

Behavioural changes through serious health games: a viable alternative to traditional treatments/techniques?

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Unhealthy behaviour is known to lead to obesity and a wide range of health issues, as well as playing a major role in the development and symptomology of mental and physical disorders. Whereas traditional methods of behavioural change require professional attention and are often costly and inefficient, serious health games can be distributed cost-efficiently to a large proportion of the target group. Serious health games are a novel way of combining entertainment with the purpose of changing health-related behaviour. This paper includes a literature review which examines models of behavioural change, the efficacy and methodology of serious health games in achieving them, as well as their limitations. To find out how the theory is applied in practice and to what extent behavioural changes occur, interviews with players of a serious game called "Habitica" have been conducted and first hand experiences have been put in relation to the identified theory. Players of the game successfully achieved and sustained behavioural changes through unconscious application of a range of theoretical models of behavioural change. A big success factor of Habitica is its social aspect, a determinant that has not yet received high levels of attention from the scientific community. Surprisingly, interviewees integrated the game into their lives and keep using it on a daily basis, which serves as a counter example of concerns the scientific community previously voiced over potential relapses and issues with long-term motivation. The theoretical findings and the case of Habitica show that serious health games can be a viable alternative to traditional methods of behavioural health change, even though individuals suffering from health conditions might benefit from further professional treatment. The findings suggest that game developers and researchers can benefit from further looking into social aspects for serious health games.

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1. INTRODUCTION

Changing health behaviour is a topic that plays a substantial role in the lives of many human beings. Traditional techniques for changing behaviours often rely on the application by healthcare professionals, which often consumes a lot of resources (Lin, Mamykina, Lindtner, Delajoux, & Strub, 2006).

A new way of changing behaviour and stimulating learning is through serious health games, a rather novel industry and academic field (Crookall, 2010).

In 2015, the market for video game entertainment is estimated to be worth \$81.4bn, with future estimates showing steady growth ("Global Games Market Will Reach \$102.9 Billion in 2017," 2014). With video games aimed at entertaining on the rise, game elements are showing promise in more serious matters as well. While yet in a niche position and in a smaller market, serious health games are games that are designed to modify some aspects of an individual's health behaviour while also being entertaining (Thompson et al., 2008).

Serious games for health have been applied in different settings, such as tackling issues with lacking fruit and vegetable intake in children (Thompson et al., 2015), promoting healthy behaviour in children (Boendermaker, Prins, & Wiers, 2015), or tackling all sorts of problems that derive from a lack of exercise and healthy diets, such as type 2 diabetes, obesity and therewith cardiovascular issues (Lin et al., 2006; Spook et al., 2015; Thompson et al., 2008).

Research still misses an up to date analysis of how viable serious health games really are, and whether they can be seen as an alternative to traditional treatments and techniques. If found viable, the acceptance of serious games by the healthcare community can potentially lead to a big growth of the industry. By combining a literature review with a qualitative study, this paper will establish an analysis of important issues that emerge when assessing serious games as an alternative to traditional behavioural change techniques.

1.1 Research Question

To come to a comprehensive conclusion about the state of the serious health games industry in the context of behavioural changes, a main research question is being researched, with a set of sub questions that will lead to its answer.

To what extent are serious health games a viable alternative to traditional techniques and methods of behavioural changes?

- What are serious games?
- Where can they be applied in a healthcare setting?
- What is behavioural change?
- What are their advantages and disadvantages compared to traditional techniques of behavioural change?
- How do they successfully achieve behavioural changes?
- What are the limitations of success?
- In what way does the behaviour of players change?
- How do they prevent relapses?
- Where did players of the serious game "Habitica" face challenges when using the game as a means to change their behaviour?
- Where did players of the serious game "Habitica" identify factors that help them to successfully change their behaviour?

- How viable are serious health games for changing behaviour?

2. METHODOLOGY

The research question is investigated by a combination of a literature review (see Appendix) and an empirical part in the form of qualitative research. In order to come to an answer to my research question, the literature review will show models and theories of the field of behavioural changes, which will then be investigated in interviews to see how they are applied in the practice of a serious game for health and give examples of theory application.

2.1 Research Methodology

The empirical part of this paper takes the form of online interviews, which have been carried out using video chat on Internet technologies such as Skype (Hanna, 2012) and text based communication (Stieger & Göritz, 2006).

The sample of interview partners were players of a serious game called "Habitica", formerly known as "HabitRPG", which aims to induce behavioural changes through the integration of habits, daily tasks and to-dos into a role-play game. Players create an avatar that gains experience, health and an in-game currency called gold through the achievement of their own objectives. Rewards are either set by the game, but can also be set by the individual players, who can then decide whether to spend their gold on equipment to strengthen their avatars, or on their individual rewards (e.g. watching their favourite TV show). Additionally, the game contains 90 pets plus event pets which the player can feed to turn into mounts. Pets are obtained by applying a hatching potion on an egg, both of which are item drops that the player obtains by fulfilling their tasks and playing quests with their party.

Accordingly, players can form groups and fight virtual enemies together by fulfilling their objectives timely, with each successful objective damaging the boss, and each undone daily task damaging the whole group. Another community aspect are so-called "guilds", which are in-game communities formed with the goal of finding other players with shared goals and interests. By recruiting players of these guilds and forming groups, a social dynamic and accountability comes into play that aims to incentivise players to work towards their goals in order to not damage their group. Furthermore, guilds offer a way of communicating and relating to people who share the same goals or conditions. The game is open source, meaning players can become contributors by helping the game grow in several areas such as design or localisation. The development was funded using the crowdfunding website kickstarter.com, and raised \$41,191 over a period of 40 days. Since after release, the game is actively financed by an optional in-game currency called "diamonds", which can be obtained by spending real money, and which can be used to buy optical enhancements such as new character designs and character backgrounds, but do not influence gameplay aspects.

While "Habitica" is not explicitly focussing on healthcare, the game's website actively advertises that players use it to manage work, health, teams, school, goals and chores. Also, guilds have formed for players with the goal to achieve a healthier lifestyle, or overcome illnesses such as ADHD or anxiety disorder.

Also, as Habitica can be played to change behaviour in more than health related ways, this paper is solely interested in changing health related behaviour. The search for interview partners thus happened in the top 5 public guilds that use the game to change health related behaviour (see Appendix).

Sadly, it was not possible to obtain a list of all members of a given guild, meaning selection of interview partners could only be done by the means of a non-probabilistic convenience sampling method, namely asking for volunteers in the public chat system of aforementioned guilds (see Appendix).

3. LITERATURE STUDY

3.1 Definitions and Application of Serious Health Games

In order to discuss the viability of serious health games as alternative interventions for behavioural change, the term serious game needs to be defined. Most papers found draw upon general definitions of serious games and/or adapt the definition to fit the goal of their research paper.

What most papers identify is that serious games consist of a combination of two or more aspects, one of them being the fact that it is a game, the other being the serious purpose, whatever type of purpose that is. Throughout the reviewed literature, some definitions of serious games applied are broader, while others are narrower. To give examples, Lin et al. (2006) defined serious games as games that “motivate increase in physical activity in a fun way through engaging individuals in games that mix real and computing worlds”, and as such identify serious games purely as motivators for physical activity, while very inclusive definitions talk about a wide range of possible serious aspects, such as the definition of serious games being digital games that improve an individual’s knowledge, skills or attitudes (Graafland et al., 2014).

