UNIVERSITY OF SOUTHAMPTON

FACULTY OF PHYSICAL SCIENCES AND ENGINEERING

School of Electronic and Computer Science

Gamification for The Self-management of Chronic Illnesses

by

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Thesis for the degree of doctor of philosophy

July_2017

UNIVERSITY OF SOUTHAMPTON

<u>ABSTRACT</u>

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GAMIFICATION FOR THE SELF-MANAGEMENT OF CHRONIC-ILLNESSES

Alaa Abdullah AlMarshedi

The use of gamification in healthcare has been receiving a great deal of attention in both academic research and industry, but there are yet to be frameworks and guidelines for its implementation. This thesis focuses on the use of gamification in the self-management of chronic illnesses, in particular, diabetes. The thesis presents a novel framework and a set of guidelines for developers to implement gamification in this area.

The framework, called The Wheel of Sukr, combines elements from self-management practices, game elements, and behaviour change methods. It consists of 28 elements grouped under 8 themes. The framework has been validated using a mixed-method approach by conducting interviews with experts from the fields of medicine, psychology, games, and gamification. Moreover, a questionnaire was completed by individuals with diabetes in order to measure their attitudes towards the themes of the framework. This study indicated an overall acceptance of the notion of gamification in the self-management of diabetes.

After validation, a set of guidelines based on the framework was introduced. The guidelines were validated using a multi-method approach where expert interviews and focus group sessions were conducted. The guidelines received support from the experts, who agreed that they accurately reflect the framework and that developers can potentially use them to create gamified self-management apps for chronic illnesses. Moreover, developers who participated in the focus group sessions welcomed the guidelines. They found them to be clear, useful, and implementable. Furthermore, they were able to suggest several ways of gamifying a non-gamified self-management app when they were presented with one. The findings suggest that the guidelines introduced in this research are clear, useful, and ready to be implemented for the creation of self-management apps that use the notion of gamification as described in the Wheel of Sukr framework.

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DECLARATION OF AUTHORSHIP

I, Alaa Abdullah Almarshedi

declare that this thesis and the work presented in it are my own and has been generated by me as the result of my own original research.

GAMIFICATION FOR THE SELF-MANAGEMENT OF CHRONIC-ILLNESSES

I confirm that:

1. This work was done wholly or mainly while in candidature for a research degree at this University;
2. Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;
3. Where I have consulted the published work of others, this is always clearly attributed;
4. Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work;
5. I have acknowledged all main sources of help;
6. Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;
7. Parts of this work have been published as:
   - AlMarshedi, Alaa, Wills, Gary and Ranchhod, Ashok (2016) Gamifying self-management of chronic illnesses: a mixed-methods study JMIR Serious Games, 4, (2), pp. 1-11. (doi:10.2196/games.5943). (PMID:27612632).
   - AlMarshedi, Alaa, Wills, Gary and Ranchhod, Ashok (2017) Guidelines for the Gamification of Self-Management of Chronic illnesses: Multi-method study. JMIR Serious Games, 5, (2), (doi:10.2196/games.7472). (PMID:28500018).
   - AlMarshedi, Alaa, Wills, Gary and Ranchhod, ashok (2015) The wheel of Sukr: a framework for gamifying diabetes self- management in Saudi Arabia The 5th International Conference on Current and Future Trends of Information and Communication Technologies in Healthcare (ICTH 2015) (doi:10.1016/j.procs.2015.08.370).
   - AlMarshedi, Alaa, Wills, Gary and Ranchhod, Ashok (2014) Gamification to improve adherence to diabetic treatment in Saudi Arabia At International Conference on Information Society (i-Society 2014), United Kingdom. 10 - 12 Nov 2014. 2 pp.
   - Almarshedi, Alaa, Wills, Gary, Wanick, Vanissa and Ranchhod, Ashok (2017) Gamification and behaviour. In, Gamification: More than just games! Using Game Element in Serious Contexts. Springer

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Date: ....

Acknowledgements

First, I would like to thank my parents, husband, and family for their constant encouragement and support, and especially my husband for his patience and understanding throughout my PhD journey.

I am very grateful to my main supervisor Dr. Gary Wills for his support and guidance. I would also like to thank my colleagues for the many discussions that we had throughout our studies.

Finally, I acknowledge the sponsorship by the Saudi Government Scholarship Program.

Chapter 1:   Introduction

Gamification is the use of game elements beyond the scope of entertainment. It incorporates the engaging and rewarding aspects of games into other areas (e.g. healthcare and education) to increase motivation and engagement, and influence behaviour. Gamification is considered one of the popular emerging technologies in industry (LeHong and Fenn, 2013). It started around ten years ago in industry, where a few companies provided gamification platforms to enhance the motivation and engagement of employees, and to create a shift in the behaviour of consumers (Dale, 2014). Ever since, it has been receiving a great deal of attention in industry and is currently applied in different areas such as in business, marketing, education, and healthcare. According to a recent report, gamification is estimated to be an 11 billion USD industry in 2020 (Markets and Markets 2016). Furthermore, there has been a growing interest in gamification in the academic literature over the past few years (Seaborn and Fels, 2014). It is an interdisciplinary field of study where the research ranges from studying its effects to providing frameworks and guidelines for its application in specific areas (Simões, Redondo and Vilas, 2012; Nguyen, 2015; Nacke and Deterding, 2017).

Moreover, the advancement in technologies, smartphones, and tracking technologies could have played a role in the increased interest in gamification, specifically for healthcare purposes (Swan, 2009; Deterding, 2012). It could be used to facilitate user-centred healthcare and influence health behaviours. Healthcare encompasses many areas such as fitness and self-management. In particular, the self-management of chronic illnesses is an area where there are many challenges and opportunities.

One of the major chronic illnesses is diabetes. Diabetes is widespread in many countries throughout the world and its prevalence is high in many places. This illness requires extensive self-care and the self-management of several aspects of daily life. This is repetitive and could be challenging to some individuals. Although there are electronic logbooks and online forums for individuals with diabetes, these tools and communities might not be engaging nor motivating to users. Thus, it is of interest to enhance the motivation of individuals with diabetes, increase their engagement with their daily self-management tasks, and make this daily process easier and perhaps an enjoyable experience. This is where gamification may play a major role.

The way that gamification tries to enhance motivation and engagement, and influence behaviour is based on a number of psychological theories. These theories address a number of aspects: First, motivation, its types, and how people are motivated. Second, the circumstances causing different

types of behaviour and how to encourage users to carry out certain tasks. Third, how to sustain the motivation and engagement of users and to achieve the desired effects of gamification.

There are many aspects of gamification that incorporate these theories. For example, a reward system that is based on points, badges and leaderboards may extrinsically motivate users, while creating an experience that enhances feelings of mastery, purpose, and autonomy can intrinsically motivate and encourage them to carry out the daily tasks of self-management.

While gamification is promising in this area, surprisingly, incorporating gamification into the self-management of chronic illnesses has not been studied a great deal in the literature. In particular, there are no frameworks or guidelines that combine elements from the gamification, behaviour change, and self-management literature to aid the development of gamified self-management apps for individuals with chronic illnesses such as diabetes. To fill this gap in the literature, this thesis will provide the first framework for the gamification of the self-management of chronic illnesses. Moreover, a set of guidelines that aid developers in the gamification of the self-management of chronic illnesses will be proposed.

The framework will synthesise elements from the literature on gamification, behaviour change, and the self-management of chronic illnesses especially diabetes. Next, to ensure that the framework is valid for such an area, it will be validated using a mixed-method approach. In particular, medical doctors, psychologists, and gamification experts will be interviewed to obtain their insights on the framework. In addition, individuals with diabetes (based in Saudi Arabia) will participate in a questionnaire that aims to measure their attitudes towards the concepts covered by the framework. The results of both studies will be used to validate the framework.

The framework will then be translated into a set of guidelines that can be applied practically by developers. The guidelines will contain definitions, goals, a description, and an application to aid developers in creating gamified self-management apps for chronic illnesses. To validate the guidelines, a multi-method approach will be used. In particular, the set of guidelines will be assessed by expert interviews to ensure that they represent the framework accurately and comprehensively. The guidelines will be modified according to the feedback of the experts. The modified version of the guidelines will be discussed with developers in focus group interviews. The purpose of the focus group discussions with developers is two-fold: the first aim is to collect their views on the clarity usefulness, and ease of implementation of the guidelines. The second aim is to test if they could think of practical ways to gamify apps based on the guidelines. The results of both studies will be used to validate the set of guidelines.

The overall structure of the thesis takes the form of six chapters:

Chapter 1 provides an introduction to the overall thesis and a list of a peer-reviewed contributions based on this PhD work.

A literature review is presented in **Chapter 2** in which the author explores the literature in the three main areas of research in this thesis: gamification, behaviour change, and the self-management of chronic illnesses (specifically diabetes).

The chapter starts with a review of gamification and includes its definition and the cultural context which has led to its popularity. Moreover, similar concepts to gamification and a focus on its applications and the fields in which it has been implemented will also be discussed.

The chapter then presents a review on motivation, it types, and how it is used in gamification. This section of the chapter also covers a number of behaviour models and theories that are linked to gamification and would be of interest in gamification for healthcare.

Finally, the chapter presents a section on the use of gamification in healthcare and the self-management of diabetes.

Chapter 3 provides the methodology used in this thesis. The chapter starts by giving an overview of the research methods employed. It then explains the specific research methods to be used in the validation of the proposed framework, namely The Wheel of Sukr. This covers the use of triangulation and mixed-methods to validate the framework, which consists of expert interviews and a questionnaire for potential users.

After that, the chapter goes on to present the research methods used in the validation of the proposed guidelines, namely The Wheel of Sukr Guidelines. This covers the use of a multi-method approach of qualitative research methods. The validation of the guidelines involved expert interviews and focus group sessions.

In **Chapter 4** the framework and its validation will be presented. The chapter starts by discussing the framework design process and its components. The research methods employed for the validation of the framework are presented. The validation process consists of two studies. First, the expert interviews and the findings are presented. Then, the questionnaire and the results are presented. Finally, the chapter ends with a discussion of the findings and results of both studies.

Chapter 5 presents the set of guidelines and their validation. The chapter starts with the transition process from the framework to the creation of the guidelines. Then, the research methods that are used to validate the set of guidelines are presented. The validation process

consists of two qualitative studies. First, the expert interviews and the findings are presented. Then, the guidelines will be modified prior to conducting the second study. After that, the second study involving focus group interviews will be presented with its findings. Lastly, the findings of both studies will be used to validate the set of guidelines.

Finally, in **Chapter 6** a conclusion to the thesis is provided and an overview of future research directions will be presented. The chapter will also present research implications and limitations.

1.1 Peer-Reviewed Contributions

This thesis combines a number of research results, which have been published in peer-reviewed journals, conferences, or books.

Book Section:

Almarshedi, Alaa, Wills, Gary, Wanick, Vanissa and Ranchhod, Ashok (2017) Gamification and behaviour In, Gamification: More than just games! Using Game Elements in Serious Contexts. Springer (Citation= 1)

Journal Papers:

AlMarshedi, Alaa, Wills, Gary and Ranchhod, Ashok (2016) Gamifying self-management of chronic illnesses: a mixed-methods study JMIR Serious Games, 4, (2), pp. 1-11. (doi:10.2196/games.5943). (PMID:27612632). (Citation= 4)

AlMarshedi, Alaa, Wills, Gary and Ranchhod, Ashok (2017) Guidelines for the Gamification of Self-Management of Chronic illnesses: Multi-method study. JMIR Serious Games, 5, (2), (doi:10.2196/games.7472). (PMID:28500018).

AlMarshedi, Alaa, Wills, Gary, Wanick, Vanissa and Ranchhod, Ashok (2015) SGI: a framework for increasing the sustainability of gamification impact International Journal for Infonomics, 8, (1/2), pp. 1044-1052. (Citation= 11)

Conferences:

AlMarshedi, Alaa, Wills, Gary and Ranchhod, ashok (2015) The wheel of Sukr: a framework for gamifying diabetes self- management in Saudi Arabia The 5th International Conference on Current and Future Trends of Information and Communication Technologies in Healthcare (ICTH 2015) (doi:10.1016/j.procs.2015.08.370). (Citation= 4)

AlMarshedi, Alaa, Wills, Gary and Ranchhod, Ashok (2014) Gamification to improve adherence to diabeteic treatment in Saudi Arabia. At International Conference on Information Society (i-Society 2014), United Kingdom. 10 - 12 Nov 2014. 2 pp.

AlMarshedi, Alaa, Wanick, Vanissa, Wills, Gary and Ranchhod, Ashok (2014) Towards a sustainable gamification impact At International Conference on Information Society (i-Society 2014), United Kingdom. 10 - 12 Nov 2014. (Citation= 4)

Chapter 2:   Literature Review

This chapter presents a review on the literature of the three main areas of research in this thesis. These are gamification, motivation and behaviour change methods, and the self-management of chronic illnesses, specifically diabetes. The chapter starts with defining gamification, gives a background on the cultural and social context that has led to its rise, discusses a similar concept, and provides an overview of some gamification apps and frameworks. The second part of the chapter covers the psychology of gamification. It discusses the different types of motivation and their relevance to gamification, and behaviour change methods that can be utilised in conjunction with gamification. The third part of the chapter covers gamification in healthcare. It starts by giving a background to chronic illnesses, the self-management of chronic illnesses, and the role of community and peer support. Then, the use of gamification for chronic illnesses, specifically diabetes, is discussed.

2.1   Gamification

The notion that games and work cannot coexist has changed in recent years. Games have surpassed their traditional boundaries (Deterding, Sicart, *et al.*, 2011), and are no longer constrained to one gender or age (Griffiths, Davies and Chappell, 2004; Williams, Yee and Caplan, 2008; Entertainment Software Association, 2016). A recent study shows that the majority (63%) of households in the US alone have at least one person who plays video games regularly (Entertainment Software Association, 2016). Moreover, millennials have grown up playing games, which make them accustomed to the nature of games in terms of pursuing rewards and seeking more engagement from experiences (Anderson and Rainie, 2012). These factors as well as the availability of cheap tracking technologies and a focus on individual and behavioural analytics have led to the rise of gamification (Deterding, 2012).

Different definitions exist for gamification in industry and academia (Llagostera, 2012; Seaborn and Fels, 2014). However, the most cited definition and the one used in this thesis is the definition introduced by (Deterding, Dixon, *et al.*, 2011; Deterding, Sicart, *et al.*, 2011):

"The use of game elements in non-gaming contexts"

The aim of gamification is to engage, motivate, and influence the behaviour of users (Deterding, Sicart, *et al.*, 2011; Hamari and Koivisto, 2015). This is achieved in a fun way, benefiting from theories used in games such as flow theory, and the innate urge in users for recognition and instant positive feedback (discussed in Section 2.2.1.3). Gamification draws heavily from games

and human psychology. For example, the elements that are considered to make games successful, according to Reeves and Read (2009), namely goals, feedback, points, levels, competitions, teamwork and self-representation (e.g. Avatars) which are implemented in a storyline that motivates users.

Some researchers say that the term "gamification" first appeared in 2008, though it did not gain momentum until 2010 (Deterding *et al.*, 2011). However, the term was coined by Nick Pelling in 2002/2003 (Hagglund, 2012; Dale, 2014). There is an on-going debate on the term "gamification" and other terms have been used in place of it such as "gameful design" (Deterding *et al.*, 2011) and "gamefulness" (McGonigal, 2011). However, the term "gamification" is still the most commonly used (Deterding *et al.*, 2011). This debate could be a result of the fact that it is a relatively new field.

Gamification is derived from games, which fall under the broader category of play (Zimmerman and Salen, 2003; Deterding, Dixon, *et al.*, 2011). Caillios (2001), the French philosopher, who studied games and play, considered them two opposite forms of play activities. Play is described as being spontaneous and imaginative, with improvisational behaviours and meanings. On the other hand, games are characterized by rules, instructions, and competitions to reach a defined goal or outcome (Zimmerman and Salen, 2003; Juul, 2005). This differentiation between play and game influenced the definition of gamification in work by Deterding, Dixon, et al (2011). More specifically, toys, for example, represent the whole concept of playing. On one hand, playful design represents only parts of the concept of play. On the other hand, gaming taken as a whole is manifested in games, or serious games, whereas gamification represents parts of the concept of gaming which are used in non-gaming contexts such as healthcare. This categorisation has been illustrated by Deterding, Dixon, *et al.* (2011) in Figure 2-1.

Gaming

Games | Gamification

Whole | Parts

Toys | Playful Design
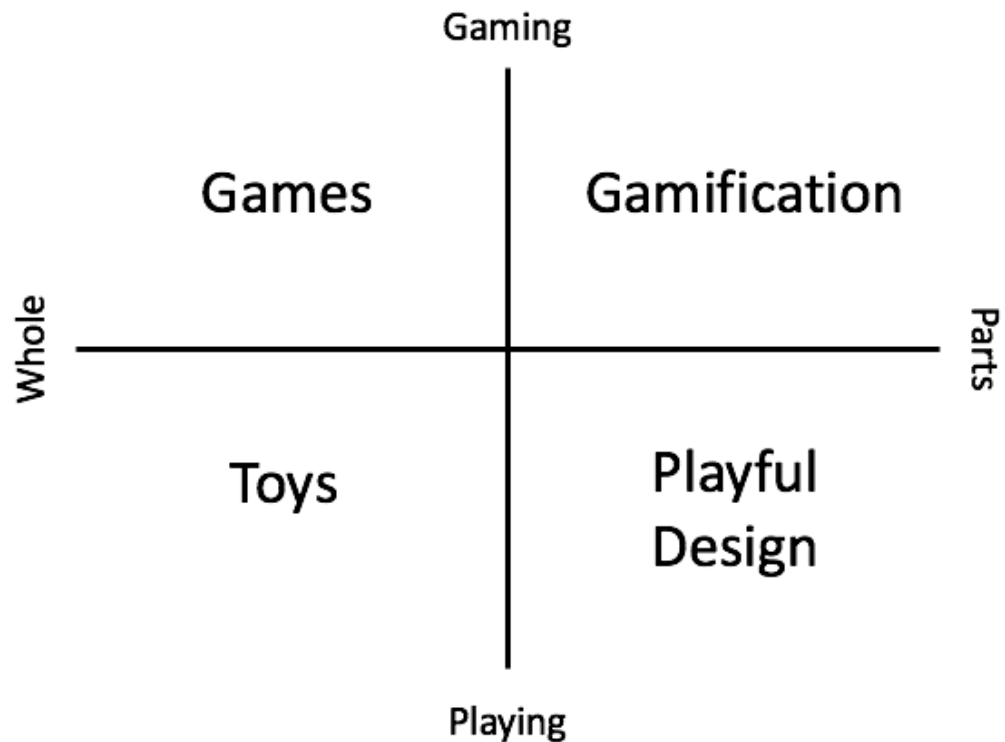
Playing

Figure 2-1 The difference between gaming and playing (Adapted from Deterding, Dixon, *et al* 2011)

Even though the term "gamification" is new, the concept itself is not. The use of points, badges, leaderboards, and competitions in the workplace had already been introduced in the past with similar goals to gamification (Nelson, 2012). Indeed, the use of rewards is not limited to the modern day; and it extends far back into history. People throughout history understood the impact of rewards, which leave people feeling happy (Schultz, 2006). These rewards could be of material form or in the form of badges, which convey status.

The use of rewards and incentives still exists in many aspects of our lives. In school for example, children are awarded "gold stars" for giving correct answers or being good in class. This also extends to the workplace, where employees are awarded the title "employee of the month" for producing high quality work. Nevertheless, the use of rewards to motivate and engage users is an old topic in human computer interaction. Games inspired the creation of "Heuristics for designing enjoyable and engaging interfaces" in the early 1980s (Malone, 1982; Deterding, Sicart, *et al.*, 2011).

In gamification, it is assumed that society is similar to games; both contain rules, prizes and penalties, winning and losing, competitions and collaborations, individual players and teams

(Wortley, 2014). Some of these factors are utilised in gamification design to influence behaviour and motivate users.

2.1.1 Game Elements and Dynamics

Game elements can be one of three types: mechanics, dynamics, and aesthetics. This is based on the well-known game design framework MDA, which stands for mechanics, dynamics, and aesthetics (Hunicke, LeBlanc and Zubek, 2004). According to the MDA framework, game mechanics refer to the rules, rewards and the actions that the can be carried out by the user in the game. In the gamification literature, game elements and game mechanics are usually used as synonymous (Werbach and Hunter, 2012; Codish and Ravid, 2014). For example, points and badges are referred to as game elements and game mechanics. On the other hand, game dynamics are what arise with time because of game mechanics (Zichermann and Cunningham, 2011). For example, competition arises from receiving badges or advancing in on a leaderboard. Moreover, game aesthetics are the emotions that resulted from the experience of the game.

Gamification encompasses a variety of elements including some of the popular video game elements that are goal-oriented and focused on rewarding achievements such as badges, levels, leaderboards and progress bars. The rewarding systems used in gamification could involve gaining virtual currency, or redeeming, trading, gifting or exchanging points. Research suggests that gamification of activities can leave users with positive effects (Hamari, Koivisto and Sarsa, 2014). This could be due to the use of rewards, which by themselves lead to feelings of liking and pleasure (Schultz, 2006). Gamification could result in a satisfying feeling when accomplishing regular or everyday tasks. It provides the user with a scale and measurement of how they are progressing (McGonigal, 2011). Rewards can be presented in many forms, including graphics and audio. This gives feedback to users and encourages them to do better and finish challenges.

Moreover, there is an on-going debate between gamification experts regarding the sole use of rewards such as points, badges, and leaderboards (PBL) (Deterding, 2012). Some claim that simply adding PBL, achievement, social challenges, and feedback leads to an increase in user engagement (McCallum, 2012b). However, Deterding (2010) argues that merely adding game mechanics and elements to an activity or a service does not result in a fun experience. He asserts that creating a gamified experience is an iterative process that is best done with the input of game developers' expertise and tests on a target audience. Deterding maintains that most gamification vendors do not use game mechanics such as resource management and time pressure, but instead they create novel "gamy" forms of feedback. This, however, does not create long-term engagement because the appeal of novelty wears off quickly (Deterding, 2012). The

location-based app Foursquare is an example of this type of gamification. The app gained over 25 million users due to the use of gamification (Frith, 2013), however, after a few months the novelty effect wore off and did not result in sustained and long term engagement (Carlson, 2012). This suggests the importance of considering long-term engagement and sustainability through intrinsic motivation (see Section 2.2).

Gamification is not limited to the use of mechanics or digital components (Deterding, Dixon, *et al.*, 2011). It includes the use of other non-mechanical aspects of games, which are game aesthetics. Storylines and themes are two game aesthetics that can be used in gamification. A storyline is the narrative or story of the game, while themes are the visual background that users connect with. These elements could come in conjunction with the flow theory (discussed in Section 2.2.1.3) to increase the engagement of users and enhance the gamification experience. In gamification, the storyline could be used to give context to the gamified activity, and this could make the experience appear meaningful. For example, in the self-management of an illness, a monster could be used to represent the illness itself, where users can "win" over the monster by completing the tasks in the app. It could be thought of as a means to sustain the engagement of users over the long term. This could be helpful for gamification in learning (Kapp, 2012).

In healthcare, the storyline could be incorporated in the form of a fictional character that the user can beat by maintaining a healthy diet for example. Also, the fictional character could be a mentor that guides the user and help them advance from one level to the other. The storyline element in a gamification application could create an environment that is of relevance to the user.

Turning back to game mechanics, a number of the widely used mechanics in gamification are suggested to be related to human desires. Bunchball (2012), compiled a table to clarify this idea [Table 2-1]. In this table, it can be seen that the desire to be rewarded is linked to getting points and status is linked to levels in game mechanics. Also we can see that status, achievements, and competition are linked to all game mechanics. The table suggests that one can use game mechanics that corresponds to human desire in order to initiate or reinforce behaviour. This is common in the video game industry as suggested by the table content.

Table 2-1 Similarities between game mechanics and human desires (Bunchball, 2012)

HUMAN DESIRES

GAME MECHANICS	Reward	Status	Achievement	Self-Expression	Competition	Altruism
POINTS	◆	■	■		■	■
LEVELS		◆	■		■	
CHALLENGES	■	■	◆	■	■	■
VIRTUAL GOODS	■	■	■	◆	■	
LEADERBOARDS		■	■		◆	■
GIFTING & CHARITY		■	■		■	◆

Furthermore, Cugelman (2013) suggests there are seven principles from games that can be incorporated into apps to make them engaging and fun. He identified these principles after conducting a review of a number of gamification studies from academic and non-academic sources. Table 2-2 lists the principles that he refers to as persuasive strategies. According to Cugelman, these are what make gamification persuasive and engaging. Thus, it could motivate users and influence their behaviour (see Section 2.2.2).

The identified ingredients, as the Cugelman points out, are related to proven health behaviour change strategies. However, the last ingredient "fun and playfulness" is an exception since it has not been studied intensively in the health behaviour change literature. Gamification adds fun and playfulness to health behavioural change theories and combining the two could result in an effective change.

Table 2-2 Persuasive Strategies (Cugelman, 2013)

The persuasive architecture of gamification and its 7 persuasive strategies	
Goal setting	Committing to achieve a goal.
Capacity to overcome challenges	Growth, learning, and development.
Providing feedback on performance	Receiving constant feedback through the experience.
Reinforcement	Gaining rewards, avoiding punishment.
Compare progress	Monitoring progress with self and others.
Social connectivity	Interacting with other people.
Fun and playfulness	Paying out an alternative reality.

Examples of game elements that are widely used in gamification include points, badges, challenges, leaderboards, levels, and virtual goods. According to Bunchball (2012), game mechanics generate challenging, fun, or satisfying emotions associated with gamified activity, in which the generated emotions are those which constitute game dynamics (such as rewards, achievement, competition, status, self-expression, and altruism).

PBL and rewards, challenges, and levels are amongst the most used elements from games in current gamified applications (Mekler *et al.*, 2013; Hamari, Koivisto and Sarsa, 2014; Seaborn and Fels, 2014; Dicheva *et al.*, 2015; Darejeh and Salim, 2016). Cugelman (2013) compiled a list of the most popular game elements used in gamification and this is shown in [Table 2-3].

Table 2-3 Ten most popular gamification elements (Cugelman, 2013)

Providing clear goals	Allocating points
Offering a challenge	Showing progress
Using levels (incremental challenges)	Providing feedback
Giving rewards	Providing badges for achievements
Showing the game leaders	Giving a story or theme

2.1.2   Cultural and Social Context

The rise of gamification could result from the intersection of a number of factors including the popularity of video games. Recent studies show that in the U.S. alone, consumers spent $23.5 billion on games in 2015 (Entertainment Software Association, 2016). The increase in the sales of computer and video games could be due to the advances made in technology and in the game industry itself. The wide acceptance and availability of smart phones and tablets could be a factor in breaking the stereotyping of games and gamers. Additionally, 36% of the most frequent gamers use smartphones to play games (Entertainment Software Association, 2016). These devices have

not only diversified the games consumer base, but also given a fresh meaning to social games. According to The Entertainment Software Association, 48% of the most frequent gamers play social games. Their statistics also showed that gamers are no longer thought to be adolescent males. The study shows that 59% of the players are male and 41% are female, breaking gender stereotypes in the game industry. Moreover, there is no age limit to being a gameplayer; in fact, the study showed that the average game player is 35 years old, and the most frequent female game player is on average 44 years old.

In light of this, there is an increasing interest in the potential of game elements to be influential in other fields such as healthcare. McCallum (2012) suggests that this is *"the beginning of 'integrated games', where the data in games and social networks becomes integrated with all other forms of personal data"*. The integration of game elements in different areas of our lives is unavoidable. Moreover, as mentioned earlier, millennials have grown up playing games and are technologically savvy with access to many digital platforms. In fact, they are connected to their digital devices when they work and on their leisure time. This suggests that incorporating game elements in education or healthcare would appeal to them.

Little research has been undertaken on how gender differences influence and affect gamification. However, one study shows that females are more likely to perceive the social benefits of gamified systems than males (Koivisto and Hamari, 2014). The study also reported that age does not affect the benefits perceived by gamification. Overall, it is important to keep in mind that not all the aspects of gamification will appeal to everyone, such as competitions. In general, there are some studies that indicate that males prefer competition more than females (Croson and Gneezy, 2009). As the gamification field is relatively new, to ensure that gamification is well designed and implemented it needs to be studied in terms of the community it is targeting.

2.1.3   Gamification and Serious Games

Gamification shares some similarities with serious games, which are fully-fledged games designed for non-entertainment purposes such as changing the players' knowledge, attitude, physical and cognitive abilities, or mental health (McCallum, 2012a; Hochleitner *et al.*, 2015). Both gamification and serious games use full games techniques or elements of games in areas outside entertainment. Table 2-4 shows the difference between video games, serious games, and gamification.

Table 2-4 Differences between video games, serious games and gamification

	Video Games	**Serious Games**	**Gamification**
Designed as	A complete game	A complete game	Not a game
Purpose	For pure entertainment.	For education, training, assessments, and other serious scenarios.	Enhance motivation, engagement, and influence behaviour.

