Ilmenau University of Technology
Institute of Media and Communication Science
Department of Media and Communication Management

Supervisor: Dr. Daniel Schultheiss

Silver Gamification

Exploring potential gamification elements for the elderly

Research Module Economic, social and psychological impact on gamification

Author 1:	**Author 2:**
Niclas Deißler	Fabian Liebrich
niclas@digitalfit.de	fabian@digitalfit.de

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Abstract

Activity in general is good for the overall wellbeing of elder people. Not just the physical health but also mental abilities can be strengthened by daily motion. Physical activity on a regular basis is well reputed as preventive measure. Despite this evidence, most elderly people are not as active as they should be. As a consequence there is a need for effective strategies to promote walking activity. While there have been a number of studies examining health-related games, far too little attention has been paid to the effects of gamification elements on the elderly. In order to explore in which extent game-elements are effective for motivating the elderly to increase the personal motivation for physical activity a study was conducted in the form of an experiment. Therefore, elderly people were equipped with activity trackers and received different activity reports once a day (3 groups: non-gamified and two different gamified versions). This study was exploratory and interpretative in nature. Only one significant difference were found between the non-gamified report and both gamified reports combined. The major limitation of this study is the small sample of 17 participants and the short duration of 13 days. Future research could assess the long-term effects of gamification elements by increasing the duration. In addition it is suggested to increase the sample size and to develop an app in order to provide direct feedback.

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1 Introduction and Background

As the global population ages, modern healthcare systems are increasingly struggling to reach a high standard in quality of service. According to the *World Health Organization* (WHO), from 2000 to 2050, the percentage of citizens over the age of 60 is expected to double from approximately 11 percent to 22 percent, whereas the number of those over the age of 80 and older is expected to multiply fourfold over the same period (WHO, 2015).

This substantially impacts on the healthcare system and society in general. With age, physical functions decline gradually, leading to limited mobility, increased frailty, and more frequent and serious physical health problems. Inactivity is the most common cause of the loss of functional capabilities in elderly citizens. In fact, physical activity can reduce muscle weakness, degradation and even increase the ability of memorization in elderly adults (Goldspink, 2005; Kim, Lee, & Oh, 2015; Taylor et al., 2004). Therefore, especially for the elderly it is important to participate in physical activity on a regular basis. The risks of diabetes mellitus type 2, osteoporosis, depression, injury, some types of cancer and cardiovascular disease can also be reduced by maintaining activity (Kolt et al., 2012, p. 206). Despite this evidence, previous studies have reported that most elderly citizens are not as active as they should be (Diewald et al., 2015; Haley & Andel, 2010). For instance, two thirds of Europe's aging population[1] does not participate in physical exercise or sports (European Commission, 2014, p. 14). In addition to this apparent lack of interest in physical activity, respondents reported poor health, a fear of injury, a lack of companionship, a lack of sports or leisure facilities, and also a lack of transport opportunities as barriers to exercise.

This is particularly worrying, especially with simultaneous consideration of a weakening global economy and aging population, which means that some older people despite of their retirement arrangements have to work longer or even have to return to their old job (Tso, Papagrigoriou, & Sowoidnich, 2015). While regular exercise is a habit that does not come easily to most people of all ages, different kinds of incentives are used to force motivation. However, most incentives or initiatives to increase participation in physical exercise require substantial financial resources such as bonus programmes in health insurance. Furthermore, according to Teixeira, Carraça, Markland, Silva, and Ryan (2012), the long-term success of these interventions is questionable.

[1] Older people that never engage in physical activity (40%, falling to 27% of 40-54 year olds, 25% of 25-39s, and 20% of 15- 24 year olds).

Considering all of this evidence, it seems that there is a real need for effective strategies that encourage voluntary participation and a long-term commitment to physical activity on a daily basis. As a result, new approaches have been put forward to motivate people to be more physically active such as digital games, namely health games, or fitness apps and gadgets (FAGs) incorporating gamification elements.

Health games

Health games, also known as *exercise games* or *exergames*, use different types of sensors and input that require users to move in order to play and win the games, as for instance balance boards, dance pads, gym equipment, cameras, remote controls with accelerometers or heart rate monitors (Lieberman et al., 2011). Research suggests, that health games “may positively influence the physical, cognitive and emotional well-being of this demographic” (Gerling & Masuch, 2011, p. 2). These exergames also provide an opportunity to be physically active in the familiar surroundings of the home, thus overcoming the challenge of transportation to and from sports and leisure facilities for the elderly, who often are limited in terms of mobility (Lange et al., 2009). For these reasons a very important aim for game designers is to find an answer to the question how to motivate or make the elderly that are able to use these games in order to live a healthier life. The main advantage of exergames is the possibility to give real-time feedback on individual's performance, which encourages him to compete with himself or other users (Anderson-Hanley, Snyder, Nimon, & Arciero, 2011). In addition, they can be adjusted based on one’s personal ability, which increases the motivation to engage in physical activity - regardless of fitness level, strength or flexibility. This aspect is by far the most important, so Lange, Flynn, and Rizzo (2009), since the barrier ‘poor health’ is non-existent because the games can easily be tailored to every physical condition. A large number of studies on exergames and physical health with relevance to different target groups have been published, such as children (Biddiss & Irwin, 2010) and a broad range of ages (Mark, Rhodes, Warburton, & Bredin, 2008; Peng, Crouse, & Lin, 2013; Primack et al., 2012; Rahmani & Boren, 2012). Recently, a number of studies have been published on health-related games for the elderly (Brox, Fernández-Luque, Evertsen, & González-Hernández, 2011; Kayama et al., 2014; Liu, Liao, & Choe, 2014; Marin, Navarro, & Lawrence, 2011; Garcia Marin, Navarro, & Lawrence, 2011; Smith & Schoene, 2012; Taylor, McCormick, Shawis, Impson, & Griffin, 2011; Wærstad & Omholt, 2013; Wiemeyer & Kliem, 2012; Bleakley et al., 2013). It seems that exergames for the elderly attracted an ample of scholarly interest in the last years.

