com/us/app/breethe-guided-meditation/id920161006?mt=8
31	RUNNING for weight loss: workout & meal plans	GRINASYS CORP.	Automatically tracking apps (GPS)	https://itunes.apple.com/us/app/running-for-weight-loss-pro/id636248681?mt=8
32	Freeletics Bodyweight - Workouts and Training	Freeletics GmbH	Manually tracking app	https://itunes.apple.com/us/app/freeletics-bodyweight-workouts-and-training/id654810212?mt=8
33	Runtastic Road Bike GPS Cycling & Ride Tracker	Runtastic	Automatically tracking apps (GPS)	https://itunes.apple.com/us/app/runtastic-road-bike-gps-cycling-ride-tracker/id467567868?mt=8
34	Relax Melodies: Sleep Sounds, White Noise and Fan	iLBSoft	Not a tracking app	https://itunes.apple.com/us/app/relax-melodies-sleep-sounds-white-noise-fan/id314498713?mt=8
35	Fertility Friend FF Tracker Ovulation and Period	Tamtris Web Services Inc.	Manually tracking app	https://itunes.apple.com/us/app/fertility-friend-ff-tracker-ovulation-and-period/id443919067?mt=8
36	Relaxing Sounds - Improve sleep, relax, meditate	Sonotap	Not a tracking app	https://itunes.apple.com/us/app/relaxing-sounds-improve-sleep-relax-meditate/id502222888?mt=8
37	Headspace: Guided Meditation	Headspace meditation limited	Not a tracking app	https://itunes.apple.com/us/app/headspace-guided-meditation/id493145008?mt=8

38	BabyBump Pregnancy Pro with Baby Names	Alt12 Apps, LLC	Manually tracking app	https://itunes.apple.com/us/app/babybump-pregnancy-pro-with-baby-names/id332366275?mt=8
39	Calorie Counter, Dining Out, Food, Exercise	Everyday Health, Inc.	Manually tracking app	https://itunes.apple.com/us/app/calorie-counter-dining-out-food-exercise/id375176386?mt=8
40	Sworkit - Custom Workouts for Exercise & Fitness	Nexercise	Manually tracking app	https://itunes.apple.com/us/app/sworkit-workouts-fitness-plans/id527219710?mt=8
41	Running, Walking and Biking with Endomondo	Endomondo.com	Automatically tracking app (GPS)	https://itunes.apple.com/us/app/running-walking-and-biking-with-endomondo/id333210180?mt=8
42	iMassage U - Vibrating Massager	Eric Lund	Not a tracking app	https://itunes.apple.com/us/app/imassage-u-vibrating-massager/id1064850875?mt=8
43	Sleep Pillow Sounds: rain, ocean, relaxing nature	FITNESS22 LTD	Automatically tracking apps (sleep)	https://itunes.apple.com/us/app/sleep-pillow-sounds-rain-ocean-relaxing-nature/id410606661?mt=8
44	Period Tracker: PMS & Ovulation Calendar	ABISHKKING LIMITED.	Manually tracking app	https://itunes.apple.com/fi/app/period-tracker-pms-ovulation-calendar/id896501514?mt=8
45	Misfit	MISFIT WEARABLES CORPORATION	Manually tracking app	https://itunes.apple.com/us/app/misfit/id564157241?mt=8

46	White Noise Free: sounds for sleep and relaxation	TMSOFT	Not a tracking app	https://itunes.apple.com/us/app/white-noise-free-sounds-for-sleep-and-relaxation/id292987597?mt=8
47	Seconds - Interval Timer for HIIT, Tabata Training	Runloop Ltd	Not a tracking app	https://itunes.apple.com/gb/app/seconds-interval-timer-for-hiit-tabata-training/id475816966?mt=8
48	My Cycles Period and Ovulation Tracker	MedHelp	Manually tracking app	https://itunes.apple.com/us/app/my-cycles-period-and-ovulation-tracker/id335875911?mt=8
49	iTriage - Health, Doctor, and Symptoms search	iTriage LLC	Not a tracking app	https://itunes.apple.com/au/app/itriage-health-doctor-and-symptoms-search/id304696939?mt=8
50	Vibrating Massager FREE	Savy Soda	Not a tracking app	https://itunes.apple.com/us/app/vibrating-massager-free/id312272622?mt=8

Table 2: General information of top 50 applications in Apple App Store in the Health & Fitness category.