Serious games are used for educational or training purposes in the healthcare field and many other areas, as opposed to video games which are solely used for entertainment purposes (Cawston, 2012; Mccallum, 2012). Unlike gamification, serious games have been on the healthcare scene for a while now (Susi, Johannesson and Backlund, 2007; Mccallum, 2012). In particular, there are serious games design frameworks for rehabilitation to increase patients motivation and engagement with their exercise routines (Flores *et al.*, 2008; Barrett *et al.*, 2016; Holmes *et al.*, 2016), and a taxonomy for serious games for rehabilitation (Rego, Moreira and Reis, 2002). Similarly, a framework for exergames, which are serious games that utilise sensor technologies, for healthcare (Göbel, Hardy and Wendel, 2010). Also, serious games for individuals with Attention Deficit Hyperactivity Disorder (ADHD) to help them develop better time management habits (Frutos-Pascual, Zapirain and Zorrilla, 2014). Moreover, serious games has been used in healthcare for educational purposes (Tashiro, 2009). Serious games has also been used for children and adolescents with diabetes to educate them about diabetes and help them foster good self-management habits (Watters *et al.*, 2006; Hertel *et al.*, 2013). However, it is important to mention that while serious games and gamification share some elements (game mechanics), they are very different from each other [Table 2.4]. Thus, it is not appropriate to use serious games framework to create gamification apps.

The entertaining aspect of serious games could play a role in creating an engaging experience and helping users in achieving the serious purpose of the game, such as learning a new skill. It has been pointed out that serious games try to influence people in a positive way psychologically since this could contribute in developing new skills, learning new knowledge, and promoting positive health habits (Watters *et al.*, 2006; Susi, Johannesson and Backlund, 2007).

Serious games can extend to physical activities through the usage of tools such as Microsoft's Kinect, which is a motion sensor device that was initially launched in 2010 as a pure entertainment add-on to the Xbox 360 games console. However, in a short time the device gained popularity especially in creating serious games for healthcare purposes, which resulted in a significant increase in the number of healthcare applications (Cawston, 2012). Jintronix, which is a

game that helps patients in physical and cognitive rehabilitation, is one of the examples of such healthcare applications that gained popularity through Kinect, as pointed out in Cawston (2012).

Since serious games have been around for a while, a variety of serious games applications that aim to help type 1 diabetic patients improve self-management of diabetes were developed. One of the early examples is the Nintendo game Packy & Marlon. This interactive video game (Brown *et al.*, 1997) targets diabetic children and teens to help them improve their self-management of diabetes. Diabetic dog[1] is another example of a serious game for diabetic children. The game takes the form of a widget that can be embedded in websites and blogs. It tests their knowledge on diabetes self-care by taking care of a diabetic dog. The game has a social aspect as well; the user can challenge friends who also use the game.

As opposed to creating a full (serious) game to manage an illness, gamification is the design of a gamified approach for this purpose. While the emphasis of serious games is the creation of a full game, the emphasis of gamification is to use game design elements and techniques in order to increase the engagement of users (Zichermann and Cunningham, 2011; Koivisto and Hamari, 2014).

Chou (2014) refers to gamification as a "human-focused design", in which systems are designed for the user to support their needs. On the other hand, he states that non-gamification designs could focus on the functionality of the system instead of the user (Chou, 2014, 2015).

2.1.4 Gamification Application Fields

Gamification has been gaining increased interest in the past few years in different fields such as education, business, and healthcare, to name but a few. Llagostera (2012) has compiled a list of references of gamification talks, books, and online discussions to highlight how the area of gamification has expanded widely during the past years.

The expansion of gamification could be attributed to the success of applications like the location-based service Foursquare and the social part of the well-known game FarmVille (Deterding, Dixon, *et al.*, 2011; Zichermann and Cunningham, 2011). In Foursquare[2], different badges and points are awarded to users for performing certain tasks such as "checking in" at different locations. However, even though Foursquare was successful at the beginning, where the number of registered users grew from 2 million to 8 million in 2011, the app did not sustain engagement of

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[1] https://www.nobelprize.org/educational/medicine/insulin/game/insulin.html
[2] https://foursquare.com/

its user base (Deterding, 2010). This could be due to the sole use of points and badges. Users stopped "checking-in" once the initial novelty effect wore off with time. This is relevant to the issue of motivation in gamification, which will be discussed in Sec. 2.2.1.

2.1.4.1   Apps and Systems

In this section we provide examples of apps and systems from different fields such as education, citizen science, and healthcare that utilised gamification. Table 2-5 listed the 27 apps and systems discussed in this section and classified them based on their aim into ten categorise i.e. children healthcare, general health management, preventive care, citizen science, user-generated content, social causes, education and training, exercise and well-being, marketing and business, and self-care.

Some news websites have utilised gamification to increase their user engagement. For example, the online news platform Mashable[3] rewarded users with badges for commenting on and sharing news articles using their social media accounts and gained followers. To customize the experience for their users they used special badges named after web memes, which were familiar to their audience.

Gamification is also implemented in user-generated content to encourage users to work toward a collective goal. One example is the forum StackOverFlow[4]. It can also be used in citizen science projects such as projects in biology, physics, and chemistry. Foldit[5], which is a user-generated content puzzle, is an example of a biochemistry project that uses gamification to attract users and keep them engaged (Fuchs *et al.*, 2014). Researchers at the University of Washington have developed Foldit, in which users are given scores on folding the structure of selected proteins using the various tools provided to them. By doing this, users can help in creating quick solutions that otherwise would take the researchers years to solve. In fact, Foldit resulted in a crowd-sourced discovery of the mystery of how a key protein might aid the search for a cure for HIV (Anderson and Rainie, 2012).

Furthermore, gamification has been used to promote social causes. An example is the gamified app Recyclebank[6], in which gamification is used to offer redeemable rewards for taking smart everyday choices to encourage better behaviour. Users of the app are encouraged to participate in a series of "green challenges" which teach them about green living and how to live a more

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[3] http://mashable.com/2011/10/26/news-gamification/#z7TEl7V16kqj
[4] https://stackoverflow.com/
[5] https://fold.it/portal/
[6] https://www.recyclebank.com/

sustainable life. In a report released by Recyclebank in partnership with Google analytics and ROI research (King, 2011), 97% of the participants indicated that their environmental knowledge increased after using the app. Moreover, 86% of the participants agreed that the gamification aspect of the app had positive effects on their awareness of this topic and in educating them about it. The study also suggests that game elements can help in motivating users to take certain actions such as positive social and environment actions.

Education is another area in which there is a growing interest in the use of gamification. It is used to encourage students and engage them in the learning process. According to de Sousa Borges *et al.* (2014), gamification studies in education focus on investigating the use of gamification to improve students' motivations and skills, and maximize their learning. Khan Academy[7] and Codecademy[8] are examples of websites and apps where online courses are provided and gamification is used. In both examples, users are rewarded with points and badges for completing assignments and continuing the course. Another example of gamified education websites and apps is RibbonHero[9], which was created by Microsoft to help users learn Office.

Gamification has been implemented in many aspects of healthcare including fitness and treatments of obesity, and in the self-management of chronic illnesses (Muntean, 2011; Blohm and Leimeister, 2013; BARGEN, Zientz and Haux, 2014). Moreover, some of the most successful examples of gamification applications that encourage healthy behaviours are Nike+[10] and RunKeeper[11] (King *et al.*, 2013). Both use gamification to increase users' motivation to exercise, and support them in monitoring their physical activities. To achieve this, users are rewarded with virtual trophies and badges for undertaking physical activities. They are able to visualize their progress and compare it to others. All of this is done in a social context in which users can compete with family and friends and others within the community. They can also share their achievements and rewards with their friends and family in other social networks. Thus, this helps turn endurance sports into games (Blohm and Leimeister, 2013).

Another successful example of gamification in health and wellness is SuperBetter[12], which is a tool for self-improvement that provides users with an engaging, and interactive experiment to assist them in reaching their health goals (Superbetter Labs, 2013; Roepke *et al.*, 2015). The application

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[7] https://www.khanacademy.org/
[8] https://www.codecademy.com/
[9] https://www.microsoft.com/en-gb/download/details.aspx?id=26531
[10] http://nikeplus.nike.com/plus/
[11] https://runkeeper.com/
[12] https://www.superbetter.com/

tracks of users' "quests" and presents daily and weekly to-do lists to reach goals one step at a time. The app provides users with personalised assistance, feedback on performance, and advice.

Zamzee[13] is another example of an app designed to increase the motivation of children and young adolescents for physical activities. It is used in conjunction with a specific wearable device that measures activities and converts them to redeemable points for both virtual and real-life rewards. Similar to Nike+ and Runkeeper, Zamzee users can advance to higher levels based on their rewards and accomplishments. Moreover, they can compete with friends.

Pain Squad[14] is another example of a gamification application in healthcare. The app is designed to help children from the age of eight to eighteen years old to track their cancer related pain by keeping daily reports. The reports include information about the place of the pain, its severity, its effect on the user's activities, the cause of the pain, and what makes it better or worse. Users are provided with virtual rewards for using the app and maintaining the reports, and they can advance to higher levels as they continue logging their data.

CafeWell[15] is a gamification platform targeting organization work places to encourage employees to partake in online competitions in a gemlike environment to improve their lifestyle. It used to be named Keas and focus on competitions, raffles, and quizzes[16]. However, the new and improved platform focuses on social, gaming and personalization techniques to drive healthcare value and change individual behaviours in the organization. Users are rewarded for completing HRA and biometric screening, and for engaging with recommended fitness activities and communities based on their health condition.

SlimKicker[17] is a gamified app for tracking health and fitness. It helps users stay motivated to reach their diet or fitness goals by turning the process of achieving this into a game-like experience they can win. Users are awarded points for eating healthy, exercising, and completing challenges provided in the app (e.g. quitting soda for a week). The app is also based on a community where users can enter challenges with others and share accomplishments. Moreover, to retain the interest of users, the difficulty of challenges increases gradually as the user progresses to higher levels. The app also provides users with personalized advice and reminders from a virtual coach.

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[13] https://www.zamzee.com/
[14] http://www.sickkids.ca/Research/I-OUCH/Pain-Squad-App/index.html
[15] https://welltok.com/
[16] http://www.enterprise-gamification.com/mediawiki/index.php?title=Keas
[17] http://www.slimkicker.com/

Mango Health[18] is a gamification app for the self-management of illnesses. It helps users manage their medication, adhere to it, and adopt healthy habits. Users are asked to create a schedule of healthy habits that they want to maintain. These could include taking medication on time, recording weight, checking blood pressure and other activities related to one's health. Then the app provides users with reminders to meet their scheduled goals. Users can record information about the healthy habits they want to maintain, such as how their medication made them feel, and they can share the notes they took with their doctors. The app enables users to compare their statistics with other users of the app. Moreover, along with virtual rewards, the app gives users a chance to enter a weekly raffle.

Bant[19] is an example of a gamified self-management app for diabetes. The first version of the app targeted adolescents with diabetes to help them track blood glucose and provided them with a community. Users were rewarded with iTunes music and apps to encourage them to transform their blood glucose test results to the app. The pilot evaluation of the app by Cafazzo *et al.* (2012) showed that the users' daily average frequency of blood glucose measurement increased by 50%. The study also showed that users were satisfied with the app and would continue to use it. The app was updated in 2016 where new features were added such as tracking diabetes-related information other than blood glucose, such as diet, weight, and physical activities (Goyal *et al.*, 2016). Moreover, gamification for self-managing diabetes will be discussed in Sec.2.3.2.

Looking at all the examples mentioned in this section, there is no one criteria for creating a gamification experience for apps. However, it can be noticed that the healthcare applications discussed in this section show similar approaches to gamification, specifically the use of PBL to motivate users, and the incorporation of social aspects. This aligns with the work of this thesis, which will be mentioned in subsequent sections.

Applications can utilise gamification for either short term use or long term use. For example, gamification can be used in a survey app to engage the audience with the app for one time only (i.e. completing the survey), or to collect data (e.g. citizen science) and once the data is collected the app is no longer to be used. On the other hand, some apps use gamification engage users for a long term, such as in healthcare applications and specifically the self-management of chronic illnesses (see 2.3.3 where we discuss systematic reviews for self-management apps). Clearly, these apps categorically differ from each other and it is not possible to follow the same criteria (framework) to achieve their purposes.

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[18] https://www.mangohealth.com/
[19] http://www.bantapp.com/

Table 2-5 shows other the gamification apps discussed and other examples categorised based on their purpose.

Table 2-5 27 Gamification apps classified into 10 categories

Children Healthcare	General Health Management	Preventive care	Citizen Science	User-generated content	Social Causes	Education and training	Exercise and wellbeing	Marketing/ and business	Self-care
Zamzee	Keas	SlimKicker	Foldit	StackoverFlow	RcycleBank	Khan Academy	Nike+	My Starbucks Reward	Bant
Pain squad	SuperBetter	Mango Health			Opower	Codecademy	RunKeeper	FreshDesk	MySugr
						RibbonHero	HealthMonth		Mango Health
						Treehouse	Foodzy		MoviPill
						Course Hero	EveryMove		Ayogo

2.1.4.2   Providers

There are a number of service providers that "offer a gamification layer" that can be integrated into applications and websites. Among these providers are Bunchball and Badgeville, which are the two most known companies for gamification. Both companies are focusing on driving customer loyalty and engagement, and employee productivity. Bunchball created the first gamification platform, Nitro, which is implemented by 300 companies including Adobe and HP (Bunchball, 2014). Badgville's gamification solutions are also implemented by some of the largest companies in the world such as Samsung, American Express and Oracle (Lynch, 2013). A study done by Gartner in 2011 predicted that more than 50% of companies that manage innovative processes will adopt gamification (Goasduff, 2011) and that 70% of Global 2000 organisations will have at least one gamified application (Pettey, 2011). The world's largest companies such as Nike, SAP, Pearson, Cisco, United Airlines, Microsoft, Siemens, and IBM are using gamification (Zichermann and Joselin, 2013). Gartner's statistics also indicated that organizations that used gamification experienced an increase of 29% in site actions in a short period of time. Thus, the number of organization that utilizes gamification is expected to rapidly increase over the next few years. Moreover, a recent report by Markets and Markets[20] indicated that gamificaiton is estimated to be an 11 billion dollar industry in 2020.

2.1.5   Gamification Frameworks

There exist some frameworks that try to help in incorporating gamification to other fields. However, the existing frameworks are mostly business originated (Mora *et al.*, 2015). None of the frameworks listed in the review article mention gamification frameworks for healthcare. This gap will be the focus of the work of this thesis.

In 2012, Marczewski[21] introduced a gamification framework named "Andrzej's Gamification Framework". This framework consists of two parts. First, there is eight steps that the designer must undertake before developing the gamification system, in which step 6 and 7 are iterative. The second part of the framework consists of seven points that the designer must keep in mind.

Part 1

1. I know what I am going to gamify.

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[20] http://www.marketsandmarkets.com/PressReleases/gamification.asp
[21] https://www.gamified.uk/2012/10/09/simple-gamification-framework/

2. I know why I am gamifying it.

3. I know who will be involved.

4. I know how I am gamifying it.

5. I have analytics set up.

6. I have tested with users.

7. I have acted on feedback.

8. I have released the solution.

Part 2:

- Think like a game designer.

- Plan for cheaters.

- Intrinsic > extrinsic.

- Don't be evil.

- Remember the fun.

- Be social.

In 2017, Marczweski[22] proposed a revised gamification framework that consists of three main iterative steps:

1. Define the problem, the users, and success.
2. Design/build the solution. Designing the user journey consist of 4 steps:
    a. The behaviour.
    b. The motivations.
    c. Emotions.
    d. The mechanics.
3. Refine.

Another framework from industry is Octalysis developed by Chou (2014). The framework has been mostly used in companies, and product design to increase user engagement, and motivation. It is divided into eight core drives. Each one represents human motivation drivers: epic meaning and calling, development and accomplishment, empowerment of creativity and feedback, ownership and possession, social influence and relatedness, scarcity and impatience, unpredictability and curiosity, loss and avoidance. These are divided into "left brain" core drivers, which represent extrinsic motivations, and "right brain" core drivers, which represent intrinsic motivations (more will be discussed on intrinsic and extrinsic motivation in Section 2.2.1.1).

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[22] https://www.gamified.uk/2017/04/06/revised-gamification-design-framework/

Moreover, there is an online Octalysis tool that is available to map gamified apps against the framework's eight core drives. In a recent paper this tool was used to classify stress management apps that use gamification (Ewais and Alluhaidan, 2015). The study shows that 50% of the apps in the study use extrinsic motivations, and 33% of the apps involved social elements in the form of sharing data with friends or inviting friends to the app. Moreover, the study indicated that only 33% of the apps used intrinsic motivations. This is aligned with what is discussed in the gamification literature about the focus on extrinsic motivators, which could result in an unsustainable app (discussed in Sec.2.2.1).

Both frameworks are too generic and came from the industry and business side. It might be argued that the right approach to gamify the self-management of chronic illnesses is to start from the need of the people concerned. Moreover, their healthcare providers' opinions should be taken into account when creating a gamification framework for their self-management. These needs are understood by the healthcare givers and the individuals with chronic illnesses. As far as we are aware, there is no such approach in the literature. Filling this gap may well be important in helping the chronic illness community to benefit from gamification, which is the focus of this research.

At the stage of writing up this thesis, a general method on how to apply gamification was introduced by Morschheuser *et al.* (2017). In a special section of the Computer Human Behaviour Journal, the authors point out the fact that gamification is receiving more attention from academia and becoming an academic discipline that merges different fields of research (Nacke and Deterding, 2017).

2.2   Gamification and Human Psychology

In addition to the engagement aspects borrowed from video games, gamification is also influenced by psychology as it plays a major role in existing gamification apps and frameworks (Mora *et al.*, 2015). According to Zichermann and Cunningham (2011), gamification is more psychology than technology. Gamification could influence people's behaviour, which makes it powerful (Hamari, Koivisto and Sarsa, 2014). It is important to understand behaviour and how it is created in order to change or influence it. Human psychology plays a major role in gamification. Some behavioural models and theories are applicable to gamification (Kapp, 2012) such as motivation (intrinsic and extrinsic), operant conditioning, self-determination theory, the Fogg behaviour model (FBM), and the nudge theory. These will be discussed in this section.

People often need to be recognized and obtain instant positive feedback, and gamification can use this to promote change in behaviour or drive user engagement. In addition to satisfying these

needs, people can be motivated in different ways including achieving personal goals, and obtaining rewards and incentives (Castro-Cedeno, 2001).

2.2.1 Motivation

Motivation is one of the main concepts in gamification (Nicholson, 2012). It is what makes games engaging and drives human behaviour. There are a number of theories that explain motivation and how it affects behaviour, such as self-determination theory and flow theory, and these will be discussed in this section.

2.2.1.1 Intrinsic and Extrinsic Motivation

Motivation is the desire to do something or perform an action. One of the theories that are used to understand motivation is the Self-Determination Theory (SDT) (Ryan and Deci, 2000). The theory suggests that people do things for either intrinsic or extrinsic reasons. Thus, there are two types of motivation: intrinsic and extrinsic (illustrated in Figure 2-2).

In intrinsic motivation three are three basic psychological needs:

- **Competence:** being effective in dealing with one's surroundings.
- **Relatedness:** being connected to and part of a community.
- **Autonomy:** having full control of one's life.

Extrinsic motivation is divided into four types:

- **External regulation:** The motivation that is caused by external rewards or duties, in which a person's behaviour is motivated because of external reasons to reach a wanted outcome. For example, an academic publishing a certain number of papers in a specific amount of time to be eligible for a promotion.
- **Introjected regulation**: The motivation that is caused by external reasons but self-imposed by internal pressure or feelings of guilt, in which a person is motivated by an external reason but unlike external regulation, the person internalises the reason and self-imposes it. For example, a person going to university because of their parents. They believe that they will make their parents proud or happy by attending university.
- **Identified regulation**: The motivation that is caused by an external reason, though unlike the previous types mentioned, the person identifies internally with the external motivator because it leads to an outcome that is internally valuable to them. Thus, the behaviour is thought to be useful. For example, following a diet because it will make a person healthier.

Integrated regulation: This type of motivation is similar to intrinsic motivation, in which a person is internally motivated. The difference is that while intrinsic motivation is inherently enjoyable, integrated regulation arises because the person believes that the thing they are motivated to do is important for their image. For example, doing sport because it is part of a person's image of who they are.
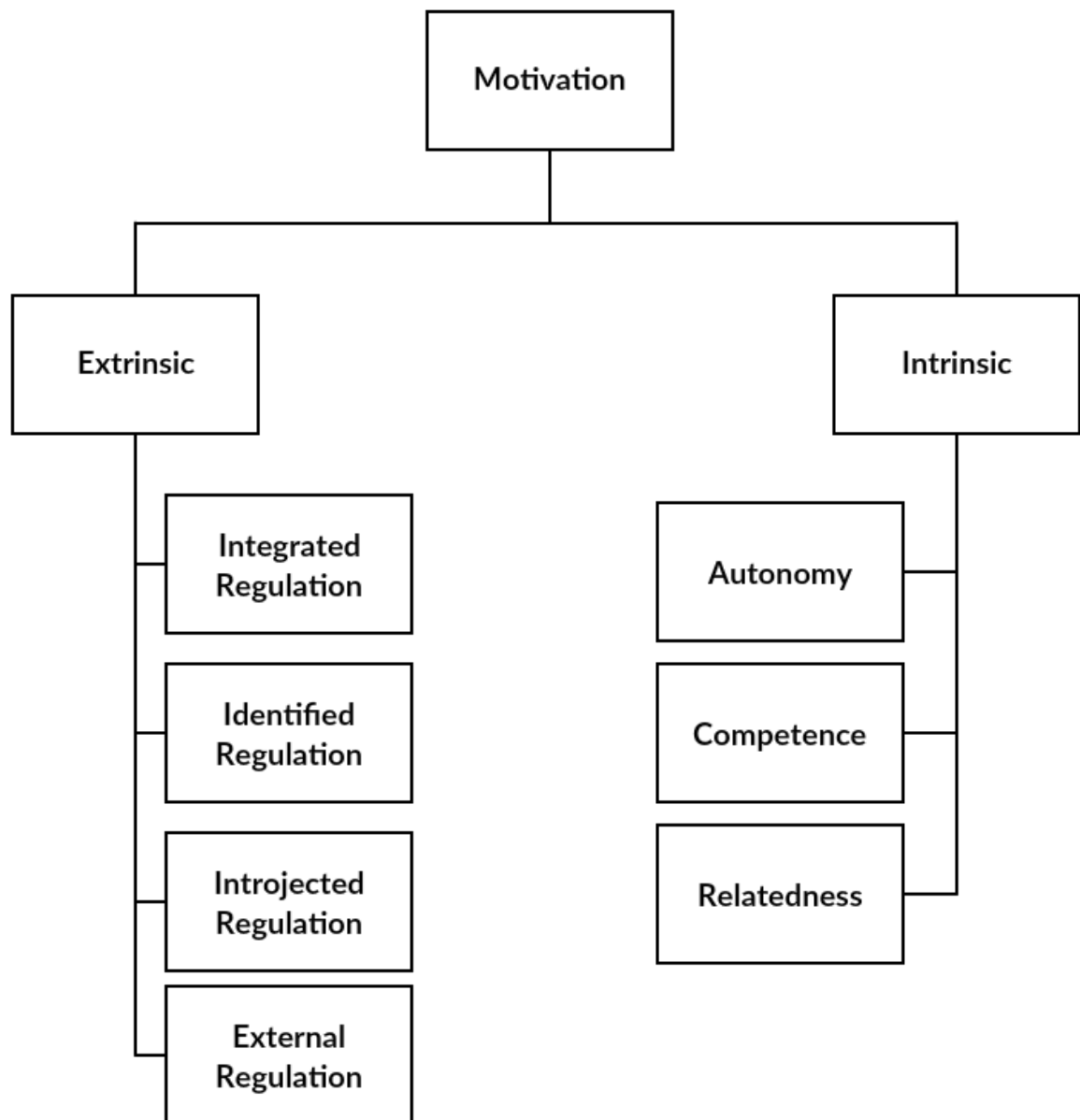
Figure 2-2 Extrinsic Motivation Classification (adapted from (Ryan and Deci, 2000))

It is essential to understand the difference between these two types and how to apply them together in gamification. Intrinsic motivation is the innate desire to do things out of enjoyment or love (Ryan and Deci, 2000). Examples of intrinsic motivators are obtaining a sense of achievement, feelings of mastery, purpose, acceptance, or fulfilling curiosity. On the other hand, extrinsic motivation is doing an activity in order to receive a reward and not because the person is

interested in the activity itself (Ryan and Deci, 2000). Examples of extrinsic motivation could be money, gaining status, grades or collecting points and badges.

It is noticeable that some gamified applications and services focus on extrinsic motivation (Sudan, 2013). Some gamification apps use rewards and incentives to motivate users to do certain tasks or increase their engagement. While rewards (extrinsic motivators) could have a positive effect on people (Schultz, 2006), if they are used on their own it might not lead to sustainable gamification. This is due to the fact that extrinsic motivation can easily lose its appeal with time (Hamari, Koivisto and Sarsa, 2014). In gamification, extrinsic motivation could be used to jumpstart an activity. Then if the gamification is designed correctly the user could be able to realise the intrinsic value of the activity and would do it without the rewards or extrinsic motivations.

Understanding the difference between extrinsic and intrinsic motivation is essential in designing gamified applications and services. Moreover, identifying what intrinsically motivates the target audience of the gamified intervention is important. For example, there would be a difference between the intrinsic motivators of an audience who want to learn about a topic and the audience who want to self-manage a chronic illness. When gamifying long term activities such as healthcare (e.g. self-managing chronic illnesses), it is essential to include both intrinsic and extrinsic motivators and not use extrinsic motivators solely (Mccallum, 2012). In gamification, the three intrinsic motivators could be used to help enhance the intrinsic motivation of the user, which could lead to sustainable engagement.

2.2.1.2   Operant Conditioning

One of the concepts related to motivation is operant conditioning, which is a term coined by the American psychologist and behaviourist Skinner (1938) in his book *The Behaviour of Organisms*. In the book, operant conditioning is defined as the process in which behaviour is changed and modified using reinforcement. According to Skinner, reinforcement comes in two forms: positive and negative. On the one hand, positive reinforcements are rewards that are given to the individual after the desired behaviour. For example, receiving a bonus at work for increasing sales. On the other hand, negative reinforcements are the removal of an undesired or unpleasant outcome after the desired behaviour is performed. Thus, behaviour is strengthened as something negative is removed. In universities, for example, increasing the teaching hours for some lecturers can be considered a negative reinforcement. In particular, if they do not meet the expectation of their superiors in terms of the number of produced publications per year. An example of positive reinforcement would be to give lecturers monetary reward every time they publish a paper in a high quality journal.

When applied to gamification, positive reinforcement could be developed through the use of rewards. Desired behaviour could be rewarded by points and badges in which the action that leads to receiving them is the stimuli involved.

2.2.1.3   The Flow Theory

A theory that has been used in various fields including games to enhance people's engagement is flow theory. The psychologist Csikszentmihalyi (1997) defined it as a mental state of absorption and engagement in an activity. In the flow state, the user is intrinsically motivated and completely immersed in what they are doing. Thus, time and the physical world around the user becomes irrelevant. Csikszentmihalyi also defined eight elements of the flow state: challenge-skills balance, action-awareness merging, clear goals, unambiguous feedback, concentration on the task at hand, sense of control, loss of self-consciousness, transformation of time, and autotelic experience. Some of these elements are more suitable for video games (i.e. action-awareness merging, loss of self-consciousness, transformation of time, and autotelic experience), while others like challenge-skills balance, clear goals, feedback, and sense of control could be suitable for gamification in healthcare.

Engaging video games can lead users to the flow state. However, the game activities should be designed according to the users' skill level. This can be accomplished by starting a game with an easy level and gradually increasing the difficulty as the user moves from one level to the next (as their skills increase) (Cugelman, 2013), which can help in sustaining the flow state. On the other hand, if the game fails to achieve the challenge-skill balance, the user will either be bored if game is too simple or quit if the game is too difficult (Figure 2-3).

In gamification, flow theory could be used to sustain the users' interest in performing the tasks. For example, when gamification is applied to the self-management of diabetes (discussed in Sec. 2.3.2), the challenge-skill balance could be achieved if the app asks a new user to enter their blood glucose test twice a day only as a first stage. Then, if the user managed to do that for a week for example, the app will ask them to enter their test results at least three times a day as a second stage. In this scenario, other flow elements such as providing the user with clear goals to achieve, instant feedback on their performance, and providing them with a sense of control could be utilised as well.
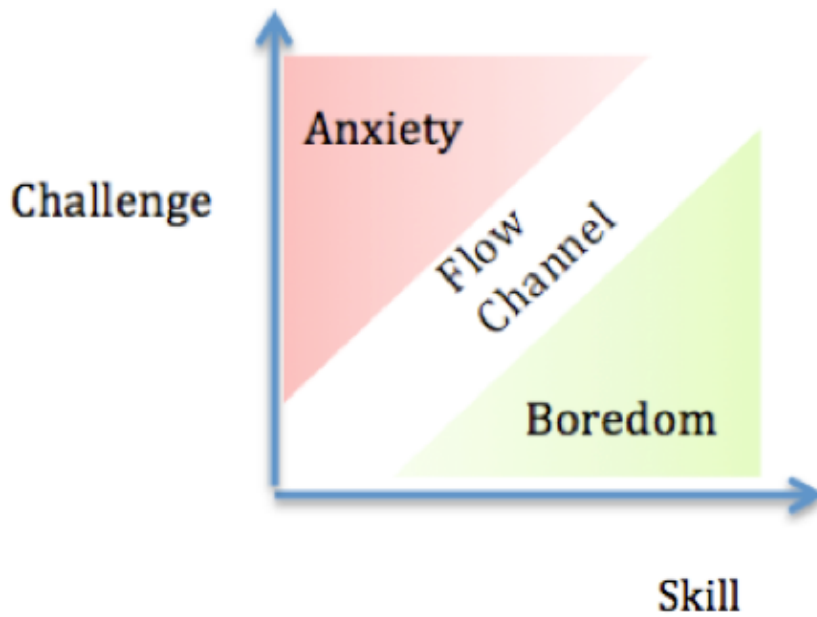
Figure 2-3 The Flow Theory: Challenge –Skill Balance (Adapted from (Csikszentmihalyi, 1990))

2.2.1.4 Maslow's Hierarchy of Needs

The Hierarchy of Needs by Abraham Maslow is one of the most well-known theories that attempts to explain human motivation (Maslow, 1943). In his work, Maslow focuses on intrinsic motivations and suggests that there are five levels of human needs. Each level must be fulfilled in order for people to desire the needs of the next level. Starting from the bottom of the pyramid in Figure 2-4, the first two levels show the most basic human needs that include eating, drinking, having a warm place to live in, and feeling secure and safe, which in turn are physiological needs. The next two levels are psychological needs, which include the need for belonging and being loved, and the need for self-respect, prestige and feelings of accomplishments. According to Maslow, after fulfilling all these needs, people start needing self-actualisation.