Gamification

However, another possibility for increasing activity is the integration of tools in everyday life or leisure activities of the elderly. Pedometers and other quantified systems try to create awareness of one's activity, however, in contrast to exergames it is considerably less persuading and motivating. A recent phenomenon that considers this problem is *gamification*, a term for "the use of video game elements (rather than full-fledged games) to improve user experience and user engagement in non-game services and applications" (Deterding, Sicart, Nacke, O'Hara, & Dixon, 2010, p. 2425). The gamification process has the specific objective of increasing user engagement and promoting behavioural changes. Although the concept was initially developed for the marketing sector, its potential is now being explored in other sectors, such as the environment, government or education and healthcare (Simões, Redondo, & Vilas, 2013). In recent years, there has been an increasing amount of literature on gamification also taking into account the beneficial aspects on physical health (Kharrazi, Lu, Gharghabi, & Coleman, 2012; Hamari & Koivisto, 2013; Hamari, Koivisto, & Pakkanen, 2014; Hamari, Koivisto, & Sarsa, 2014; Kamel Boulos et al., 2015; King, Greaves, Exeter, & Darzi, 2013; Lister, West, Cannon, Sax, & Brodegard, 2014). The initial research focus was on early-phase piloting and development, with various trials providing preliminary evidence on the efficacy of gamification elements integrated in FAGs, including an increasing amount of randomised controlled trials. A glance at the most popular fitness apps available today shows that they incorporate gamification elements (Schollas, 2014, p. 6). Nike claims that their Nike+ running community comprises approximately 18 million members since it was launched in 2006 (Nike), that enables users to track runs, earn points and challenge Nike+ community members.[2] The apps allowing users to collect points, compare their performance statistics in leader boards or participate in challenges. Three years later the mobile fitness company *Runtastic* was founded, which surpassed the 70 million[3] membership mark in a short period of time. A study that focusses on gamification elements in an app for elder people was conducted by Oliveira, Cherubini, & Oliver (2010). The app *MoviPill* tries to improve patient's medication compliance by rewarding the intake of medication. The closer the users take their pills to the time prescribed by the physician, the more points they earn. Their study showed, that patients took their medication 43% closer to

[2] Nike Running App: http://nikeinc.com/news/nike-evolves-just-do-it-with-new-campaign
Nike Training Club App: http://news.nike.com/news/betterforit-together-fueled-by-a-global-community

[3] http://www.adidas-group.com/en/media/news-archive/press-releases/2015/adidas-group-acquires-runtastic/

the prescribed time. But since patients were also reminded by an alert to take their medicine, it is difficult to distinguish, whether gamification elements or the reminder were more responsible for the effects (Oliveira, Cherubini, & Oliver, 2010).

It can be said, that several studies have investigated the use of gamification-elements in effects of fitness-related related topics, but there is still insufficient considering the effects of gamification on the elderly (Gerling & Masuch, 2011). This is contrary to the many studies examining health games for the elderly (Friedl, Floerecke, & Lehner, 2015). What we know about gamification is largely based upon studies that involves younger participants. Although designers and researchers have identified the necessity to adopt these guidelines for programming a playful frontend design there still little scientific evidence whether and how gamification elements might benefit the same way for elderly people (Richins, 2015). In fact existing research already revealed that the common smartphone fitness apps like Runtastic or Nike plus don’t fit the needs of older people (Silva, Holden, & Nii, 2014, p. 347). Therefore, this study aims to explore how these elements will be accepted for a 60+ aged target group in an experiment that examines the influence of gamification elements on routine walking by using a gamified activity report.

2 Preliminary considerations

Physical and mental particularities of the elderly

Elderly people find it increasingly challenging to remain physically active as their mobility, flexibility and strength decrease with age. More and more they live in full-care nursing facilities, with staff struggling to encourage residents to stay physically and mentally fit, as well as socially active (Gerling & Masuch, 2011). According to Gerling, Schild, and Masuch (2010), aging affects the quality of life in three different ways:

- **Cognitive impairments** (e.g. memory loss, memory lapse) have a negative impact on problem solving and information processing skills. As a result, elderly people often suffer from a shortened attention span during complex tasks.
- **A decline in existing motor skills** results in the loss of fine motor skills and changes in posture and balance. Age also impacts negatively on motor learning of new skills. These physical impairments can also severely limit sensory processes that affect the elderly's ability to interact with their environment.
- **Chronic illnesses,** ranging from arthritis to severe heart conditions, have an injurious impact on the mobility of senior citizens.