Throughout the range of definitions, it becomes evident that rather than agreeing on one definition of what serious games are, papers often adapt the serious aspect of it for the purpose of their paper.

The most striking difference in definitions stems from the use of serious games with the serious purpose of either learning (Crookall, 2010; Dieckmann, Friis, Lippert, & Østergaard, 2012; Spook et al., 2015) or driving behavioural changes (Lin et al., 2006; Thompson et al., 2008; Thompson et al., 2015), even though the two of them are strongly interrelated.

It is also worth mentioning that another term that has been used for serious health games is the term “Exergames”, which refers to games aiming specifically at increasing physical activity in participants (Lin et al., 2006), but serious health games are being researched and applied in more scenarios than that.

Since the focus of this research paper is behavioural changes through serious health games, the most fitting definition, and the one applied for this paper is that serious health games are games that are “designed to entertain players while attempting to modify some aspect of their health behaviour” (Thompson et al., 2008).

Throughout the range of literature, serious health games have been applied for a very wide range of purposes. Evidently, serious games do not only work as drivers for a healthier lifestyle for people without specific health conditions as suggested by the amount of papers on exercise and dietary changes that can be found in the literature. What was found is that serious health games also work as additional methods of changing behaviour and coping in children and adults alike suffering from physical and mental health conditions. More specifically, studies have been identified researching the effect of serious games on motivating dietary changes in children (Thompson et al., 2015), promoting healthy behaviour in children (Graafland et al., 2014), improving health levels in the elderly population (Wiemeyer & Kliem, 2012), treating mental disorders such as Bulimia Nervosa (Giner-Bartolome et al.,

2015) or anxiety in children with an Autism Spectrum Disorder (Wijnhoven, Creemers, Engels, & Granic, 2015). The amount of serious health games for mental health conditions is however still rather limited, even though existing games show promise (Boendermaker et al., 2015).

3.2 Models of Behavioural Change

The concept of behavioural changes stems from the discipline of Psychology and has been thoroughly researched. Models for predicting and analysing behaviour are plentiful in the psychological research domain, reaching back at least as far as 1977 with the introduction of the theory of self-efficacy (Bandura, Adams, & Beyer, 1977). Subsequently, research on behaviour in the past has revealed that it is the result of multiple influences, which in turn means that rather than trying to change behaviour directly, behavioural scientists approach changes with a complex, multistep process to change the mediators of behaviour (Baranowski, Lin, Wetter, Resnicow, & Hearn, 1997). Self-efficacy refers to an individual’s belief in his capacity to achieve certain outcomes through adopting certain behaviour, and has been adopted in the context of serious gaming (Thompson et al., 2008). Mediators are variables that influence behaviour, and it has been found that when interventions fail, it is often due to them building upon theoretical models that do not account for all the variability in their relationships, and therefore are limited in their ability to predict behavioural changes through mediating variables. Also, it has been found that interventions have been unsuccessful in changing mediators in the past (Hansen & McNeal, 1996).

A famous theory for predicting behaviour is the Theory of Planned Behaviour (TPB), which aims to predict intention to use and subsequently behaviour by the use of the variables attitude, subjective norm and perceived behavioural control (Ajzen, 1991). Attitude here refers to the individual’s belief about the outcomes of the behaviour, the subjective norm refers to social aspects or social pressures urging the individual to perform or not perform the behaviour, and perceived behavioural control is the summation of beliefs of perceived difficulty of a behaviour. These three variables then result in the individual’s intention to adopt a certain behaviour. However, the actual behaviour is then again influenced by the perceived behavioural control, since only when the individual perceives that he can actually perform a behaviour, will he attempt to do so.

Another aspect of behavioural changes is that rather than creating sudden changes, it is often the case that behaviour changes incrementally in small steps. This has been found in the Transtheoretical Model of change, which argues that individuals gradually change their behaviour through a series of steps (Grimley, Prochaska, Velicer, Blais, & DiClemente, 1994).

Nonetheless, during the past decades, a lot more has been done in the field.

The self-regulation theory aims to manage an individual’s health behaviour through impulse control and management of short-term desires. The individual is reinforced to monitor his own behaviour, evaluate how it affects his health, change it and subsequently adapt the new behaviour through willpower. This theory however relies on the notion that the individual already has an interest in changing his behaviour (Boekaerts, Pintrich, & Zeidner, 2005).

For the motivational side of changes, the self-determination theory is a widely accepted theory outlining the differences between extrinsic and intrinsic motivation (Deci & Ryan, 1985). During the decades since the introduction of the self-

determination theory, a lot of research has been done on the resulting behaviour through extrinsic vs. intrinsic motivation. Intrinsic motivation refers to doing something because an individual finds it inherently interesting or enjoyable, while extrinsic motivation refers to “doing something because it leads to a separable outcome” (Ryan & Deci, 2000). Self-determined actions are actions that are done with a sense of autonomy and freedom. While intrinsic motivators are self-determined, the amount of self-determination that stems from extrinsic motivation depends on the integration and internalisation of them (Ryan & Deci, 2000).

3.3 Advantages of Serious Health Games

Serious health games have several advantages compared to traditional techniques of behavioural change. It should be mentioned that traditional techniques and serious games for health both rely on validated theoretical methods. Interventions applying theoretical models have been successful in increasing physical activity as well as treating a number of undesirable behaviours such as alcohol abuse, domestic violence, and smoking (Grimley et al., 1994). While partly effective, traditional techniques rely on healthcare professionals applying the theories and designing intervention programs, which is often costly (Lin et al., 2006). Another article studying the effect of a serious health game for solving problems with type 2 diabetes and obesity in schoolchildren stated that traditional school-based approaches showed little change in body composition when trying to change diet and exercising behaviour (Thompson et al., 2008). Related to obesity issues, another study on obesity of youth in low socioeconomic families established that interventions targeting physical exercise or dietary intake are often small and fail due to poor intervention use, large dropout rates and low compliance. Traditional health programmes for the elderly did not have the expected success either (Wiemeyer & Kliem, 2012).

On the other hand, young people often use smartphones and play games, making an intervention based on serious games more attractive (Spook et al., 2015). As serious games have a gameplay component, “patients, students and professionals generally view game-based interventions as fun and challenging” (Graafland et al., 2014). Serious health games have been found effective in reducing impulsivity in individuals with eating disorders (Giner-Bartolome et al., 2015) when used in addition to cognitive behavioural therapy, as well as helping children with autism who generally struggle to gain a lot of value out of treatment as usual (TAU) (Wijnhoven et al., 2015).

Throughout the literature, it becomes evident that disadvantages of traditional techniques are often the opposite to the advantages of serious games (see Table 1).