When thinking about gamification, the belonging and esteem needs could be of interest. Belonging covers the need to be part of a community and to have social cohesion. According to Zichermann and Cunningham (2011), most people are socializers and thus many games have utilised the social feature. In a gamification app for healthcare, for example, it might be effective to base some of the gamification aspects around a community. Moreover, esteem, which is the need for self-esteem, achievements, competence, and the need for recognition and respect from others, could also be part of a gamification app. These needs could be fulfilled in the context of the app. For example, in the gamification of an exercise app where the user goal is to be more active and lose weight, the esteem needs of Maslow's model could be fulfilled by illustrating the

achievements of the user, and this could leave users with positive feelings about themselves (increasing their self-esteem).
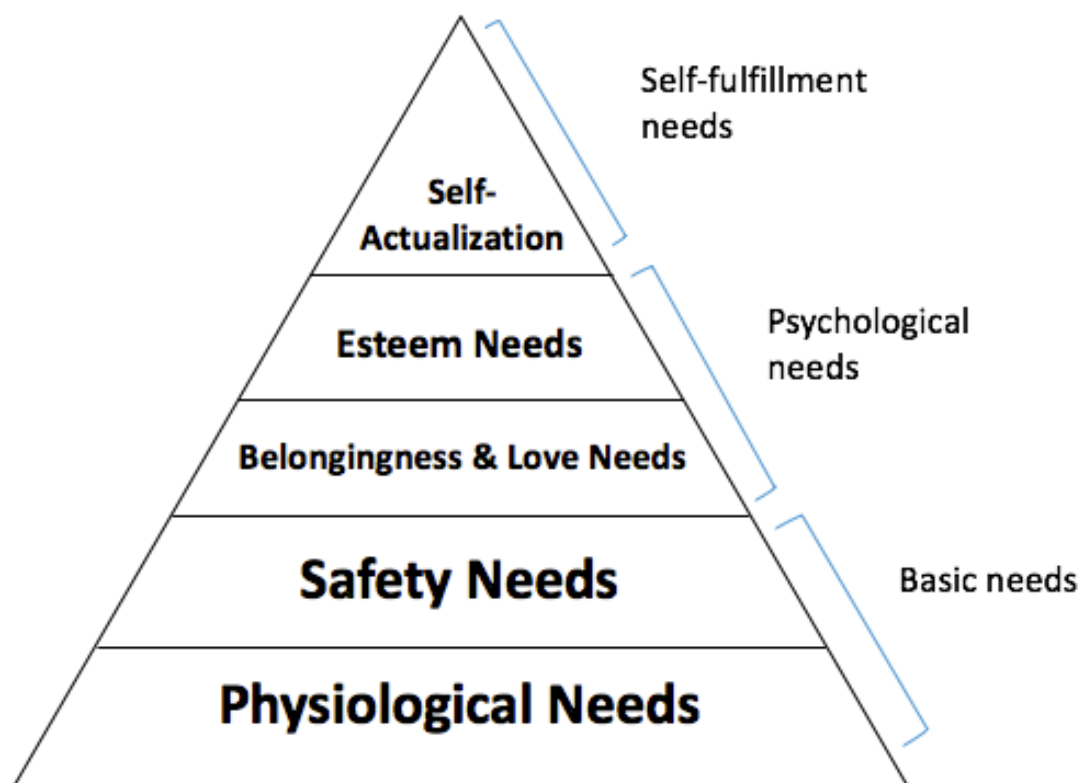
Figure 2-4 Maslow's Hierarchy of Human Needs

2.2.1.5   Pink's Element to Drive Motivation

According to Pink (2009), intrinsic motivation is driven by three elements: autonomy, mastery, and purpose. First, autonomy is when people have full control over when and to what level they want to carry out an activity. In games, one of the components of autonomy is entering the Flow State (defined in Sec. 2.2.1.3). Second, mastery is becoming better at a certain activity. For example, in games the sense of mastery can be reached through improvement in playing and progressing towards goals (McGonigal, 2011). Finally, purpose is where people have a reason to do an activity.

2.2.2   Behaviour Change

Behaviour change is the process in which an undesired behaviour is abandoned in favour of a better one. There are some methods and theories to assist in changing the behaviour of an individual or a community (N.I.C.E, 2007). They are used in many fields, especially in the area of

healthcare. Furthermore, it has been proven that online behaviour change methods are successful in influencing users behaviour (Cugelman, Thelwall and Dawes, 2011).

2.2.2.1   Fogg Behavioural Model (FBM)

B.J. Fogg (2009) proposed a model that explains how behaviour occurs. The Fogg Behaviour Model (FBM) shows that human behaviour is an outcome of three elements. The first element is motivation, which is when the person has the desire to perform certain behaviour. The second element is ability, which is when the person has the capacity to perform the behaviour. The last element is trigger, which is when the person is triggered to perform the behaviour through different cues. Moreover, Fogg states that these elements must happen at the same time in order for behaviour to result (Figure 2-5).
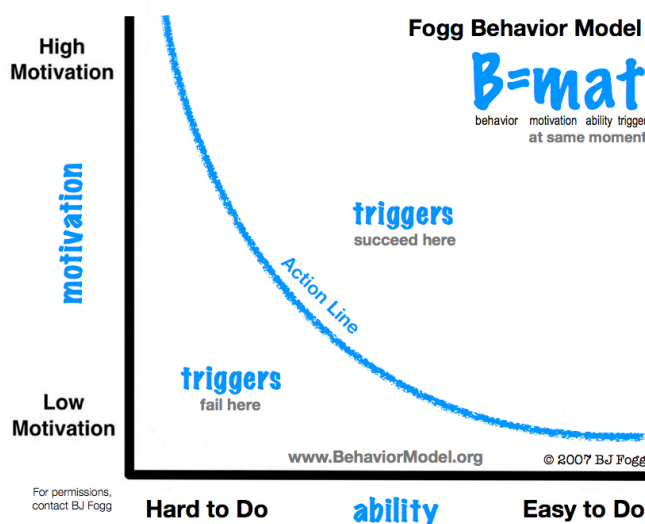
Figure 2-5 Fogg's Behaviour Model[23]

Furthermore, influencing behaviour requires creating a new behaviour and eliminating an undesired habit. There are a number of situations where people choose to change their behaviour. For example, some people are internally motivated to become healthier so they workout and eat healthy food on their own. Other ways to change behaviour comes from a change in environment, or developing a new behaviour through a sequence of steps. The latter is called "tiny habits" a method used to changing behaviour in which a planned sequence of small changes in daily routine results in the adoption of tiny habits to reach a desired behaviour (Fogg, 2011, 2013). It relies on the fact that small changes are easier to accept than big shifts in daily

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[23] http://www.behaviormodel.org

behaviour (Figure 2-6). Creating small habits step-by-step could ensure that they last longer than by just exploiting motivationally extrinsic rewards.
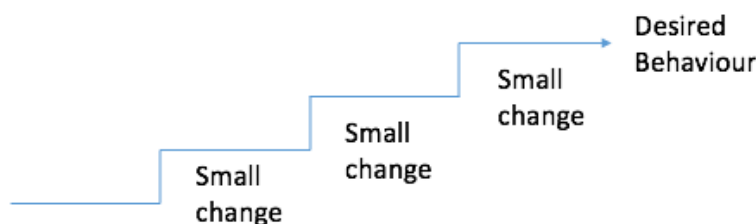
Figure 2-6 Tiny habits

2.2.2.2   The Nudge Theory

Nudge theory comes from behavioural science and is used to drive behaviour. It has been applied in political and economic environments (Thaler and Sunstien, 2009). It concerns positive reinforcement and indirect signals toward a non-forced action by creating the simplest path to the behaviour. For example, using defaults where users are given a default choice out of many choices. This pushes the user to choose the default choice thinking it is the recommended one (Wu, 2014). The use of the nudge theory could create a good environment where gamification is used by giving rewards and incentives as well as 'nudging' behaviour into wanted behaviours. According to Wu (2014), the nudge theory can be used in gamification to drive behaviour through simplifying the context to lead to the desired behaviour.

2.3   Gamification for Healthcare

The use of gamification in healthcare could add fun and playfulness. Gamification could result in an effective change in behaviour when combined with health behavioural change theories. Furthermore, influencing behaviour in healthcare situations is not an easy task. According to Cugelman (2013), digital healthcare applications and services impact only 10% of their users. In general, to influence user's behaviour, one must understand how behaviour occurs and what are the factors that contribute to it, as discussed in the previous section.

The healthcare industry is experiencing significant changes due to advances in information and communication technologies (Eysenbach, 2008). These advances have led to changes in communication between patients and doctors, and between patients themselves. Health and medical information has become more available and easy to access. Also, there have been

advances in public health education, practices, and self-management. A more user-centred approach is being used to facilitate change in health delivery. There has been a focus on utilizing mobile technologies for health behaviour interventions. Smart phones are becoming a tool that offers users the ability to adhere to medication, manage illnesses, and monitor their health wherever they are (Sizemore and Jones, 2011). There is a growing interest in health monitoring and tracking technologies (Swan, 2009), and the recent health apps and health tracking platforms created by smart phones companies such as Apple and Samsung are an indication of that (Morris, 2014). Moreover, online communities provide patients with the emotional and psychological support they might need. Today there are a growing number of support groups and self-management tools on the Internet (Hughes, Joshi and Wareham, 2008; Van De Belt *et al.*, 2010). However, some Web and mobile health care interventions might be considered to be lacking effective and engaging features, which may make them unattractive to users.

McCallum (2012) claimed that games will be integrated with healthcare interventions, and it could be an essential part of it. The researcher argues that the desire for a sense of control over one's health, and the focus on personalized healthcare has lead to an increase in game and gamification integration to healthcare. In support of this, Stott and Neustaedter (2013) pointed out that successful game dynamics indeed increase the feelings of control in users. Moreover, gamification could be very useful in healthcare interventions. Not only because it is engaging and motivating, but also because of the similarities between game elements and personalized healthcare in that they both focus on the user and their abilities. In addition, the researcher states that the use of Flow theory in games and gamification resembles some characteristic of personalized healthcare, in which the intervention matches the user's ability and the difficulty increases with the development of the user's ability.

Indeed, the adoption of gamification has been growing in different fields including healthcare (Hamari, Koivisto and Sarsa, 2014). In healthcare, gamification has been receiving a great deal of attention in both academic research and the industry (Brown *et al.*, 1997; Anderson and Rainie, 2012; Mccallum, 2012; Ahola *et al.*, 2013; Cugelman, 2013; Seaborn and Fels, 2014; Wortley, 2014; Lister, West, Cannon, Sax and Bordegard, 2014; Miller, Cafazzo and Seto, 2014; de Vette *et al.*, 2015; Kamel Boulos *et al.*, 2015; Lazem *et al.*, 2015). The attention given to gamification might be attributed to the perceived usefulness and potential benefits of gamification, especially when dealing with chronic illnesses and daily self-management by patients (Lister, West, Cannon, Sax and Bordegard, 2014; Allam *et al.*, 2015a; Johnson *et al.*, 2016). Chronic illnesses require repetitive but important tasks that could be made easier to handle with gamification (discussed in Sec. 2.3).

Gamification with its potential behavioural change capabilities and the element of enjoyment it brings is applicable to personal healthcare. The rewarding elements in gamification may help in motivating users towards healthy behaviours, which they might find difficult to start or maintain. These include disease prevention behaviours and disease management. Furthermore, Werbach and Hunter (2012) maintains that gamification is fundamentally a motivational tool. In healthcare, gamification can be used to increase users' commitment to certain health behaviours, or encourage users to exercise more and take medication regularly. It could help in integrating healthy habits and make them a daily routine. This could be the reason behind the noticeable increase in the number of apps that are dedicated to gamifying healthcare.

Some healthcare activities might be difficult or tedious which could discourage people from undertaking these activities. For example, exercising, making healthier choices, adhering to medication, and disease management. Gamification could turn these activities into an entertaining and rewarding experience (King *et al.*, 2013). This is because gamification emphasizes positive reinforcement, which is thought to be more effective than punishment. However, rewarding users for good behaviour is not an element of gamification in some apps. For example, one gamification app "Stickk[24]", which is meant to help users in quitting the habit of smoking, asks for money payment every time a user smokes as a punishment. However, the application has failed, and this negative reinforcement might have been the reason.

2.3.1   Chronic Illnesses and Self-management

One of the areas of healthcare is self-management of chronic illnesses. There are many chronic illnesses such as asthma, heart diseases, diabetes and many more. Diabetes is a very common chronic illness and is the focus of this thesis. It is a metabolic disorder that results from various conditions. There are two kinds of diabetes: type 1 and type 2. The former requires regular injections of insulin, while the latter does not require such action (Alberti and Zimmet, 1998). The autoimmune destruction of a specific kind of cells called beta cells is thought to be the cause of type 1 diabetes, and is the reason behind the lack of naturally produced insulin in the body (Yoon and Jun, 2005; Association, 2013). Type 2 diabetes is associated with some insulin deficiency in the body (Association, 2013). The symptoms of diabetes include large production of urine, excessive thirst, loss of weight, and blurred vision (Alberti and Zimmet, 1998). Moreover, the self-management of both types of diabetes is generally similar and includes monitoring blood glucose, food intake, exercise, and taking medication (Phillips, 2016).

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[24] http://www.techhive.com/article/259717/

Diabetes is considered to be the disease of this century (Engelgau *et al.*, 2003). There are more than 382 million people around the world who live with diabetes. Given this number and the high prevalence, it has been called an "epidemic" by some (Zimmet, Alberti and Shaw, 2001; Bassett, 2005). The Middle East and North Africa (MENA) region has 35 million diabetic cases (Aguiree *et al.*, 2013). For example, the number of individuals with diabetes in Saudi Arabia is one the rise, and has recently estimated to be 64000 individuals (Al-Herbish and El-Mouzan, 2008; Aguiree *et al.*, 2013). Moreover, the prevalence of diabetes among younger generations in the MENA region is one of the highest in the world (Aguiree *et al.*, 2013). This suggests the importance of creating effective self-management interventions especially for the younger population.

In fact, diabetes is a serious disease that could lead to other illnesses such as heart diseases, failure of the kidney, loss of sights, amputations, and depression (Egede, Zheng and Simpson, 2002; Association, 2013). Therefore, it is vital for individuals with diabetes to properly self-manage their condition and adhere to their medication. This requires a great deal of self-care, such as taking medication, keeping track of food intake, exercising, recording the level of glucose in the blood on a daily basis and undertaking a certain type of diet.

Clearly, the illness requires self-management skills that are vital in preventing the complications associated with the disease and maintaining a healthy life (The Diabetes Control and Complications Trial Research Group, 1993). This includes the ability to deal with diabetes requirements such as lifestyle changes, medication, and physical and social consequences (Nodhturft and Schneider, 2000; Dunning, 2014). This allows patients to monitor their condition and make the required cognitive, behavioural and emotional changes to maintain a healthy life (Coleman and Newton, 2005). Moreover, effective self-management of diabetes leads to reduction in hospitalizations, and emergency visits. In addition, diabetes studies showed that effective self-management improves glycaemic control.

Individuals with diabetes are recommended to undertake a number of tasks and share information about their condition and activities with their doctors. These tasks include keeping a record of glucose levels in their blood, and a log of physical activities (Heisler *et al.*, 2002). Such tasks can be made easier to perform by using electronic apps (e.g. Glucose Buddy[25], Glooko Logbook[26], and AgaMatrix Diabetes Manager[27]). Performing the previously mentioned tasks and

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[25] http://www.glucosebuddy.com/
[26] https://www.glooko.com/
[27] http://agamatrix.com/products/agamatrix-diabetes-manager/

reporting them enables individuals with diabetes to receive feedback, and thus helps them to accomplish their goals of being healthy (Rao *et al.*, 2010).

Moreover, electronic logbooks could allow individuals with diabetes to observe any alarming conditions such as spikes in their blood glucose after specific meals. Another benefit of such apps is the ease of sharing medical information with their doctors. In fact, studies have shown that the use of such services on smart phones is helping immensely in reducing readmissions to hospitals and the progression of diseases (Buie, Sizemore and Jones, 2012; Morris, 2014). Moreover, it is important to empower individuals with diabetes to be able to take control of their condition and live a healthy life. An important way to achieve that is to motivate them to adopt a healthier style of self-management (Kharrazi, Faiola and Defazio, 2009).

Another important side of self-managing diabetes is the role that peer-support plays. There are different ways for receiving this support such as being part of a support group either physically or online. The latter has gained momentum with the advent of the Internet (White, 2001). Both types have been suggested to have positive effects on individuals with diabetes and other chronic illnesses (Davison, Pennebaker and Dickerson, 2000). Online peer support could be more convenient for many reasons including anonymity, not being restricted by location or time, and not requiring spending money or effort to go to hospitals or locations of meetings. Finding other individuals with diabetes online in order to receive peer support has been facilitated by social networks (Boyd and Ellison, 2007; Kleek *et al.*, 2013). In fact, Zrebiec (2005) found that almost half of the participants (in his study on a Facebook community for diabetes) changed their view on their illness as a result of becoming part of a community.

There are many benefits that social networking can provide for individuals with diabetes. These include emotional and psychological support (Zrebiec, 2005; Heisler *et al.*, 2007), learning from the experiences of other (van der Ven, 2003), asking questions without fearing from judgment (White, 2001), and the positive effect that they leave on their health (Seeman, 1996; Barrera *et al.*, 2002). These features are particularly important to individuals with diabetes as has been suggested by many studies (Egede, Zheng and Simpson, 2002; van der Ven, 2003; Peyrot *et al.*, 2005; Zrebiec, 2005).

2.3.2   Gamifying Self-management of Chronic Illnesses

It is suggested that gamification could positively influence patients with chronic illnesses in terms of adhering to their medication and self-manage effectively (Cafazzo *et al.*, 2012; Mccallum, 2012). Gamifying this could turn the tedious and repetitive tasks of self-managing an illness to a rewarding and more engaging activity (King *et al.*, 2013). Moreover, it can lead to an increase in

the adoption of digital health care services, which is generally slow, often because such services are poorly designed and do not meet users needs (Biesdorf and Niedermann, 2014). El-Gayar *et al.* (2013) suggest that the users' expectations and healthcare providers' insight should be considered in the design of self-management apps. Moreover, in a recent study, 75% of participants showed interest in using digital health services, especially if they provide assistance with routine health tasks (Biesdorf and Niedermann, 2014). However, the sole reliance on points and badges could damage the longevity effect of gamification and thus diminish the purpose of gamification in the first place. While points and badges are a part of gamification, there are other crucial game techniques that need to be considered. Therefore, to benefit from all the advantages of gamification, one needs to understand the environment to which it is applied, so specific gamification techniques can be tailored and applied to this specific environment.

Having a chronic illness requires a great deal of self-care. Patients' time is drained by the many repetitive tasks that are required by their physicians. These include, taking medication, keeping a note of their food intake, their exercises and other. Mobile apps can provide assistance in this department, allowing patients to be more efficient in their self-management (Gruman, 2013). As McGonigal (2011) stated in her book Reality is Broken,

> "The more we start to monitor and self-report our daily activity… the more we will be able to chart our progress, set goals, accept challenges, and support each other…"

Gamified services, with their ability to engage and motivate users, have high potential in healthcare (Primack *et al.*, 2012). They could enhance the effectiveness of self-management and adherence to medication. Moreover, the motivation to take medication at a certain time and taking care of one's health is intrinsic. People want to be healthy, and when they feel sick they will take action to get better. However, when dealing with self-management of chronic illnesses it is important to realize those patients have to cope with the illnesses every day of their lives. The motivation to do so could diminish with the other stress of life or they could become bored of the routine tasks. The idea of incorporating gamification to the tasks of self-managing the illness is to engage users, motivate them, and utilize the social aspect in gamification to create behaviour change in a fun and playful way. It could also minimize any negative connotations that could be associated with the chronic illness. Moreover, it could be important to convey to the user the benefits they can gain from using the gamification health app. For example, explain to the users that gamification could help them provide a more enjoyable experience in managing their condition.

As discussed earlier (see Sec. 2.2) gamification can be thought of as a motivational tool (Werbach and Hunter, 2012). Generally, there is a number of ways to motivate people in order to achieve

their goals, satisfy personal needs, fulfil leader expectations, and gain rewards or incentives (Krippendorff, 2004). The healthcare community has been realizing the power of gamification on motivation (Anderson and Rainie, 2012; Cugelman, 2013; Allam *et al.*, 2015b; de Vette *et al.*, 2015). Thus, some gamification features have been incorporated in a number of health and fitness apps (King *et al.*, 2013; Lister, West, Cannon, Sax and Bordegard, 2014).

Gamification has been also incorporated in some self-management apps for diabetic patients. A study by Cafazzo *et al*. (2012) pointed out that gamified diabetes apps showed an improvement in patients' self-monitoring abilities. An example of a gamified self-management app for diabetes is *MySugr*[28], which has features such as monitoring the level of glucose in the blood, calories, and medication. The application used positive reinforcement in the form of rewards for being consistent in performing the self-management tasks. At the time of conducting this research the app was limited by geographical location, as it is available only to users in the United States and Europe. However, as of 2017 the app is spreading to more countries.

Monster Manor[29] is another example of a gamified diabetes management application. It helps families of young children with Type 1 diabetes logging test results. The app aims to engage children in managing their health and improving their adherence to treatment while having fun. Furthermore, Monster Manor is integrated with *BlueLoop*[30], which is a diabetes-tracking app. This allows children to enter their diabetes information and parents to monitor their children's health. Children are awarded every time they enter their test results, and they can collect more "monsters" and "gold" that can be used to buy new pets for their monsters. The app is targeting children but it also allows parents to support their children's management efforts through insights and strategies provided by the app.

These are commercial apps and developed over the years to reach a position where many features that the researcher observed in the literature are included. Clearly, this development might not have been based on an extensive research. Those apps could have found the best features to include by trial and error, suggestion by user, or other means. However, given the nature of the field the researcher aimed at figuring out the essential aspects that should be included in an app that should be included in an that target based on the three areas of literature review discussed in this chapter. These features will be synthesised in a framework which is to our

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[28] http://mysugr.com
[29] http://ayogo.com/blog/monster-manor/
[30] https://blueloop.mycareconnect.com

knowledge the first framework that target the gamification of the self-management of chronic illnesses.

It can be noticed that many gamification applications in healthcare do not follow standardized guidelines (Seaborn and Fels, 2014). It is argued that not following any standard guidelines might affect the overall experience of the users. For instance, users could get bored of using a certain gamified application if it only relies on points, badges, and leaderboards (Farzan *et al.*, 2008). Also, some studies suggest that gender and age could be a factor in how sustainable the usage of gamification is, particularly that as age increases gamification becomes less efficient (Koivisto and Hamari, 2014). In healthcare applications, especially the ones that target self-management of chronic illnesses, developers are advised to take into consideration all of the previous aspects of that are related to gamification and its application in self-management.

Furthermore, there has been relatively little research on the use of gamification in self-management and adherence to medication. The academic literature on gamification for healthcare lacks empirical data on the effects of gamification intervention on the self-management of chronic illnesses, which could be due to the difficulties securing long term funding that might not be available (Mccallum, 2012).

The social elements of games have been part of the discussion of gamification and are perceived to be an essential part of it (Simões, Redondo and Vilas, 2012; Hamari and Koivisto, 2013). In general, social network users are keen on social gaming (Simões, Redondo and Vilas, 2012), which lately has been receiving increased attention from gamers (Entertainment Software Association, 2016). Moreover, when discussing gamification for chronic illnesses (specifically diabetes) it is important to consider the positive influence that being in a community have on the user (Hamari and Koivisto, 2013). Also, there are users who are motivated by the social interaction and sharing (Simões, Redondo and Vilas, 2012).

The social aspect has been established as an important factor for individuals with diabetes, and that it can help them in managing their illness. Thus, a social element should be part of any gamified app for self-management of chronic illnesses. Creating a community that encompasses other gamification aspects could provide users with the peer support they might need. Moreover, the social aspect could enhance the gamification experience by creating a context to the game element used (such as friendly competitions), and add value to others (such as points, badges, and levels). It could also enhance the sustainability of the gamification app.

2.3.3   The Gap in the Literature and its Importance:

The literature on self-management apps for diabetes suggests that there is a need for increasing the engagement of users and providing better experiences for them. In fact, a recent systematic review of 14 studies on the effect of apps in improving the glycaemic control (HbA1c) in the self-management of diabetes, found that the effect of the apps decrease over time (Hou et al, 2016). This is due to the lack of: ease of use, perceived additional benefits, and the utilisation of gamification (Hou et al, 2016; Scheible et al., 2015). The authors recommended that future applications should consider the use of behavioural change theories and gamification to improve the self-management process and the HbA1c.

Furthermore, a systematic review by (Brzan et al., 2016) tested and evaluated 65 app for the self-management of diabetes. In their study, they found that only 3 out of the 65 apps provided useful features for the self-management of diabetes. Additionally, they proposed a number of recommendation for developers that involves the input of medical experts, including social support elements, enabling basic self-management tasks (i.e. monitoring blood glucose, medication, nutrition, and activity levels), enabling saving and sharing data, including motivational elements for health behaviour change, and enabling alerts and reminders.

It has been suggested that incorporating gamification elements into apps for the self-management of diabetes could enhance the experience of users and motivate them to continue using the app (Scheible et al., 2015). Yet, a very limited number of apps for diabetes self-management utilize gamification elements (Diabetes Market, 2014). The existing gamified apps do not reflect the gamification approaches found in the literature (Seaborn and Fels, 2014). In their paper, Seaborn and Fels (2014) argue that theoretical work is not studied empirically and that the apps and systems that applied some of the theories did not test their validity empirically. Additionally, the current implementations of gamification in healthcare do not follow a certain criteria (framework) or standard guidelines (Lister, West, Cannon, Sax and Bordegard, 2014).

As discussed earlier (see sec.2.1.5), there exist a few gamification frameworks, however, most of them originated in the industry and target the use of gamification for businesses (Mora *et al.*, 2015). These frameworks are not suitable for purpose related to self-management of chronic illnesses since this area deals with patients and their daily management routines. As far as we know there are no gamification frameworks or developer guidelines for the self-management of chronic illnesses. This gap will be the focus of this thesis.

In this thesis we aim to investigate the rich literature on the self-management of diabetes, gamification techniques, and behaviour change theories and synthesise the key elements needed

for the gamification of self-management of diabetes. Given that the gamification of self-management of chronic illnesses is still considered to be at an early stage a framework and a set of comprehensive developer guidelines are important to fill in the gap in the literature.

Finally, it is essential to involve people with medical, psychological, gamification expertise, and the end user (individuals with chronic illnesses) in the validation of the framework. Once the framework is created and validated a set of guidelines for developers will be created. This is an important step since in this area developers, software engineers are not expected to know all of the issues surrounding the area of healthcare and self-management of chronic illnesses. The guidelines should enable the creation of application for the self-management of chronic illnesses that follows the themes of the framework. The guidelines must reflect the validated themes of the framework, and it should be clear and presented at a level that can be used by developers. To achieve this, it is important to involve experts in the areas of software engineering, games, gamification, software sustainability, healthcare apps, and application development.

2.4   Summary

In this chapter a literature review was conducted on the three main areas of research in this theses. These are gamification, the psychology of gamification including motivational and behavioural change methods, and self-management of chronic illnesses, focusing on diabetes.

The term "gamification", which is the use of game elements in environments other than pure entertainment, was coined in 2002/2003 and gained the interest of academic in 2011. Many factors contributed to the rise of gamification, including the popularity of video games especially amongst those who grow up playing them, the widespread use of smartphones and tracking technologies, and the focus on individual and behavioural analytics. Gamification can be used in apps for learning and education, marketing and business, and healthcare to increase engagement, enhance motivation, and influence the behaviour of users. It incorporates game elements such as badges, levels, leader boards and progress bars, which are amongst the most used game elements in gamification, with motivational and behaviour change theories to achieve this.

Gamification is influenced by psychology and uses motivation and behavioural methods in combination with elements borrowed from video games. These theories and methods play a major role in existing gamification apps and frameworks. Both types of motivation: intrinsic and extrinsic are utilised in gamification. Intrinsic motivation, which is the internal desire to do things out of enjoyment or love, is exemplified in the use of the self-determination theory that lists three intrinsic motivators: competence, relatedness and autonomy. Moreover, Pink argues that motivation is intrinsic and it is driven by three elements: autonomy, mastery, and purpose. On the

other hand, extrinsic motivation, which is doing things solely for the outcome, is exemplified in the use of external rewards such as points and badges. The use of both types of motivations could drive users' motivation and influence their behaviour.