It has been stated, that low levels of physical activity pose a risk factor for falls and injuries among older people. According to Nelson et al. (2007), many pre-existing medical conditions can be treated through regular movement. Exercise intervention trials have shown again and again that exercise has numerous benefits for the elderly, helping maintain mobility, physical functioning, muscle strength and balance, all of which can protect against falls. An increase of the daily routine walking can be seen as a sufficient exercise for elderly people since it is also proved to be a complex cognitive task (Hausdorff, Yogev, Springer, Simon, & Giladi, 2005). In addition, more intensive physical activity can increase the likelihood of falling if the elderly overexert themselves, exercise on rough terrain or fail to consult a medical professional on suitable physical activities (Gregg, Pereira, & Caspersen, 2000). Gerling & Masuch (2011) claim that game-like experiences can motivate elderly users to engage in physical or cognitive therapy in the long term. Even though gamified techniques may successfully motivate elderly people to be more active, additionally age-specific challenges persist. The elderly often lack experience in using digital technology and may already suffer from cognitive challenges caused by old age as well as a range of physical conditions that can limit mobility and physical activity (Gerling & Masuch, 2011). A target oriented design is therefore crucial to fit the needs of these users, but unfortunately the development of applications for elderly lags behind applications for all other age groups (Richins, 2015), which results in higher access barriers to gamified systems (Gerling et al., 2010). Furthermore, the lack of digital gaming experience urgently needs to be addressed, since younger users are more familiar with gaming systems and game elements. In addition, the used elements should be engaging and entertaining enough to encourage the elderly to increase their activity. It might be possible that some of the elderly are used to life-long routines and may be less keen to try something new and change their habits. Therefore, the applications and gadgets should integrate easily into day-to-day life, rather than being a tiresome and time consuming additional chore (Gerling & Masuch, 2011).

Identifying suitable gamification elements for the elderly

As mentioned above, gamification can be applied to various fields, such as motivating people to increase physical activity. In fact, this approach has proven highly successful in this field since users improve their health by challenging themselves or competing with others in a fun and engaging way. According to Mueller, Peer, Agamanolis, and Sheridan (2011), exercise is often unappealing since it requires physical efforts and time commitments. In order to guard against this, the gamification approach makes physical exercise more attractive, incentivises users to become active and in turn promotes the health benefits of exercise. Most typically, an element of competition is used to turn exercising into a game. This of course means there has to be a way to measure and compare participants' performances. Therefore tools need to be applied in order to measure and quantify physical activities.

Measuring physical activity becomes possible due to recently popularised – and suitable for the mass – technology that records athletic performance over distance and time (Grenz, 2014, p. 32). This means performances can be tracked regardless of the users' geographical location and compared over a period of time, thus highlighting improvements in fitness, endurance and strength. These technological advances enable the measurement of a range of data, which was previously harder to acquire and understand, such as body fat percentages, heart rates or sleeping patterns. Now it is possible to utilise this data in a gaming context.

Different incentive systems have been used over the years to motivate individuals to increase their physical activity. In the following section, the most common approaches for quantified systems and gamification elements were discussed.

Quantified systems offering self knowledge through numbers

Quantified systems measure one or several parameters and provide concrete numerical data, which can then be used to inspire reflection with regard to exercising habits and routines (Li, Dey, & Forlizzi, 2010). Schön (1983) differentiates between two different types of reflection: *reflection-in-action* and *reflection-on-action*. Reflection-in-action means the user reflects on data provided during exercising, whereas reflection-on-action refers to the contemplation of data on previous exercise sessions. According to Ploderer, Reitberger, Oinas-Kukkonen, and van Gemert-Pijnen (2014), both modes of reflection can potentially motivate users to alter their exercise habits.

Pedometers and Fitness Trackers are the most commonly available examples of a quantified system that promotes exercise. Pedometers are small gadgets, typically worn at the waist, which record and display the amounts of steps taken. Some pedometers can also calculate the calories burned and/or the distance travelled, but these measurements are often inaccurate (Tudor-Locke, 2002). Pedometers are widely used in clinical interventions to increase physical activity in combination with formal effectiveness assessments (Bravata et al., 2007). This evaluation process provides insight into how motivation works in the context of physical exercise. In contrast to indirect measures such as self-reports, pedometer-based studies are more reliable since the participants' activities are measured directly. In contrast to self-reports there are less influencing or artificial factors, since the participants are equipped with a pedometer and can conduct their normal daily routines (Kowalski, Rhodes, Naylor, Tuokko, & MacDonald, 2012, p. 148). Several studies showed that pedometer users increased their physical activity, which also resulted in reductions in weight and blood pressure of the elderly (Tudor-Locke, 2002; Richardson et al., 2008; Tudor-Locke, Hart, & Washington, 2009). This simple quantified system therefore has successfully induced behavioural changes. Pedometers are considered so effective because they enhance the wearer's awareness of physical activity (Tudor-Locke & Lutes, 2009) while also promoting walking as a form of exercise that can be done whenever convenient (Richardson et al., 2008). Being able to set targets for the amount of steps taken in a day is an additional motivational factor in pedometers. Regardless of whether the target is provided automatically by the device or by each individual user, research has found that the total number of steps taken is higher in users with a target than those without (Bravata et al., 2007). The role of goal setting in motivation has been widely studied by academics (Locke & Latham, 2002) and the HCI community (Consolvo, Klasnja, McDonald, & Landay, 2009).

