Gamification in health and fitness applications to improve your health!

A literature review on the effects of gamification in health and fitness applications on health literacy and adherence

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1. Abstract

The goal of this paper is to examine the effects of gamification in health and fitness applications on health literacy and adherence. This is done by performing a systematic literature review of the literature regarding these subjects. Based on the available literature two hypotheses were formulated. The hypotheses were subsequently tested by means of systematic review of 15 carefully selected studies into each subject. The inclusion criteria for the studies were gamification as dependent variable and health literacy or adherence as independent variable. This review suggests that gamification in health and fitness applications has a positive effect on health literacy, but no positive effect on adherence. The results also imply that the effect on adherence fades away over time and that social gamification features do have a positive effect on adherence in comparison to other gamification elements.

2. Introduction

There is a revolution happening in the modern healthcare sector. Digitalization of society has forced the inception of eHealth applications. eHealth refers to healthcare services provided by information and communication technology (ICT)(Moss, Süle, Kohl, 2019). There are over 325,000 eHealth applications available and approximately 1000 new applications are being published every month (Pohl, 2017). These applications are designed to help people to obtain healthy habits or a healthy lifestyle. There are many health issues that are a threat to modern society at the moment, including, but not limited to, smoking, obesity, mental health, unsafe sexual practices, alcoholism and drug abuse (WHO, 2021). eHealth applications can be used to assist medical professionals in every aspect, from prevention of disease to providing information and therapy adherence. In a world where digital communication has become the standard for communication, eHealth applications are designed to communicate effectively to bring about behavioral changes that encourage a healthier lifestyle.

With over 6 billion mobile phone subscribers and a rapidly growing mobile application market, there is an increasing importance for mobile health (mHealth) solutions within the field of eHealth (Tomlinson et al., 2013). mHealth solutions are eHealth programs but specifically designed for mobile devices, usually in the form of a mobile application. Around 60 percent of mobile phone owners in the United States have downloaded one of these applications for personal health (Krebs & Duncan, 2015). mHealth solutions make use of the technological advantages of mobile devices to facilitate health care and deliver health information and services (Nilsen et al., 2012). These advantages include GPS, mobile web

access and the ability for pop-ups or notifications, designed to interact with users. With these advantages, mHealth solutions provide health care professionals with a useful tool to tackle unhealthy lifestyles in individuals.

Unhealthy lifestyles often start with a lack of physical activity, which can lead to being overweight. Being overweight is one of the most pressing concerns in the current age. An alarming number of children and adolescents are overweight, due to lack of exercise and an unhealthy diet. The World Health Organization has declared obesity a global epidemic and claims that 1 billion adults are overweight. Besides the health issues, obesity also imposes a large economic burden on society, as obesity costs account for 6% of global health care costs (WHO, 2021). Reasons for the obesity pandemic are the availability of inexpensive calorie dense food and technologies that reduce or replace physical activities (Meldrum et al., 2017). mHealth applications aim to make use of the popularity of the technologies that are causing unhealthy habits to undo these effects.

Health and fitness applications are mobile tools for users to obtain a healthier lifestyle. In many countries fitness, being physically fit and healthy, is a priority (Philips et al., 2010). Fitness can be achieved through a balance between proper exercise, diet and sleep habits. Health and fitness applications support users in achieving these goals in different ways. Most of the health and fitness applications focus on physical activity and weight loss, actively encouraging and tracking physical activities. Other health and fitness applications are dedicated to inform users about healthy decisions and about a healthy lifestyle, and thereby increasing the health literacy of the user. The applications in general are increasing in popularity and use, and have proven to improve physical activity, according to Joseph et al. (2014). However, fitness applications seem to struggle with user continuance, because users tend to quit the applications before reaching their fitness goals (Murnane et al., 2015).