Id	Avatars	3D Environment	Story	Team	Rankings	Marketplaces and economies	Competition	Feedback
1	0	0	0	0	0	0	0	Progress bar, charts
2	Virtual instructor for fitness.	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	Charts for sleeping
4	0	0	0	0	0	0	0	Log and charts for weights.
5	0	0	0	0	0	0	0	Progress bar and charts
6	0	0	0	0	0	0	0	Progress bar and charts
7	0	0	0	Get support from team coach	users have ranks.	0	Compete with your team members	Progress bars.
8	0	0	0	0	users have ranks.	0	0	Progress bars, charts
9	0	0	0	0	0	0	0	Progress bars.
10	0	0	0	0	0	0	0	Progress bars.
11	0	0	0	0	Ranking system based on the time of running.	0	0	Progress bars.
12	0	0	0	0	0	0	0	Charts.
13	0	0	0	0	Ranking system	0	0	Progress bars and charts
14	0	0	0	Run as a team with friends.	Ranking system	0	Compete with others	Progress bars.
15	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	Charts.
17	0	0	0	0	Ranking system	0	Compete with others	Progress bars.
18	0	0	0	0	0	0	0	0
19	0	0	0	Users can do their goals as a team.	0	0	0	0
20	0	0	0	0	0	0	0	0
21	Virtual gym instructor.	0	0	0	0	0	0	0

22	An avatar for selecting the body parts of symptoms.	3D avatar	0	0	0	0	0	0
23	Virtual instructor.	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0
25	0	0	0	0	Ranking system	0	0	Progress bars.
26	0	0	0	0	0	0	Competitive games	Progress bars.
27	0	0	0	0	0	0	0	0
28	Virtual instructor.	0	0	0	0	0	0	Progress bars.
29	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0
31	0	0	0	0	Ranking system	0	0	Progress bars.
32	0	0	0	0	0	0	0	0
33	0	0	0	0	Ranking system	0	0	Progress bars.
34	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	0	Progress bars.
36	0	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	Progress bars.
38	0	0	0	0	0	0	0	Progress bars.
39	0	0	0	0	Ranking system	0	0	Progress bars.
40	Virtual instructor.	0	0	0	0	0	0	0
41	0	0	0	0	Ranking system	0	0	0
42	0	0	0	0	0	0	0	0
43	0	0	0	0	0	0	0	0

44	0	0	0	0	0	0	0	Progress bars.
45	0	0	0	0	Ranking system	0	0	Progress bars, charts.
46	0	0	0	0	0	0	0	0
47	0	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0	Progress bars.
49	Virtual instructor.	0	0	0	0	0	0	0
50	0	0	0	0	0	0	0	0

Table 3: corresponding gamification elements used in top 50 applications in Apple App Store in the Health & Fitness category. 0 represents the gamification element is not used in the application.

Appendix B. – Interview questions

The interview questions:

MARS questions

How does each designed gamification elements increases app's engagement / entertainment?

1 Dull, not fun or entertaining at all
2 Mostly boring
3 OK, fun enough to entertain user for a brief time (< 5 minutes)
4 Moderately fun and entertaining, would entertain user for some time (5-10 minutes total)
5 Highly entertaining and fun, would stimulate repeat use

Does each designed gamification elements present its content in an interesting way?

1 Not interesting at all
2 Mostly uninteresting
3 OK, neither interesting nor uninteresting; would engage user for a brief time (< 5 minutes)
4 Moderately interesting; would engage user for some time (5-10 minutes total)
5 Very interesting, would engage user in repeat use

How good does the gamified app looks (compare to non-gamified application)?

1 No visual appeal, unpleasant to look at, poorly designed,
2 Little visual appeal – poorly designed, visually boring
3 Some visual appeal – average, neither pleasant, nor unpleasant

4 High level of visual appeal – seamless graphics – consistent and professionally designed

5 As above plus very attractive, memorable

How many times do you think you would use this app (before and after gamification) in the next 12 months if it was relevant to you?

1 None
2 1-2
3 3-10
4 10-50
5 >50

Heuristics questions

Are gamification elements shown at the appropriate time? Is the feedback of gamification appropriate?

Is the communication between the feedback of gamification element and a user clear? Are gamification elements clearly displayed? Is there any way to improve it?

Can everyone perceive the implemented gamification elements in the same way? Do experts have more advantages than non-experts?

Appendix C. – Interview results

The result of the interviews.

	Avatar	Story	Feedback
Entertainment	4	2	2
Interesting	4	2	3

Table 4: Average entertainment and interesting components score for each designed gamification elements.

Visual appeal after including elements	4
The application usage if it was relevant to them in next 12 months	4 - 10-50

Table 5: Average visual appeal and application usage score for the prototype.