Moreover, it is important to understand how behaviour occurs and what motivates it to change or influence it through gamification. There are a number of theories and methods that explain behaviour and how it occurs such as Fogg Behaviour Model, which suggest that behaviour is an outcome of three elements: Motivation, Ability, and Trigger. According to the model the three elements must happen simultaneously for behaviour to occur. Fogg also suggested the use of "Tiny Habits" methods, in which an activity is broken into a sequence of small changes in daily routine results in the adoption of tiny habits to reach a desired behaviour. Furthermore, the Nudge theory, which is the positive reinforcement and indirect signals toward a non-forced action, can be used in combination with gamification to encourage a desired behaviour.

Gamification has been applied to different fields including healthcare. One of the areas of healthcare that could benefit from gamification is the self-management of chronic illnesses. Living with a chronic illness such as diabetes requires a great deal of care from the individual's side. Self-managing diabetes includes daily management of medication, keeping a track of food intake and exercises, and maintaining a record of test results. This is vital to prevent the complications associated with the illness and to maintain a healthy life. Gamification could help in this area by motivating users towards healthy behaviours that they might find difficult to start or maintain. Moreover, gamification could have positive impacts on users by turning the tedious and repetitive tasks of managing diabetes to a more rewarding and engaging activity. Furthermore, incorporating gamification with an online community to provide users with emotional and psychological support that they might need.

However, even though there are some gamification frameworks to help in understanding it and implementing it, they are mostly business originated. As far as we know there are no gamification frameworks or guidelines for healthcare and especially for self-managing chronic illnesses. This gap will be the focus of the work of this thesis.

Chapter 3:   Methodology

In the previous chapter a literature review of research on the areas of gamification, self-managing chronic illnesses, and a general overview of behaviour change methods was provided. Gamification was defined and a summary of the current state of gamified applications was provided. Gamification for healthcare was also examined and a summary of serious games in this particular sector was given. The self-management of chronic illnesses, focusing on diabetes, and its self-management tools and communities was covered together with a general view of motivation and behaviour change methods.

In this chapter, an overview of research methods is given where mixed methods, and multi methods are discussed. The research design and research questions are given. Moreover, the research methods chosen to answer the research questions are provided.

3.1   Overview of Research Methods

Research methods are the technical procedures followed when investigating a research problem or answering a research question (Creswell, 2003). There are a number of different methods that help the researcher collect data from participants. These are qualitative methods, quantitative methods.

Moreover, combining quantitative and qualitative methods is called mixed method research. This type of research widely used in the social sciences (Creswell, 2003; Morse, 2003). The two methods chosen can be conducted in parallel or sequentially (Johnson and Onwuegbuzie, 2004). The combination of qualitative and quantitative methods is thought to provide a broader image and a better understanding of the issue in question (Creswell, 2003).

On the other hand, the use of two or more qualitative data collection methods in a research study is called multi-method research (Morse, 2003). This type of a research strategy does not have to mix quantitative and qualitative research methods. Using two qualitative data collection methods provide a wider perspective to answer the research question (Morse, 2003). This helps with obtaining results from different angles, providing triangulation. This provides more comprehensive results than either study on-its-own (Morse, 2003).

Combining methods either in a mixed method approach or multi-method approach falls under the concept of triangulation (Rothbauer, 2008). Triangulation is the use of two or more methodologies to improve the accuracy of the findings (Denzin, 1978; Jick, 1979). The use of

mixed methods creates a balance between the weaknesses of qualitative and quantitative methods (Jick, 1979). This allows for a well-rounded representation (Thurmond, 2001). There are four types of triangulation (Denzin, 1978; Thurmond, 2001; Guion, Diehl and Mcdonald, 2002; Runeson and Höst, 2009):

- Data triangulation: a number of different sources is used to collect data. This includes, different people, at different locations, and at different times.
- Investigator triangulation: data is collected using the same methods but by different researchers (investigators)
- Theoretical triangulation: the same data interpreted by different experts from different fields of study.
- Methodological triangulation: data collected using multiple qualitative and/or quantitative methods to validate the same thing. This includes using interviews and questionnaires or focus groups and individual interviews.

3.1.1.1 Qualitative Methods

Qualitative research methods comprise a variety of methods that are used in many disciplines of academic research including social sciences and natural sciences. This type of research helps in understanding the human factors of the research problem, specifically, the population that is involved in it (Mack, Woodsong and MacQueen, 2005). Qualitative research methods enable the researcher to uncover the social, gender, ethnicity, and religion roles in the research problem (Crotty, 1998). Thus, it relies more on open-ended questions that allow participants to dive into the issue (Crotty, 1998). The data collected from qualitative research in general take the form of notes, audio recordings or transcripts (Mack, Woodsong and MacQueen, 2005).

One of the qualitative methods that is widely used is interviews. By using this method, the researcher can explore the research question in more depth and deduce important information, such as opinions, feedback, critique, and confirmations that only those who have the knowledge or expertise can provide. Interviews can be conducted either individually or in a group, which is also known as focus group discussions (Krueger and Casey, 2009).

Individual interviews can be conducted in a face-to-face manner, by phone, or through various digital interfaces (Rogers, Sharp and Preece, 2011). There are four types of interviews that depend on the type, sequence and wording of the questions asked. These are, structured interviews, semi-structured interviews, unstructured interviews, and focus groups (Britten, 1995; Rogers, Sharp and Preece, 2011). The semi-structured interview is characterised by a number of close-ended questions, and open-ended questions. In this type of interview participants are given the

space to elaborate on the issue at hand. Thus, creating a conversation between interviewer and interviewee (Britten, 1995). The interviewer could start with an open-ended question that leads to other questions based on the participant's answer (Britten, 1995).

On the hand, focus groups allow the researcher to collect the data from multiple individuals at the same time, and through a semi-structured interview process. It is an effective technique for exploring attitudes, inform, test ideas, programs, and products (Kitzinger, 1995; Logie, 2014).

One of the advantages of focus groups interviews is that it involves selecting participants based on a shared aspect relevant to the study. Another advantage is the ability to collect data from a number of people at the same time. The discussion between participants is considered to be one of the main strengths of the focus group method, because this is what enriches the data collected by encouraging sharing and comparing of experiences and opinions between participants (Morgan, 1997; Logie, 2014). In general, participants should be encouraged to discuss and share experiences and points of view (Kitzinger, 1995; Logie, 2014). In focus group interviews the sessions could take one or two hours. Thus, it is recommended that the interviews are audio recorded and notes are taken during the sessions (Kitzinger, 1995).

Using this method, the researcher or a group leader has to moderate the interview session. The extent to which the researcher is involved in asking questions and managing the group discussion varies depending on the goal of the study.

The sampling and number of participants in the focus group differs based on the research question and goal. The ideal size of the group may range from four to eight individuals, and the ideal number of focus group sessions is three (Kitzinger, 1995; Logie, 2014). However, groups could be smaller or larger than that (Morgan, 1997).

Overall, using these different types of interviews can be beneficial in terms of having flexibility with the questions asked, the ability to explain any misunderstandings, and collecting any additional information from participants when needed (Britten, 1995; DiCicco-Bloom and Crabtree, 2006). On the other hand, some disadvantages of using interviews could be that it requires more time than questionnaires, for instance, and the lack of anonymity (Openakker, 2006). These factors could discourage participants to be part of the study or lead to biased answers. However, these disadvantages could be eliminated by the researcher through making the participant as comfortable as possible by taking their schedule, preferred way of communication into consideration (Berg, 2009).

3.1.1.2 Quantitative Methods

Quantitative research method is the use of statistical techniques to investigate the data collected by answering questions with pre-determined list of answers. Using this method, researchers seek to confirm a certain hypothesis through highly structured methods such as questionnaires, surveys, and experiments (Mack, Woodsong and MacQueen, 2005). Quantitative methods such as questionnaires can be used to collect opinions of a large sample of participants as well as their demographical data (Rogers, Sharp and Preece, 2011). The data collected through this method are mainly numerical in form.

The questionnaire type of quantitative research method is a very common choice for the collection of data. This is because the collection of the large number of data can be carried out cheaply. Moreover, the data collected is convenient to analyse objectively through statistical analysis than qualitative data (e.g. interviews). Other advantages include eliminating any biases that can result in a one-on-one interview, and retaining anonymity (Somekh and Lewin, 2005). On the other hand, the lack of contact between the researcher and the participant when answering the questionnaire means the answers are accepted even if the participant misunderstood or chose the wrong answer by mistake. Thus, the questionnaire must contain straightforward questions that are simple to comprehend by participants. Moreover, the lack of control over who fills out the questionnaire is also considered a disadvantage (Somekh and Lewin, 2005). Therefore, much care must be put in distributing the questionnaire to its intended audience.

In quantitative research, the size of the sample should be determined before conducting the study. The size of the sample plays a role in the statistical validity of the conclusions drawn from analysing the data. The required sample size depends on the type of the statistical test being used. The minimum size can be calculated based on a number of statistical variables.

There are many packages that are available to carry out this calculation. A popular choice is the program G*Power, which is a statistical power analysis tool (Faul *et al.*, 2007, 2009). It computes the required sample size given three variables:

- Type 1 error (alpha), which represent a false positive result.
- Type 2 error (beta), which represent a false negative result.
- Effect size, which determines the magnitude of the difference between two groups.

Sample are usually chosen to represent a larger a population (Mendenhall, Beaver and Beaver, 2012). One of the methods to collect a sample, which is considered a non-probability sampling, is snowball (Chromy, 2008). This method relies on selecting participants from the targeted population, then asking them to find other participants from the same population. One of the

advantages of this method is that it allows the researcher to find participants from specific populations that might be under-represented or difficult to reach. However, one of the drawbacks of this method is that it can require a long time until the required sample size is achieved.

Table 2-5 summarise the differences between the qualitative and quantitative methods. The table shows the difference in terms of purpose, data collection approach, sample, data type, advantages, and disadvantages

Table 3-1 Differences between Quantitative and Qualitative Methods

	Quantitative Methodology	Qualitative Methodology
Purpose	Measure quantities, and test a hypothesis	Acquiring in-depth insights, confirmation, and assessment
Data Collection Approach	Questionnaires, and experiments	Interviews, and focus group discussions
Sample	Large number of participants	Small number of participants
Data Type	Numerical	Textual or audio
Analysis	Statistical analysis	Interpretative analysis
Advantages	Ability to compare, and generalize.	Obtaining views and experiences that otherwise hard to acquire.
Disadvantages	The lack of ability to clarify or ask participants to elaborate	Lack of anonymity, and time consuming.

3.2   Research Process

There are two major aims of this research. First, to provide a validated framework for the gamification of self-management of chronic illnesses. This aim is captured in the following research question:

RQ1: What is an appropriate framework for the gamification of self-management of chronic illnesses?

Second, to transform the validated framework into a set of guidelines for developers. That enable them to implement gamification in the self-management of chronic illnesses. This aim is captured in the following research question:

RQ2: What is an appropriate set of clear, useful, and implementable developer guidelines for the gamification of self-management of chronic illnesses?

Chapter 3

In order to achieve these goals, by answering the research questions, the research was divided
into three phases as illustrated in (Figure 3-1).

The first phase consisted of a literature review, the identification of the research gap, and
proposing a framework. The purpose of the literature review was to gather information on:

1. Gamification and its applications
2. The psychology of gamification and the theories of behaviour change that are used in this
   area.
3. Chronic illnesses especially diabetes and its self-management requirements.
4. The use of gamification in healthcare.

Next, the researcher was able to identify the gap in the literature, which was manifested in the
lack of a validated framework in the area of gamification in the self-management of chronic
illnesses especially diabetes. Then, the researcher identified the concepts that are necessary for
combining gamification in this specific area of healthcare, and synthesised them into one
construct that is the proposed framework. The outcome of this phase was published in
(AlMarshedi *et al*. 2017) and (AlMarshedi, Wills, and Ranchhod 2015).

The second phase was to validate the proposed framework by using a mixed-method approach.
The qualitative method consisted of expert interviews. The interviews were conducted with
experts from medical fields, including endocrinologists, diabetic educators, psychiatrists and
psychologists, and experts from academia in gamification and serious games. The aim of the
interviews was to validate the content of the framework. On the other hand, the quantitative
method consisted of a questionnaire to collect data that measures the attitudes of individual with
diabetes who are based in Saudi Arabia towards the framework. The outcome of this phase has
been published in (AlMarshedi, Wills, and Ranchhod 2016).

The third and final phase included two parts. First, building a set of guidelines for developers
based on the validated framework. Next, validating the content of the guidelines using a
qualitative multi-method approach. Namely, expert interviews and focus group interviews. The
expert interviews are conducted with experts in game design, user experience, serious games for
health and gamification. After analysing the findings from the expert interviews and updating the
guidelines accordingly, the second qualitative study took place, where a number of developers
and software sustainability experts were interviewed in small focus group sessions. The purpose
of the focus group interviews was to review and discuss the updated guidelines from the
perspective of developers as a mean to cross-validate it. The outcome of this phase was published
in (Almarshedi, Wills *et al*. 2017).
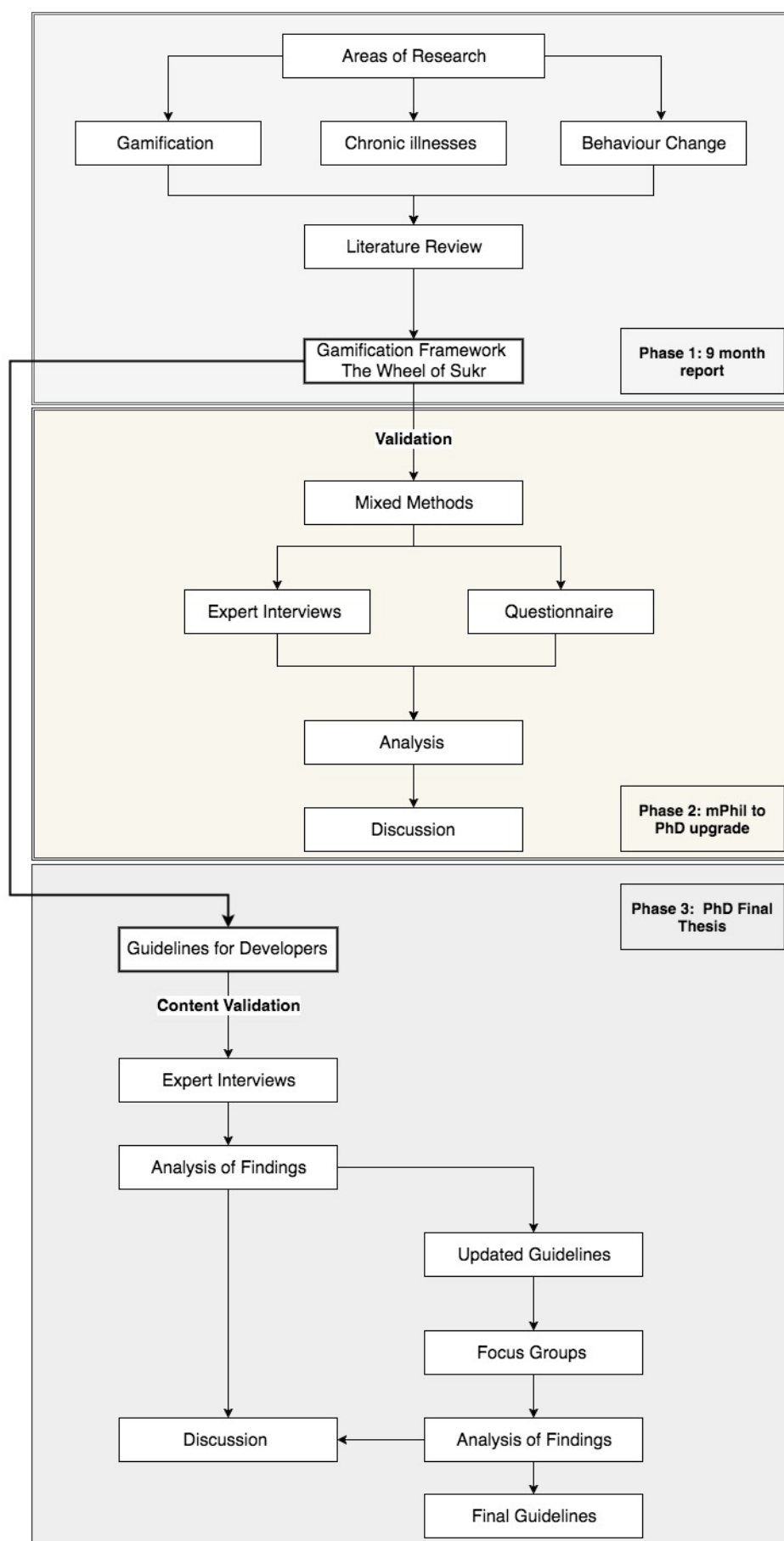
Figure 3-1 Research Process

3.3   Summary

In this chapter, an overview of research methods is given where mixed methods, and multi methods are discussed. The research design and research questions were given. Moreover, the research methods chosen to answer the research questions were provided.

Research methods are the procedures used to explore a research problem or to answer a research question. There are two ways to collect data: qualitative research methods, and quantitative research methods. The combination of quantitative and qualitative methods is called mixed-method research. On the other hand, the use of two qualitative methods is called multi-method research. Moreover, combining two research methods is thought to provide better understanding, and a wider perspective to answer the research question.

Qualitative research methods help in understanding the human factor of the research problem. Interviews, both individual and group interviews are popular qualitative research methods. On the other hand, quantitative research method is the use of statistical techniques to investigate the data collected by answering questions with pre-determined list of answers. This method is used to confirm a certain hypothesis through highly structured methods such as questionnaires, surveys, and experiments.

This thesis has two major aims of this research. First, to provide a validated framework for the gamification of self-management of chronic illnesses, which is captured RQ1. Second, to transform the validated framework into a set of guidelines for developers that enable them to implement gamification in the self-management of chronic illnesses, which is captured in RQ2.

> RQ1: What is an appropriate framework for the gamification of self-management of chronic illnesses?

To answer this question, the researcher conducted a literature review on gamification and its applications, the psychology of gamification and the theories of behaviour change that are used in this area, and the self- management of chronic illnesses especially diabetes. Then, the researcher identified the gap in the literature, which is the lack of a validated framework in the area of gamification in the self-management of chronic illnesses especially diabetes. After that, the researcher identified a number of elements from the literature and synthesised them into one construct that is the proposed framework.

The framework was then validated using a mixed-method approach: expert interviews, and questionnaires. The interviews were conducted with experts from medical fields, including doctors of diabetes, diabetic educators, psychiatrists and psychologists, and experts from

academia in gamification and serious games. The questionnaires were distributed to collect data that measures the attitudes of individual with diabetes who are based in Saudi Arabia towards the framework.

RQ2: What is an appropriate set of clear, useful, and implementable developer guidelines for the gamification of self-management of chronic illnesses?

To answer RQ2, a set of guidelines for developers was designed based on the validated framework. Then, the content of the guidelines was validated using a qualitative multi-method approach: expert interviews, and focus group interviews. For the first study, experts in game design, user experience, serious games for health and gamification were interviewed individually. Then, the qualitative data of the interviews was analysed the guidelines were updated based on the findings. After that, the focus group interviews were conducted with a number of developers to review and discuss the updated guidelines from the perspective of developers.

Chapter 4: Framework and its Validation

The literature review chapter (Ch. 2) presented an investigation on the three main areas of focus in this thesis: gamification, behaviour change, and self-management of chronic illnesses. In Ch. 2 we discussed gamification in the context of healthcare and the self-management of chronic illnesses, specifically diabetes. Moreover, the research process and an overview of the methodology used in this study were discussed in Ch. 3.

In this chapter, we answer the first research question in this thesis:

RQ1: What is an appropriate framework for gamifying the self-management of chronic illnesses?

To answer this question, a framework for gamifying the self-management of chronic illnesses shall be introduced. The framework will be based on what has been found from the literature review regarding gamification, and how it might be relevant to the self-management of chronic illnesses. The framework was validated through a mixed-method approach.

4.1 Background

As discussed in the literature review (see Sec.2.3), gamification has been receiving a great deal of attention in the healthcare industry. This rise of this interest may well be attributed to the fact that it is perceived by many that the use of gamification can benefit healthcare in terms of increasing engagement in healthcare, preventive healthcare, medication adherence, and self-management. In particular, self-management is crucial to the health of individuals living with chronic illnesses. These tasks might be made easy by the use of gamification. However, it is important to base any combination between gamification and the self-management of chronic illnesses on informed research giving the seriousness of such illnesses. Additionally, it is important to understand the needs of individuals with diabetes in terms of self-management in order to incorporate gamification into it, thus, tailoring it to this specific environment.

Although there exist some apps for the self-management of chronic illnesses that utilise some aspects of gamification (PBL system), it is not clear if these apps have followed a framework or guidelines that are specific to this task. In fact, there exists no such framework in the literature as mentioned previously. The existing frameworks in the literature are mainly focused on business and marketing (see Sec. 2.1.5).

The proposed framework that incorporates gamification and the self-management of diabetes should enable the following aspects:

- Empower patients to take good care of their health.
- Increase adherence to medication.
- Fulfil the need to be part of a community that share the same goals and challenges.
- Encourage better self-management habits.
- Encourage consistent logging of data (e.g. blood tests, food intake)
- Turn self-managing a chronic illness from a mundane task into a fun activity.
- Provide consistent and informative feedback to users.

4.2 Framework Design Process

Prior to building the framework, a literature review was undertaken on the three domains identified by the author to be the main areas of research, namely gamification, chronic illnesses self-management (focusing on diabetes), and behavioural change methods. The three areas and their intersection are illustrated in

Figure 4-1. The framework is a result of the careful review and analysis of these areas. The relations between the three areas were studied and a number of elements were synthesised. These elements form the basis of the framework.
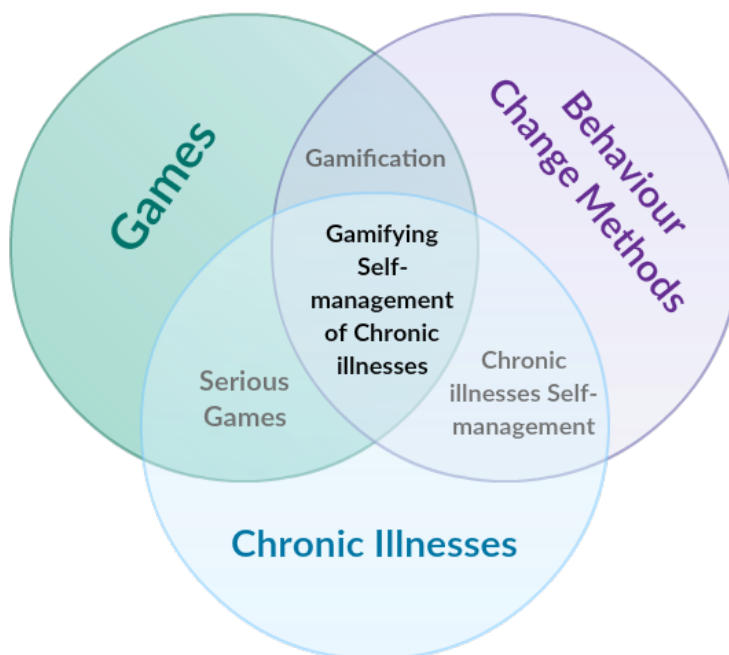
Figure 4-1 The Three Main Areas of Research

4.2.1 The Elements and Themes

The researcher synthesised twenty-eight elements from the three domains shown in Figure 4-2. It is important to note that the term "element of the framework" is different from that of "game elements". The elements in the framework come from gamification, the psychology of gamification, and self-management. These elements are listed in

Table 4-2, Table 4-1, and Table 4-3. The tables show the elements based on which part of the literature they are extracted from.

In particular, from the gamification part twelve elements were extracted (Table 4-1), from the self-management part of the literature review seven elements were extracted (Table 4-2), and from the psychology of gamification part nine elements were extracted (Table 4-3).

As discussed in the literature, there is a no of a framework for the gamification of the self-management of chronic illnesses (see Sec.2.1.5). However, the synthesised elements will be used to construct a framework that fills this gap.

Table 4-1 A list of elements synthesised from the literature on the healthcare of chronic illnesses

Healthcare of Chronic Illnesses	Logbook: an electronic logbook where users can save their blood glucose test results and associated information.
	Visualisation of data: Logged data represented in a visual way such as in graphs.
	Trends alert: pop-up messages to highlight trends in the logged data.
	Peer-support: a mechanism that enables users to access each other's accounts and support them.
	Community: a mechanism that enable users to interact and communicate.
	Social media: a mechanism to link the system users to other social media platforms.
	Sharing: a method to allow users to share information about their achievements or their logbook data.

Table 4-2 A list of elements synthsised from gamification literature

Game Elements and Dynamics	Badges: graphical symbols that represent an electronic medallion for a pre-defined accomplishment.
	Points: counters that track the specific activities of the user. These activities are defined by the developer and would differ based on the context.
	Challenges: Obstacles designed in the system for the user to overcome with a time limit.
	Competitions: is a dynamic element that results from collect points and badges to rank up in leaderboard.
	Feedback: a mechanism to show users instant comments on their activities, achievements, or engagement with the system.
	Leaderboards: a construct that accumulates the user's achievements and compares them with other users in the system and then rank the users.
	Levels: a space in the system that can be reached after completing a specific set of activities and collecting a specific number of points.
	Storyline /themes: a narrative that ties in all aspects of the system and creates a context for the user.
	Reputation: This is an element that arises dynamically through the interaction with the system and the community.
	Goals: milestones set by the system and the user.
	Avatars: graphical representation of one's self.
	Progress bar: a graphical representation of user process.

Table 4-3 A list of elements synthesised from behaviour and gamification literature

Psychology of Gamification	Intrinsic motivation: internal drivers of behaviour that can arise dynamically in the system or directly implemented it.
	Extrinsic motivation: external drivers of behaviour that can be implemented in the system.
	Flow: a theory that is used in the system to increase engagement by gradually increasing the difficulty of levels.
	Nudge: a theory that is used in the system to direct the user towards a desired behaviour.
	Baby steps/tiny habits: a theory used to break down tasks and activities into smaller steps.
	Autonomy: freedom of choices within the system.
	Ability: the user's capacity to performing tasks and activities within the system.
	Purpose: linking the system to the bigger picture (i.e. health).
	Trigger: actions to remind users to be engaged with the system.

These elements can be further subdivided into more specific themes that serve a common purpose. For example, collecting points and badges, and participating in challenges and competitions can be enjoyable activities that can create a game-like environment, which we call the fun theme.

The researcher observed that the elements fall into eight themes. These are: Fun, Socialising, Self-representation, Self-management, Motivation, Growth, Esteem, and Sustainability. The rest of this section discusses the themes and combines them to create the proposed framework for the self-management of chronic illnesses. The themes and their corresponding elements are illustrated in Figure 4-2.

Fun	Motivation	Self-Management	Socializing
Points Badges Challenges Competitions	Intrinsic Extrinsic	Logbook Visuailsation of Data Trend Alerts	Community Social Media Peer-Support Sharing
Esteem	Self-Representation	Sustainability	Growth
Leaderboards Levels Progress bar Reputation	Avatars Autonomy Ability Purpose	Trigger Flow Storyline/Theme Nudge	Feedback Achieving goals Baby steps (tiny habits)

Figure 4-2 The Eight Themes and their Elements

The fun theme covers the basic elements for gamification. The four elements of the fun theme could give rise to a fun environment where the user is engaged with the system to collect points and engage in competitions and challenges. Badges and points signify the use of rewards to encourage positive behaviour in the self-management of a chronic illness. Users can be rewarded for keeping a logbook of their test results and related information, and their engagement with other users. Moreover, creating challenges and competitions (that are not related to test results or the medical information of the user) could increase the engagement of users. These can either be between users or be self-challenges for users.

The motivation theme covers the two types of motivations considered in gamification. The first type is intrinsic motivation, which is the innate desire to do something. This type of motivation can be cultivated though the use of mastery and using a combination of other elements such as autonomy and purpose. The second type is extrinsic motivation, which is doing something only if there is a reward. This type of motivation could be created through the use of rewards such as points and badges. This could make people become interested in doing a certain act (i.e. keep a logbook of their daily glucose tests). Incorporating intrinsic and extrinsic motivators could sustain this interest. Moreover, the rewards used should be tailored to the target population so that they are relevant and valuable.

The socialisation theme covers four elements that create a social environment. This social aspect is thought to be important for gamification and especially for self-managing a chronic illness. The

elements of this theme add to the value of the fun theme elements. Moreover, being in a community that understands what the user is going through could provide the psychological support needed by the user. It was mentioned previously that it is common for diabetic patients to get clinically depressed. Thus, we gather that it is important to provide a medium where they can share and receive support from their peers. Moreover, Maslow's Hierarchy of Needs (see Sec. 2.2.1.4) indicates the importance of having a sense of belonging.

The esteem theme covers the elements that could create feelings of value and respect. Based on Maslow's work it is believed that people need to be respected, feel good about their achievements and have self-worth. Some people do things for the recognition and to be valued. Most gamification elements are esteem boosters when designed for the right context. Furthermore, as users see their name moving up in a leaderboard, as their progress bar advances, or as they accumulate of a number of badges, it could satisfy their need for recognition and positively affect their self-esteem in general.

The self-representation theme covers four elements that could create a connection between the user and the gamified app. Also, representing the user, their goals, and their abilities in the gamified system is important to increase the engagement. This could be achieved partially through providing customized profiles and avatars. In addition, giving users the chance to set their own goals such as glucose level goals will enhance their sense of autonomy and will tailor the experience to them. These include positive management habits such as keeping a record of daily tests and being aware of one's progress.

The sustainability theme covers the elements that ensure sustainability of gamification effects. These elements are derived from game design and behavioural theories. The flow element is based on the flow theory, the nudge element is based on the nudge theory, the trigger element is based on Fog's behavioural model, and storyline/theme element based in MDA framework (discussed in Sec.2.2 and Sec.2.1.1). Having flow and a storyline or a theme could be effective in capturing the long-term attention of users in video games. In addition, trigger and nudge are behavioural theories that are believed to shift the behaviour of the user to the desired direction. In this context, using the nudge theory and triggers may reinforce positive behaviour in managing diabetes.