An important component of mHealth solutions that combats users quitting early, is interactivity. Due to the nature of health applications, interactivity might be crucial for the success of mHealth solutions. Health applications aim to change behaviour, which can be a lengthy process to achieve. Continued interactions with the application therefore significantly increase the chances of success for the applications. Higher levels of interactivity lead to greater user satisfaction and repeat use, according to Willoughby and L'Engle (2015). Because high interactivity leads to repeat use, it is an important predictor for long term engagement. Long term engagement can be defined as the degree of voluntary use of a system over a long period of time, involving meaningful interactions (Febretti and Garzotto, 2009). Research regarding long term engagement in mHealth applications suggests that some

mHealth applications lack long-term engagement (Conroy, Yang, & Maher, 2014). This lack of long term engagement might be explained through perceived interactivity.

Several studies have concluded that the presence of interactive features does not guarantee higher perceptions of interactivity among users (Bucy & Tao, 2007; Chu & Yuan, 2013; Song & Zinkhan, 2008; van Noort, Voorveld, & van Reijmersdal, 2012; Voorveld, Neijens, & Smit, 2011). This means that it is hard for application designers to turn interactivity into engagement. This can be attributed to a lack of understanding theory and motivational techniques in the design process of the applications (Shute, 2014). So in order for mHealth solutions to be considered successful, it is not only important to be interactive, but it is important that the interactivity leads to long term engagement. In search of a solution to fulfill the needs for engagement, mHealth solutions have turned to gamification.

Gamification is the use of game-related elements in a non-game context (Basten, 2017). It is a design-technique to increase levels of engagement with apps, using the basic design elements of games to keep users engaged and/or interested. There are various levels to gamification; application designers might take elements straight out of games and implement them in their application, or use a game design process when developing their application. The basic principle remains the same; games are designed to keep the user engaged and gamification builds on this concept in a non-game context. Gamification might therefore be an important tool for mHealth solutions to keep users engaged and up to date on their progress to a healthier lifestyle.

In order to understand the relationship between gamification in health and fitness applications and health and fitness goals, this paper will review existing literature on the topic. Unhealthy eating habits and lack of exercise have caused obesity to rise to all-time high levels in western countries. At the same time, mHealth applications are of increasing importance to deliver healthcare services to users. The total digital health services market is expected to grow 25% annually, as more and more people rely on their mobile devices to access health-related information. It is therefore important that health applications are developed in an efficient manner.

More recent studies focus on the effectiveness of gamification on specific mhealth applications, often specifically designed for the study. For example, Cechettie et al. (2019) investigated gamification methods in an mHealth application specifically designed for hypertension monitoring and developed two different versions of the application. Despite some studies that have given some insight into how gamification has an effect through those specific applications, little is known about the effects of gamification on different general

goals of health applications. Therefore, this paper explores the relationship between gamification in fitness and health-related factors, namely therapy adherence and health literacy. This paper aims to answer the question: does gamification in health and fitness applications increase user adherence and health literacy? This literature review will further examine the role of gamification in fitness applications, which will be useful for health professionals and the designers of health interventions. The paper is organised as follows. First, the concepts of gamification, fitness applications, health literacy and user adherence are explained. In section 4, the search method for finding relevant literature is presented. The results of the analysis are given in section 5. Last, the results and implications are summarized and discussed in section 6.

3. Theoretical background

3.1 Fitness

Fitness is the state of being physically fit and healthy (Higgins, 2016). This can be achieved through physical activity, a healthy diet and good sleeping habits. Physical activity refers to all movement, like walking, sports or weightlifting, and can be done at every level of skill (WHO, 2021). Regular physical activity has proven to increase overall fitness, as well as many other benefits like increasing disease prevention and increasing mental health. Despite the many advantages of regular physical activity, it is estimated that 1 in 4 adults globally do not engage in enough physical activity to be considered healthy (WHO, 2021). In order to reach fitness goals or overall health, more and more people turn to mHealth applications focussed on fitness. In 2010, around 60% of smartphone owners had at least one mHealth application installed on their mobile device (Proudfoot et al., 2010).