Today, a number of more advanced quantified systems is available, such as the activity trackers *Fitbit Zip*[4] and Fitbit Charge[5] or apps, such as *Moves*[6] and *Apple Health*[7] which take use of the integrated smartphone sensors. These devices are accelerometer- or GPS-based trackers that present a range of data on physical activity, such as the number of steps taken, total calories burned, average speed or distance travelled. They are worn directly on the body, either around the waist, on the wrist or inside a shoe, and the collected data is presented on a website or mobile application for users to track their progress and set specific goals. Compared to classic pedometers, these systems go a step further to enhance the users' motivation.

Gamification for enhancing motivation

In addition to collecting and presenting data, most of the recent activity trackers and apps are using gamification elements, such as virtual rewards based on physical performance. Furthermore, they provide an opportunity for users to interaction, comparison and in some cases provide motivation and support for each other. Some researchers such as Deterding (2013) argue

[4] http://www.fitbit.com/de/zip
[5] http://www.fitbit.com/de/charge
[6] https://www.moves-app.com/
[7] http://www.apple.com/ios/health/

that goal setting and real-time feedback are already considered to be gaming elements themselves. However, the devices listed above primarily use goal setting and real-time feedback in non-gamified contexts. Regardless, researchers agree that these tools can facilitate reflection (Ploderer et al., 2014) and inspire behavioural change (Ashford, Edmunds, & French, 2010; Michie, Abraham, Whittington, McAteer, & Gupta, 2009).

The application of a gaming approach to physical exercise is assumed to make it more enjoyable and to motivate users to be more active. In their work, Deterding et al. (2011) suggest a hierarchy of game design elements, ranging from levels 1-5. Level 1 entails basic game interface design patterns, such as badges and rewards, leader boards or levels of completion. Level 2 encompasses game design patterns and mechanics, including time constraints, limited resources and player turns. Level 3 includes game design principles and heuristics, such as playtime duration and goals cleared in a variety of game styles. Level 4 refers to game models, such as challenge, fantasy or curiosity. Level 5 comprises game design methods, including playtesting, playcentric design and value-conscious game design. This study focuses on two elements of the first level: *badges* with regard to *virtual rewards* and a *leader board* as an instrument of *social comparison*, which aim to influence the users' behaviour and motivation directly.

3 Theoretical base

The concept of gamification is based on motivation, which can be differentiated in internal or external motivation. Internal motivation is driven from within, inspiring action because the individual considers the activity itself as meaningful, regardless of potential rewards. External motivation is driven solely by the promise of rewards, such as money, social status or achievement points (Hunter & Werbach, 2012; Zichermann & Linder, 2013). A differentiation of both concepts often proves to be difficult in practice. Nike+ Running for example motivates its members to be physically active. The desire of exercising more frequently or running faster can be considered to be internal motivation, while a supporting community and point rewards represent external motivation. According to the *self-determination theory* (SDT) motivation is determined by three psychological needs: *competence*, *autonomy* and *relatedness*. Satisfying these needs enhances internal motivation, while a failure to satisfy them might reduce internal motivation (Deci & Ryan, 1996). There has been an inconclusive debate about how gamification processes address external motivation. Nicholson (2012) claims that external rewards have a negative impact on users, while Zichermann and Cunningham (2011) believe external rewards can successfully engage them. While there has been an inconclusive debate about that topic, it the duration of this study is too short to investigate the effects of internal and external rewards. Instead, this paper tries to find an answer to the following research questions:

In which extent are game-elements effective for motivating the elderly to increase the personal motivation for physical activity (routine walking)?

Elements of the gamified activity reports

As mentioned above, the SDT is concerned with studying what increases and reduces intrinsic motivation. According to Deci, Koestner, and Ryan (2001), the use of external rewards can potentially reduce intrinsic motivation. Deterding (2011) argues that playing is an intentional and voluntary act without of consequences. Therefore, playing a game increases perceived autonomy - a feeling that boosts intrinsic motivation. In contrast, using a gamified system that provides virtual rewards and a public social comparison of results may not seem voluntary or free of consequence. Some users may feel that this diminishes their autonomy and hence their intrinsic motivation. Accordingly, Nicholson (2012) predicts that external gamification elements linked to underlying non-game activities could reduce motivation in the long run. In the following sections we take a closer look at the empirical findings on the effects of the selected game elements, virtual rewards and social comparison, as elements in a gamified activity report to promote the elderlies' walking activity.