Serious Health Games	Traditional Technique
Lower dropout rates (Spook et al., 2015)	Large dropout rates (Spook et al., 2015)
Consistent delivery and accessibility of care (Lin et al., 2006; Thompson et al., 2008)	Waiting lists (Giner-Bartolome et al., 2015)
No geographical and timely boundaries (Lin et al., 2006)	Application by professional individually or in group setting (Lin et al., 2006)
Enhanced compliance (Wiemeyer & Kliem, 2012)	Poor compliance (Spook et al., 2015)
High price effectiveness (Lin et al., 2006)	Limited success in behavioural changes (Thompson et al., 2008)

	Wiemeyer & Kliem, 2012)
Enhanced method of treatment where TAU falls short (Giner-Bartolome et al., 2015)	
Fun and challenging (Graafland et al., 2014)	

Table 1. Advantages of Serious Health Games

3.4 Achievement of Behavioural Change in Serious Health Games

As serious games for health differ from classical interventions for changing behaviour, they have their own set of success factors and limitations to overcome.

Graafland et al. (2014) developed a framework used to assess the usefulness and effectiveness of serious games through the assessment of 5 themes, namely game description, rationale, functionality, validity and data safety. This framework however is rather new and has not been properly validated yet. Additionally, it explicitly claims to not assess the success or user attractiveness of a serious game. It is based on a framework used for non-game mobile health apps (Albrecht, 2013; Lewis, 2013), which was reviewed and reworked to fit serious health games.

The game description in the framework discusses the official registration of the game, the affiliation of the creators and sources of revenue. Graafland et al. (2014) consider it important due to the possibility of hidden agendas or biases that might pose a danger to a serious game’s validity.

Rationale is the game’s purpose outside of the game which might differ from gameplay objectives inside of the serious game. It relates to the target group as well as the goal the serious game is trying to achieve in the user.

Serious games differ from the base model for mobile health apps since they have an interactive part through which a behavioural change or learning is stimulated. Thus, functional information on content, instruction and performance assessment are necessary in order to make sure that the content is actually valid to achieve the games’ goals.

Validity is necessary to ensure that “evidence and theory supports the interpretations of [game] scores entailed by the proposed use of [the game]” (American Psychological Association, 1999). Many serious games struggle with this step due to their limited funding, since proving a game’s validity takes time and resources, unless specifically designed with validated theories in mind.

The framework’s last aspect, data protection, is especially relevant when patient data is included and collected in the serious game. Gathered data has to be dealt with in conformity with the laws of the countries in which it will be published, as well as make sure that data is sufficiently protected. For reasons of visibility and trust, information on data privacy must be disclosed to the users.

What a lot of other papers discussed were practical methods of merging behavioural changes and game design into a coherent product. Intervention design methods that were used for these purposes include the Intervention Mapping protocol (Bartholomew, Parcel, Kok, & Gottlieb, 2011) and the RE-AIM model (Glasgow, Vogt, & Boles, 1999; Spook et al., 2015), which should be combined with game design elements such as character development and storyline to enhance immersion and entertainment (Thompson et al., 2008).

In a more general sense, usability as well as behavioural methods should be implemented in a game to make it successful

(Spook et al., 2015), as a serious health game is for entertainment as well as changing behaviour, and needs a fit of both to work.

In line with these findings, Thompson et al. (2008) observed that serious health games work best with mixed teams combining behavioural change experts as well as entertainment experts to combine both. They found that entertainment likely attracts and holds the players attention on the video game, which increases the time players actually play and therefore also the time they spend with the behavioural change mechanisms involved. Immersion is one of the mediators for behavioural change according to the authors. They also found that clear goals, feedback on performance, problem solving when goals are missed and debriefing form important aspects of a serious game, while debriefing for serious games is often different than the usual way of an after-intervention interview for traditional interventions.

The importance of debriefing for learning was further highlighted by Crookall (2010), who criticized the lack of debriefing procedures in serious games. Debriefing is “the reflection on and sharing of game experience to turn it into learning” (Crookall, 2010), which is the main aspect that leads to actual learning from the game experience and enhances the transfer of skills and knowledge from the game into real life (Thompson et al., 2008). Crookall (2010) further argued that debriefing can be added to serious games by means of creating online communities and discussion boards, since people debrief about issues in their daily lives anyway through means of communication.

In a later study, Thompson et al. (2015) found that including action plans in serious games has a significant effect on increasing and maintaining children’s fruit vegetable intake. Action plans have been described as highly specified plans outlining how the goal will be attained in a tangible manner.

On a more general note, game elements need to focus not only on creating initial attraction, but also towards keeping motivation in order to work on a longer term and make changes habitual (Lin et al., 2006).

Overall, aspects that contribute to the efficacy of a serious health game contain proper use of game design elements as well as theory application from the wide range of practical and empirical research that has been done on behavioural changes.

3.5 Limitations of Serious Health Games

Through the range of identified literature, different theories have been used to drive behavioural changes. It is evident that theory use and game design aspects as well as the scope of behavioural changes vary depending on the target group and type of behaviour the game-based intervention aims to change.

That is in line with recent findings by Dieckmann et al. (2012), suggesting that people involved should be actively engaged in game development and that mismatches between goals, target group and methods can limit success. The importance of a match between the serious health game and the target group has also been shown in a study on elderly, revealing the importance of including appropriate content, interface design and game demands to appeal to the right audience (Wiemeyer & Kliem, 2012).

Financially, serious health games are limited in success by a lack of understanding of underlying concepts amongst health care professionals, leading to limited investments (Boendermaker et al., 2015; Graafland et al., 2014).

Other limitations identified are that the term “game” might lead to unrealistic expectations and that serious health games are

unlikely to be as much fun as games that are produced for the sole purpose of entertainment and that some gameplay aspects might be distracting from the behavioural change intervention and might thus reduce task performance (Boendermaker et al., 2015).

Furthermore, some parts of the population that have difficulties handling digital games need further assistance when adopting them, such as the elderly (Wiemeyer & Kliem, 2012).

Aspects that have shown to successfully lead to behavioural changes can also be their limitation when not implemented successfully. As such, when goals are not aligned with the target group and are seen as unachievable or not challenging, disuse of the serious game might be the consequence. Too much negative reinforcement may have the same effect, as some participants decide to stop playing a serious game when confronted with negative results rather than attempting to change their behaviour to transform the negative into positive (Lin et al., 2006).

Another game design element that needs to be carefully used is immersion. While it has been found as a mediator by Thompson et al. (2008), another study found that too many immersive features have a counteractive part on performance, as they distract from the behavioural aspect (Spook et al., 2015).

All in all, the literature suggests that there is no general one-fits-all model for designing serious health game interventions, but rather shows the heterogeneity of potential adopters, highlighting the importance of matching game design elements with the target group in mind and balancing them carefully.

3.6 Nature of Changes

The actual behavioural changes that are the result of serious health games are manifold, and often times show that game based interventions worked to achieve the behavioural change or not, even if sometimes to a lesser extent than hoped for. In line with the change objectives of the research papers, game-based interventions targeting fruit and vegetable intake in children have increased and kept fruit and vegetable intake in children (Thompson et al., 2015), the elderly showed improvements in physiological, psychological, sensory-motor and social levels (Wiemeyer & Kliem, 2012), and an intervention to increase the number in daily steps has been successful in doing so (Lin et al., 2006).

It can be said that behavioural changes occurred the way that serious health games designed them to change, or had limited success in it due to reasons outlined in section 3.5.

3.7 Relapse Prevention

The prevention of relapses has not been mentioned by many of the papers in the identified literature, but has been one of the aspects that have been criticized by Boendermaker et al. (2015), who thus established that serious games work best when training times are short. Two of the studies found in the identified literature conducted post-test studies to investigate the long-term effect of their interventions.