3.2 Health and fitness applications

mHealth is a subset of eHealth. eHealth is healthcare that is supported by electronic means (Liu, Zhu, Holroyd & Seng, 2011). When eHealth is presented on mobile devices, it can be referred to as mHealth (mobile health). mHealth applications make specific use of mobile technologies, such as smartphones, tablets and the internet (Free, 2010). mHealth is usually designed in the form of an application or a web-based program. The accessibility of mHealth applications present various advantages over traditional health care. It is cost-effective, easy to scale up and improves the quality of care (Sun, Guo, Wang & Zeng, 2016). Consumers use

mhealth applications to monitor their lifestyle, change their behaviour, educate themselves or for chronic disease management (Free et al., 2010).

Health and fitness applications are mHealth solutions that focus on physical activities and health literacy. These applications aim to monitor and stimulate physical activities, in order to support healthy behavior changes. Most of the health and fitness applications are focused on self-monitoring (Sama et al., 2014). It is found that after the initial adoption of health related applications, people's use of the application frequently only lasts for a short period of time (Cho, 2016). Low sustained usage of health and fitness applications is detrimental to the users as well as the health developers behind the app. The health professionals behind the application receive little data and feedback and will most likely not derive financial benefits from subscriptions, in-app purchases and advertisements (Chiu et al., 2020). Lacking continued use of a health and fitness application may negatively affect the health-related behaviors of users (Cho, 2016), which means that when a user disengages form the app, he or she is also likely to disengage from the health goals she was trying to achieve using that health and fitness application. It is therefore also in the best interest of the users to design applications that facilitate interactions with the application, also known as user engagement.

3.3 User engagement

User engagement in applications refers to the perceived quality of the user experience that emphasizes the positive aspects of interacting with the application and the desire to use the application for an extended period of time (Lalmas et al., 2014). It consists of user attitudes, goals and mental models and motor skills, but, most importantly, users activities on applications (Kappelman, 1995)(Said, 2004). User engagement reveals user curiosity, attention, intrinsic interest, attention and motivation (Chapman, 1997).

User engagement is crucial in mobile technologies; successful technologies are not just usable, they *engage* users (O'Brien & Toms, 2008). In an organizational context, high levels of engagement significantly increase the chances of success (Harter et al., 2002). But for many health applications, user engagement is required in order to be effective (Böhm et al., 2020). This is because of the nature of health care; medicines often need to be taken over a longer period of time to be effective and physical activity only improves your health when it is done on a regular basis. There are several ways to increase engagement in applications, like increasing authenticity, currency, contextualization of advice and encouraging a sense of community (Smith et al., 2017). But there are also ways to increase user engagement from a

design standpoint. A technique that is being used in mobile applications and has been very popular in health and fitness applications to increase engagement is gamification.

3.4 Gamification

In the last decade, gaming has become increasingly popular all over the world and has cemented a permanent role in the daily lives of many people. In 2014, 59% of the population played computer games and the entire gaming industry brought in 15 billion dollar in revenue (ESA, 2014). In 2020, this number has risen to 179.7 billion dollars (IDC, 2020). The explosive popularity of gaming has increased the quality and diversity of the games offered to the market today. The developments in this industry, in particular the designing of games, have since transcended the boundaries of gaming and entered the mobile application realm. This development is called gamification.

The phrase "gamification" was first coined by Brett Terill in a blog post in 2008, describing it as "taking game mechanics and applying them to other web properties to increase engagement". Since Terill's blog, gamification has been frequently used in web and mobile applications, and some scholars have redefined the definition of gamification. Werbach's (2014, p1.) perspective at gamification comes from a designers point of view, and presents a more general definition of gamification as "the process of making activities more game-like".

But Deterding et al. (2011) define gamification as "the use of game design elements in non-game contexts". This definition has become widely used and accepted as the standard definition of gamification and will also be used in this paper.

Gamification is used in applications to turn otherwise mundane and uninspiring tasks into tasks that engage users and motivate users to complete the required task. Deterding et al. (2011) suggest that gamification uses elements of *gameful design*, *gameful interaction* and *gamefulness* with a specific intention in mind. In other words, gamification applies game elements to other contexts to make them feel more *game-like*. Gamification is essentially an umbrella term for all game-elements that can be used in non-game settings. Some of the most popular game elements used in for example health applications are the use of points, leaderboards, badges and rewards. Social incentives can also fall under the gamification umbrella; competing or collaborating with friends to obtain rewards or objectives originate in the gaming industry.