Virtual rewards

Virtual rewards are digital or intangible incentives that are awarded in response to a specific behaviour or achievement with a view to reinforcing this behaviour or achievement in the future. They can include points, badges or extra game commodities (Lindqvist, Cranshaw, Wiese, Hong, & Zimmerman, 2011). Regarding to the function of badges, Antin and Churchill (2011) identified five individual and social purposes. These are setting of specific goals, give instructions to the user, users' reputation, status & affirmation as well as group identification. The function of each badge depends on what it is rewarded for, such as a certain number of steps, and in which context it is applied, such as the *early-bird* [8] badge that can be achieved using Nike+ when the user completed 5 runs before 6am in the morning. However, in reality badges do not have a universal appeal, with some users paying more attention to them than others. For

[8] Examples of Nike+ badges ca be found at: http://www.garcard.com/nikeplus.php

example, users of *Fitocracy*, an online plattform that enables users to set weekly exercise goals, track their physical activity, review their progress and obtain rewards, such as ribbons and trophies, said they were indifferent to the rewards (Martin, Melnyk, & Zimmerman, 2015) . They did however enjoy setting goals, which they found motivating. Another popular example would be *Foursquare* that allows his users to earn badges or points for visiting both new and previously visited merchants, and further broadcast their checked-in locations and to pride themselves on achievements to their friends via social media (McClimans, 2011). *Into* is a similar application which presents the collected data on physical activity in a map-based virtual world. The mobile application's accelerometer tracks users' steps and presents their journey on a map. Once users reach their target destination, they receive a reward in the form of an electronic postcard. A study indicated that users considered the application as motivating and appealing, but provided no data on the application's effectiveness in promoting physical activity (Hvannberg, 2010).

Furthermore Mekler, Brühlmann, Opwis, and Tuch (2013) conducted a formal assessment of the effectiveness of virtual rewards in the context of an image annotation task. The study focused on participants' performance on a specific time-limited task rather than the context of physical activity. Mekler et al. (2013) explored to what extent participants' performance was influenced by awarding points and framing the task's instructions in a meaningful way. They found that points determined the amount of tags provided by participants, while meaningful frames determined the quality of the image annotations. The findings finally indicate that the best results occur when combining points with meaningful framing as a motivational stimulus. Another example would be the *Zamzee* fitness tracker that measures your daily activity in order to partake in different challenges that allows you to earn bonus points when finishing an activity in a certain time. In a study there was found that Zamzee increased the physical activity like dancing, climbing or jogging by 59% (Cole, 2015). However there still is a lack of empirical studies that seek to investigate if there are age related differences in the perception and the effects of these virtual rewards on elderly people so in sum, the body of research on the effectiveness of virtual rewards in promoting physical activity is inconclusive and incomplete. While some studies highlight the positive effects of virtual rewards on physical activity, user engagement and motivation, others find them to be less effective.

Social comparison

Social comparison, also known as *social traces* (Ploderer et al., 2014), enables individuals to compare their own abilities and opinions to those of others (Festinger, 1954; Kruglanski & Mayseless, 1990). Applications and gadgets that aim to promote physical activity frequently use social comparison, based on the assumption that it will increase competition between community members and thus improve their exercise habits. An often used element for social comparison are leader boards with the aim of a simple comparison to friends or other users (Zichermann & Cunningham, 2011).

An early example would be the research project *Houston* that combines an activity tracker with a mobile application (Consolvo, Everitt, Smith, & Landay, 2006). Users can share their daily step count with their friends, keep track of their progress and send motivational messages. The study found that sharing exercise-related data put pressure on users to meet their personal goals, beat a friend or avoid having the lowest step count. Further, the users were able to motivate each other and receive recognition when achieving a new high score. In contrast, users of *GoalPost*, which shares data on users' physical activity on Facebook, said they were hesitant to share their information with others (Munson & Consolvo, 2012). Another study among runners indicated that the system’s effectiveness in boosting performance was mainly due to the user-friendliness of the interface during a run rather than the virtual competition induced by social comparison. *Fish’n’Steps* is a system that provides different incentives for increasing physical activity using a fitness tracker (Lin, Mamykina, Lindtner, Delajoux, & Strub, 2006). At a more personal level, the caregiving of a virtual pet fish is used as an incentive - the more active the user, the healthier the fish. The application also provides the opportunity to compete as teams, including the regular announcement of winning teams and the comparison of team members' fish. However, according to the study, in practice many users stopped checking up on their fish tank or stopped using the application altogether once the fish were no longer pretty to look at (Lin et al., 2006). “Admittedly, studies of behaviour change support systems using goal setting and competition have found mixed results” (Ploderer et al., 2014, p. 1669). Some argued that social comparison increased users’ motivation to outperform others, while other studies found social comparison to be less effective - often even negatively impacting on physical activity. Furthermore, most studies assessed these systems as a whole, rather than looking at individual components.