The growth theme covers the personal growth of people with chronic illnesses in terms of managing their illness; learning new healthy habits, and achieving their self-management related goals. One of the most important aspects of the success of gamification is providing real-time feedback that is meaningful and relevant to users. Moreover, in the context of self-managing

illnesses this can be useful. Feedback can be represented in many ways, including rewards and incentives, which give immediate feedback to users about their performance.

The self-management theme covers the basic elements for self-managing a chronic illness. The logbook is to help users in keeping a track of their blood glucose test results for examples and related information. The visualisation of data element takes the information from the logbook and presents it in graphs. Through providing feedback in terms of graphs of blood tests the user will learn about his/her condition and will recognize any patterns. Moreover, the alert element indicates alerting the user when their blood glucose continues to be lower or higher than average for example.

Table 4-4 list the eight themes that constitute the framework. The table also provide a summarised definition of each theme.

Table 4-4 The Wheel of Sukr Themes

Themes	Definition
Self-management	Basic elements needed to self-monitor blood glucose, including tracking measures of blood glucose, insulin, food intake, and other related information; getting feedback based on the entries; and being notified when blood glucose measures fluctuate.
Socializing	Being part of a group of people that shares the same situation, which offers social and emotional support and adds to the value of rewards.
Self-representation	Tailoring the experience to create a bond with the user, thus increasing engagement and creating a meaningful experience.
Fun	Creating a game-like experience.
Esteem	Satisfying the fourth level of Maslow's Hierarchy of Needs, thus catering to the psychological side of managing diabetes.
Motivation	Appealing to the desire to do things.
Sustainability	The ability of the system to maintain the same level of engagement to sustain the desired effect.
Growth	Creating a fruitful experience for the user, where gamification in a social and psychological context can result in personal growth in terms of managing diabetes, learning new healthy habits, and understanding the disease better.

4.3 The Wheel of Sukr Framework

The themes and their associated elements are synthesized into a framework that we call The Wheel of Sukr (Figure 4-3). The word 'Sukr' means sugar in Arabic and it is also a common way to refer to diabetes in Saudi Arabia. The shape of the wheel was chosen to reflect the importance of all of the themes together. At this stage we assume that the themes are of equal importance.

To our knowledge, this is the first framework that targets the use of gamification in the self-management of chronic illnesses. As discussed earlier, The Wheel of Sukr combines elements from gamification, self-management practices, and behavioural methods to create an engaging and fun self-management experience.

The Wheel of Sukr proposes a way to utilise gamification and behaviour change methods in the self-management of chronic illnesses. Through the use of motivation, rewards, positive feedback and peer support, a positive behaviour in managing chronic illnesses is aimed to be reinforced. The positive management habits include keeping a record of daily tests and being aware of one's progress. Furthermore, the use of concepts underlined in the framework might allow users to realise patterns and make decisions accordingly. This eventually could lead to an increase in the feeling of autonomy on the users' side giving them a sense of control over their own condition.
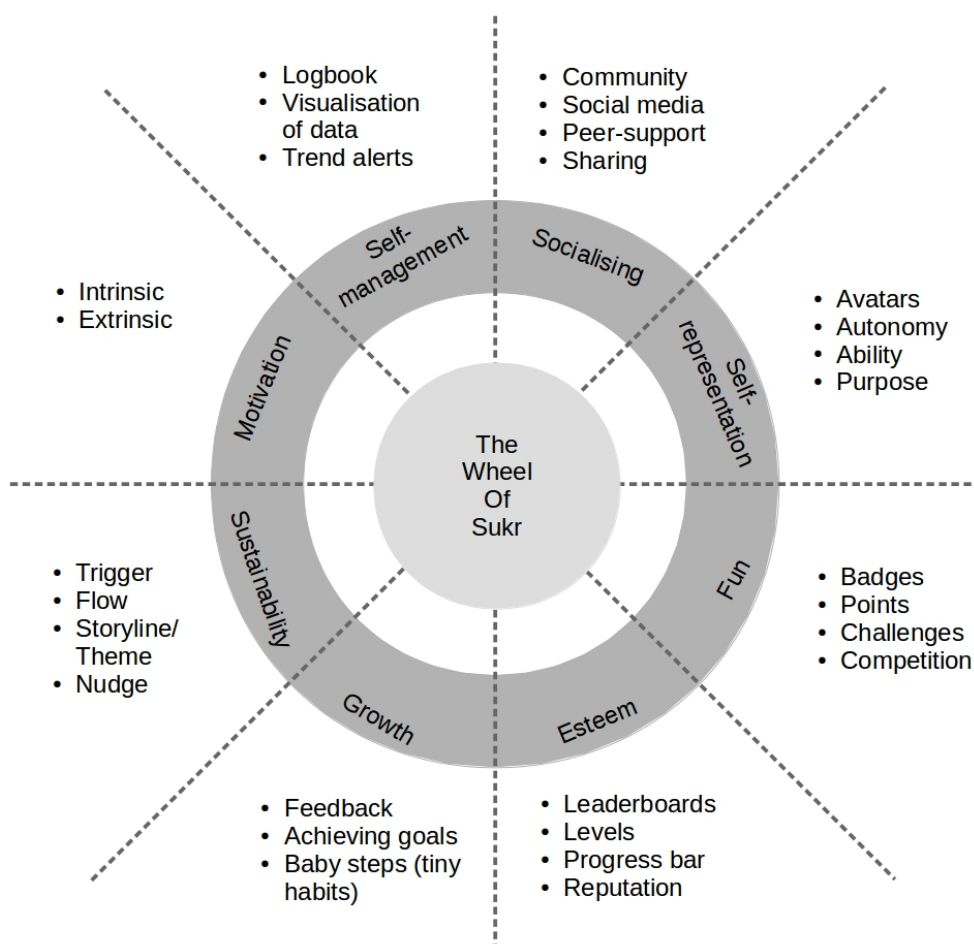
Figure 4-3 The Wheel of Sukr

4.4 Validation of the Wheel of Sukr: Mixed-Methods

Methodological triangulation was chosen as the mixed-method research approach for validating the framework [Figure 4-4]. As shown in the figure, the framework is validated using three steps. First, the literature review provided elements that have been shown to work in the fields of gamification, self-management, and psychology of gamification. Then, the themes of the framework were validated using both expert interviews, and a questionnaire. The expert interviews and the questionnaire were conducted to confirm the inclusion of the themes to create a framework for gamifying the self-management of chronic illnesses (specifically diabetes).
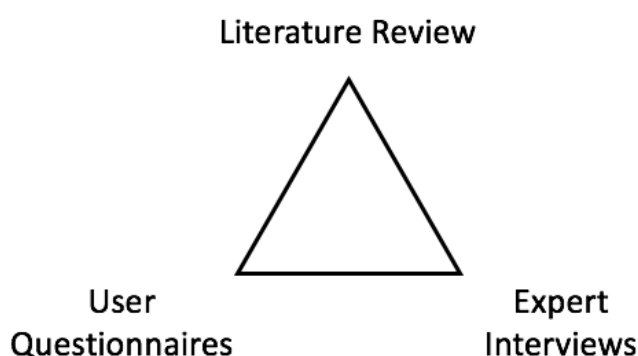
Figure 4-4 Components of Triangulation for Framework Validation

The interviews were conducted with a group of medical doctors, psychiatrists and psychologists, and game and gamification experts (see Sec.4.5). On the other hand, an online questionnaire was answered to individuals with diabetes based in Saudi Arabia (see Sec.4.6).

It is essential to obtain the insight of diabetic doctors, psychologists, and psychiatrists on the framework, along with the feedback of gamification and serious games experts (See 2.1). This enable the validation of the framework holistically. Moreover, the questionnaire provided the input of people with a chronic illness (people with diabetes) on the framework's concept. This is considered to be crucial in validating the framework. It permits measuring participants' attitudes towards the framework, and if it meets their needs once it is applied to self-management tools. Thus, by conducting both studies we aim to validate the framework and measure the level of acceptance of gamified self-management applications, and understand what might be lacking from their point of view.

Ethical approvals for both studies were obtained from the Ethics Committee of the University of Southampton prior to conducting the interviews and questionnaires (reference numbers: ERGO/FPSE/14208 and ERGO/FPSE/15296).

4.5 Study 1: Expert Interviews

In this section, the first study for the validation of the framework is discussed. The objective of the interviews is to validate the themes of the framework. The section is divided into two parts. First, the interview design and process are discussed. Then, the findings of the interviews are presented.

4.5.1 Interviews Design and Process

The interviews were conducted with doctors specialising in diabetes, psychologists and psychiatrists who have worked with individual with diabetes, and game and gamification experts. The aim of the expert interviews was to validate the proposed framework from three different perspectives that reflect the areas of research (see

Figure 4-1).

The Wheel of Sukr framework targets the self-management of chronic illnesses and specifically diabetes, which is chosen to limit the scope of this study. Since the framework is designed for the self-management of diabetes it was essential to consult experts who have medical knowledge of the illness, the self-management it requires, and have direct experience with individuals with diabetes. This is reflected in the sample of the interviews. They understand what is necessary to self-manage the illness properly, the struggles that their patients face, and the psychological difficulties of living with this condition (i.e. motivation, behaviour methods, cognitive behavioural therapy, and peer-support).

Eight experts were carefully selected based on their experience in their fields. Then, they were then contacted by email and in person, and the interviews were conducted face-to-face. The doctors, psychologists, and psychiatrists who participated in the study were selected from major public and private hospitals in Riyadh, Saudi Arabia. Those experts were chosen based on their experience with the diabetic community in Saudi Arabia and their expertise in this area. Moreover, as discussed earlier gamification has elements extracted from games. These elements are thought to be what make games engaging. Thus, two PhD researchers from the University of Southampton with expertise in gamification and games were selected to validate the themes of the framework in an open-ended discussion.

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While interviews are very valuable, however, it is important to mention that they require a significant amount of time to arrange and conduct. This consists of several steps including the identification of possible participants, contacting stage, arrangement of a suitable time, and conducting the interview itself. In this study, the researcher conducted most of the interviews in Saudi Arabia to meet with the medical and psychology experts. Interviews can be very expensive in terms of time and funding. However, it was worthwhile and the experts chosen are at the top of their fields. The experts in the study were:

- A chair professor in psychiatry with experience in working with diabetic individuals. This expert is based in one of Saudi Arabia's major hospitals. The expert has 20 years of experience.
- A prominent consultant psychiatrist with extensive experience in cognitive behavioural therapy.
- Two diabetes and endocrine consultants in one of Saudi Arabia's biggest hospitals located in Riyadh. One is an expert in child and adolescent diabetes. Both have more than 10 years of experience.
- A diabetes educator expert from of a major Saudi hospital.
- A nutrition expert from the nutrition clinic of a major Saudi hospital, who is specializing in working with individuals with diabetes.
- Two senior PhD researchers from the University of Southampton with experience in gamification and games. Both are part of the Game Design Hub at the University of Southampton.

In qualitative studies, the size of the sample is affected by the saturation of data. When the data collected starts to become redundant, it means the interviews have reached the point of saturation and no more interviews needs to be conducted (Guest and Johnson, 2006). The overall total number of experts was eight [Table 4-5], and no more expert interviews were required since the data from the interviews approached the saturation level.

Table 4-5 Interview Experts

Diabetic doctors	Experts #1 #3 #4 #8
Psychologists and psychiatrists	Experts #2 #5
Game experts	Experts #6 #7

At the start of the interview, the purpose of study and the process by which the interview will be conducted were explained to the interviewee to clarify any ambiguities. Each expert was

presented with the participant information sheet and consent form to sign. The interviews were audio recorded for the transcription and analysis.

A semi-structured approach was chosen for the interviews (Sec. 3.1.1.1). Each interview consisted of two parts: a set of closed questions about the general domain that is intended to set the stage and focus the discussion on the concepts underlying the framework, and a set of open-ended questions to start the discussion (Appendix A). The experts were asked questions based on their area of expertise, and discussed the underlying concepts of the framework as well as any extra points that they could provide based on their field.

Once the data was collected it was analysed using a coding system based on the eight themes of the framework. This method is called a deductive thematic analysis, which is used in order to confirm or disprove a pre-existing hypothesis as opposed to an inductive thematic approach in which the researcher tries to discover new patterns or establish a new theory (Braun and Clarke, 2006). The deductive approach was chosen in this study since we have established a framework, and this stage is concerned with confirming that the framework and the concepts underlying it are valid from the point of view of medical experts, gamification experts, and users.

Given that the number of the interviews is manageable the content of the transcribed interviews was analysed manually. This was done by going through the content of each interview and dividing the data into eight groups according to the pre-existing themes (the themes of the framework). Data that did not fall directly under any of the eight themes were put into a separate category called "other results". This data was outside the scope of this research (medical experts' concerns regarding diabetes education and awareness), however, it was divided into a number of topics and it helped in directing future work (see sec.6.2)

To ensure that the reporting of the interviews findings is unbiased and objective the following steps were taken:

- ➢ The researcher reported the outcome of each pre-selected theme without discarding any data.
- ➢ The researcher used verbatim quotes representing the opinions of the experts.
- ➢ During the interview the researcher ensured not to influence the experts by mentioning the benefit, advantages (perceived by the researcher) or discuss the researcher's opinion on the subject to influence the outcome.
- ➢ The researcher took a listener position and guided the discussion to uncover more information based on the knowledge and experience of the experts.

In the following section the findings of the thematic analysis of the interviews are presented.

4.5.2   Interviews Findings

The doctors and educators on diabetes provided valuable information based on their immediate experience with diabetics in Saudi Arabia. Similarly, the psychologists and psychiatrists provided insight into the psychological issues that diabetics face in Saudi Arabia that can affect their self-management. As for game experts, their input was specifically focused on the elements derived from gamification literature. The overall findings of the interviews provided the validation of the Wheel of Sukr.

Here the findings and discussion of the interviews based on the themes of the Wheel of Sukr is presented.

<u>Fun</u>

The fun aspect of gamification of the self-management of chronic illnesses has been established in the literature since the PBL system, if integrated with the other themes, can create an experience that is enjoyable for the user while performing their important self-management tasks. The findings of the interviews support this aspect of the framework. The idea of creating an enjoyable experience for diabetic patients was strongly welcomed by experts. As Expert #3 said:

> "Naturally people like to be rewarded. Thus, if this is applied to the self-management of diabetes it would be very effective."

While it is difficult to test how effective the framework will be once it is implemented. This indeed requires another study that aims to measure the effectiveness, which is outside the scope and aim of this study. However, the literature suggests that the rewarding aspect is one of the essential parts of what motivates people. This means rewards that arise in the fun environment (e.g. receiving points, badges, and higher ranking of the leaderboard in the self-management app) it is an important part of the framework.

Moreover, Expert #3 also mentioned that such a fun environment could have a positive effect in the way that the user perceives the self-management tasks. As they state that:

> "It will change the view and the experience of self-management of diabetes for the patient."

Indeed, self-management is very serious process and requires repetitive tasks and this nature can be daunting and boring. The fun theme should be able to deal with issues and also could help the self-esteem of users as Expert #5 said:

"Positive reward is enjoyable in whichever form it comes. This will help patients' self esteem."

Furthermore, Expert #8 who regularly participates in events for diabetic patients said:

"Using games, competitions, and fun events have shown a positive effect on diabetic patients."

This suggests that creating a game-like experience that entertains the users can be a relevant part to improving the self-management process.

<u>Socializing</u>

The ability to share the same experiences and concerns with other individual with diabetes can offer the social and emotional support that an individual with diabetes needs. It creates a good environment for gamification where the existence of a social community adds to the value of rewards, competitions, and motivation. As Expert #2 pointed out:

"In today's world, the effects of social media on young and early adolescents is very big. In fact, it could leave a stronger impact on the patient than that of the doctor."

Due to that, adding the social aspect in a gamified app can have a wide range of impacts on the experience of the user. This impact can be very positive if it allows the users to learn, share, and feel as a part of a community. This accords with what has been found in the literature on the importance of community in diabetes self-management. Additionally, being part of a community can help patients over come the stigma surrounding the illnesses as confirmed by the same expert.

Expert#1 (endocrinologist) stressed that the community should be exclusive to diabetic users. The expert pointed out that including others who do not have diabetes might result in the spread of wrong information about the illnesses, and that the patient will only benefit if the users of the community shared their understanding of the illnesses and experience. Additionally, the community will benefit from users who are educated about their illness in terms of medication and self-management. The expert mentioned his personal experience with patients who mismanage their illness. In particular, some patients, according to the doctor, fail to take their medicine and maintain the blood glucose that is recommended to them, because they can be easily influenced by family or friends who do not have diabetes and have misconceptions about it. Thus, the doctor suggested that the community should be diabetic only.

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The doctor also highlighted the importance of creating a diabetic society where diabetics can interact and be active members. However, and according to the doctor, some patients are reluctant to participate in diabetic events or talk about their illness publicly. The doctor said that he and his colleagues have tried to create diabetic events on diabetic day, for example, but a limited number of people would show up. This gives the impression that an online community might be a good option for the Saudi community. This information was supported by another expert (psychiatrist), who pointed out the value of peer support to the patient. The psychiatrist said that peer support is important to everyone but especially important to those living with chronic illnesses. The expert discussed the effect that diabetes can leave on some patients in terms of being socially shy and hiding their illness (i.e. not taking medication in front of people or ignoring testing blood glucose before and after meals if people are around). Thus, the expert stressed that the use of online community is important because it give patients the support they need while still keeping their privacy. The expert said:

> "I believe that the effect of peer support is important if it is provided to the patient in an online form. I believe this will facilitate ease of communication especially to those who are shy about talking about their illness and prefer to keep their privacy. Online they can communicate with their peers knowing that they share the same experience and understand what they are going through but they can still keep their personal information private which is comforting to a lot".

Therefore, the social and community aspect of the framework can be essential in providing support for diabetics and in tying in all the other themes of the framework.

Esteem

One of the experts mentioned that it is important to keep the users on top of their progress so that they can have better handling of self-care. This can be achieved by the progress bar for example. The rewarding aspect that has been discussed in the Fun theme section, also applies for the esteem theme since Leaderboards (as part of gamification) are based on ranking and users who achieve higher ranks can feel rewarded. This could enhance their self-esteem and their view on their self-management.

Additionally, the medical experts discussed the stigma on diabetes in Saudi Arabia. The medical experts talked about the effect of society and sometimes parents and family on the self-esteem of the individual with diabetes. Some parents and family of diabetic individuals enforce this by being overprotective of their diabetic kids. Some experts expressed that some of their young patients

have overprotective parents who do not allow them to go out with friends or eat outside the house and thus affecting their self-esteem. This affects their self-management, as Expert #8 said:

"How the patient feels about diabetes has a great effect on their self-management."

Another expert (psychiatrist) said that adolescents and young adults with diabetes may have low self-esteem because of the illness, and might rebel against their parents and families by stopping medication. The expert explained that this happens because adolescents and young adults feel isolated due to having diabetes (and because it is natural for teenagers to want to be independent and get rid of all the restrictions but having this illness is part of the restrictions). The expert indicated that it is essential to focus on the elevating the self-esteem of individuals with diabetes and motivating them and that his will lead to better self-management and adherence to medication.

Therefore, a self-management app for diabetes should take into account the self-esteem of the patient. Self-esteem can be addressed in gamification by competitions, leaderboards, levels, and progress bars. Creating competitions between peers and adding leaderboards (community/ tracking progress compared to others), levels (individual), and showing progress bars (individual) in a self-management tool could be essential in boosting users' self-esteem. This might fulfil the need for recognition and instant positive feedback within the human nature. This could result in positive change in behaviour regarding the self-management of diabetes.

<u>Self-Management</u>

According to some experts, some diabetics feel stigmatized and could be shy to deal with their condition when they are participating in social activities. This in turn could prevent them from maintaining their daily self-management routines, for example, missing taking blood glucose test results. However, experts argued that some families play a negative role, which prevents individuals with diabetes from self-managing diabetes properly. This was supported by Expert #3 who said:

"The stigma on diabetes in Saudi Arabia affects the ability of some patients to perform the daily self-management activities in public or around other people."

This shows that there are some difficulties faced by individuals with diabetes in terms of dealing with diabetes self-management tasks in public. Furthermore, expert #1 expressed that the main challenge that he faces is the education and awareness of patients. Part of what he discussed is the importance of daily self-management at home. However, the doctor said that some of his patients do not realise the value of the daily self-management and their role in improving their

health. He said *"some patients are not keen to learn about diabetes and the self-management of if"*, and that they mainly rely on their doctor. The doctor agreed that some patients need more motivation to self-manage their illness.

Additionally, the expert said that in the country he worked in before coming to Saudi Arabia, many patients would come with a logbook of their daily test and graphs and pie charts of the results. An app that shows a visualization of daily logged test results (e.g. graphs) not only would benefit patients and help them in self-managing, but also help their doctors in treating them and making informed decisions. This support the need of an electronic self-management logbook in Arabic that not only help users keep their daily tests but also visualize the data in graphs and pie charts and show trends. This will help empowering the patient and giving them autonomy over their own health and help the doctors make informed decisions.

In fact, the expert mentioned that many individuals with diabetes are not aware of existing self-management tools for example. This might be because of language barriers or because they have underestimation of the quality of apps. Indeed, an app that is plain and simple might have little chance of attracting such individuals as opposed to a gamified app.

Therefore, a gamified self-management tool should enable users to self-manage with ease and confidence and without embarrassment or delay. The framework themes collectively could achieve this by raising the users' awareness of the importance of the self-management. For example, showing them graphs or pie charts of their test results could motivate them to keep on top of their health, nudging them into taking the tests or adhere to their medicine, and be encouraged by other individuals from their community within the app.

<u>Motivation</u>

The majority of experts agreed that many diabetic patients lack motivation in terms of self-management. The diabetic doctors highlighted that there is a lack of motivation in following the right procedures for self-management and caring for oneself among some patients. Both Experts #1 and #3 said that some patients are not motivated to learn about their illness and learn self-management skills. This could be also relevant to the "growth" theme (discussed later) in which feedback and progress are essential. Expert #4 expressed that game elements and rewards could be the solution to the lack of motivation, which supports the "fun" theme discussed earlier.

The medical experts agreed that it could be very challenging in Saudi Arabia to motivate individual with diabetes, and a few of them mentioned that they have tried to organize motivational group events for their patients. However, there is usually very little attendance and engagement. Changing this is very crucial, and self-management apps with gamification that are designed to

increase motivation could help in this regard. Indeed, Expert #2 talked about the importance of motivation, the expert said:

"Motivation, self-esteem, and acceptance of circumstances are important factors to focus on in order to have a balanced view of oneself".

Furthermore, Expert #7 said:

> "in terms of motivation, from my personal experience in research I think it is important to priorities intrinsic motivation over extrinsic motivation, because intrinsic motivation is the more longer lasting … so get them to use the system with extrinsic motivation and then use intrinsic motivation to let them continue using it."

Therefore, a gamified self-management tool should take both types of motivation into consideration. This is the reason why motivation is a significant part of the framework.

Growth

The experts agreed that elements of the Growth theme such as Feedback are essential to the self-management of diabetes. Experts asserted that the feedback aspect of a self-management app is very important. The feedback could come in a visual form that informs the user about their activities and the tasks they have undertaken, is an important aspect of the app. Moreover, as mentioned in previous elements, there is a lack of motivation in self-management and a lack of consistency. Therefore, the Growth theme is a vital part of the framework, and applying all the themes combined may help in creating new habits in self-management of diabetes and creating consistency.

The medical experts talked about the difficulty they face with some patients in terms of keeping up with their self-management routines and adherence to medication, even though those some of those patients had been diagnosed with diabetes for a year or more. This indicate to us that there might be a problem that face those patients in term of creating the new habits of self-managing diabetes. This might be addressed by the growth theme and specifically the "Baby steps/tiny habits" method which could help in adopting new habits by breaking them into smaller tasks that can be combined with daily reunites.

Self-Representation

Some patients could feel that they are being blamed for not taking care of their condition; for example, if their blood glucose was higher or lower than normal. However, if the patients were in

an environment where they are encouraged by other peers, then this could help them improve their self-managing skills. In fact, Expert # 2 said:

> "Peers and peer relations are very important to youngsters and adults alike but especially to those with special needs such as living with diabetes".

Also, adolescents might be reluctant to take their doctors' instructions responsibly, possibly because it could undermine their independence as suggested by the same expert. This is reinforced by the opinion of Expert #6:

> "If the user has a sense of control of what they are doing, they will feel that things are not imposed on them and they are the actors."

Furthermore, one expert mentioned that autonomy is very important aspect, especially for young adults who usually seek independence. Moreover, Expert#6 indicated the sense of autonomy, and the purpose in gamification is important due to being in control, as opposed to having things imposed the user, and this might increase engagement. The expert also mentioned that the use of an avatar can create identification to the user and keep their anonymity. Additionally, when asked about the self-representation theme and its relation to gamification expert #6 said:

> "it is extremely important because you have the sense of connection with the system"

Therefore, a gamified self-management app should provide an environment for diabetic patients where they feel represented and in control. The environment should allow them to pursue and achieve their goals regarding self-managing diabetes.

Sustainability

Sustainability is essential to the success of any gamification app. Maintaining the same level of engagement can result in the positive change in behaviour in self-management of diabetes. The game and gamification experts agreed that the use of triggers and nudge theory, which are the elements of sustainability theme, might direct users into the desired behaviour for self-management. One expert (gamification expert) suggested that nudging the user could help in persuading them to complete tasks of self-management. The expert also suggested that the storyline is an important aspect and could connect the other themes together. Expert #6 said:

> "The visual part is important because you can have a pleasurable experience with an interface that is more familiar to you and it has some meaning."

The expert mentioned that *"the user will learn through the system and with the system so they don't stay in the same level"*, which is captured in the flow element of the sustainability theme.

Moreover, the expert discussed the relation between the Sustainability theme and the Growth theme highlighting that the latter is related to the user (in terms of providing the user with feedback, achieving goals, and adopting new habits), and the former is related more to the system (in terms of increasing the difficulty of tasks (flow), creating triggers to get the user to perform tasks, providing a storyline or a theme, and nudging the user to wanted behaviour).

Furthermore, the expert pointed out that Nudging the user can make the experience of using the app easier and quicker. Thus, by facilitating ease of use and providing the user with instant feedback it can persuade and guide the users to perform the tasks that they need to do.

Therefore, sustainability theme is important to address some of the issues related to sustaining the engagement and user interest in the app.

Other Results:

During the interviews, the experts discussed other areas that are not necessarily related to the themes or the aim of the framework. However, these are issues that concern the medical experts regarding the diabetic community. These additional comments are organized under three tags: education, age, and negative connotation about diabetes.

<u>Education:</u>

One of the endocrinologists, Expert #2, raised the issue of education while discussing the self-management of diabetes and his experience with patients. The expert stressed the importance of education of diabetes and how to self-manage it. Based on his experience, the doctor thinks that some patients are not keen to learn about the illness and not keen on self-managing it. The doctor said that some patients do not meet their diabetic educators and diabetic nutritionist. The doctor said:

> "The problem that faces me is the education of diabetic people about what is diabetes and how to manage it, and what are complications of it. Until now when I ask my diabetic patients about their HbA1c (haemoglobin A1c) they do not know it. They do not know the value of it in the assessment of diabetes. They do not know the value of self-monitoring blood glucose at home."

The doctor also said that he spends a great deal of time teaching some of his patients about diabetes because they do not see their diabetic educators. As he said:

> "Some of the diabetic patients do not have motivation and not keen to be educated."

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The doctor talked about the need to raise awareness not only with diabetic people but also about diabetes to enable others to avoid it by having better diet and doing sports. Expert # 2 said that there are some efforts in raising awareness and education regarding diabetes that are taking place in Saudi Arabia. The expert explained that these programmes are Arabic and aim to create a channel between diabetics and experts (endocrinologists, psychiatrists, and nutritionist) and the patients and their carers to enable them to ask questions and receive answers from the experts using an SMS service.

Age:

One of the psychiatrists, Expert #2, who have conducted studies on the effects of diabetes on the psychology and personality of children with diabetes in Saudi Arabia, expressed that it is essential to consider age when dealing with diabetic patients. Moreover, she said that in order to have effective communication and peer-support between users it is important that they are from the same age range. The expert also expressed that the use of rewards in this sense could be effective on adolescents and children.

Negative connotation about diabetes:

All the medical experts agreed on the presence of a negative connotation around diabetes in the community. The experts mentioned that they face problems with some of their patients who do not take their insulin shots if they are out in public and around people and end up missing the medication. Others said that patients are reluctant to test their blood glucose before and after meals if they are out in public and around people. This leads to them not having a daily record of their blood glucose and also not taking the right amount of insulin.

Expert # 3 (diabetic educator) viewed the shyness from taking medication or testing blood glucose in public, and the image of diabetes in society as a problem that faces doctors and diabetic educators. The expert said that even when they set up group meeting about self-management most of the patients refuse to attend it because they prefer one to one meeting to keep their privacy. Furthermore, the expert expressed her worries that some patients might not want to communicate online as well, because as she said some of them do not want to talk about their illness.

Overall

In general, the findings of the interviews show a consensus from both the medical experts and the game/gamification experts on the importance of the concepts that compose the framework. The games and gamification experts were shown the framework and they indicated that the

framework is comprehensive and the game mechanics are integrated with the other elements. One of the expert said: *"it has all the principles of gamification.* And the community aspect is very good. I think gamification always work in a community because you are able to share something you achieved, or some comments, or suggestions or experiences and stories. If you think about the story aspect and then people get empathy from what they have been doing, they relate themselves to others, which create relatedness. So I think it has everything integrated."