Games are powerful experiences that leverage motivation and engagement (Deterding, 2012). Motivation and engagement are crucial for the success of an application.

Given the general idea behind gamification it should improve engagement with the application and when engagement is improved, the application is more likely to succeed in its goals. The most common goals of existing health and fitness applications are improving health literacy and improving adherence to the applications health program.

3.5 Adherence

As mentioned earlier, continued app usage is an important predictor of success in mobile applications. This applies to the individual user, who is less likely to reach his or her goals when disengaging from an application, as well as for the designers of the application who will see their revenues drop and fail. This is particularly true for health and fitness applications; when users disengage from the applications, they are very likely to also disengage from the healthy behavior the app was stimulating (Huang et al., 2019). Therefore, it is extremely important for health and fitness applications to stimulate adherence to the program that is presented to them in the form of the health application. Adherence often derives from user engagement; without user engagement, users are less likely to want to continue using the application. Given the general idea of gamification mentioned earlier, namely the incorporation of game-elements in other applications in order to increase engagement and interactions, we expect gamification to have a positive effect on adherence in health and fitness applications (H1).

3.6 Health literacy

Over the years, the term “health literacy” has been defined and refined many times. Many scholars that have defined literacy agree that health literacy is an individual construct, rather than a group construct. When referred to in a group context, health literacy is conceptualized as “public health literacy”. The most used definition for health literacy in individuals comes from Ratzan and Parker (2000) and it was included in the Institute of Medicine report *Health Literacy: A Prescription to End Confusion* (2004). Ratzan & Parker defined health literacy as the degree to which individuals have the capacity to obtain, process, understand and communicate about health-related information needed to make informed health decisions. This is the definition that is being used in the context of mHealth solutions, because health literacy is measured on an individual level. According to the theory behind gamification, in regards to health literacy. Therefore we expect gamification in health and fitness applications to have a positive effect on health literacy. (H2)

4. Method

In order to answer the question: “How does gamification facilitate fitness applications in increasing user adherence and health literacy?” this paper will review existing literature on the subject. A literature search was performed in the following databases: *Google Scholar* and *Web of Science.* The search queries that were used to find the literature were:

“gamification & mHealth”
“gamification & “health literacy”
“gamification” & “adherence”
“gamification” & “therapy adherence”
“gamification” & “mHealth” & “adherence”
“gamification & “mHealth” & “health literacy
“game elements” & “health literacy”
“Gamificiaton” & “fitness adherence”

These search queries were used on both databases and for all fields. After the initial database searches, a focused search within the databases was conducted using the following criteria: the article must be written in English and must be published no earlier than 2010. The main subject must be gamification in health applications.. After this, the search was further refined to only include studies in which gamification was the independent variable. In addition, the experimental studies in which adherence and health literacy were dependent variables were selected.

5. Results

In this section the research question and the hypotheses will be researched and tested. Firstly, the hypotheses that gamification has a positive effect on adherence in health and fitness applications will be tested. Secondly, the hypotheses that gamification in health and fitness applications has a positive effect on health literacy will be tested. Out of the 15 studies that were found for this review, seven had health literacy as subject and eight studies had adherence as subject. All studies used in this review were experimental and manipulated gamification, albeit that not all studies had a control group.

5.1 Adherence

The first hypothesis is: gamification in health and fitness applications has a positive effect on adherence. To test this hypothesis, eight studies (Maher et al., 2015; Ahn et al., 2019; Chen et al., 2014; Kurtzman et al., 2018; Kuramoto et al., 2013; Chen & Pu, 2014; Thorsteinsen et al., 2014; Löwensteyn et al., 2019; see Table 1) were tested. The results of these studies are discussed below.