4 Methodology

The aim of the study is to explore whether gamification elements have an influence on elder peoples' motivation for daily routine walking. In order to investigate this idea an experiment was conducted in June 2015 whereby elder people were equipped with the activity tracker *Fitbit Zip*[9]. The decision for this device was based on the convenient handling and the long battery power. After the setup and configuration were made by the research team the participants were able to use the tracker without engaging themselves in any form of further interaction like charging or maintenance. All participants were obtained at the *Medical Fitness-Studio*[10] (MFS) in *Bad Neuenahr-Ahrweiler, Germany,* which also provided the needed devices. The sample size contained of 21 participants aged between 60 and 82 years[11] that should have been divided into three groups, with each group containing seven people. Unfortunately three participants cancelled their attendance before the official start and another participant had to be excluded from the sample due to technical problems with the activity tracker, whereby the final sample size consisted of 17 subjects. In a pre-experimental phase – the initial phase – the implementation of the experiment was discussed with the employees of *MFS* to enable them to manage an adequate volunteer acquisition. For this step some information about the research aim and a step-by-step manual was designed to make it as easy as possible for the participants to familiarize themselves with the fitness tracker and its use.

Each participant received his own activity tracker that enabled them to continuously measure their daily steps which is the measurement variable for the analysis.[12] In order to receive a maximum of comparability the groups were kept as homogenous as possible, which means that all participants had no functional disabilities (capable of walking), were equally mixed regarding age and gender, and were equally mixed concerning the participants' 'activity level'. To determine this level a settling-in period of three days was implemented in the experiment design. The data (daily steps) of these three days formed the baseline for the daily personal goals that should serve as a guidance for the participants. The average steps of all three days were

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[9] For more information visit: https://www.fitbit.com/de/zip

[10] Operating company: Aktiengesellschaft Bad Neuenahr: http://www.ag-bad-neuenahr.de

[11] The average age is 70.24 years (SD = 5.65) and the distribution by gender reports 47.1% male and 52.9% female participants.

[12] In advance it was ensured that every participant has access to an own computer with internet access to install and use the Fitbit hard- and software. For technical problems and other questions regarding the experiment the research team also provided a telephone hotline.

defined as baseline. This value has been increased by 20 percent to set an individual's daily goal that each person could possibly manage without very high efforts, but also should not demand too little from the participant. After the settling-in period the actual experiment started.

Within 10 days, three groups have been stimulated by different visualizations to impact their motivation for routine walking. Therefore a daily activity report was designed that every participant got sent via e-mail every morning containing the data of the previous day. The reports differ in their appearance regarding the stimulus in form of gamification elements. The *first group* got stimulated by the *quantified version* of the report, which only shows the individual personal goal in steps and its achievement in percentage terms together with a weekly overview of the total steps per day illustrated in a bar chart. Due to reasons of comprehensibility there were no extra information provided in the activity reports with the result that the participants could focus on their daily goal and their achievements.

Table 1: Gamification elements used for each group

Group 1 (n=4)	**Group 2** (n=7)	**Group 3** (n=6)
• Daily Steps • Personal goal (progress in %)	• Daily Steps • Personal goal (progress in %) • Virtual Rewards (Badges)	• Daily Steps • Personal goal (progress in %) • Virtual Rewards (Badges) • Social Comparison (Leader Board)

In addition participants of *group 2 & 3* had the possibility to achieve motivational badges. As discussed in chapter 3 these badges were made in an encouraging design with the intention to increase the motivation for keeping up the daily goal and maybe even improve the walking performance. To reduce potential reservations of the elderly with this unusual form of feedback, the badges have been created with a regional connection. Figure 1 shows three examples of badges that could be scored during the experiment phase.

Figure 1: Motivational badges for group 2 and 3

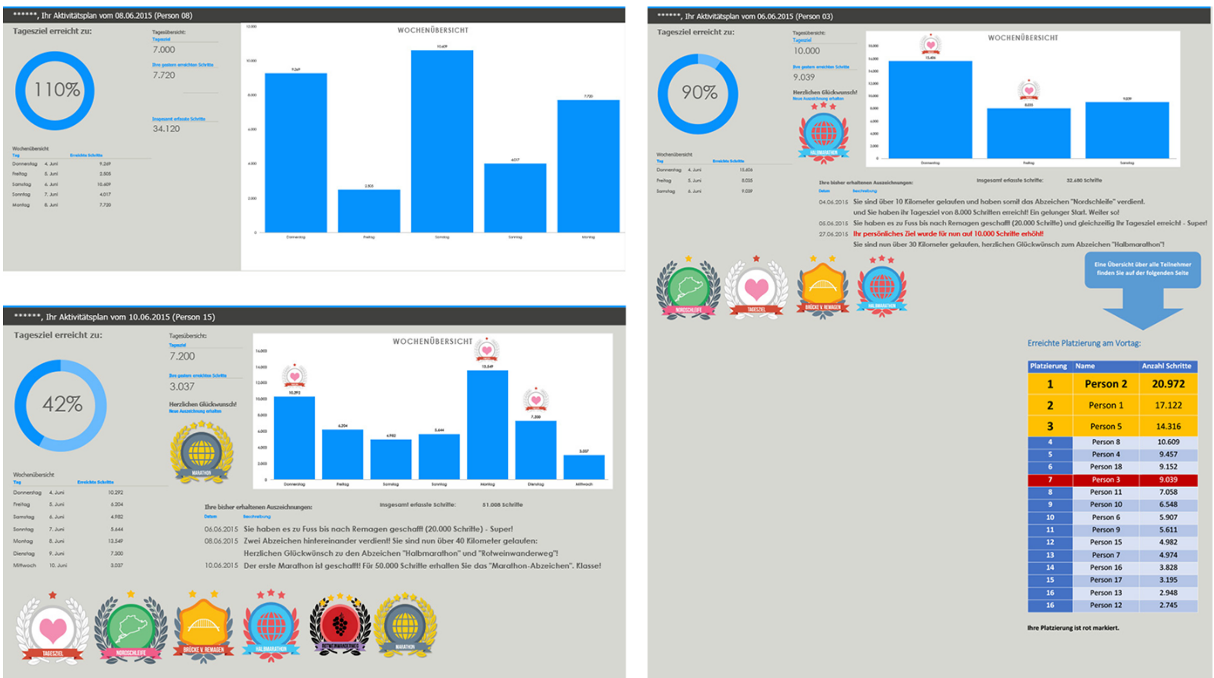
Motivational badges (f.l.t.r.): *Nordschleife* (5km), *Ahr-Steiger* (50km), Most daily steps