The study by Thompson et al. (2015) that aimed at increasing fruit and vegetable intake in children has shown that by using action plans in the goal setting method, an increase of 0.68 servings of fruit and vegetables was maintained after 3 months.

Lin et al. (2006) who conducted an experiment of a serious game on changing exercise behaviour by analysing the amount of steps walked every day found that their short serious game experiment did not make long-term continuation of the experiment necessary, since behavioural changes caused by their intervention became habitual and were still observable at post-study.

3.8 Interview Model

The next part of the paper includes interviews of players of the aforementioned game “Habitica”. The aim for the interviews is to collect experiences of players and see how they use the game to change their behaviour, how their behaviour subsequently changed and how the change relates to the change theories that have been identified earlier.

To structure the interviews and give direction regarding what I want to know, a framework has been established prior to interview conduction that helps measuring hurdles and success factors for change, as well as getting a good picture of how the use of Habitica and its’ features affect behavioural change success (see Appendix). The Graafland et al. (2014) framework poses interesting questions for assessing a serious health game, and while not predictive of success, is still interesting to look into. However, most of the aspects of the Graafland et al. (2014) framework are not suited for an interview framework, and it was never designed to be. Nonetheless, the framework raises important questions. Several different models for behavioural change have been shown in section 3.2, and since Habitica is aiming at behavioural changes, a general framework has been designed that measures an interviewees health condition, their use of Habiticas’ features, their perceived success, their frequency of use and some technical aspects derived from Graafland et al. (2014). In order to get a good picture of challenges and successes, the interview also includes a question from the Critical Incident Technique (Flanagan, 1954), asking for concrete experiences that were good or bad and encouraging the interviewee to focus on them in as much detail as possible. Nonetheless, the framework only serves as an orientation, and the interviews developed an own dynamic when interesting aspects come into play that do not fit in my general framework.

4. INTERVIEWS

The first interviewee was a 24 years old female university graduate from Belgium currently looking for a job. She uses Habitica for coping with ADD and dyspraxia, which give her forgetfulness, overall clumsiness, and illogical thoughts.

She previously went to therapy at her local university, which consisted of talking therapy with a counsellor in which techniques were established that helped her with her ADHD, such as scheduling, to-do lists, diary keeping and remembering to eat. In addition, she had social therapy in a group that helped her with the problem of not being able to read social cues properly. She mentioned that Habitica on its own can do a lot to help, but it’s the combination of Habitica with medication and therapy that helps the most.

Regarding the use of features, the most successful aspects of Habitica according to my first interviewee are the daily task and habit system, which strongly motivates her to accomplish her own set tasks and habits in order to grow her character and not damage her or other characters in her party. A big problem for her is that ADD often makes it hard to get started doing something, and Habitica helps with that due to the daily system which forces her to actually do her tasks on a daily basis.

The dailies she set for herself are things like eating breakfast, doing something to improve her apartment and brushing her teeth. As she struggles with forgetting to eat regularly, she uses the habit system to reward herself for eating breakfast and fruits once a day, which thus also changes her dietary intake to a healthier one. She also used to have a workout daily which strengthened her back.

What also helps her a lot is the social aspect of Habitica. Guilds make it possible to relate to and communicate with people who share the same problems/conditions, which means that she can

ask questions that are hard to ask anywhere else. She also regarded this as one of the limitations of the traditional technique of talking therapy, as therapists know a lot of theories that help, but have often not actually experienced the specific conditions that patients suffer from. Also, accountability was mentioned as an important motivational aspect since missing daily tasks would not only hurt her own character, but also her party members.

The reward system was mentioned as a less successful feature and the only aspect that could be a limitation, since rewards have to be set by the individual and cost gold, however the amount of gold your character receives changes as you level up and add or remove tasks, making the system difficult to figure out and apply consistently. However, the interviewee mentioned that gathering pets and mounts is still motivational.

After being officially diagnosed in 2010, she started using Habitica in 2011 when it was still known as “HabitRPG”, and is now using it on a daily basis.

Regarding technical aspects, she usually worries about data privacy, but mentioned it is fine in Habitica since no one knows who she is due to the anonymity of a username. Sometimes the system has bugs which used to be more frequent, but she is not bothered as they have become less frequent. She uses Habitica only on the PC, as she only has a Windows Phone, which does not offer her access to available mobile applications of Habitica.

The second interview partner was a female Australian university student studying a psyche related degree. She does not suffer from any conditions, but uses Habitica for a wide variety of goals, namely chores, health, exercise, diet and learning Spanish. In order to achieve and maintain new behaviour and habits, she uses a combination of all the features Habitica has to offer, including its advertised main aspects habits, dailies and to-do’s and the game’s social aspects. Health related habits she uses are drinking water, snacking healthily, exercising and not getting off the bike when getting up a hill, spending time outside every day, putting sunscreen on and posture.

The social aspect plays a big role for my second interviewee, as the party system gives her a lot of motivation to not leave her dailies unchecked, which would result in damaging her friends’ characters just because she did not feel like doing something. In the same social category and even more valuable than the party system for her is the quest system, in which you gather items or fight strong monsters with your group, which yields rewards and acts as a motivator to not leave dailies unchecked. However what keeps her coming back the most is the community aspect, since she finds it easy to engage with people, and guilds offer a great way of getting support for how to get some of the more tricky things done, as well as getting suggestions as to what to do. Guild specific challenges were also mentioned as a motivating aspect, in which several members work towards a challenge goal with certain tasks, for example walking a certain amount of steps, or doing a certain number of squats.

The rewards in the game were perceived as well-balanced, where collectibles such as pets, mounts and equipment serve as a motivational incentive. It was also perceived as motivational to see the progress she made with doing her tasks, thus making awareness an important aspect of Habitica for her.

Lastly she also mentioned that Habitica is open source, and contributing makes you more attached, leading to users actually sticking to it even more. Also, you get a contributor batch on your profile which looks nice.

While my second interviewee could not think about any actively problematic issues with Habitica, the levelling system

does not motivate her much, whereas gold and item drops do. Comparing her behaviour and health before Habitica with after Habitica, she stated that she improved quite a bit by making her fitter and healthier, even though that did not happen overnight. For example, adding the daily to eat 5 vegetables a day made her realize how few vegetables she actually ate. Regarding adoption and diffusion, she started playing at the 7th of February 2015 and used Habitica regularly ever since, with a current log-in streak of 95 days in a row. As for the technical aspects of the system, a bug that rearranges the priorities in the to-do list was found as particularly annoying.

My third interviewee was a 21 year old Argentinian woman using Habitica to deal with depression and self-esteem problems. She also mentioned that she sometimes hears voices in her head. Even though undiagnosed, one of her issues with depression is that it sometimes leaves her lethargic and unable to do anything. Her inability to perform actions leads to a downward spiral as she tends to beat herself up mentally, leading to feelings of guilt and uselessness. She uses Habitica to reward herself for simple tasks such as brushing her teeth, meditating or studying.

While she uses the habit system for easing depression symptoms, the dailies and to-dos reflect goals and tasks that she set for her life in general. Besides using the reward system, the to-dos also fulfil their classical purpose of reminding her what she needs to do, as she tends to forget writing down tasks and appointments into her calendar.