Table 1. Overview of studies regarding adherence used in this literature review

Authors	Year	Subject	N	Context
Maher et al.	2015	Adherence	110 adults	Physical activity
Ahn et al.	2019	Adherence	67 children	Physical activity
Chen et al.	2014	Adherence	24 students	Physical activity
Kurtzman et al.	2018	Adherence	196 obese patients	Weight loss
Kuramoto et al.	2013	Adherence	9 students	Standing up
Chen & Pu	2014	Adherence	36 adults	Physical activity
Thorsteinsen et al.	2014	Adherence	20 adults	Physical activity
Löwensteyn et al.	2019	Adherence	189 company employees	Overall health / physical activity

The eight studies that investigated the relationship between gamification and therapy adherence showed very mixed results. There were also many differences in experimental design and in the manipulation of gamification. Three of the studies manipulated gamification in a social context and were focused on physical activity (Maher et al., 2015; Chen et al., 2015; Chen & Pu, 2014). All of these studies indicated a positive effect of a socially gamified application on adherence, but in the study conducted by Maher et al. (2015) the positive effect disappeared over time. The adherence of the participants had significantly increased after an 8 week period, but the increase at the 20 week interval was lost. Despite

not having found a significant relationship over time, the researchers observed high levels of engagement with the intervention and the self-monitoring features. These results give rise to doubt about the relationship between gamification and adherence, as theory indicates that high levels of engagement should generally lead to better adherence.

The other two studies that manipulated gamification in a social context showed significant positive effects on adherence. However, the study conducted by Chen et al. (2015) did not have many participants (12 dyads) to be able to generalise the results. What is interesting though, is that in this study the focus was on social accountability and the researchers also investigated three different kinds of social accountability settings. All three settings showed significant results in comparison to the baseline results. During the experiment, a participant would receive Karma points for exercising. In the competition setting, the dyads would compete for the most points, in the hybrid setting the points of both players were combined and in the accountability setting only the points of your partner would count. The results have shown that the hybrid setting leads to better adherence and more social contact between the duo-members.

These results are in line with the results of a very similar study by Chen & Pu (2014), where the participants were also paired up in dyads and social incentives were measured in the same three settings as in the study mentioned above. The only noteworthy differences were the intervention itself and the greater number of participants. The results of these two studies validate each other and suggest that in social gamified interventions, working together leads to greater adherence than competing with each other. Overall, the findings of these studies, which conceptualize gamification in a social context suggest that this (social) form of gamification has a positive effect on adherence.

Adherence is strongly dependent on the duration of a program or intervention, so the most attention should be paid to the study conducted by Lowensteyn et al. (2019). The intervention in this study was a gamified wellness program for employees of a national company located in Canada, with a duration of 2 years. The intervention incorporated gamification strategies whenever possible, Even though the primary outcomes were the participation rates, the study is very relevant in this research as weekly physical activity and general health, as well as engagement were the secondary outcomes. The researchers found significant improvements in general health and weekly physical activity, suggesting that the gamified intervention has a positive influence on the adherence of the wellness program. The longitude of this study provides valuable insight into adherence, despite the lack of a control group to compare the results to.

Of the eight studies regarding adherence, three studies have shown that gamification did not have a positive effect on adherence (Ahn et al., 2014; Kurtzman et al., 2018; Thorsteinsen et al., 2014). The study by Thorsteinsen et al. (2014) did find a significant short-term effect, but the effect was lost at the end of the study after 12 weeks. These results are somewhat similar to the results of the study conducted by Maher et al. (2015), suggesting that gamification does have a short term effect on adherence, but the effect was lost over time. The studies conducted by Ahn et al. (2014) and Kurtzman et al. (2018) did not find a significant effect of gamification on adherence at all, which is surprising. For the study by Ahn et al. (2014), an explanation might be found in the participants. The participants were young children, for which the motivations for physical activity can be very complex, as the researchers themselves explain. The gamified intervention might not have made much difference in comparison with the control group, because the children were already intrinsically motivated to engage in physical activity.