Finally, one of the psychiatrist (Expert #3), said, by the end of the interview, that the framework is comprehensive and is a very good start to increase the engagement and motivation of diabetic patients. The expert said that she believes that it could impact users especially adolescent and children with diabetes more than the impact of the medical doctors. She also mentioned that this can be generalized to other illnesses that need self-management. However, she said that the framework needs to be implemented in an application and studied with a small group of people to revel any deficit in it and make modifications if needed before generalizing it. Future work is discussed in (Sec. 6.2).

The findings of the expert interviews validate the themes of the framework, and the next stage is to cross-validate the framework via the quantitative study.

4.6   Study 2: The Questionnaire

In this section, the second part of the validation of the framework is presented. This part consists of the quantitative study of the mixed method approach chosen for validation. The objective of the questionnaire is to measure the acceptance of the individuals with diabetes based in Saudi Arabia toward the concepts of the framework. The section is divided into three parts. First, the questionnaire design and sampling are presented. Then, the questionnaire process is discussed. Finally, the questionnaire results are presented.

4.6.1   Questionnaire Design and Process

The self-administered questionnaire is the second part of the methodological triangulation study to validate the framework The Wheel of Sukr (See Sec.3.1). Combining two or more methods in the research can enhance the results by providing better understanding of the issue from multiple sides (Creswel, 2003). Also, methodological triangulation is used to minimize bias in the study, and increases the validity of the results and ensures that it is not "a methodological artefact" (Denzin, 1978).

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The aim of the questionnaire is to measure the acceptance of the individuals with diabetes in Saudi Arabia towards the concepts underlying the framework. The questionnaire was chosen to collect data this data as opposed to other methods such as interviews or focus groups. As mentioned in Sec. 3.1.1.2 questionnaires is very common choice for collecting due to many reasons including the ability to collect large number of data, it can be analysed objectively through statistical methods, "the ability to count frequency of occurrence of opinions and attitudes", the anonymity factor can eliminate any biases that could result in a face to face study (Somekh and Lwein, 2005) (See Sec.3.1.1.3). Furthermore, in this study an online questionnaire was the best choice to get data from individuals with diabetes based in Saudi Arabia. That is because having one to one interviews or focus group interviews is not feasible in this case due to high stigma and other gender based cultural reasons.

There are several methods to collect responses from participants in a questionnaire e.g. yes or no, multiple choice, and Likert scale. The latter is a common method to collect participants' beliefs, attitudes, and opinions. In this approach participants chose between number of choices to express their agreement, disagreement, or neutrality to a statement (i.e. the question). On the other hand, in dichotomous questions (i.e. yes or no) the participants are limited to two responses. While this method is easy to score for the user, it does not provide the researcher with enough information to analyse. Furthermore, multiple-choice questions provide the participants with a number of options to choose from. This type of questions is good to provide the participants with specific answers to choose from, each set of answers is specific to the question. It is easy to answer and could be used to collect demographic information on the participants.

A combination of multiple choice questions and Likert scale questions are used in this study. A five point Likert scale is used in this study as opposed to a 6 point Likert scale. This is to allow a range of answers that covers arrange of agreement and a neutral choice. Also, to avoid a forced answer that could result of the use of an even number Likert scale. The researcher wants to leave the opportunity to participant to express their opinion in a 5 point Likeret scale that has a "neutral" option to get honest responses without pushing them to either sides (agree or disagree). For example, some people might not find it important to them to have an application with good design to log data, but at the same time they will not object to including this so they will be neutral. Having a "neutral" point can give people a chance to those who do not have a strong opinion about the issue at hand.

The self-administered questionnaire consists of two parts: multiple-choice questions and Likert-scale questions, which had five choices (strongly agree, agree, neutral, disagree, and strongly disagree), each weighted from 5 to 1 respectively. Moreover, a space was offered (i.e. comment

box) at the end of the questionnaire to leave an optional comment. The multiple-choice questions were asked in order to gather information from participants about demographics and self-management habits. The part of the questionnaire is where the inclusion and exclusion criteria are specified.

The second part of the questionnaire consisted of 5 point Likert scale that was used to measure the attitude of the participants toward the underlying concepts of the framework themes. Each question has to capture an underlying concept in the framework and gather the opinion, attitudes of the patients towards it. The questions had to follow standards such as avoid the use of jargon, it should be easy and straight forward, short as possible, and not ambiguous (Choi and Pak, 2005; Rowley, 2014).

Furthermore, since the questions are about the themes of the framework, which are synthesised from literature, then this study is a deductive research. In particular, the questions are informed by previous research in terms of the type of things to be asked (Rowley, 2014). For example, the questions on the socializing theme are informed by the literature on the positive effects of web 2.0 and social media on individuals with diabetes (Steinhardt *et al.*, 2009; Shaw and Johnson, 2011; Haltiwanger and Brutus, 2012; Nacke, Klauser and Prescod, 2015), and the fun and motivation themes questions are informed by the literature on gamification and user comments on existing gamified self-management apps (e.g. mySugr) (Lin and Zhu, 2012; Bunchball Inc, 2013; King *et al.*, 2013; Rose, Konig and Wiesbauer, 2013; Hamari and Koivisto, 2015).

In particular, the questions were designed to capture the overall idea of the framework and its themes instead of focusing on the technical concepts of the elements. This is because gamification may not be a familiar topic to most participants. To clarify, assume that the researcher wanted to validate the badges element of the Fun theme using the following statement: Getting badges on my diabetic entries is going to make me consistent in doing so. Since gamification is a new concept and not many applications are using it, nor many articles (at the time of the study) were written about it in Arabic, chances are that the participant will not understand the meaning of the question. This is especially because the statement is out of context and there are no examples or previous experience with gamification that the user can build their answer upon. However, the researcher chose to present the statements in a way that no matter what knowledge or experience an individual had on gamification or any other concept of the Wheel of Sukr he/she could give an honest answer. So, instead of using the word badges the idea of reward was used.

After designing the questionnaire, it was piloted with three researchers in the area of games and gamification (with expertise in writing questionnaires) and some of the questions were modified

after that. The feedback from them helped in some of the technical jargon that was found and to improve the questions. Furthermore, the questions were placed randomly in the questionnaire, and a few questions were repeated in different places to ensure validity of the answers. Then, the questionnaire was translated into Arabic language because it is targeting individuals with diabetes in Saudi Arabia. However, to verify the accuracy of the questionnaire it was back translated by academics with professional translation skills. Moreover, a good practice in designing questionnaires is to validate it with sample users, before distributing it to the intended audience (Rogers, Sharp and Preece, 2011). Thus, the Arabic version of the questionnaire was piloted with two individuals with diabetes before distributing it to the targeted audience, and changes were made according to their feedback. Finally, Cronbach's alpha was applied to check the internal consistency of the questionnaire (Bland and Altman, 1997). The test was applied to the questionnaire, and the result was 0.91, which indicates an internal consistency of the questionnaire.

The target audience of the questionnaire is diabetics in Saudi Arabia, where diabetes is wide spread (3.4 million in 2015) and has a high prevalence (*Saudi Arabia | International Diabetes Federation*, 2015; Cho *et al.*, 2015). Saudi Arabia is one of the top 10 countries for number of children with type 1 diabetes—it has 16,200 children 15 years old and younger in 2015, which is a quarter of the region's total of 60,700 patients (Cho *et al.*, 2015). The self-administered questionnaire was distributed to a sample of diabetic patients in Saudi Arabia through social media (Twitter and Facebook).

Table 4-6 shows the Likert scale part of the questionnaire. Each question is linked to a theme. The themes are shown as follows: Fun (F), Socialising (So), Esteem (E), Self-management (S-M), Motivation (M), Growth (G), Self-representation (S-R), and Sustainability (Su).

Table 4-6 The questionnaire

	Q	Question/s
F	1	It is important for me when I use an App for diabetes that it is not boring in its design and usage.
	2	I prefer social networks are the ones containing entertainment (and encouragements) features.
	3	I feel satisfied when my work in self-managing my diabetes is appreciated.
	4	I will work relentlessly to always keep a record of my test results if I have the opportunity to positively compete with other diabetic patients.
	5	The availability of different types of motivators in the diabetic social networks will encourage me to promptly record my tests.
S	6	I like to share my positive results with others
	7	I prefer to interact with diabetic patients through the internet but not in real life.
	8	I would like to make friendships with diabetic patients.
	9	Communicating with diabetic friends is helping me cope with diabetes.
	10	Social networks is helping me cope with diabetes.
	11	Being part of a diabetic-oriented social network will help me to live positively with diabetes.
	12	The social support that I receive from the Internet is important to me.
	13	It is difficult for my non-diabetic friends to understand and appreciate my situation.
	14	I would like to participate in a social network that enables me to communicate with diabetic patients.
E	15	I will be more encouraged to self-manage my diabetes if I see other patients' records\progress.
	16	I would like to share my diabetes tests with other diabetic friends, especially the positive results.
	17	I will be motivated to support others if I participate in a social network for diabetes.
S-	18	I only record my tests to show them to my doctor

M	19	A self-management system for diabetes is beneficial if it provides feedback to the users based on their daily entries.
M	20	I lack self-motivation to keep a record and follow up my situation in a daily basis.
	21	I am well aware of the importance of my role in managing my diabetes.
	22	I would like to self-manage my condition as best as possible along with keeping my routinely meetings with the doctor.
G	23	I would like to receive notifications every time I record my test results, and for them to be compared to my previous tests.
	24	I would like to be notified with my glucose level fluctuates abnormally.
	25	My understanding of how to self-manage my situation makes me feel secure and content.
	26	It is important to me to control my health through improving my self-management skills.
	27	When I use a new App, it is important for me that it helps me achieve my goals that are related to my situation. (E.g. achieving a certain level of glucose, or burning a certain number of calories.)
S-R	28	I would like my virtual account on the Internet (profile, photo, etc.) to reflect my personality.
	29	I do not use Arabic Apps for diabetes (mobile or computer) because of their bad design and quality.
	30	Diabetes is negatively looked at in Saudi Arabia
Su	31	When using a diabetes management App, it is important that it is regularly updated.
	32	I need to be encouraged in order to keep recording my test on a daily basis.
	33	I feel bored when using an app for several times.
	34	I enjoy being challenged at a level that suits me when I play in my mobile or computer.

4.6.1.1 Questionnaire Sample

In quantitative methods, statistical validity is sought. Thus, the size of the sample must be determined prior to distributing the questionnaire. A sample is chosen from a larger measurement that is a population (Mendenhall, Beaver and Beaver, 2012). In this case, the population is the all the diabetic people in Saudi Arabia. However, it is not possible to study all the population, so a sample is chosen as a representative of the population. This describes the behaviour of the population on the basis of the information obtained from the representative sample from that population.

Furthermore, samples can be selected by two methods, either probability (simple random, systematic random, stratified, multi-stage cluster) or non-probability (Convenience, Snowball, Quota, Theoretical) (Bernard, 2006). In this study, the snowball method was used to select the sample for the patients' questionnaire.

Prior to the distribution of the questionnaire, the sample size was estimated by power analysis using the program G*power [Table 4-7]. Following the convention, setting α =.05, β=0.2, and the effect size d is chosen to be large (set to 0.8) to ensure that the means of the data significantly deviate from the mean of the weights (Cohen, 1988). Based on this, the minimum sample size is 15.

However, after distributing the questionnaire, 42 individuals completed it, which is larger than the minimum sample size calculated by power analysis. Additionally, this number suggest that we can use t-tests on this sample because according to the central limit theorem the t distribution of a sample larger than 30 is close to a normal distribution regardless of the distribution of the data.

Table 4-7 G*Power Values

Effect size d	0.8 (large)
α type 1 error	0.05
Power (1-β)	0.8
Minimum Sample Size	**15**

4.6.1.2   Questionnaire Process

The data was collected via the online tool SurveyMonkey[31]. The questionnaire was distributed using social media outlets (i.e. Twitter and Facebook). A number of social media groups for diabetes patients were identified and were asked to share the questionnaire. An inclusion and exclusion method was used in terms of demographical questions where the participants had to be diabetics, ranging in age between 18 and 40.

Following the ethical requirements, the first page of the questionnaire presents a participant's information sheet. This includes the aim of the questionnaire and the target audience (i.e. individuals with diabetes). Moreover, it was declared that the participants would be anonymous and that no personal data would be collected. In addition, it was mentioned that their participation was voluntary and that they could withdraw at any time without consequences.

Those who choose to participate in the study were presented with the first part of the questionnaire, which included the six general and demographical questions [Table 4-8]. After answering these questions, the participants were presented with the second part of the questionnaire which contains thirty-four questions on the themes of The Wheel of Sukr.

The questionnaire was designed in a way that reflects the ideas of the themes without using jargon or confusing the user. It was not assumed that users were familiar with gamification or games used for the self-management of diabetes, as there are no gamification apps for this in the Saudi Arabia.

4.6.1.3   Data Analysis

Demographic data:

The data from each question from the first part of the questionnaire was subjected to a descriptive analysis whereby the frequencies of responses were obtained. Frequencies are the number of times a certain answer has appeared. This gives insight into possible clustering for one of the variables. For example, it could show that the majority are around a certain age or of a certain gender and so forth. Two common ways to show frequencies are pie charts and histograms.

Likert scale data:

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[31] https://www.surveymonkey.co.uk/

A Likert scale can be analysed by different statistical tests. The goal of these tests is to check the difference of a statistical quantity of a sample (such as the mean or median) against a constant mean. Performing all of these statistical tests can be carried out through a number of well-known programs such as SPSS, which is user-friendly as it has a graphical interface and the statistical analysis is readily available through a number of functions.

T-tests are the most common test used for Likert scale analysis since the standard deviation of the population is usually unknown. In order to apply the t-test it is usually important to check the following assumptions. First, the data should be randomly selected. Second, the data should come from a population that is normally distributed. However, it is known that the t-test is not subject to significant changes when the second assumption is violated, especially if the size of the sample is large enough (Mendenhall, Beaver and Beaver, 2006).

Thus, to analyse the data of the Likert scale in this study a one-sample t-test (2 tailed) is performed. The t-test can be used on this sample following the central limit theorem rule (as discussed in Sec. 0). The aim of the test is to check whether the mean of the answers for each item in the questionnaire differs from 3 with statistical significance.

The following hypotheses were used for each question:

H_0 (null hypothesis): mean = 3

H_1 (alternative hypothesis): mean $\neq$ 3

To reject the null hypothesis, the P value must be $P < \alpha$ (type 1 error). Since the questionnaire contains 34 questions, the Bonferroni correction was used (Bland and Altman, 1995). Specifically, α is corrected to be .05/34=.0014705. Hence, the P value for each question should be less or equal to the new corrected value for the null hypothesis to be rejected. However, it is worth mentioning that the Bonferroni correction can be too conservative.

4.6.2   Questionnaire Results

In this section, the results from the analysis of the questionnaire are presented and discussed. The section is divided into two parts based on the questionnaire. The first part discusses the demographical and multiple-choice general questions in the questionnaire, and the second part discusses the results of the frequency test and statistical analysis of the Likert scale questions.

4.6.2.1   Part one of the Questionnaire

Table 4-8 shows the results of Part 1 of the questionnaire, which contained multiple-choice questions on demographical questions and habits related to their self-management.
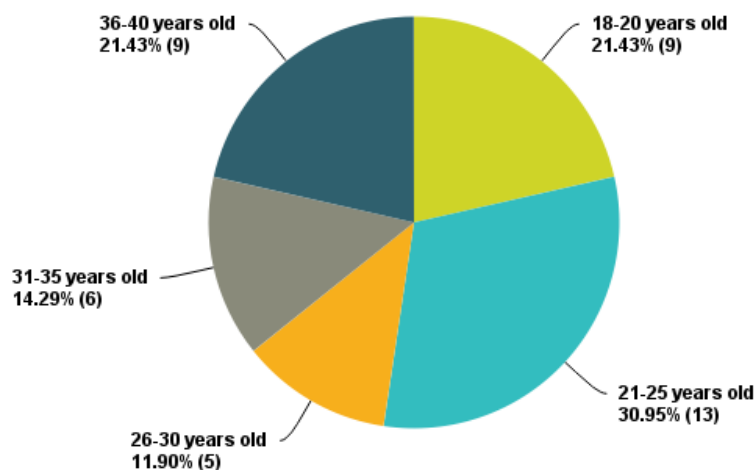
Figure 4-5 Participants Age Group

45.24% of the participants were diagnosed with diabetes 9+ years ago. The participants were from different age groups [Figure 4-5]. 45% of participants search for diabetes on the Internet in both English and Arabic, while 33% search only in Arabic and 16% do not use the Internet to get information on diabetes. Also, most of the participants have diabetic friends (71%). Furthermore, 59.52% of participants do not record their blood glucose on a daily basis. When they do keep a record, 66.67% use manual logbooks to record their data (pen and paper).

4.6.2.2   Part two of the Questionnaire

Table 4-9 shows the results of the second part of the questionnaire, which contained Likert-scale questions on the themes of the framework. Each theme was associated with a number of questions to measure the attitude towards the theme as shown in the table.

The fun theme, for example, has five questions related to it. The frequencies for each Likert-scale item (e.g. strongly agree) were averaged. This result is shown in the first column in Table 3 (39.05%). In addition, the sum of the "strongly agree" and "agree" answers is shown in the "fun" row (75.71%). Similarly, the sum of the "disagree" and "strongly disagree" is shown. The same procedure was done for all the questions.

Table 4-10 shows the mean and P value of the questions asked.

Table 4-8 Data from Part 1 of the Questionnaire

Question/answer choice	Responses
Age group	
18-20 years old	21.43%
21-25 years old	30.95%
26-30 years old	11.90%
31-35 years old	14.29%
36-40 years old	21.43%
Gender	
Female	76.19%
Male	23.81%
When where you diagnosed with diabetes?	
0-1 years	14.29%
2-4 years	26.19%
5-8 years	14.29%
9+ years	45.24%
Do you have friends with diabetes?	
Yes	71.43%
No	28.57%
Do you keep a log of all your daily test results?	
Yes	40.48%
No	59.52%
How do you log your daily test results?	
Manually (using a pen and paper)	66.67%
Electronically (using mobile apps, or computer systems, etc)	33.33%

Table 4-9 Frequency Table

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	
	39.05%	36.67%		3.81%	0.95%	100.00%
Fun	75.71%		19.52%	4.76%		
	33.86%	34.13%		11.64%	1.59%	100.00%
Social	67.99%		18.78%	13.23%		
	34.92%	44.44%		8.73%	0.79%	100.00%
Esteem	79.37%		11.11%	9.52%		
Self-management	23.81%	48.81%		11.90%	2.38%	100.00%
	72.62%		13.10%	14.29%		
	38.89%	38.10%		8.73%	2.38%	100.00%
Motivation	76.98%		11.90%	11.11%		
	43.33%	44.76%		2.86%	0.48%	100.00%
Growth	88.10%		8.57%	3.33%		
Self-representation	19.05%	23.81%		19.05%	1.59%	100.00%
	42.86%		36.51%	20.63%		
	27.38%	41.07%		10.71%	0.00%	100.00%
Sustainability	68.45%		20.83%	10.71%		

Table 4-10 The Statistical Analysis of the Questionnaire (SPSS)

Question Number	Mean	P-Value (2-tailed)
1	4.33	<0.001
2	3.95	<0.001
3	4.50	<0.001
4	3.76	<0.001
5	3.90	<0.001
6	3.76	<0.001
7	3.07	.667
8	4.12	<0.001
9	4.14	<0.001
10	4.02	<0.001
11	4.05	<0.001
12	4.10	<0.001
13	3.40	.058
14	4.17	<0.001
15	3.95	<0.001
16	3.79	<0.001
17	4.38	<0.001
18	3.40	.030
19	4.19	<0.001
20	3.24	.215
21	4.55	<0.001
22	4.29	<0.001
23	3.76	<0.001
24	4.48	<0.001

25	4.43	<0.001
26	4.40	<0.001
27	4.31	<0.001
28	3.71	<0.001
29	3.14	.279
30	3.33	.070
31	4.24	<0.001
32	4.07	<0.001
33	3.17	.255
34	3.93	<0.001

<u>The Fun Theme</u>

Overall, when we average the frequencies of the answers to each Likert item we find that 32/42 (76%) responded by strongly agree or agree, 8/42 (19%) were neutral, and 2/42 (5%) strongly disagreed or disagreed. This suggests that the majority of the participants support the importance of the fun theme. Since it helps them overcome any boredom from the repetitive tasks and provide entertainment and encouragement. It also gives them the opportunity to be appreciated for their efforts in self-management, and the opportunity to positively compete with one another.

More specifically, it is worth mentioning that when individuals with diabetes were asked:

Q1: it is important for me when I use an app for diabetes that it is not boring in its design and usage.

Q2: I prefer social networks are the ones containing entertainment features.

47.62% of the participants strongly agreed with the statement of Q1, the mean of the answers to this question is 4.33 ($P \ll 0.001$). In addition, when asked about using entertainment features in a social context, participants agreed to this statement (Q2) as indicated by a mean of 3.95 ($P \ll 0.001$). This suggests that an entertaining and enjoyable experience in using a self-management app can be of interest to the users.

Moreover, when the participants were asked:

Q3: I feel satisfied when my work in self-managing my diabetes is appreciated

59.52% of them strongly agreed with this statement, and the mean of the answers of this question was 4.50 (P << 0.001) suggesting that the use of a reward system to encourage them and acknowledge their self-management efforts is important and could have a positive effect on them.

The Socialising Theme

Following the same procedure as described in the fun theme, 28/42 (68%) of the participants answered with strongly agree or agree, 8/42 (19%) were neutral, and 5/42 (13%) supported strongly disagree or disagree. This suggests that diabetics like sharing their positive results with one another, and establishing new friendships with their peers. This could help them cope and live positively with their condition.

Particularly, when participants were asked:

> *Q6: I like to share my positive results with others*
>
> *Q8: I would like to make friendships with diabetic patients.*
>
> *Q9: communicating with diabetic friends will help me cope with diabetes*

The mean of the answers of Q6 was 3.79 with P << 0.001, and the mean of the answers of Q8 was 4.12 with P << 0.001, this could indicate that the social aspect especially making connections with other individuals with diabetes and sharing with them positive results would be appreciated by the user. This can also help individuals with diabetes cope with their illnesses as supported by Q9 (mean = 4.14, P << 0.001).

The Esteem Theme

The results of the averaged frequencies of the answers to the Likert scale are as follows: 33/42 (79%) strongly agree or agree, 5/42 (11%) neutral, and 4/42 (9%) strongly disagree or disagree. Clearly, the majority of the participants supported this theme. It is worth recalling that the esteem theme includes progress bars, leaderboards, and reputation. So, by enabling the patients to see each other's scores and progress they will be encouraged to self-manage. More importantly, the patients will have the chance to support and encourage each other.

Specifically, when asked about:

> *Q15: I will be more encouraged to self-manage my diabetes if I see other patients' record/progress.*

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The mean of the answers for Q15 was 3.95 with P << 0.001. This indicates that the use of leaderboards and progress bar can be effective in motivating users to self-manage, which is also related to other themes such as socialising and fun themes.

The Self-Management Theme

Participants who strongly agreed or agreed were 31/42 (73%), 5/42 (13%) were neutral, and 6/42 (14%) strongly disagreed or disagreed. In particular, the majority of participants see that that a self-management system should provide information, tips, and notification. Moreover, when participants were asked about:

Q18: I only record my tests to show them to my doctor

24/42 (57%) agreed or strongly agreed with this statement, with the mean = 3.40 and P =0.03. This could signify a need for developing better self-management habits.

The Motivation Theme

The overall results of participants who strongly agreed or agreed were 32/42 (76%), 5/42 (12%) were neutral, and 5/42 (12%) strongly disagreed or disagreed. The participants supported the relevance of the motivation theme. The result indicates that the participants recognize their role in managing their condition, and they are keen to keep their illness in control.

More specifically, when participants were asked:

Q22: I would like to self-manage my condition as best as possible along with keeping my
routinely meeting with the doctor.

The mean of the answers is 4.29 with P<<0.001, which suggest that participants are wants to better their self-management skills and by using external motivators and enhancing their internal motivation they can achieve this.

The Growth Theme

37/42 (88%) of the participants answered agree or strongly agree, while 1/42 (3%) answered disagree or strongly disagree. This theme received much support from the participants. Recall that the growth theme combines feedback, achieving goals and tiny habits. The participants agreed that receiving feedback regarding inputs (glucose levels, food intake, etc) is important since this enables them to self-manage their condition.

Particularly, when participants were asked,

> *Q25: my understanding of how to self-manage my situation makes me feel secure and content.*

> *Q26: It is important to me to control my health through improving my self-management skills.*

Both Q25 and Q26 had means of answers 4.43 and 4.40, and P values << 0.001, respectively. This indicates users could benefit from the use of self-management apps that help them in growing in terms of their self-management skills. The use of other elements such visualisation of data from the self-management theme could help them in doing so.

The Self-Representation Theme

Participants who agreed and strongly agreed were 18/42 (43%), 15/42 (36%) were neutral, and 9/42 (21%) disagreed or strongly disagreed. If we consider question 27 (It is important to me to keep an eye on my health though improving my self-management skills) only, then 23/42 (55%) agree or strongly agree, while 6/42 (14%) disagree. This indicates that online self-representation is important to a significant number of the participants, which suggests that the self-representation theme is indeed relevant.

When the participants were asked:

> *Q28: I would like my virtual account on the internet (profile, photo, etc.) to reflect my personality.*

The mean of the answers is 3.71 with p << 0.001, which indicate the significance of personalisation of the user experience in using the app.

The Sustainability Theme

The results showed that 28/42 (68%) agreed or strongly agreed, 9/42 (21%) were neutral, and 5/42 (11%) disagreed or strongly disagreed. A considerably large number of participants agreed that self-management apps should be regularly updated. These updates should keep them encouraged to keep using the app, for instance, by adding more levels or challenges that keep the patients motivated to use the app, and therefore continue self-managing their condition in a sustainable manner. Also, the results show that people need to be triggered and motivated into using an electronic logbook on a daily basis.

In particular, when asked:

Q31: when using a diabetes management app, it is important that it is regularly updated.

Q34: I enjoy being challenged at a level that suits me when I play in my mobile or computer.

The mean of the answers for Q31 is 4.07 (P<<0.001), and the mean of answers for Q34 is 3.93 (P<<0.001). This suggest that the users find tools that are not updated regularly are useless. Moreover, that the flow theory is an important aspect of the continuity of an activity. In such, when the level of difficulty of a game is aligned to the level of experience the user is gaining. Thus, if the experience is static the user will get bored, as well as when the level of difficulty does not increase with the user's abilities.

Further Analysis:

In the previous section we discussed the statistical analysis of the questionnaire in terms of the themes. In this section we analyse the questions in terms of context and highlight any relationships or contradictions. It is worth mentioning that the relationship between the demographical information and the answers were checked and no statistical significance was found for almost all of the questions. The data was checked using a 2-tailed, 2 sample t-test to check if the means to each answer differ based on the demographical data. However, questions 22, 20, 18, 30, 29, 13, 33 and 34 have some interesting observations which are discussed in this section.

- The relationship between the answers of Q22 and Q20:

    Q22: I would like to self-manage my condition as best as possible along with keeping my routinely meeting with the doctor.

    Q20: I lack self-motivation to keep a record and follow up my situation in a daily basis.

As discussed in the Motivation theme Q22 suggests that participants want to better self-management skills. However, no significance was found in Q20 where we had to keep the null hypothesis. Upon further analysis of this question and the demographics, it can be seen that 5 out of 17 of those who record their test results daily answered with strongly agree or agree to Q20, while 3 were neutral to Q20. This shows that even though they record daily they feel like they need more motivation. Also, more than half (15 out of 25) of those who do not record their test results daily answered with agree or strongly agree to Q20, while 5 were neutral and the other 5 disagreed. In total the number of those who disagreed or strongly disagreed (to Q20) was 14 out

of 42 participants, which is less than the number of those who agreed or strongly agreed that they lack motivation (in total 20 out of 42). Therefore, the data seems to be consistent.

The demographical data also showed that 11 out of 28 of those who record their test results manually disagreed with Q20, while 5 were neutral, and 12 agreed or strongly agreed to lacking motivation. On the other hand, only 3 out of the 14 who log their data electronically disagreed or strongly disagreed to lacking motivation, 3 were neutral, and 8 out of the 14 (more than half) agreed or strongly agreed. Clearly, motivation is an issue to a significant portion of the participants, and this might be addressed by the Wheel of Sukr and it themes.

- The relationship between the answers of Q18 and Q20:

   Q18: I only record my tests to show them to my doctor

   Q20: I lack self-motivation to keep a record and follow up my situation in a daily basis.

23 out of 42 participants answered agree or strongly agree to both questions, disagree or strongly disagree, or answered neutral to both questions. On the other hand, 8 participants answered neutral to one of the questions while answering agree or disagree to the other questions. Finally, 9 out of 42 showed agreement or disagreement to one of the questions while giving an opposite answer to the other question. Specifically, 5 out of 42 agreed to Q18 but disagreed to Q20. 2 of those 5 do not record their data on a daily basis while the other 3 record their data daily. Moreover, 4 out of 42 disagreed to Q18 but agreed to Q20 and all of them do not record their data daily.