This mode of reflection is called “reflection-on-action” (Schön, 1983) and means that only previous activities can be assessed, so there is no real-time feedback on their progress because the activity report only refers on the previous day.

In addition to the quantified version and the badges, the participants of *group 3* were able to compare their performance with each other. For this purpose, a daily leaderboard was created, which was integrated into the activity report. This leaderboard showed a list of all participants and their corresponding ranking. The activity reports are based on an excel sheet, which automatically calculated the level of achievements for each day and the resulting badges. The data from the log files of the Fitbit tracker were also automatically transferred to a Google sheets and afterwards copied into the activity report for further processing. For usability reasons the final reports were converted into a pdf-file for sending them the registered e-mail addresses of the test persons.

Figure 2 represents examples for each activity report (group 1, 2 and 3). After the experiment a group discussion helped to gather more information about the user experiences and/or motivations and critics, to get further insights about whether the displayed visualization might have had an impact on the participant’s motivation to increase their routine walking or not. The findings of the analysis of the data and the group discussion will be discussed in the next chapter.

Figure 2: Activity reports for each group



Top left: Activity report for Group 1, Bottom left: Group 2 & right side: Activity report for Group 3

5 Findings and Discussion

The sample size of the experiment reports a total number of 17 participants with an average age of 70.24 years (SD = 5.65). In order to identify a possible influence of Gamification elements on the participants' walking activity, the number of average steps before receiving activity reports (initial phase) were compared with those days, in which the participants were informed about their activities (active phase). Table 2 provides an overview of the different groups and their activity during the study. As can be seen from the last row in the table, there was an overall increase in daily steps of 32.16% among all participants. The highest increase of 43.53% was measured in Group 2, followed by Group 3 (34.35%) while only a small change of 8.95% was found in Group 1. T-tests were used to analyze the difference between initial phase and active phase. While the effect in Group 1 was not significant, participants' walking activity in group 2 was significantly greater when the activity was rewarded with badges compared to the time when no reward was given ($t(6) = -4.80$, $p < .01$, $r = 0.89$). A similar significant increase was found in group 3 ($t(5) = -3.42$, $p < .05$, $r = 0.84$). Therefore, the data suggest that gamification elements in activity reports may promote routine walking of the elderly. However, it must be stated that the sample size was especially in group 1 very small as other studies have shown that even the awareness of one's own activity should lead to an significant increase.

Table 2: Overview of the Walking Activity

	All n = 17	**Group 1** n = 4	**Group 2** n = 7	**Group 3** n = 6
Daily steps during the initial phase (Baseline)	**6,958.43**	**6,910.00**	**7,261.29**	**6,637.39**
Standard Deviation	2,859.70	2,003.27	3,016.14	3,244.89
Daily steps during the active phase	**9,086.31**	**7,422.35**	**10,064.21**	**9,054.72**
Standard Deviation	4,737.95	2,462.05	5,263.86	4,987.63
Personal goal (in steps)	**9,688.24**	**9,625.00**	**10,057.14**	**9,300.00**
Standard Deviation	3,389.57	1,702.00	3,657.38	3,877.36
Percent of goal achieved (daily)	**91.72**	**75.40**	**99.11**	**93.97**
Standard Deviation	44.73	30.18	56.66	33.53
Number of days goal was achieved	**3.62**		**3.71**	**3.5**
Standard Deviation	1.71		2.14	1.23
Number of badges	**13.08**		**13.71**	**12.33**
Standard Deviation	5.47		5.38	5.99
Differences: Initial and active phase (quotient)	**132.16**	**108.95**	**143.53**	**134.35**
Standard Deviation	64.31	40.32	82.53	47.79

Means and Standard deviation

While it was proven that there is a difference in the activity before and after receiving the activity reports, a Kruskal-Wallis H test showed that there is also a statistically significant difference in daily steps between the different groups, $H(2) = 6.42$, $p < .05$. Mann–Whitney tests were used to follow up this finding. A Bonferroni correction was applied and so effects are only significant to the level of .0167. The analyses revealed no significant differences when comparing the increased activities of one group with another. It appeared that the daily steps were no different when Badges ($U = 2$, $r = 3.32$) or Badges & a Leaderboard ($U = 2$, $r = 3.16$) are used in activity reports compared to non-gamification elements. While the group-by-group differences were not significant relative to the adjusted level of .0167, the p-values for the comparisons between Group 1 and Group 2 as well as Group 1 and Group 3 were less than the standard alpha level of .05. Therefore, in future studies with a comparable experimental setup it is recommended to raise the number of participants what may lead to a better outcome. Though, a comparison between the non-gamified reports (Group 1) and both gamified reports combined (Group 2&3) showed that there is a significant difference. Based on the results of the study, participants who received gamification elements tend to be more active than participants who received activity reports without gamification elements, $U = 4.0$, $z = -2.49$, $p < .05$, $r = -.60$. However, with a small sample size, caution must be applied, as the findings might not be generalizable. Furthermore, no significant differences between male and female participants were found.