The study conducted by Kuramoto et al. (2014) only had 9 participants, so it is very difficult to generalise the results. At first, the results of the 12 week program were promising as adherence increased over time. As the participants adhered to the program, they would receive digital equipment items for their avatar. However, when the researchers ran out of items to (digitally) give to the avatars of the participants, the motivation and performance of the participants dropped. Given that the only thing that changed was the collecting of equipment items, we can assume that this element of gamification had some effect on the participants adherence, despite the small sample size.

We were not able to detect an effect of gamification on adherence, as the results of the studies regarding adherence were very mixed. The results of this review do indicate that of the gamification elements that were manipulated in the studies, the social gamification incentives have the greatest positive impact on adherence. Furthermore, the results also suggest that gamification has short term effectiveness on adherence. In the long term, the findings of this review indicate no positive relationship between gamification and adherence.

5.2 Health literacy

The first hypothesis is: gamification in health and fitness applications has a positive effect on health literacy. To test this hypothesis, seven studies (Allam et al., 2015; Haruna et al., 2021; Parisod et al., 2018; Azevedo et al., 2019; Haruna et al., 2018; Higtow-Weidman et al., 2018; Ingadottir et al., 2018; see Table 2) were tested. The results of these studies are discussed below.

Table 2. Overview of studies regarding health literacy used in the literature review

Authors	Year	Subject	N	Context
Allam et al.	2015	Health literacy	157 rheumatic patients	Disease
Haruna et al.	2021	Health literacy	108 students	Sexual health
Parisod et al.	2018	Health literacy	151 early adolescents	Smoking
Azevedo et al.	2019	Health literacy	877 families	Nutrition
Haruna et al.	2018	Health literacy	120 students	Sexual health
Hightow-Weidman et al.	2018	Health literacy	20 HIV patients	Disease
Ingadottir et al.	2018	Health literacy	20 patients	Pain management

Out of the seven studies that manipulated gamification to examine its effect on health literacy, 6 reported a significant positive effect. Even more encouraging is the fact that these studies have very diverse themes, ranging from sexual health awareness to nutrition.

Of the six studies that reported a significant positive effect of gamification on health literacy, the least importance should be attributed to the studies conducted by Ingadottir et al. (2017) and by Hightow-Weidman et al. (2018). In the study conducted by Ingadottier et al. (2017), participants evaluated the usability, user experience and efficacy of a computer-based game about post-operative pain management. They did this using self-reported questionnaires. In the study conducted by Hightow-Weidman et al. (2018) participants evaluated a novel, theoretically-based smartphone application, designed to improve engagement in care and adherence to HIV therapy adherence.

Not only did these studies have the least number of participants (N=20), these were also the only studies that did not have a control group. The researchers of both studies indicated themselves that to further investigate the effects they were looking into, scaling up the sample size would be preferable. Even though the results of the study are promising and in line with the theories about gamification and with the other studies, the sample size is not big enough to draw concrete conclusions.

The studies by Parisod et al. (2018) and Haruna et al. (2019) show a lot of similarities in experimental design as well as in the results found. The relatively large sample sizes in Parisod et al. (2018)(N = 151) and Haruna et al. (2019)(N = 105) and the presence of control groups provide for robust results. The manipulation of 'gamification' also shows many similarities, as in both studies the gamified intervention consisted of points, badges and leaderboards. In Haruna et al. (2019), there was a non-gamified intervention in the form of conventional instructions. In Parisod et al. (2018), the non-gamified intervention consisted of a website instead of an application. In both studies, the participants assigned to the gamified intervention outperformed the participants assigned to the non-gamified intervention in aspects of health literacy. In Haruna et al. (2019) these were learning outcomes and sexual health literacy and in Parisod et al. (2018) it was tobacco-related health literacy.