- A detailed analysis of the answers of Q30 and the demographical questions:

   Q30: Diabetes is negatively looked at in Saudi Arabia

As shown in Table 4-10, Q30 did not have statistical significance and we had to keep the null hypothesis. However, when analysing this questions further with regards to the demographical questions a few interesting points arise:

- There was an age difference in terms of agreement to the existing of stigma. 12 out of 22 of the participants 25 years old or younger agreed to the existence of stigma, 6 out of 22 were neutral, and 4 out of 22 disagreed. On the other hand, participants older than 25, 9 out 20 participants said they disagree with Q30, 8 agreed or strongly agreed, and 3 were neutral.
- In terms of years of illness (0-4, 6 out of 11 disagreed or strongly disagreed, while 8 out of 11 said they strongly agree or agree) and (5-9+, 7 out of 19 said they disagree or strongly disagree, while 12 out of 19 said they agree or strongly agree)
- Using manual or electronic tools to record tests has no correlation with the answers regarding stigma. From those who record data electronically, 9 out of 28 said they disagree while 5 out of 28 were neutral, and 14 out of 28 agreed or strongly agreed. From

those who record manually, 4 out of 14 disagreed, 4 out of 14 were neutral, and 6 out of 14 agreed or strongly agreed.

- A detailed analysis of the answers of Q29 and the demographical questions:

  Q29: I do not use Arabic Apps for diabetes (mobile or computer) because of their bad design and quality)

Q29 did not have statistical significance so it the null hypothesis was not rejected. However, when analysing this questions further with regards to the demographical questions a few interesting points arise:

- Those who record data by hand: 16 out of 28 were neutral, while 7 out of 28 agreed or strongly agreed, and 5 out of 28 disagreed or strongly disagreed.
- Those who record their test results electronically: 8 out of 14 were neutral, while 4 out of 18 agreed or strongly agreed, and 6 out od 18 disagreed or strongly disagreed.

- A detailed analysis of the answers of Q33 and the demographical questions:

  Q33: I feel bored when using an app for several times.

  - 5 out of 20 of those who are over 25 years old were neutral, while 5 of them disagreed and 10 out of 20 agreed or strongly agreed.

  - 9 out of 22 of those who are 25 years old or younger were neutral, while 7 out of 22 disagreed, and 6 out of 22 agreed or strongly agreed.
  - Only 1 out of 14 of those who log their data electronically disagreed, 6 were neutral, and 7 out of 14 agreed or strongly agreed.

- A detailed analysis of the answers of Q13 compared to Q30 and to the demographical questions:

  Q13: it is difficult for my non-diabetic friends to understand and appreciate my situation.

  Q30: Diabetes is negatively looked at in Saudi Arabia.

The results of both questions did not have statistical significance, and the null hypothesis was accepted. However, upon analysing the data from both questions and comparing them we found the following points:

  - 19 out of 42 answered similarly to both questions. Specifically, 13 out of 19 agreed or strongly agreed to both statements, while 1 out of 19 was neutral, and 5 out of 19 disagreed.

Demographical information, specifically the age of the participants for Q13:

- For those above 25 years old: 6 out of 20 disagreed or strongly disagreed, 4 out of 20 were neutral, and 10 out of 20 agreed or strongly agreed.
- For those 25 and younger: 8 out of 22 disagreed or strongly disagreed, only 2 were neutral, and 12 agreed or strongly agreed.

This indicates that peer support is an issue for many of the participants and it can be addressed by the framework.

Participants Comments:

At the end of the questionnaire there was a "Comment Box" for participants to leave optional comments. Six participants left comments. Three of those were related to the lack of awareness on diabetes in the society. As one of them said:

> "I wish there is more awareness about diabetes in my society, and that people would understand that it is not contagious and that diabetics who take care of themselves can cope and live a normal life."

Two other participants talked about the lack of awareness from the community and how it affects them negatively in terms of the self-management. this also supports the doctors' comments regarding the negative connotation around the diabetes and how it affects the diabetic self-esteem and their self-management. Furthermore, one of the patients said that self-management of diabetes enable them to be positive in dealing with the illness. Another one said that *"we need applications for logging test results"*, which indicate that there is a lack of self-management apps in Arabic. Finally, one the patients mentioned their frustration that people around them and their doctor give them instruction without living what she is going through.

4.7 Discussion

Gamification has been receiving a great deal of attention in the health care field. In Lister *et al.* (2014), it was pointed out that there is a lack of professional criteria or guidelines to help developers in creating effective apps utilising gamification and behavioural change theories. In this chapter we present a validated framework for gamifying the self-management of chronic illnesses to fill a gap in the literature.

The validation was carried out by a mixed method, which included expert interviews as well as patient questionnaires. The combination of the comments from the experts and the results from the questions validate the framework. The findings of the interviews and results of the questionnaires support the idea of incorporating gamification in the self-management process of diabetes. Both experts and patients agreed that utilising the combined themes of the Wheel of

Sukr to create a gamified self-management tool might help achieve effective self-management and behavioural change. To our knowledge the Wheel of Sukr is the first of its kind.

Self-management of chronic illnesses, especially in diabetes, can be turned into an engaging and enjoyable experience by the use of gamification. The results of this study support this notion, and indicate that both experts and diabetic patients recognize the potential of gamification in improving self-management of diabetes significantly. In particular, experts highlighted the importance of rewards, competition, and other fun elements in creating an enjoyable and rewarding experience that could lead to positive behavioural change. This, in turn, is reinforced by the findings from the patient questionnaire as shown in the Results section.

The results of both studies also indicated that there is an issue with engagement with applications and the self-management process. Answers to Q33 show that 7 out of the 14 participants who log their data electronically feel bored when they use an app several times. This issue can be addressed by the Wheel of Sukr framework and especially that it takes sustainability into account. Indeed, the findings of the experts' interviews suggested that the use of elements such as autonomy and purpose (from the self-representation themes) can enhance the sense of control in the user and increase their engagement. Also, the rewarding and engaging aspect of gamification can be enhanced by the sustainability theme element such as the use storyline and themes where the user can connect with the app and have a pleasurable experience.

Diabetes is a lonely illness and diabetics are more prone to depression (Egede, Zheng and Simpson, 2002). As stated in Sec. 2.3.1, being part of an online community could provide patients with the emotional and psychological support they need. This is confirmed by the results of the interviews and the questionnaire. In particular, experts emphasised the positive impact of social media and peer support on patients. Furthermore, as one of the medical expert mentioned that the community must be diabetic only. This point is fulfilled in the Wheel of Sukr framework since it is for the self-management of diabetes and not a general community. Additionally, the results of the questionnaire indicate that patients would like to share positive results with their peers and establish friendships with them. This can help them overcome any negative feelings they might encounter. This also accords with the findings from the medical experts as one of them mentioned that providing a community for patients can enable them to support and educate each other. Furthermore, the community aspect of a gamified self-management tool could enhance the value of rewards and other elements of the framework. This is manifested in a statement by one of the gamification experts who mentioned that the community aspect is the most important part in terms of integrating all the other elements especially the gamification elements.

Indeed, the socializing theme received a great deal of support from the experts and the patients. Particularly, the peer support element which according to the medical experts essential to individuals with chronic illness. This is also supported by the literature as shown in Sec.#.#.#. Furthermore, the interviews findings show the importance of online community to patients because peers can influence each other, share experiences and learn more about their illness in a private environment. The socializing theme is also important in gamification as indicated by the gamifcation experts and the gamification literature (see sec. 2.3.2). Specifically, the community aspect integrates all the themes of the framework, and adds to the value of the gamification elements such as rewards and competitions. Moreover, the analysis of Q13 showed that 22 of the participants agreed or strongly agreed that their friends do not understand their situation. Also, one of the participants expressed frustration that friends and family and even doctors do not understand her experience with the illness and daily self-management. This shows that peer support could be an issue for many of participants and it can be addressed by the framework.

Additionally, regarding the stigma, the results of the questionnaire show that not all the patients agree that there is a negative view on diabetes even though the doctors stressed this point clearly in the interview. In any case, 20 out of 42 (almost half of the participants) agreed that there is a stigma and 9 were neutral (Q30). Since, this issue is very important for patients who have to deal with such situations are in need for peer support and people who can understand their situation. As one of the patients mentioned in her comments that was discussed in the result section (see sec. 4.6.2). Therefore, it is essential for an application that approach gamificaiton and self-management holistically to enable peer support. Indeed, this also accords with what one of the doctors said, that individuals with diabetes can have a stronger impact on each other and educate each other more than that of a medical doctor.

Moreover, the results support the notion that creating a fun and enjoyable experience for diabetic patients could help their self-esteem. In particular, the interviews indicate that patient's self-esteem has an effect on self-management, as one expert stated:

"How the patient feels about diabetes has a great effect on their self-management"

Additionally, the use of leaderboards and creating friendly competition between peers could help in boosting user's self-esteem. While some users might find leaderboards demotivating (Nicholson, 2015), others find leaderboards and being recognized in the community motivating. In fact, Hamari and Koivisto (2015), investigated the effects of being in a community and getting recognized by other users for what you do in a gamified service for exercise. They measured how the social influence affect the engagement of the user with the gamified service and the maintenance of the exercise supported by the service. The study showed that the social influence

and being recognized in the community (which is achieved in gamification by leaderboards) can increase users' motivation and engagement with the exercise activities, and that the more friends the user have in the gamified service the stronger the influence. Furthermore, the use of gamified applications that includes leaderboards has either positive or partially positive effect on users (see (Appendix A) in Hamari et al (2013)). However, leaderboards should not be compulsory (to be viewed) on all of the users, but rather they should be asked optionally as is done in many games and gamified apps. The esteem theme and its elements are also supported by the majority of participants in the questionnaire. This is because it enables them to track their progress (individually) and have the option to compare it to others. Also it could trigger positive competition between peers in a friendly, non-judgmental environment. This is supported by the patients answers to Q4, Q6, Q15, and Q16.

In 2013, a study pointed out that around 73% of diabetics do not document their daily glucose tests (Rose, Koenig, and Weisbauer, 2013). Our results agree with those results since, in general, patients admitted that they only record their test results for their doctors to see. In fact, almost 75% of the participants only record their data to show it to their doctors. Moreover, according to the demographical data in the questionnaire, almost 60% do not keep a logbook of their daily test results. This accords with the findings of the experts' interviews, where medical doctors said that their patients do not keep a daily logbook of their results. This could be because the patients are not aware of the importance of self-management or they find the self-management process mundane, which were suggested by the medical experts. The results of both the interviews and the questionnaires suggest that a gamified self-management system might help them document daily. Therefore, gamification in self-management is expected to make the self-management experience less mundane.

The results of the questionnaire show that 20 out 42 agreed or strongly agreed that they lack motivation to self-manage their illness (Q20), which accords to the findings of the medical experts interviews. These people who lack self-motivation need to be encouraged and motivated to self-manage their illnesses and the framework contains themes that have the opportunity to address this issue. This includes the use of both intrinsic and extrinsic motivators, which was supported by the experts. As one of the games and gamification expert said that it is important to consider both types of motivation, because extrinsic can grab the attention of the user but could be short term and intrinsic motivation is longer lasting. Also, the medical experts expressed the importance of motivation to the self-management process. Furthermore, people who are intrinsically motivated can benefit from the external motivation part of the framework.

Furthermore, the results show that patients are willing to learn more about their condition and manage themselves better. However, this could be prevented by the shortage of well-constructed self-management tools (especially in Saudi Arabia where the patients are from). This is supported by the findings of the expert interviews that indicated that many patients are not motivated to learn or self-manage. Gamifying self-management could increase patients' motivation. Yet, many existing gamified applications and services focus only on extrinsic motivation (Seaborn and Fels, 2014). However, extrinsic motivation solely does not create a sustainable gamification affect. The Wheel of Sukr considers both types of motivation (intrinsic and extrinsic). This allows it to address some of the issues raised by the experts and enables it to satisfy the patients' expectations.

Providing real-time feedback that is meaningful and relevant to users is an essential part of gamification. The feedback can come in many forms including rewards and graphs of blood tests. The latter will help users learn more about their condition and recognize patterns. This is supported by the majority of participants in the questionnaire who mentioned that they would like to receive feedback regarding their self-managing progress and be notified when their blood glucose fluctuates. Additionally, the importance of being represented and being autonomous were highlighted by the results of the expert interviews. Participants in the questionnaire also supported this. A great deal of them stressed that they would like their virtual accounts to reflect their personality, which is an integral part of the Wheel of Sukr.

Furthermore, the medical experts talked about two issues regarding diabetes, the lack of education amongst some of their patients and the lack of awareness in the community. This point could explain the reason why 2 of the participants in the questionnaire agreed that they only record their data to show them to their doctors (Q18), but disagreed that they lack motivation to self-manage (Q20). Also, the demographic information shows that both participants do not record their test results daily. Moreover, medical experts and two of the participants in the questionnaire discussed the lack of awareness about diabetes in the society. The experts mentioned that this issue could negatively influence the self-management process of individuals with diabetes. Indeed, this accords to the comment of one of the participants (see sec. 4.6.2). While the issues of education and awareness are important, it falls outside the scope of the framework, which is concerned with the use of gamification in increasing engagement and motivation to the self-management process.

All in all, the results of the questionnaire and interviews combined supports all the themes of the framework. There was nothing in the analysis that suggests hierarchy or importance of one theme over the other. Thus, the equal importance assumption is still valid. This assumption can only be

tested in a longitudinal study where an application that uses the framework collects data from individual with diabetes or other chronic illnesses.

The correlation between gamification and health behaviour theories has been discussed (Lister, West, Cannon, Sax and Bordegard, 2014). It was mentioned that even though gamification apps for health and fitness are using motivation from the health behaviour theory, the use of capacity or triggers is ignored. Patients mentioned the importance of keeping apps updated to sustain their interest in using them. They also noted the need to be encouraged to keep recording daily. This can be done through using triggers, which are an essential part of the framework. Moreover, patients stated that they enjoy being challenged at a level that suits their abilities. The Wheel of Sukr framework answers this by considering the user's ability and employing triggers.

It is worth mentioning that using the mixed-method design provided a clear image of the issue. It created a balance between the weaknesses of qualitative (interviews) and quantitative (questionnaire) methods (as suggested by Jick (1979)), which allows for a well-rounded representation. Moreover, the data were collected from both expert and patients, using interviews and questionnaires. The results from the interviews and the questionnaires do complement each other. In fact, relying on the expert interviews alone would have resulted in a loss of all the important information provided by the patients and vice versa.

However, it is important to mention that, in Saudi Arabia, there is a stigma surrounding diabetes (Alzaid, 2012). The medical experts supported this and as one of the participants said in the optional comment box of the questionnaire:

> *"I wish there is more awareness about diabetes in my society, and that people would understand that it is not contagious and that diabetics who take care of themselves can cope and live a normal life."*

This stigma could have been a factor in discouraging individuals with diabetes from participating in such studies. In fact, it was challenging and time consuming to get people to open and talk about their illness. An online questionnaire was the best choice to get the opinions of individuals with diabetes in Saudi Arabia. For this study, we managed to get 42 participants, but it was very difficult. According to the tool used for the questionnaire (SurveyMonkey) 95 people entered the link and answered part of the multiple choice questions but only 42 of them continued to answer the full questionnaire.

Additionally, given the cultural differences communicating with the medical experts required the researcher to personally approach the doctors, since it is not common to use emails/phones/video calls for such purposes in Saudi Arabia. Therefore, it took time to get the

experts needed for this study. However, this effort was worthwhile given that the expert interviews strengthened the study as mentioned earlier.

The results of the questionnaire and interviews combined supports all the themes of the framework. There was nothing in the analysis that suggests hierarchy or importance of one theme over the other. Thus, the equal importance assumption is still valid. This assumption can only be tested in a longitudinal study where an application that uses the framework collects data from individual with diabetes or other chronic illnesses.

In a future work the importance of the themes of the Wheel of Sukr and their hierarchy will be studied in the longitudinal study where the themes are implemented in an app that is used by the intended users for a sufficient period of time. In this study, the themes of the Wheel of Sukr can be measured separately to find their level effectiveness in the self-management of chronic illnesses. The importance of the themes might differ based on the demographic (e.g. age of the target users). Thus, multiple studies should be conducted.

Furthermore, while all measures were taken to ensure an unbiased questionnaire, bias cannot be completely removed due to misunderstanding of the questions (since the questionnaires are self-administered) or issues with some of the questions. Thus, in a future study, to minimize the bias one could either use standard questions that are validated for a certain purpose (e.g. engagement instruments, or self-determination theory instrument). However, both instrument requires the users to engage with a gamified application first and then the researcher can measure their engagement and motivation.

4.8   Summary

In this chapter the Wheel of Sukr, which is a framework that gamify self-management of chronic illnesses, was introduced. The framework consists of 28 elements that were synthesised from the literature on gamification, behavioural theories, and self-management of chronic illnesses. It emphasizes the link between these areas and gamification into the self-management process of chronic illnesses. The elements are encapsulated in eight themes:

1.   Self- management: logbook, visualization of data, and trend alerts
2.   Socializing: community, social media, peer-support, and sharing.
3.   Self-representation: avatars, autonomy, ability, and purpose.
4.   Fun: badges, points, challenges, and competition.
5.   Esteem: leaderboards, levels, progress bars, and reputation.
6.   Motivation: intrinsic and extrinsic

7. Sustainability: trigger, flow, storyline/theme, and nudge

8. Growth: feedback, achieving goals, and tiny habits.

The framework was validated using a mixed-method approach. The qualitative and quantitative methods chosen were expert interviews and questionnaires. The expert interviews consisted of a semi-structured individual interviews with experts from different background that reflects the three areas of research. There were experts from medical doctors, psychologist and psychiatrists, and gamification researchers. The interviews were audio-recorded, transcribed, and analysed using thematic analysis. The findings of this analysis show a consensus among the experts on the importance of the themes of the framework.

Additionally, the questionnaire was distributed to individuals with diabetes based in Saudi Arabia. It consisted of two parts, a demographical and general question part, and a Likret scale part to measure the participants' attitude towards the concepts of framework. The data collected was analysed using a 1 sample t-test (2 tail) using SPSS. The results of the statistical analysis validated the themes of the framework.

Overall, the findings and results of both studies suggest a general acceptance of the notion of gamifying self-management of diabetes. They also show that it could be important in improving the experience of patients. The Wheel of Sukr framework sets the stage for further studies such as creating developer guidelines for the gamification of self-management of chronic illnesses, which is the subject of the next chapter.

Chapter 5:   The Set of Guidelines and its Validation

In the previous chapter, The Wheel of Sukr framework was presented for the gamification of the self-management of chronic illnesses. The Wheel of Sukr was validated using a mixed-method approach. This entailed expert interviews with medical doctors, psychologists, and gamification experts. The participants were interviewed in a face-to-face manner. The study also involved a quantitative study, where individuals living with diabetes took part in answering an online self-administered questionnaire. This was undertaken in order to measure their attitudes toward the concepts covered by the framework. The results suggested that participants are keen to see self-management apps containing the concepts of The Wheel of Sukr. Additionally, the findings of the interviews suggest that experts see the need for gamification as represented in the framework in the area of the self-management of diabetes and other chronic illnesses.

In this chapter we present a set of guidelines based on The Wheel of Sukr framework. The set of guidelines is meant to enable developers to incorporate gamification in the creation of self-management apps for chronic illnesses. The guidelines are assessed by expert interviews and discussed with developers in focus groups. The purpose of the expert interviews is to ensure that the guidelines represent the framework accurately and comprehensively. The purpose of the focus group discussions with developers is two-fold: The first aim is to collect their views on the clarity, usefulness, and ease of implementation of The Wheel of Sukr guidelines. The second is to test if they could think of practical ways to gamify apps based on the guidelines.

5.1   The Transition from the Framework to the Guidelines

The Wheel of Sukr is a theoretical framework and so is considered a high-level construct. It was constructed with the user in mind (i.e. individuals with chronic illnesses especially diabetes). After filling the gap in the literature by proposing and validating the framework, the aim of this phase is to advance this area of research by providing a set of guidelines that is built with the developers in mind. The validation of the framework was an important step for creating the guidelines. Otherwise, the set of guidelines itself would not necessarily represent a gamification approach that is suitable for the self-management of chronic illnesses.

To establish the transition from the theoretical side to the practical side, the framework and its content should be translated into a set of guidelines that can be applied practically by developers. This can be accomplished by deconstructing the framework, and presenting the content from an angle that is suitable for developers. Consequently, there is a crucial difference between the

framework and the guidelines in that the framework was built with the end user of the app in mind, which are individuals with diabetes, while the guidelines are built for developers who are responsible for creating such an app. Such guidelines should contain definitions, instructions, or suggestions that target developers who can then gamify the self-management of chronic illnesses apps or systems.

The current literature on gamification is not directly appropriate for the purpose of developing gamified self-management of chronic illnesses apps. In particular, gamifying the self-management of chronic illnesses is different from gamification to increase productivity of employees as we are dealing with patients and daily self-management. Furthermore, software engineers and developers are not expected to know the literature on self-managing diabetes, gamification in healthcare, and behaviour change methods. A set of guidelines based on the Wheel of Sukr, which is a framework for the gamification of chronic illnesses self-management and was validated by experts and patients, could be helpful to assist developers. Guidelines influence the decisions made in the planning and design phase of developing software and applications, and it can be used as a checklist in the evaluation and testing phase (Dix et al, 2004).

It is worthwhile mentioning that there is a wide range of guidelines aimed at aiding developers and designers in the fields of human-computer interaction, software engineering, and web technology. A well-known example is Nielson's discounted usability engineering guidelines, which are called "heuristics of usability design" (Nielsen, 1994). Nielson's guidelines are not very specific but broad rules of thumb that are used by web developers to guide them through the process of creating a website interface that is easy to use by all users, or as an evaluation test (i.e. heuristic inspection) to ensure the usability of the interface of the website in the "testing and evaluation" phase.

There exist guidelines for gamification in education specifically in the use of social gamification in k-6 learning (Simões et al., 2013). However, there are no existing guidelines for the design of gamification of self-managing chronic illnesses applications. Even though there is a widespread adoption of gamification in healthcare and some attempts in gamifying self-management of diabetes (See Sec.2.3.2), there is a lack of guidelines for the development of gamification in the self-management of chronic illnesses (Lister et al., 2014; Seaborn, Fels, 2015). There is a need for guidelines in this specific field (i.e. gamification of self-management of chronic illnesses).

The set of guidelines presented in this chapter is a new contribution to the field of HCI, software engineering, web technology and development. It is based on the validated the Wheel of Sukr framework and literature review. In particular, the themes and the elements of The Wheel of Sukr are the basis of the guidelines. It is meant to offer guidance in the process of developing gamified

self-management applications for individuals with chronic illnesses. Thus, bridging the gap in the areas of software engineering and HCI regarding the implementation of gamification for the self-management of chronic illnesses.

Integrating gamification into any application or system could have different goals and objectives that vary depending on the context. However, it is essential to have a clear guide for developers in order to achieve a successful integration of gamification. As mentioned in the literature review chapter (see Sec. 2.1.5), there is a lack of guidelines for developers in this field, and research has shown that current gamified apps do not follow specific guidelines.

"The set of guidelines is based on the Wheel of Sukr framework, thus, it includes all the themes and their elements. As shown in Ch.4, the elements of the framework are synthesized from the literature (see Ch.2), and all the themes that encapsulate the elements received support from the medical experts, game and gamification experts, and the individuals with diabetes who participated in the study.

As shown in Sec. 4.5.2 and Sec 4.6.2 the fun and the esteem themes received a lot of support from both the experts in the interviews and by patients who answered the questionnaire. The elements of the both themes were synthesised from the gamification literature, and they are considered fundamentals of gamification. The gamification experts stated that the elements of the fun theme and the esteem theme constitute the essential principles of gamification. Also, the medical experts welcomed the idea of rewarding and creating competitions to motivate and encourage users to self-manage diabetes daily. The results of the questionnaire reflect the support for both themes by the patients.

The socializing theme received a lot of support from all the experts and the patients. The endocrinologists and psychiatrists discussed the importance of being in a community with other diabetic and peer-support to patients of diabetes. Also, the game and gamification expert talked about the use of a community in gamification, and that it integrates all the other elements and adds to the value of gamification (e.g. rewards, and competitions). The community aspect was also supported by literature in both self-managing diabetes and in gamification.

As the Wheel of Sukr is a framework for gamification for the self-management of chronic illnesses the "self-management" theme is essential. It received support from both experts and patients. Medical experts, especially endocrinologists, supported having an electronic logbook and the visualisation of data as it makes the patient self-manage properly and then they can provide their doctors with visual representation of their tests results. Furthermore, the literature review

showed that there is evidence on the positive effects of the use electronic apps in healthcare. These include reducing readmissions to hospitals and the progressions of diseases (see Sec. 2.3.1).

The sustainability and the growth themes received support in both the expert interviews and the patients questionnaire. The gamification expert discussed the importance of both themes in sustaining the users' engagement with the gamified app. The experts discussed how one of the growth theme is directed at the user in terms of providing them with feedback, set goals and achieve them, and break down steps of the self-management activities to create positive habits. On the other hand, the sustainability theme is more related to the system in terms of creating a storyline or a theme (narrative) that links the other elements of the framework and engage the user. Experts also supported the importance of nudging and using triggers in persuading users to undertake tasks in the app.

Also, both the findings of the interviews and the results of the questionnaire supports the motivation theme. The medical experts discussed the importance of motivating patients to self-manage their illness and that some patients might lack motivation. This was also reflected in the patients questionnaire were the results were divided between those who agreed to the lack of motivation and those who were neutral. Furthermore, the gamification experts also discussed the value of distinguishing between intrinsic and extrinsic motivation when using gamification. This was also supported by literature as discussed in Sec.2.2.1

It is worth mentioning that some empirical studies (in gamification for education specifically) show that the outcomes of gamification are primarily positive, but there are some drawbacks in terms of the use of leaderboards (Hamari et. al, 2014). This could be because not all users are competitive; some users find competitions motivating and others are demotivated by it (Werbach and Hunter 2012). However, the Wheel of Sukr guidelines take a holistic approach to gamification that includes all the elements that motivate users. Any element that might have a demotivating effects on some users can be made optional to access to the users, which is the case in most apps. In particular, the developer can make the access to leaderboards optional, those who do not want to socialise or compete with others can simply ignore this feature in the app. For example, those who use some fitness tracker apps can choose to withhold from sharing their data with others and not follow other users even though the app incorporates social and competitive aspects (i.e. leaderboards). This could be the right approach to cater to those who find motivating or demotivating because they have the choice to access it or not."

The set of guidelines proposed in this chapter aims to aid developers in creating a gamified self-management system for chronic illnesses. It will provide "what" should be included in a gamified self-management app. The themes that are included in the guidelines are discussed in the

following section. In particular, each theme is explained in terms of its relevance to developers and the process of planning.

1. Fun Theme:

The fun theme represents what is considered as the basic gamification elements that enable the creation of a game-like experience. In an app that targets the self-management of chronic illnesses, a reward system can be implemented through the use of the game elements, namely badges and points, and the creation of friendly competitions and challenges.

The points can be associated with smaller and more repetitive tasks that are relevant to the self-management process. For example, users can be awarded with points for entering test results, completing the minimum required tests per day, completing a week of entering test results, completing a challenge, and when communicating with other users.

The badges can be awarded to users at multiple stages based on the objectives of the app. For example, it can be given to users at registration, upon collecting points, and when completing milestone tasks in the self-management of an illness, such as keeping a daily logbook for a month.

In addition, the creation of friendly competitions can be designed directly by the developer, or it could arise dynamically by a combination of other elements. For example, the developer can create weekly competitions. On the other hand, the users can compete amongst themselves to collect more badges or score higher on the leaderboard.

Challenges can be designed by the developer to be competed with a time limit. For example, completing a week of entering test results. Moreover, both challenges and competitions should not be related to the results of the tests and common sense should be applied in similar situations. The sensitivity of the issue should be taken into account while designing competitions and challenges.

2. Esteem Theme

The esteem theme embodies the elements that could create feelings of admiration and respect for the user. In the community of an app that targets the self-management of chronic illnesses, esteem could be accomplished by utilising leaderboards, levels, progress bars, and reputation.

Leaderboards can be associated with the points or badges collected. They can be linked to the points collected for keeping a daily logbook of test results or by the number of badges collected.

Progress bars can be designed to show the user how well they are progressing through their daily tasks of self-management.

Moreover, the developer can create Levels for the user to go through by accomplishing specific goals or collecting badges. The levels can be linked to the storyline and theme of the app, or it can be linked to the time the user spends using the app.

The reputation element is created dynamically through the use of leaderboards in the community.

All the of the previous elements can contribute to the admiration and respect when the user engage with the app and find themselves advancing in their interaction with the app and the community.

3. Growth theme

The growth theme represents the elements that could help users in terms of their self-management skills, which could be accomplished through the use of the following elements: feedback, achieving goals, and baby steps (tiny habits).

Feedback could be given to the user based on their test result entries and the overall performance in the application.

Goals could be set by the user or the developer. They could be linked to self-management tasks. For example, users can set goals for themselves to be persistent in testing and logging the results, or they can be pre-existing in the app and related to the tests themselves only if they are set by health professionals.

The daily tasks of self-management can be broken down into smaller steps (baby steps/tiny habits) to make it easier for the user to adopt new habits.

4. Motivation theme

The motivation theme represents the two types of motivation: intrinsic and extrinsic motivation. In an app for the self-management of chronic illnesses, users may be intrinsically motivated to self-manage their illness to become healthier.

Intrinsic motivation could be enhanced through the use of other elements such as achieving goals, and the visual representation of data which could create feelings of mastery and autonomy.

Extrinsic motivation could come in the form of rewards (i.e. points, badges), wining competitions, or advancing in the leaderboard to gain status.

5. Sustainability theme

The sustainability theme embodies the elements that could lead to sustainable engagement from users in a self-management app. This is covered in four elements: trigger, flow, storyline/theme, and nudge.

The trigger element is implemented by the developer as a message or a sound. Triggers could be used to remind the user to check the app, enter test results, or communicate.