She sees the social aspect of Habitica as highly valuable, even though the actual helpfulness depends on the specific guild. The interviewee mentioned the mentally ill guild as being priceless as it is a place in which she and people sharing her problems can vent, reach out for help, or find someone who listens, or at least offers some kind words. The same applies to the scholar's guild for studying, while other guilds turned into a "looking for party" hub without a helpful community aspect.

While she had success with the guild system, she does not draw motivation out of the accountability aspects of the party system, which she just uses for levelling up her character. She also does not use the challenge system as she does not find it motivational, but acknowledges that other users with mental health issues successfully use it. For her, the smallest slip in a challenge leads her into the aforementioned downward spiral and subsequently creates feelings of worthlessness. The comparison of Habitica with a tool was drawn, meaning that you have to learn how to play the game properly before achieving results. When she first started, she added too many items in all the categories to her in-game agenda, which made her feel worse about life in general as she could not handle everything. She identified this as one of the limitations of the game, since users have to establish their own goals and tasks to work towards them, as well as setting their own appropriate rewards.

One of her big problems that she had for years was finding the motivation to study. With Habitica, she now manages to study every day, even without a fixed routine.

Regarding frequency of use, she started playing Habitica in 2014, had a hiatus of a few months in 2015 and uses it every day since getting back to it.

At the start of adoption, she was worried that people could read her tasks and judge her, but besides that she did not mention any issues regarding data privacy, especially since she does not use her real name or her main email account. Habitica is only used by her on the PC and not on other mobile devices, as her phone is too old to have the app.

My fourth interviewee was a 21 years old female psychology student from the USA, suffering from ADHD and migraines. As with my first interviewee, ADHD resulted in an inability to sit down and focus and forgetfulness, as well as problems with getting started doing tasks. The migraines resulted in a lot of pain, leading to difficulties organizing her life, since she does not know when she can study and when she is disabled by the pain.

She takes medication for both conditions, while adding behavioural techniques and routines to ADHD and migraines, such as keeping life very regular, eating the same food, going to bed at the same time every day and waking up at the same time, as well as keeping healthy.

She mentioned that the community aspect is the biggest success factor in Habitica, as the game and its community encourage a strong sense of positivity and growth. Users of Habitica do not complain, but rather talk about their challenges and grow together. As with the other interviewees, she also likes the party system since it offers a sense of accountability, leading to more consistent dailies accomplishment in order to not hurt party members, while quests offer rewards for accomplishments. The guilds such as the chronic illness and ADHD guild offer relatability as well as advice and help for using Habitica to cope. My fourth interviewee is mostly motivated by gameplay elements she needs right now, e.g. drops when she wants more pets, or gold when she is out of gold. To cope with ADHD and studying, she established a system that rewards her for 1 daily every 15 minutes of doing homework for the first three hours, and 2 dailies for 15 minutes afterwards, so that a streak of studying leads to bigger rewards, motivating her to keep studying rather than stopping. In addition to that, she adds reading sections of chapters to habits to reward herself for the progress she made while doing homework. For dealing with her migraine, she used exercise habits and dailies for getting to bed on time and waking up on time. Other dailies for overcoming motivational hurdles during the day are to do something in general, and cleaning things up.

She registered on the 13th of October 2013 and uses Habitica multiple times on a daily basis.

The only negative aspect she could think of was that spending time in the community takes time away that you could spend productively. The fact that you get punished if you pick on too many tasks is not problematic for her, as dying in the game is not as bad, as you can always start again and reduce the amount of tasks you set for yourself.

All in all, she grew over the time she used Habitica by a lot of incremental behavioural changes, such as remembering to take her medicine more often, studying more and being less forgetful. On top of that, her attitude changed as she does not get as frustrated anymore when she cannot achieve her set goals. Also, my interviewee mentioned that Habitica just adds a bit of structure and a dimension of fun to dealing with life.

The fifth interviewee is a 29 years old female Australian writer, currently unemployed and living in the US. She suffers from a range of conditions, namely Bipolar disorder, BPD, OCD, Fibromyalgia, ME/CFS, IBS, Hypothyroidism, and Hidradenitis Suppurativa. During the past, she tried a wide range of treatments for her conditions, such as medication, weekly therapy for mental health issues and pacing and meditation for both her mental and physical conditions.

On top of that, she is aiming to lose weight and tried exercise regimens such as yoga or Tai chi. It has taken a while to figure out, but she managed to find a combination of medication that works for her, and which she probably will be on for the rest of her life. She aims to continue therapy for as long as she can

afford it, since it plays a big role in her recovery. Meditation was an activity that helped her to change a lot in just one month. Exercising has been more harmful than positive to her, but losing weight helped.

She uses Habitica to incentivise herself to create and work on her to-do list, which includes a lot of activities for her numerous health conditions, which has led to her changing a lot of habits. She uses habits for taking medicine, flossing teeth, observing dietary intake, logging her weight and deep breathing. Dailies she uses are practicing self-care, meditating and doing meditation homework, while her to-dos change regarding what she has to do, with frequent items being to refill her pill box and picking up medication.

While first doubtful, she now uses Habitica's social features and enjoys them. Not only is she in a party with her mother who offers her an additional anchor of support, but she also uses the guilds, in which the quality differs depending on which guild it is. Habitica's features help her to maintain small changes on a daily basis that add up to bigger changes over time, and assists her in keeping focused working towards long-term goals. Interestingly, the reward system and gamification are the features that motivate her most in working towards her goals. Regarding aspects that can be improved, she mentioned that it would be nice to have tasks that work similar to dailies, but allow her to specify a larger timeframe, e.g. four days to complete, rather than one day. Another aspect was a preview system for how much gold a task is going to yield, which would make it easier to personalise rewards.

Since using Habitica, my interviewee is much more motivated to complete tasks like cleaning the kitchen, and Habitica introduced her to meditation which is an integral and life-changing part for her now. Regarding adoption and diffusion, she started using Habitica a few years back, stopped playing and then started again a few months ago, using it every day ever since. Bugs were not perceived as a big problem, but the Android version of Habitica was mentioned to be far inferior to the PC version due to lack of features. Further on the technical site, data privacy was not mentioned as an important issue. Lastly she also strengthened the relationship with her mum by playing together with her.

My sixth and final interviewee is a 22 years old woman from the United States of America, currently living in California. She does not use Habitica to cope with health conditions, but rather uses it to improve her health in general.

Regarding other games, she also tried the serious game "SuperBetter", which she stopped playing after a short time because she went into it alone, highlighting the importance of the social aspect that is prevalent in Habitica.

On Habitica, she uses dailies, habits and to-dos as well as the party system and the guilds. Health related dailies of hers are to work out certain body parts in the gym on certain days of the week, drinking warm lemon water every time she wakes up or drinking tea that is beneficial for her health. Habits evolve around thinking positively about her health, including eating healthy foods over junk food, and cooking her own dinner.