There was very little difference in sample size and the age of the participants (in both studies the participants were children in lower secondary school) between the studies, which improves the reliability of the outcomes. The fact that the two studies are so similar and show very similar effects of gamified interventions on health literacy are very encouraging. What is even more encouraging is that the two studies were focused on very different health-related issues. Where the study by Parisod et al. (2018) was focused on smoking, Haruna et al. (2019) research revolved around sexual health. The only remark to this comparison is that the study by Parisod et al. (2018) was focused on short-term effectiveness, whereas the other study by Haruna et al. (2019) was more focused on health literacy over a longer period of time.

When we look at sample size and experimental design, the results of the study conducted by Azevedo et al. (2019) should bear the most weight. The presence of a control group and the fact that gamification was manipulated in a way similar to the other studies make for trustworthy results. The gamified intervention used social features and challenges to incentive engagement with the application. Health literacy was measured on various levels. This study, which was focused on nutritional literacy, measured nutritional literacy on several levels, such as knowledge about nutrition, but also practical- and communicative skills regarding nutritional information. The results of the study show a significant difference in nutritional literacy between the control group and the intervention group, in line with the expectations of the researchers and with the results of other studies.

Only one of the six studies investigated if there were any differences between gender regarding gamification and health literacy. The study conducted by Haruna et al. (2021) delivered sexual health lessons to students in three experimental settings: sexual health

lessons using serious games, gamified sexual health lessons and conventional sexual health lessons. Both experimental groups had a significant increase in learning outcomes, whereas the group receiving conventional sexual health lessons did not. This study focused on education about health; a part of health literacy that has not been researched often. Next to learning outcomes, the researchers also looked into differences in learning outcomes between genders. For all conditions, no significant results were found between boys and girls.

The only study that did not show a positive effect of a gamified intervention on health literacy was the study conducted by Allam et al (2015). The gamified intervention in this study was similar to other studies; standard gamified elements such as points, leaderboards and badges were implemented. The reason for the deviant results in this study might lie in the design of the experiment theme and the participants. All participants were rheumatoid arthritis patients. Knowledge about the condition was a secondary outcome, while physical activity, health care utilization and medication overuse were primary outcomes. The intervention therefore was not designed to increase knowledge, but to stimulate the primary outcomes. Also, the age of the participants was much higher in this study compared to the other five; it is comprehensible to assume that it is harder to process and absorb knowledge at a higher age. These factors and the fact that this study focused specifically on rheumatoid arthritis might explain the deviant results of this study in comparison to the others.

To conclude, we have found a positive relation between gamification and health literacy in six out of seven researched articles. Even more encouraging is the fact that these studies have very diverse themes, ranging from sexual health awareness to nutrition. The expectation that gamification leads to better health literacy is therefore confirmed.

6. Discussion

The goal of this paper was to examine the effects of gamification in health and fitness applications on health literacy and adherence. Gamification is a promising design technique that aims to improve engagement in other fields than games, for example in the mobile health sector. When engagement is improved in health and fitness applications, users are more likely to achieve their health goals (Cho, 2016). There have not been many studies regarding this subject, while the mHealth sector and people relying on health care are continuously growing. It is therefore important that the literature is discussed. Based on the available literature regarding this subject two hypotheses were formulated. The hypotheses were subsequently tested by means of systematic review of 15 carefully selected studies into each subject.

6.1 Adherence

The results of the eight studies discussed (Maher et al., 2015; Ahn et al., 2019; Chen et al., 2014; Kurtzman et al., 2018; Kuramoto et al., 2013; Chen & Pu, 2014; Thorsteinsen et al., 2014; Löwensteyn et al., 2019) regarding the first hypothesis about adherence, did not suggest that gamification in health and fitness applications stimulates adherence. Four out of the eight studies did not find a positive effect of gamification in health and fitness applications. This might be attributed to the various ways in which gamification was manipulated between these studies. Some studies went with standard gamification aspects like badges and points, where others choose for social features as the gamified intervention.