The Spearman's Rank-Order correlation were used to determine the relationship between the received gamification elements and the participants' walking behavior on the basis of daily data. Since each participant has a different activity level, the use of steps were seen as unsuitable for correlation analyses. Therefore, the gamification elements a participant received in the morning were correlated with his change in activity on that day[13]. Due to the short period of 13 days, it seems plausible that statistical outliers such as an extraordinary day of activity falsify the results. With a longer period it may be assumed that such outliers are becoming irrelevant. It should also be mentioned that in some cases the correlated elements are dependent on one another. These results therefore need to be interpreted with caution: Among all three groups[14] there was a significant negative relationship between the achieved personal goal and the following activity ($r_s = -.71$, $p < .001$) which might suggest that a low percentage lead to a guilty

[13] Percentage change from the previous day
[14] n = 168 days of active phase

conscience which consequently results in an increased walking activity. Obtaining a badge for the one's achievement of personal goal was significantly related to the participants' activities in Group 2 and Group 3[15] (r_s = .43, p < .001), therefore, it can be concluded that it served as a motivation boost. On the contrary, activity was negatively correlated with the other badges for the most active participant of the day, r_s = -.23, p < .05, and for reaching a new milestone, r_s = -.42, p < .001. This inconsistency may be attributed to the short period so that outliers have a greater effect in contrast to a long-term study. For instance a day of extraordinary high activity that is followed by a day of comparatively lower activity lead to both a high number of badges and a decrease of activity compared to the day before. When focusing on Group 3[16], the position in the daily ranking was also significantly related to the participants' activity. The lower the position in the ranking, the higher the activity compared to the previous day, r_s = -.39, p < .05. On the one hand there are people who felt a pressure to increase activity when finishing up on a low place, on the other hand a higher place in the ranking lead to lower activity. It may be possible that finishing up on a higher play evoke a false sense of security in the participants' mindset, since they don't get any updates during the day. Therefore, the restriction to an activity report once a day is definitely the main weakness of this study. Therefore, due to financial and technical limitations this research cannot investigate if a live feedback would have a different influence on the participants' behavior.

Limitations and Future Research

As with any scientific study there are some limitations and suggestions for future research. There have been technical problems with the *Fitbit Zip* that led to a failure of one device and therefore the loss of one whole data case. Additionally two of the participants complained in the final group discussion about inaccuracies during the measurements. In fact the Fitbit Accounts were pre-arranged by the research team, still everyone got his own Fitbit Account with access to the gathered data so the participants were able to double-check their step count. According to their statements some measurements were dissent from their actual walking distance, a complaint that is hard to determine and evaluate.

Another participant stated that she got too many badges during the experiment phase. The distance between two badges was set at 10,000 steps. As a matter of fact several participants were

[15] n = 128 days of active phase
[16] n = 59 days of active phase

able to reach one or even two badges per day, which could have decreased the motivation to earn another reward with some extra effort. In other words the participant might have been spoiled for evolving internal motivation. The explanation for that can easily be found in the acquisition of the participants. All volunteers were only acquired at the MFS and are therefore above-average in terms of activity relating to their age group.

Regarding this problem one lesson has already been taken during the experiment, namely that we re-adjusted the personal goal when realizing that someone excessively increased his amount of steps after the settling-in period. A similar adjustment could have been done with respect of the distances between the badges. Finally, 10 days might have been too short to represent an average activity level realistically. This is also true for the sample size. A total number of 17 participants does not provide significant results for making a reliable statement about the population of the elderly in general but the results might be interesting for future work in this field. Therefore we suggest to concentrate on similar study designs with a focus on the social comparison component on contrast to external rewards such as badges and other achievements.

Even though most of the findings were not empirically significant, the significant difference between the gamified and non-gamified report might indicate some interesting results regarding the design and use of gamification elements for elderly people. Particularly because our population is aging continuously there have to be smart solutions for healthcare prevention not only to unburden the health insurance funds, but also to enable the elderly people to live a healthier and fulfilled life even in an advanced age.

The results have shown that gamification elements for the elderly have a considerable potential, but that further studies with a higher number of participants and a longer duration are necessary in order to make more precise statements By increasing the duration may possible to test how effective these elements are on the long-term. The generalizability of these results is subject to certain limitations. For instance, the reports were only delivered once a day. It might be possible, that direct feedback or a message when a badge was achieved would have a different impact on the activity. Future research should therefore concentrate on the developing of an app or a different form which provides direct feedback to the participants.

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