What my last interviewee likes most about Habitica is the party system, in which she partied up with two of her friends. She mentioned that through talking with party members, you create a sense of intimacy resulting in encouragement and support for each other and each other's tasks. Through that, she feels a friendly environment is created that also makes you liable for the health of the whole party, since your success on Habitica through accomplishing tasks determines how well you do in a party and whether you damage your members or not. Further she mentioned that the party aspect is the most important

feature in Habitica and is a necessity for having fun with it. Advising Habitica to encourage new players more strongly to use the party system was suggested. The guilds were perceived as useful in so far that my interviewee felt confident that she could ask health related questions to them, but it feels more like dealing with strangers opposed to the party system. Additionally, she mentioned that it feels like she is collecting guilds by joining a lot of them rather than having in-depth communication in them.

Rewards were seen as motivating, as equipment is fun to get and mounts and pets are cute. However, while equipment is fun to collect, my interviewee felt that it was too easy to collect it later in the game, as the amount of gold obtained increases and the amount of ways to spend it decreases.

She personally does not perceive strong limitations with Habitica, but identifies that it might be problematic for new players who are not comfortable with organising their lives in lists.

She started playing Habitica in 2014 and uses it every day, with brief interruptions when she is travelling and does not have signal.

On the technical site, bugs were not reported as being too problematic and none were experienced personally. Data privacy does not matter for my interviewee on Habitica. She plays the game on her computer and on an iOS device, which both work well.

4.1 Results

What was found through the qualitative method is that the serious game Habitica play a substantial role in leading behavioural changes in the everyday lives for my interview partners. A distinction needs to be made in some aspects between players who use Habitica for changing their health behaviours while not suffering from any health conditions, opposed to players who suffer from health conditions and use Habitica to cope and become healthier. An overview of interview data can be found in Table 2.

During the literature review, theories of change and success factors of serious health games have been identified. The interview results interestingly show overlap in several of those theories and success factors.

A highly useful aspect overall that has been mentioned by every interview partner is some form of the social aspect of Habitica, which takes the form of the guilds and the party system. The fact that guilds exist for specific conditions as well as general health improvements and other goals leads to a strong and supportive community. If wanting to socialize, players can find other players with shared experiences and problems and find support, encouragement and a forum for discussion. The fact that everyone in those guilds is playing the game to change their behaviour and to reach their goals creates an atmosphere of growth and positivity. This is partly a feature of debriefing that was mentioned earlier in the paper, as players can discuss about their experiences and talk to each other (Crookall, 2010), which is a strong indicator for actual change and learning to occur. Other methods of debriefing in Habitica can be seen by weekly reports that the game sends you per email to show the progress you made in that week.

Interviewee/Interview aspect	Daily/Habit /To-Do 's	Party	Guilds	Challenges	Rewards	Health improvement	Frequency of use	Bugs	Ease of learning the game
One*	++	++	+	/	-	++	++	+	-
Two	+	++	++	+	o	++	++	-	o
Three*	+	--	+	-	o	+	++	o	-
Four*	+	++	++	/	++	++	++	/	/
Five*	+	++	+	/	++	+	++	++	/
Six	+	++	-	/	o	+	++	+	+

Table 2. Interviewees with a * suffer from a health condition; ++ strongly positive; + positive; o neutral; - negative; -- strongly negative; / not applicable

The success of the guilds for contributing to behavioural change can also be explained by the theory of planned behavior (Ajzen, 1991), where perceived behavioral control and normative beliefs are being influenced by the guilds, since they offer a productive and supportive atmosphere and encourage personal development, through which the player feels that tasks are more accomplishable, as well as that others expect him to work on them rather than complaining about them.

However, while the guilds were mentioned as success factors, some were also seen as less helpful, which suggests that the guilds function as a form of sub cultures or sub communities with their own set of rules and norms, with some being more helpful than others.

One of the interviewees also mentioned that she sometimes spends too much time talking in the guild, which can almost distract her from her tasks. Even though mentioned as a very minor limitation, this aspect shows similarities with the findings of Thompson et al. (2008), who found that too much immersion can distract the player from the behavioural objective and might thus reduce performance and effectiveness.

Evidently, players of Habitica who suffer from mental and/or physical health conditions benefit more from the guild system in which they can form relationships with other individuals suffering from the same or similar conditions. While each of the interviewees with health conditions mentioned the guild system as helpful, only one of two interviewees without a health condition perceived it equally useful. However, a difference surfaces in the use of the guilds. While interviewees suffering from conditions see the guilds as a hub to find relatability and support with people suffering from similar conditions, my interviewees that use Habitica to improve their general health see it more as a social hub for communication and advice in general. One interviewee suffering from ADHD also mentioned that the guilds are unique in that they offer an aspect that cannot be delivered through common therapy in that it allows you to ask questions and to communicate with people who have experienced the same conditions rather than experts knowing theoretical ways of helping, but not necessarily knowing how it actually feels to suffer from specific conditions.

Another success factor of the game are the motivational aspects that drive behavioural changes. The interviews have shown that interviewees are motivated by extrinsic rewards. While the type of reward that motivates differs per person, every interviewee was motivated by at least one type of reward, be it equipment, experience, pets, mounts or gold. The game rewards players for their desirable behaviours while punishing them for undesirable ones.

The self-determination theory outlined in section 3.2 plays a role here, as extrinsic rewards are given to players who behave in the desired way (Deci & Ryan, 1985). Intrinsic motivation is to a limited degree a prerequisite for successful adoption on

Habitica, as it is a serious game that targets people who already have the will to change their behaviours, but struggle in doing so. On Habitica, a combination of intrinsic and extrinsic mechanisms is at play on several levels. The rewards serve as extrinsic motivators, while intrinsic motivation comes from the desire to finish set tasks, habits and to-dos sufficiently to not damage party members or herself. The border between intrinsic and extrinsic appears to blur on Habitica as the reward system is personalised and internalised as the individual keeps playing. Elaborating on that aspect, one of my interview partners mentioned that extrinsic rewards such as pets and mounts have been a strong motivator at the beginning, but in line with the experience of another interview partner, became less motivating as the player progresses through them. My last interviewee also mentioned that equipment is too easy to obtain after a year of playing, since the gold rewards outweigh the amount of items in the progression of a character class. Nonetheless, Habitica works on that aspect by periodically releasing new content to offer more rewards to established players.

Another observation is that behavioural changes work much along the lines of the Transtheoretical Model of change (Grimley et al., 1994). My fourth and fifth interviewees for example mentioned that changes that have been made through Habitica are plentiful if seen over a longer scale, but are very small and incremental on their own, which is in line with the theory stating that changing behaviour is a multistep process that leads to behavioural changes through incremental changes over time.

Interestingly, the fact that the game is open source was found as a motivator by one of the interview partners. Players can actively contribute to the game by submitting content like pixel art, code or translations, which results in a contributor badge on the player's profile. A limitation that was mentioned in the literature review was that a mismatch between goals, target group and methods limit success (Dieckmann et al., 2012). The authors suggested involving the target audience in game development to make sure abovementioned aspects are in match. By allowing users to contribute to Habitica and voice their feedback, the game does just that.

Action plans have been mentioned by Thompson et al. (2015) as a practical method of transforming goals into tangible tasks, leading to more sustained and more efficient behavioural changes. As one of the core features of Habitica is the establishing of habits, dailies and to-dos in a tangible manner, the game utilises aspects of action planning.