In the three studies that manipulated the same gamification element, namely social features, the results were more consistent. These three studies indicated a positive effect of gamification on adherence. They all manipulated gamification by adding social features to the application. However, the positive effect seemed to disappear over a longer period of time in two studies. This might indicate that the assumptions about the effects of gamification are incomplete, and lack knowledge about the long term effects. It might not have been researched enough, so it would be very interesting for future research to further investigate the effect over time. Future studies might shed new light on the long-term effects of gamification. Long term engagement is especially important for adherence, because adherence is measured over a period of time. The results of this study also give rise to further examination of whether the social aspect of gamification indeed positively impacts adherence. Hopefully, this study provides a first step for research to focus on the long-term effects of gamification in health and fitness applications, improving therapy adherence and overall health.

It is crucial that further research is done regarding gamification and adherence because therapy adherence is one of the most important factors in achieving a healthier lifestyle. Well designed applications might improve therapy adherence for obesity patients, which would increase overall health for the patients and cut health care costs. Gamification might still be the solution. The results of this review reveal that gamification is promising, but has yet to prove to significantly increase adherence over a long period of time.

6.2 Health literacy

The results of the seven studies discussed (Maher et al., 2015; Ahn et al., 2019; Chen et al., 2014; Kurtzman et al., 2018; Kuramoto et al., 2013; Chen & Pu, 2014; Thorsteinsen et al.,

2014; Löwensteyn et al., 2019) regarding the second hypothesis about health literacy, suggest that gamification in health and fitness applications does improve health literacy. Six out of the seven studies had found a positive effect. The results of these studies also suggest that gamification is not dependent on the aspect of health care the application is focused on and can therefore be addressed to the manipulation. The various contexts of the studies show us that gamification is effective regardless of the subject and improves overall health literacy. This paper can therefore state that gamification is a useful tool for all health applications focused on health literacy.

In the only study that did not find a significant effect, health literacy was not a primary outcome. The goal of the manipulation was therefore not to increase health literacy, which may have affected the results. The results are nevertheless valuable for health professionals and application designers. They might take these results into consideration when developing an efficient mHealth solution. It is also good news for application users; when better and more efficient applications are designed, the user will be more knowledgeable about health care which may lead to disease prevention or an overall healthier lifestyle.

6.3 Limitations and implications

There are some limitations to this study. The number of studies reviewed was fairly limited, with only fifteen studies. These studies were also divided into two different subjects (adherence and health literacy) which means that only seven or eight studies were taken into account for each hypothesis. This does however provide an opportunity for further research, also into the two different subjects. For health literacy, future research can confirm the suggestions this study makes and validate our findings regarding the effects of gamification on different aspects of health. For adherence, our findings give rise to more questions than answers, which means that further research is very interesting. Our findings also give rise to the idea that the social element of gamification does indeed have a positive effect on adherence. To further examine this effect and help improve adherence, further research into adherence should make a split between social gamification and non-social gamification.

Because gamification was manipulated in various different ways, we can not yet identify which gamification elements work best in terms of adherence and health literacy. Future research would therefore benefit from continuing to manipulate gamification in different ways. Gamification stands for different ways of incorporating game elements, like social features or badges and challenges. It would be very interesting to see the results of the

different elements as it would provide us with more insight into what parts of gamification actually has an effect on health literacy or adherence. Perhaps health literacy and adherence would benefit from different gamification elements.

A point of criticism might be that some studies discussed in this paper did not have a control group. Without a control group, it is hard to isolate manipulation. As a result, it is hard to attribute the effects that were found to the manipulation. Other factors could have influenced the results as well. In order to avoid this, future research would benefit from designing experiments in which there is a control group, which is not assigned to a gamified intervention but a conventional intervention.

6.4 Conclusion

Altogether, we can conclude that gamification in health and fitness applications increases health literacy, but does not increase adherence. Health applications that are focused on health literacy benefit from using gamification in their applications, as is in line with the theory behind gamification. The results regarding adherence might be somewhat surprising, given that the existing literature on gamification suggests that gamification increases engagement, which should theoretically last over a longer period of time. We know now that the limited research into this subject is inconsistent. This review has proven that there is still work to do in this space. More research focused on long lasting effects of gamification is needed to build towards a definitive answer, to ultimately assist health care professionals with providing efficient, good care through their mobile device.

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8. Appendix

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