Interview partners further mentioned that the use of Habitica has made them more aware of their actual behaviour and showed them that such behaviour can be changed to a healthier one. This is in line with the self-regulation theory, which suggests that the individual monitors his behaviour, sees how it

affects him, changes it and maintains the changes (Boekaerts et al., 2005).

A surprising finding is that all my interviewees played the game consistently for a long period of time, which is not in line with the concerns voiced by (Boendermaker et al., 2015) who stated that serious games are most effective when training times are short due to issues with long-term motivation.

The technical aspects obtained from the Graafland et al. (2014) model regarding bugs, platform stability and data privacy were of no concern to any of my interview partners, even though the Android app of Habitica was criticised. That suggests that these aspects do not play a major role on Habitica.

5. CONCLUSIONS

The paper has shown that serious health games are being applied in a lot of different scenarios and do indeed achieve success when applying theoretical change models and balancing game design with theory, as well as applying a fit of goals, methods and target group. The interview results and the literature review show that serious health games have different stakeholders, which are either players who play them to cope with health conditions opposed to ones who play them to achieve a healthier lifestyle in general. Interview partners included people suffering from mental or physical conditions, as well as people who suffer from both or from none.

For individuals with health conditions, Habitica has shown to improve their lives and change attitudes and behaviours through small incremental changes over a longer period of time. Nonetheless, the interviewees suffering from conditions reported that even though Habitica can help on its own, it is the combination of it with further treatment techniques such as medication or therapy that brings the most success.

Interestingly, a very important aspect of Habitica that has largely been overlooked by the serious gaming literature is the social aspect, which was one of the main aspects for many of my interview partners that helped them and kept them coming back each day. Other aspects that were identified as important in this paper are motivational aspects such as rewards, which have been shown to be internalized throughout the use of the game, leading to players being more self-determined in their goal-achievement.

Through observations in the literature and interviews, serious health games have been shown to be successful in changing health behaviour for the interviewed players of the serious game "Habitica".

While individuals suffering from specific health conditions benefit from further professional treatment, this paper has shown that serious health games have a valid position as alternative methods of serious health games if they incorporate theoretical change methods in gameplay and game mechanics, include social aspects and are designed with the target group in mind.

In that case, it can be said that serious health games do indeed have potential to be viable alternatives to traditional treatments and techniques.

6. LIMITATIONS AND RECOMMENDATIONS

Even though this study presented interesting findings, it comes with a few limitations. The literature review might be limited due to the rather inclusive search terms, which might lead to some areas of serious health game literature falling outside of the scope of this research paper. Also, papers from different

sources were used for behavioural changes and for proving validity of research methods.

Regarding the study design, the sample size was just six and was thus rather small. This is partly due to the fact that some volunteers did not show up during scheduled interview times and/or did not respond to messages after voicing their interest. One of the reasons for that could be that behavioural changes through Habitica are a rather private topic that individuals might not want to talk about after all, leading to volunteers changing their mind when receiving messages. Also, the sample solely consisted of female players, and might not account for differences due to gender. Due to the small sample size and the focus of the interview sample on the game Habitica, the generalisability of the game to other serious health games could be questioned. In addition, the research method relies on convenience sampling and volunteers, leading to further limitations in generalisability.

Further research can focus more on the effect of social aspects and community building on behavioural change success of serious health games, as the community has been shown to be the factor that kept interviewees coming back to Habitica the most. Also, it may be interesting to further research the differences between players that aim to improve their health behaviour in general opposed to people that cope with health conditions.

As this paper has shown, serious health games need a couple of factors that play a role in game and intervention design, and should thus be implemented by game developers in practice. The strongest aspect that was revealed through the interview results and that was not specifically mentioned at such length in literature is the social aspect of serious health games and community building. As five out of six interview partners mentioned it as one of the most motivational aspects in keeping them playing every day, game developers would want to think about community building and social features when designing their serious health games.

7. REFERENCES

- Ajzen, I. (1991). The theory of planned behavior. *Organizational behavior and human decision processes*, 50(2), 179-211.
- Albrecht, U.-V. (2013). Transparency of health-apps for trust and decision making. *Journal of medical Internet research*, 15(12), e277.
- Association, A. E. R., Association, A. P., Education, N. C. o. M. i., Educational, J. C. o. S. f., & Testing, P. (1999). *Standards for educational and psychological testing*: Amer Educational Research Assn.
- Bandura, A., Adams, N. E., & Beyer, J. (1977). Cognitive processes mediating behavioral change. *Journal of Personality and Social Psychology*, 35(3), 125-139. doi:10.1037/0022-3514.35.3.125
- Baranowski, T., Lin, L. S., Wetter, D. W., Resnicow, K., & Hearn, M. D. (1997). Theory as mediating variables: why aren't community interventions working as desired? *Annals of Epidemiology*, 7(7), S89-S95.
- Bartholomew, L. K., Parcel, G. S., Kok, G., & Gottlieb, N. H. (2011). *Planning health promotion programs: an intervention mapping approach*: John Wiley & Sons.
- Boekaerts, M., Pintrich, P. R., & Zeidner, M. (2005). *Handbook of self-regulation*: Elsevier.
- Boendermaker, W. J., Prins, P. J. M., & Wiers, R. W. (2015). Cognitive Bias Modification for adolescents with substance use problems - Can serious games help? *Journal of Behavior Therapy and Experimental*

- Psychiatry*, 49, 13-20.
doi:10.1016/j.jbtep.2015.03.008
- Crookall, D. (2010). Serious Games, Debriefing, and Simulation/Gaming as a Discipline. *Simulation & Gaming*, 41(6), 898-920.
doi:10.1177/1046878110390784
- Deci, E. L., & Ryan, R. M. (1985). *Intrinsic motivation and self-determination in human behavior*: Springer Science & Business Media.
- Dieckmann, P., Friis, S. M., Lippert, A., & Østergaard, D. (2012). Goals, Success Factors, and Barriers for Simulation-Based Learning: A Qualitative Interview Study in Health Care. *Simulation and Gaming*, 43(5), 627-647. doi:10.1177/1046878112439649
- Dijk, T. v., Spil, A. A. M., Burg, S. v. d., Wenzler, I., & Dalmolen, S. (2014, 2014). *Present or Play, Some First Evidence on the Effect on Behaviour of Serious Gaming*. Paper presented at the ECGBL 2014, 8th European conference on games based learning, Berlin, 9-10 October 2014.
- Flanagan, J. C. (1954). The critical incident technique. *Psychological bulletin*, 51(4), 327.
- Giner-Bartolome, C., Fagundo, A. B., Sanchez, I., Jimenez-Murcia, S., Santamaria, J. J., Ladouceur, R., . . . Fernandez-Aranda, F. (2015). Can an intervention based on a serious videogame prior to cognitive behavioral therapy be helpful in bulimia nervosa? A clinical case study. *Frontiers in Psychology*, 6, 9. doi:10.3389/fpsyg.2015.00982
- Glasgow, R. E., Vogt, T. M., & Boles, S. M. (1999). Evaluating the public health impact of health promotion interventions: the RE-AIM framework. *American journal of public health*, 89(9), 1322-1327. Retrieved from <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1508772/pdf/amjph00009-0018.pdf>
- Global Games Market Will Reach \$102.9 Billion in 2017. (2014, 14.05.2014). Retrieved from <http://www.newzoo.com/insights/global-games-market-will-reach-102-9-billion-2017-2/>
- Graafland, M., Dankbaar, M., Mert, A., Lagro, J., De Wit-Zuurendonk, L., Schuit, S., . . . Schijven, M. (2014). How to Systematically Assess Serious Games Applied to Health Care. *JMIR Serious Games*, 2(2), e11. doi:10.2196/games.3825
- Grimley, D., Prochaska, J. O., Velicer, W. F., Blais, L. M., & DiClemente, C. C. (1994). The transtheoretical model of change. *Changing the self: Philosophies, techniques, and experiences*, 201-227.
- Hanna, P. (2012). Using internet technologies (such as Skype) as a research medium: a research note. *Qualitative Research*, 12(2), 239-242.
- Hansen, W. B., & McNeal, R. B. (1996). The law of maximum expected potential effect: Constraints placed on program effectiveness by mediator relationships. *Health Education Research*, 11(4), 501-507.
- Lewis, T. L. (2013). A systematic self-certification model for mobile medical apps. *Journal of medical Internet research*, 15(4), e89.
- Lin, J., Mamykina, L., Lindtner, S., Delajoux, G., & Strub, H. (2006). Fish'n'Steps: Encouraging Physical Activity with an Interactive Computer Game. In P. Dourish & A. Friday (Eds.), *UbiComp 2006: Ubiquitous Computing* (Vol. 4206, pp. 261-278): Springer Berlin Heidelberg.
- Ryan, R. M., & Deci, E. L. (2000). Intrinsic and Extrinsic Motivations: Classic Definitions and New Directions. *Contemporary Educational Psychology*, 25(1), 54-67. doi:<http://dx.doi.org/10.1006/ceps.1999.1020>
- Spook, J. E., Paulussen, T., Paulissen, R., Visschedijk, G., Kok, G., & van Empelen, P. (2015). Design Rationale Behind the Serious Self-Regulation Game Intervention "Balance It": Overweight Prevention Among Secondary Vocational Education Students in The Netherlands. *Games for health journal*, 4(5), 387-400. doi:10.1089/g4h.2014.0142
- Stieger, S., & Göritz, A. S. (2006). Using instant messaging for Internet-based interviews. *CyberPsychology & Behavior*, 9(5), 552-559.
- Thompson, D., Baranowski, T., Buday, R., Baranowski, J., Thompson, V., Jago, R., & Griffith, M. J. (2008). Serious video games for health: how behavioral science guided the design of a game on diabetes and obesity. *Simulation & Gaming*.
- Thompson, D., Bhatt, R., Vazquez, I., Cullen, K. W., Baranowski, J., Baranowski, T., & Liu, Y. (2015). Creating action plans in a serious video game increases and maintains child fruit-vegetable intake: a randomized controlled trial. *The international journal of behavioral nutrition and physical activity*, 12(1). doi:10.1186/s12966-015-0199-z
- Wiemeyer, J., & Kliem, A. (2012). Serious games in prevention and rehabilitation—a new panacea for elderly people? *European Review of Aging and Physical Activity*, 9(1), 41-50.
- Wijnhoven, L., Creemers, D. H. M., Engels, R., & Granic, I. (2015). The effect of the video game Mindlight on anxiety symptoms in children with an Autism Spectrum Disorder. *Bmc Psychiatry*, 15, 9. doi:10.1186/s12888-015-0522-x
- Wolfswinkel, J. F., Furtmueller, E., & Wilderom, C. P. M. (2013). Using grounded theory as a method for rigorously reviewing literature. *European Journal of Information Systems*, 22(1), 45-55. doi:10.1057/ejis.2011.51

8. APPENDIX

A1. Literature research method

In order to achieve validity in the literature reviewing method, this paper partly applied the grounded literature reviewing method by Wolfswinkel, Furtmueller, and Wilderom (2013). To mostly find papers that talk about serious games as well as behavioural changes, the following search query was executed on Web of Science:

TOPIC: (serious gam*) AND TOPIC: (behavio*)

Refined by: RESEARCH DOMAINS: (SOCIAL SCIENCES)

The search yielded 322 papers, which were then scanned and papers that talked about serious games and behavioural changes were worked through and added to this research paper if containing relevant information. Initially, Google Scholar

was used to get a general idea of the serious game research domain, as well as the paper by (Dijk, Spil, Burg, Wenzler, & Dalmolen, 2014). An additional literature search was conducted for behavioural changes by searching for “behavioral change” and “behavioural change” on Google Scholar, to include papers in British English as well as American English.

A2. Top 5 health related guilds on Habitica

Name of guild	Public description as seen in the game	Members as of 29-09-2015
The Health Nuts	For people who want to achieve or maintain good health, whether it be through eating, exercise, or otherwise.	5251
ADHDers Guild	This is a guild for those of us with ADD/ADHD using HabitRPG to help manage the issues of motivation and distraction that come with our disorder. If you want to talk about ways to manage your ADD/ADHD outside of HabitRPG, have intelligent discussions about the disorders, find resources about ADD/ADHD, ask a question about the disorder, or if you just want to have a chat then you have come to the right place. We have a kind, friendly, and dedicated community that is here to help and is focused on ensuring that your experience with HabitRPG is-Look! Something Shiny! *	2996
Mentally ill	For those of use suffering from mental illness and trying to develop better habits to deal with them.	2314
Anxiety Alliance	Do you suffer from anxiety, either generally or in specific situations? You are not alone! Diagnosed, undiagnosed, chronic or occasional, all are welcome to a supportive environment where we can talk about our experiences and share techniques for relaxation and anxiety management.	1194
The Chronic Illness Guild	A guild for players dealing with chronic illnesses. Trade tips on how to use HabitRPG to help stick to routines and make more positive choices, encourage and support other guild members, or just vent about symptoms keeping you from completing certain tasks!	938

A3. Convenience sampling

“Hello everyone, I am a student and I am currently working on my bachelors thesis which is about the viability of serious health games as an alternative method for changing behaviour. For my research, I would like to interview players of this game who are playing it to deal with illnesses and conditions, or who aim to achieve a healthier lifestyle in general. I would highly welcome PMs of interested players who would be up for a short interview. :)“

A4. Interview question items

Questions
Demographics (Age, location, occupation)
If you suffer from any physical or mental health conditions, what are they?
What did you try so far to cope or overcome your health conditions?
How have the methods you tried helped you?
How do you use Habitica to change your health related behaviour and/or cope with your health conditions? (E.g. use of Habitica features)
What are your health related habits, dailies and to-dos on Habitica?
What do you think about the social aspect of Habitica? (Elaborate on party system and guilds, challenges)
How do the features help you in improving your health or dealing with your health condition(s)?
What on Habitica motivates you most to change your habits and work towards your goals?
Where do you see limitations of Habitica? (E.g. where can it not help, what can be improved?)
How have you and your behaviour changed from before you used Habitica to after?
Since when do you use Habitica and how frequently do you use it?
How do bugs on Habitica affect your user experience?
Can you elaborate on any special positive or negative experiences that occurred with Habitica?
Do you use Habitica on multiple devices? If yes, are they of equal quality?
What do you think about data privacy on Habitica?
What else would you like to add?