The flow element is realised by designing the activities in the app according to the user's skill level in which the difficulty of the activities gradually increases as the user's skills increase.

For the storyline/theme elements, the developer can create a meaningful journey that makes the user part of it and increases their engagement. Other elements such as levels and competitions could also be part of one storyline or theme.

The nudge element can be implemented by the developer through creating default choices. For example, when the app triggers the user to enter test results, the developer can create an option for users who want to skip the entry and remind them after a certain amount of time with a reminder box that needs to be ticked as a default option.

6. Self-representation

The self-representation theme encompasses the elements that could create a link between the user and the system in terms of reflecting the user's identity. It has four elements: avatars, autonomy, ability, and purpose.

Developers can allow users to create or customise their avatars to express themselves and create a connection with the app.

When designing the tasks, challenges, competitions, and other elements, the user developer must take into consideration the ability of the users.

The autonomy of the user should be increased by giving them choices whenever it is possible. Autonomy is also closely related to the flow element of the sustainability theme.

The developer can enhance the sense of purpose of the user by a combination of other elements. These elements could range from the self-management tasks and the visual representation of data to being part of a community and offering peer-support. The developer can give users the chance to help others such as by giving them the ability to give badges to other helpful users in the community.

7. Socialising theme

The socialising theme represents the social aspect of the self-management of chronic illnesses. It is created through the use of community, social media, peer-support, and sharing.

The developer can create a community, i.e. a network within the self-management app where users can communicate. This could also be linked to other elements such as the fun and esteem theme elements.

Developers can also provide users with the choice of linking their accounts within the app with other social media networks such as Facebook or Twitter.

Peer-support is provided through the community and the social media features.

Furthermore, developers can give users the choice to share their test results, progress and achievements with others within the app community or with linked social media networks.

8. Self-management

Self-management is considered the essential part for this app. This is covered by three elements: a logbook, the visualization of data, and trend alerts.

The logbook can allow users to keep track of their test results, dates and times, food intake, exercise, feelings and other relevant information.

The data saved in the logbook can be turned into visual data so that the user can benefit from the accumulated information. For example, with the visualization of data elements the user can follow their progress over a particular period of time (e.g. the past week or month), enabling them to spot patterns easier.

Trend alerts are also based on the data entered by the user.

The Guidelines Structure

The guidelines are built based on The Wheel of Sukr. Similar to the framework, the guidelines contain 8 themes, each of which is divided into 5 sections as shown in Table 5-1.

Table 5-1 Sections of the Guidelines

Theme	A general construct containing elements that share the same goal.
Definition	The general idea of the theme is defined.

Goal	The purpose of the theme and its elements are stated.
Description	The theme and its elements are elaborated.
Application	The theme is translated into pointers to help in implementation.

The Wheel of Sukr guidelines are designed such that they can be tailored to the goals and objectives of each app or system and its audience. For example, the type of badges and points could be different if the app is targeting children with diabetes as opposed to adults. The guidelines should reflect The Wheel of Sukr accurately, and be comprehensive such that developers can use the set of guidelines directly without needing to go back to the framework. In addition, the guidelines should be clear and useful to developers, and easy to implement from their point of view.

The guidelines are presented in the next section in the form of tables; each theme of The Wheel of Sukr has its own table. The tables are divided into themes and their elements, a definition of the theme, the goal of the theme, the description of the elements in the theme, and the application of the theme.

5.2   The Wheel of Sukr Guidelines

In this section, the final version of the set of guidelines is represented in eight tables based on the structure of the framework.

Guidelines for Gamifying Self-management of Chronic illnesses

Fun Theme (Badges, points, challenges and competition)	
Definition	The fun theme has the basic building blocks of any gamification system. It represents the rewarding features of gamification and enables the creation of a game like experience.
Goal	Create a rewarding and engaging experience.
Description	• The badges element indicates the special designs that can be awarded to users as a sign of membership and achievement. It can be awarded to users once they start using the application, when accumulating a number of points, and when completing a level. • The points element indicates the points that are awarded to users when entering test results, completing the minimum required tests per day, completing a week of entering test results, completing a challenge, and when communicating with other users. • The challenges element indicates the motivators created in the gamified system to get users to engage in difficult but obtainable tasks. These could be completing a week of entering test results, or maintaining a certain level of glucose. • The competition element indicates the competitive environment that can be created using the elements in this theme and other themes (such as levels and leaderboards) to increase user engagement. The competitive environment should be exclusive to the activities completed (i.e. the number of times the user logged in, the user's involvement in the community, completing tasks… etc.) and not regarding their test results. Users can compete with each other in the community and with themselves.
Application	Design a system of rewards (points and badges) based on the community you are targeting and on the unique goals of the app/system. Create challenges for users to increase their engagement and help them meet their goals. Give users the option to view each other's achievements. Design the competitions with the user in mind (i.e. do not create insensitive competitions regarding their test results). Make the experience positive and rewarding. Remember that collecting badges and points is a manifestation of the "collection" core dynamics in games and you could use different manifestation of collection. This theme is closely related to the Esteem and Motivation themes.

Esteem Theme (leaderboards, levels, progress bars, and reputation)	
Definition	The esteem theme encompasses the essential elements needed to create feelings of respect and admiration for the user. It communicates the state of the system to users.
Goal	Enable users to respect and admire their own achievements and those of others.
Description	• The leaderboard element indicates the leaderboards that are used in video games. Similar to video games, in gamification leaderboards are social features used to increase engagement, motivation, and the level of competition between players. This is done by ranking them in a number of ways such as according to the number of points or badges collected or the levels achieved, etc. There are different types of leaderboards, such as global leaderboards, which rank the top users of the application, and friends or social leaderboards that rank the user's friends or those in their social network (Twitter, Facebook... etc.). • The progress bar element is a graphical element in the user interface that shows the progression of the user and how close he/she is to completing a set of tasks. It could be expressed as a percentage, in visual form or a textual representation. • The levels element indicates the part of the application that users need to complete to meet specific goals to advance to the next level. The difficulty of every level increases as the user completes new levels. • The reputation element indicates the user's status, rank and expertise in the community. It is the way in which users showcase their points and badges. Reputation mechanics must be designed and updated based on the community.
Application	Design leaderboards and choose the type or types of leaderboards that fit the community and the app/system goal. Create a progress bar that measures the user's activity based on the goal of the app. For example, measure the user's involvement in the community or the user's progress in logging their test results. Design levels based on the goal of the app, considering the storyline and theme elements (from the sustainability theme), and the reward and competition elements (from the fun theme). Design feedback, leaderboards, progress bar, levels and the community (from the socializing theme) coherently to utilize the reputation mechanics where the user can showcase their status in the community. Consider the sensitivity of the issue with regards to social gaming and the level of confidentiality involved.

Growth theme (feedback, achieving goals, and baby steps (tiny habits))	
Definition	The growth theme represents the elements that aid the users in growing and developing in the self-management of their chronic illness.
Goal	Empower patients to take good care of their health by learning about their illness and learning to manage it.
Description	• The feedback element indicates the comments users receive regarding their test results entries and their overall performance in the application (their self-management habits). • The achieving goals element indicates outlining clear goals and rules in the system. Goals could also be set by the user or with the help of caregivers. These could include self-monitoring blood glucose, such as the frequency of blood testing, and whether the patient keeps a log of the tests or not. • The baby steps/tiny habits element indicates the breakdown of activities into a sequence of smaller tasks that are easy to incorporate into the users' daily routine. This is believed to result in the adoption of the new "tiny habits" to reach a desired behaviour. This helps in changing behaviour in self-management.
Application	Design a feedback system based on the goal of the app/system. Link the feedback system to the points and badges. Set goals for users to encourage them to start with the self-management tasks. Give users the option to set their own goals. Remember that breaking goals and challenges into smaller steps would make it easier for the users to adopt. Do not make tasks and gaining points and badges too difficult for the user to avoid decreasing their engagement and interest in the app/system. Increase the difficulty as their experience increases. This theme is closely related to the self-management theme.

Motivation theme (intrinsic motivations, extrinsic motivations)	
Definition	The motivation theme includes motivators that are innate to the user and extrinsic motivators. Both types of motivators are important in the design of gamified apps/systems.
Goal	Utilize extrinsic motivators to increase intrinsic motivation.

Description	• The intrinsic motivation element indicates the innate desire to perform an activity for the love and joy that it brings. Intrinsic motivators could include health, social satisfaction, status, mastery, purpose, acceptance, and curiosity.
	• The extrinsic motivation element indicates the performance of an activity solely for the external rewards, which could include points, rewards, and gaining status. It includes four types:
	    o External regulation: results from outward rewards or punishments.
	    o Introjection: results from self-esteem issues such as doing something to avoid guilt or anxiety, or to boost one's ego.
	    o Identification: occurs when a person self-identifies with the importance of a behaviour and has accepted it as their own.
	    o Integration: external motivation that has been internally integrated by the user. This type of motivation shares qualities with intrinsic motivation, such as autonomy and being unconflicted.

Application	<u>Know</u> your target audience and what motivates them. <u>Remember</u> that the self-management tasks that patients should do may not feel inherently interesting or enjoyable to them. This could be due to the lack of perceived autonomy and competence, which are essential for intrinsic motivation. <u>Utilize</u> the types of extrinsic motivations that could promote more active and volitional (as opposed to passive and controlling) forms of extrinsic motivation.

Sustainability theme (trigger, flow, storyline and theme, and nudge)	
Definition	The sustainability theme includes elements that ensure longevity and continuous user engagement and interest.
Goal	Ensure the longevity of the gamified effect and encourage consistent and better self-management habits.
Description	• The trigger element indicates the visual or audio messages or cues that could trigger behaviour. In the context of the self-management of diabetes, a trigger could be a message to the user to remind him/her to enter test results, or communicate with others... etc. • The flow element represents the mental state of absorption and engagement in an activity or a game. In the flow state, the user is intrinsically motivated and completely immersed in what they are doing. The gamified activities in the self-management application should be designed according to users' skill level, thus, gradually increasing the difficulty as the users' skills increase. • The storyline and theme elements indicate the importance of creating a link between the user and the application. The theme is the background that the user might connect to at the beginning, whereas the storyline is about controlling the progress and the arc the user takes through the experience. These elements also give more meaning to gamification features, creating a journey that makes the user part of it and increases their engagement. • The nudge element is based on one of the theories known to drive behaviour - nudge theory. A nudge is the use of positive reinforcement and indirect signals to lead to a non-forced action by creating the simplest path to certain behaviour.
Application	Create a bond with the user, through introducing a theme and constructing a storyline in the app/system, and create a journey. Design reminders for the user to log their daily test results by using triggers such as sound cues or messages. Nudge the user into the desired behaviours you want them to undertake. For example, showing them the logbook once they sign up to the app to encourage them to fill it in first.

Self-representation (avatars, autonomy, ability, and purpose)	
Definition	The self-representation theme signifies the importance of creating a link between the user and the app.
Goal	Enhance the gamification experience and efficiency of self-management.
Description	• The avatar element means providing the user with the means to express themselves in terms of allowing them to upload profile images, offer predesigned images for them to choose from, or allow them to personalise their profiles. • The autonomy element occurs when the users have full control over their choices and activities. • The ability element suggests that developers should consider the varied abilities of users and that they should simplify the tasks required. • The purpose element indicates that the goal and purpose of self- management is clear to the user.
Application	Give the user options to express themselves in the system to help them create a bond with the system. Remember that to keep and enhance the user's intrinsic motivation, they must experience their behaviour to be autonomous. Design the challenges, tasks and other gamification features in an obtainable way. Clarify the importance of the tasks and activities in the app/system to users.

Socializing theme (community, social media, peer-support, and sharing**)**	
Definition	The socializing theme covers the social and emotional aspect of self-managing diabetes.
Goal	Provide users with a community that creates a base for the gamification features and offers them emotional and social support for diabetics.
Description	• The community element means creating a network that is held together by the shared experience of having chronic illness and the common goal of living a healthy life. • The social media element means providing the user with the choice to link his/her self-management profile or activities with their other social media accounts such as Facebook or Twitter. • The peer-support element indicates the support that is provided through the community (other users in the app), the social media (if the app is linked to social media such as Twitter and Facebook), and the gamified features such as feedback and rewards. • The sharing elements involve providing the user with the option to share their test results, progress etc., with others in the community.
Application	Create a community where users can share their experiences and learn coping strategies from each other. Allow users to link their profiles to their social media profiles in which they can share their achievements and rewards with their family and friends who are not in the community. Link the fun theme, esteem theme, and sustainability theme elements with the community and social media features to enhance the value of rewards, challenges, and competition.

Self-management (logbook, visualization of data, and trend alerts)	
Definition	The self-management theme covers the essential elements of a diabetes self-management app/system.
Goal	Assist users in self-managing their illness in an efficient way.
Description	• The logbook is a space that allows the user to keep logs on their test results, date/time, food intake, exercise, how they are feeling, and other relevant information. • The visualization of data element indicates turning the data in the user's logbook into visual representations. In this way, the user can benefit from the accumulated information. For example, a user can see how well they did in the past week or month using a table or a specific graph. Moreover, this would enable them to spot patterns easier. • The trend alert element indicates the use of the logged data to alert the user of any sudden changes or worrying results such as extreme lows/highs in their blood glucose, etc.
Application	Create a logbook where users can enter all the data they need to save from their daily medical test results. For example, blood glucose level, insulin injection, psychological state, food intake, and activities. Create graphs and charts from the data saved by the user. Present these graphs in weekly, monthly, and yearly options. Alert the user of any trends such as very low/high blood glucose or if the user did not enter their test results during the day. Consider the privacy of the user's data.

5.3   Validation of the Guidelines: Multi-Methods

The set of guidelines is validated using a multi-method approach. The results of two qualitative studies are triangulated for the validation of the guidelines (Figure 5-1). In particular, interviews with experts from academia (with expertise in gamification, serious games for healthcare, user experience and game design) assessed the guidelines. The expert interviews were aimed at confirming that the guidelines, as a whole, are comprehensive, clear, and reflect the framework. The other part of the multi-method approach was focus groups, where developers were interviewed in groups to validate and discuss the guidelines. The validation here is to confirm the guidelines proposed, find out whether the proposed guidelines are comprehensive, and to know whether the proposed guidelines are practical.
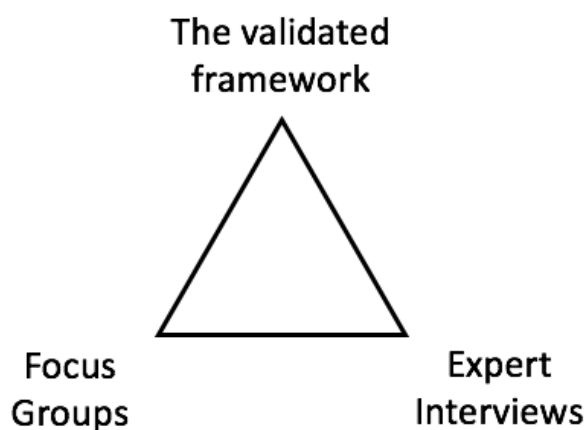
Figure 5-1 Components of Triangulation of Guidelines Validation

Unlike the validation of the framework mentioned in the previous section, the validation of the guidelines consisted of two sequential steps. First, the expert interviews were conducted and the findings were analysed. It was essential to get the feedback of experts from academia on the content of the guidelines, and whether or not they reflected the validated framework. Then, the guidelines are updated based on the findings and the recommendations from the experts. After that, the second study took place, where a number of developers are interviewed in focus groups, and the findings were analysed. This study was conducted to ensure the clarity, usefulness, and ease of implementation for developers, whom are the end user of the guidelines. Next, the final version of the guidelines was created.

The ethical approval for both studies was obtained from the Ethics Committee of the University of Southampton prior to conducting the interviews (reference number: ERGO/FPSE/20757).

5.4 Study 1: Expert Interviews

To ensure the accuracy and clearness of the guidelines, experts from academia assessed the guidelines (study 1) and then these were discussed with developers in focus groups (study 2). It is worth mentioning that the group of experts and the group of developers did not overlap in our study. Moreover, prior to conducting the study, piloting was completed with three researchers from the University of Southampton.

In this section, the interviews design and process by which they were conducted is discussed. Also, the findings of the interviews are presented.

5.4.1 Interviews Design and Process

Qualitative data was collected through expert interviews. The aim of the interviews was to conduct a formative evaluation of the guidelines to ensure that they represent the framework accurately and comprehensively. The experts were selected from the University of Southampton. They were identified and contacted in person or through email by the first author. They are from one or more of the following areas: game development, user experience, and gamification.

As discussed earlier (see Sec. 3.1.1.1), there are different types of interviews; in this study we chose a semi-structured interview. In each interview, the researcher started by explaining the background of the study and the framework. Next, the expert was presented with the guidelines, and was asked to read one theme at a time. Then, the researcher asked the expert a number of open-ended questions to start a conversation.

Semi-structured interviews were conducted with experts in developing apps and games, experts in design and user experience, and game experts in academia. The interviewer stopped conducting interviews after reaching the point of saturation. This point is when data becomes redundant and no new data are found (Guest and Johnson, 2006; Bodenheimer, 2002). Saturation was achieved after interviewing 6 experts.

As mentioned in the previously (see Sec. 3.1.1.1), the saturation level affects the number of participants in expert interviews. In this study, saturation was achieved after interviewing six experts. Thus, no more interviews were conducted. Moreover, it is common to have smaller sample sizes in studies with more than one method (Lee, Woo and Mackenzie, 2002).

The duration of each interview was 50 minutes on average, and each interview was audio recorded after obtaining approval from the participant. After that, the interviews were transcribed verbatim and were analysed using a thematic analysis approach. The data were coded

with tags that represent the eight themes of the guidelines. Similar sets of data were identified and categorized.

The findings from the analysis were used to update the guidelines before conducting the second study (focus group interviews).

5.4.2   Interviews Findings

In this section, the findings of the expert interviews are presented. The findings of the expert interviews were divided into eight subsections according to the themes of The Wheel of Sukr.

The expert interviews were aimed at confirming that The Wheel of Sukr guidelines as a whole are comprehensive and clear, and reflect the framework (the Wheel of Sukr).

The experts acknowledged the importance of introducing such guidelines. They provided a number of suggestions that were taken into account. Overall, the experts thought that the guidelines provide good guidance for developers and have enough information to help them in this area. Moreover, they said that the way the guidelines are arranged flows nicely. The expert comments and feedback are divided based on the themes of the framework.

<u>Fun</u>

The discussion showed that there is a general consensus amongst the experts that this part of the guidelines is understandable, easy to use, and comprehensive. They also agreed that the points discussed in the guidelines are fundamental in making the self-management experience fun and rewarding as one of the experts said:

> "The information you have under this theme is appropriate, and in a gamification approach you need these four elements. You need something to win like a badge or something that gives the user a sense of achievement and that can be compared and shared with others. In the gamification world this is part of the experience. Challenges are important as well because it keeps the momentum and keep people interested and engaged otherwise they reach a certain level and they lose interest."

Moreover, the experts agreed that the guidelines are general enough to be used in creating different apps. As one expert stated:

> "It is very clear and it is not very specific that it can only be applied to a single case which is good."

Nevertheless, one issue that needed clarification is the use of competition in the context of chronic illness self-management. Competition should not be associated with the self-managing tasks themselves or the results of the medical tests but rather with the number of times the user interacts with the system or the level of engagement the user has with the community, thereby gamifying the experience of self-management. Consequently, a clarification remark was added to the competition element in the guidelines.

Some experts suggested considering the use of other core dynamics or other manifestations of the collection core dynamic. From a game design point of view, the badges and points are manifestations of the core game design collection. This manifestation is the most used in gamification in general. However, this does not mean that developers are limited to this form of core design. In light of this finding, the guidelines for the Fun theme were improved. Other core design elements were mentioned in a way that is still true to the research and the framework of rewarding the user, not just creating a game-like experience. It is important to keep in mind the goal of the Fun part of the guidelines, which is to make the experience of self-managing chronic illnesses efficient while being enjoyable and positive.

Esteem

There was strong support for this part of the guidelines and the way in which it is presented. This is evident from the comments of one expert:

> "The way you described how they [the elements] need to be implemented in terms of the leaderboard and the progress bar is a very coherent way to represent how to encourage esteem both in the community (the external) and the internal in terms of how the person sees themselves in that community."

One point of clarification is that it is important to consider what the users might not want to share with others. For example, in self-managing diabetes some people might not be comfortable sharing their blood glucose levels. This issue was raised by one of the experts and the guidelines were modified accordingly.

Another expert stressed the importance of creating feelings of respect and admiration for the user:

> "I believe this is extremely important because of the way that the user needs to know their progress and keep track."

The expert also mentioned the value of having reputation in the community:

> "It is also important to enable the user to be recognized by the community as a 'super
> user' or something like that."

Moreover, it was pointed out that in the chronic illnesses communities the content of this theme is particularly useful. This is due to the fact that it allows those who do well in self-management to be an example to others and inspire them without pointing out to other users that you have to be like him or her. As the expert said:

> "Those who keep track of their self-management activities and do well, they will become
> an example and an encouragement to others in the community, and it will happen
> naturally."

Additionally, on using an app for self-management that has the elements of the Esteem theme, the expert said:

> "In this environment the motivation could be even stronger than that of [other
> entertainment games] because it is related to users' health."

Growth

The impression about this part of the guidelines was very positive. Experts acknowledged that the guidelines are easy to understand, comprehensive, and reflect the Wheel of Sukr. This is exemplified in what one of the experts stated:

> "I agree with the elements that you got...and the way you want to link the system to the
> point and badges so that the person can see himself or herself growing in terms of
> changing their behaviour and start having more control."

Regarding the elements related to achieving goals and baby steps (tiny habits), one expert said:

> "We need a combination of difficult and easy tasks for the user, and the level of
> difficulty needs to increase in order to retain engagement. This is because if the user
> starts becoming an expert in what they do and they managed to change a tiny habit
> then surely you want to increase the difficulty."

Motivation

The experts agreed on the comprehensiveness and clarity of the content of this guideline. One expert talked about linking intrinsic motivation to the app or system to help users understand that the reason they are feeling better is because of what they are doing in the app. This could be done through:

"...prompting people you can imagine having things like 'Oh this week you managed to do better than you did last week.'"

Moreover, one of the experts discussed the age aspect and said:

"I can see this working for both children and adults. The badges work for all age groups. Perhaps the colours would change and the theme but the elements work well for all the ages."

Overall, the motivation guidelines were clear and comprehensive. This is exemplified in what one of the expert said:

"You have considered two very important components of motivation. The one that comes from within and the one that I can develop from either what I see or that can hopefully feed my inner motivation."

The expert continued by saying that using both types of motivation would lead to increased engagement *("in something that is interesting and fun")*, as well as allowing users to grow (*"so that their inner self can be truly motivated and keep good health and the activities of self-management"*). Thus, no changes were made to the motivation guidelines.

Sustainability

The common viewpoint among the experts was that the content of this guideline is comprehensive and clear. They expressed a strong view that this theme is a very important part of the guideline. Experts indicated the importance of reminding the user to use the app or to perform the self-management activities through using triggers, which could be in the form of text or sounds.

The storyline and theme elements received the most attention. One expert expressed enthusiasm about the storyline element by saying:

"It is very important -I really like this element in this theme. It is the way to actually make it [the experience of self-managing] meaningful. It creates the context where you can jump into that world and 'find the magic.'"

Another expert linked the story element back to intrinsic motivation:

"In intrinsic motivation you seem like you are trying to say I want to point out to people that these things are being beneficial to their health, which you might communicate via story or you might communicate via some other means."

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The expert continued saying that the storyline could be used as a motivator in this context.

Another expert suggested that we separate the definition of the storyline and themes. Regarding the difference between the 2 elements, the expert said that the theme is:

"the background that the user might connect to, to begin with"

while the storyline

"is about controlling progress and the arc the player takes through their experience and on that note it might be important to think about what is the arc for the user for this system."

Furthermore, the expert discussed the way the developer will implement the storyline. They indicated that the developer must know the expected path the user will take to be able to manage their chronic illness in a good way. They also must know the pace and the structure of the story that they are going to use. They also must consider the arc and structure of the story and how it will be connected to the game in order to create engagement. As the expert said:

"The idea is that at the beginning you get the user or players attention and get them engaged in the experience, and then you relax that because you get impact with the user when you have acceleration. You have series of microclimatic before you have the big climax at the end and then relax."

Moreover, the standard design practice with regard to pacing and story structure should apply.

Self-Representation

The experts agreed that the content of this guideline is easy to understand and comprehensive. They agreed that it is important for the user to be able to change their avatar in a way that enables them to identify with the app. Giving users a way to express themselves would possibly increase their investment in the app.

The autonomy element is important in the context of self-managing chronic illnesses because giving the user control over their choices and activities could lead to patient empowerment. As one of the experts said:

"How in control you are in a process, I can see how that is important to people managing conditions with these kinds of technology."

Socializing

The general reaction to this theme was very positive as well. The experts thought that this part is straightforward, easy to understand, and comprehensive. As one of them said:

> "I agree with everything here, because I can see that on Twitter and social media you there are groups for all chronic conditions and people get together, they support each other they understand they go through the same thing and they are there for each other."

The expert continued to say that peer support specifically is very important in the context of gamifying the self-management of chronic illnesses. The expert said:

> "...We feel connected with someone that we know understands because we are going through the same thing and it is different to hear it from someone who is speaking from a different place."

<u>Self-Management</u>

The expert consensus on the guidelines for the self-management theme was that it is comprehensive and clear. As one expert said:

> "I agree with all the elements and especially the alert element, which I think is very important because it is required to help those who want to learn how to self-manage or to guide them on what to do."

Regarding the alert element, experts agreed on its importance in the context of self-managing. As one expert said:

> "We tend to think about self-management 'oh you are independent you don't need help', but this is not the case; it is just that the person is prepared to know who to contact and how to follow the necessary steps to follow to keep the condition under control. So an alert is very important."

One expert linked this theme to the esteem theme by saying:

> "You are essentially talking about communicating two types of information. One is about the status of the system and the "game" and it is covered by the Esteem theme. The other one about the underlying status of their illness."

5.5   Study 2: Focus Group Interviews

In this section, the focus group interviews design and process is discussed. Then the findings of the study are presented.

5.5.1   Focus Group Interviews Design and Process

In order to avoid creating a set of guidelines from the perspectives of researchers alone, it was essential to take the opinions of the intended users into consideration, i.e. the developers. The focus group method was chosen to gather information and the opinions of developers on the clarity, usefulness, and ease of implementation of the guidelines. In particular, the focus group interviews were conducted to find out the clarity of the content of the guidelines (such as definition, goals, etc.) for the developers. Also, to find out if the developers thought that the guidelines could potentially help them in creating gamified apps for the self-management of chronic illnesses and to assess if developers thought that implementing The Wheel of Sukr into an app would be feasible and if they could think of practical ways to gamify apps based on the guidelines.

The selected developers are PhD researchers and postdoctoral researchers in computer science, Web technology, and software engineering at the University of Southampton. When a candidate participant was approached, they were asked if they had experience in developing apps to be included in the study, regardless of their level. Twenty experts were approached by email and in person and asked to take part in the study; fifteen of them confirmed that they would.

In this study, five focus groups were conducted. Each one consisted of two to four developers, resulting in fifteen participants. After conducting the five focus group interviews, the point of saturation was reached where no new data were found. The main criterion for choosing the sample was that they have experience in developing applications (Tessmer, 1993). The sample also consisted of developers with expertise in software sustainability.

Each focus group session started with giving the developers an overview of the research, and why they were chosen to participate. Next, developers were presented with the guidelines to read and understand them. After reading each theme, the developers were asked to rate the guidelines for that theme based on three aspects: clarity, usefulness, and ease of implementation. In particular, they were asked to choose a score from 1 to 9 (1 being negative and 9 being positive). Then, they were asked to discuss the guidelines and raise any concerns about the content.

At the end of each focus group session, snap-shots of an application for the self-management of diabetes, which was arbitrarily chosen and does not contain any gamification, were presented to the developers. They were asked to use the guidelines to suggest improvement to the app.

The focus group interviews lasted 60 to 90 minutes each. The interviews were audio recorded after obtaining the consent of the participants. The interviews were transcribed, and analysed based on the themes of the framework.

5.5.2 Focus Group Interviews Findings

In this section, we present the findings of the focus group discussions with developers. As explained earlier, the developers were handed the set of guidelines and snapshots of a non-gamified app for self-managing diabetes. They were asked to read the guidelines and discuss them theme-by-theme. After reading each theme, they were asked to rate it from 0 to 9 (0 the lowest rating and 9 the highest) in terms of clarity, usefulness, and ease of implementation. The average scores of each theme contained in the guideline are shown in Table 2. It should be noted that these scores reflect the opinions of the developers on the guidelines. Clearly, the results show a very positive opinion toward them.

Table 5-2 Score Table (Ratings from 0-9)

	Clarity	Usefulness	Ease of implementation
Fun	7.5	7.7	7.1
Esteem	7.1	7.3	7.1
Growth	7.1	7.7	7.3
Motivation	6.1	7.7	5.5
Sustainability	7.8	8.1	7.5
Self-representation	7.5	7.8	7.9
Socializing	8.1	7.9	8.0
Self-management	8.3	8.2	8.4

The findings of the focus group interviews were divided into eight groups following the eight themes of The Wheel of Sukr.

Fun

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One of developer said:

"I have very little background in gamification but now I can read this and understand what these elements are, and what I am supposed to do."

Another developer said:

"Your guidelines adapt with what exist now [in the area of Web and app development] and it is very clear. ...our lives depend on collecting points and rewards."

It was evident that the Fun theme elements are very clear as many of the developers managed to relate these elements to apps that they have been using, in particular health and fitness apps in which gamification aspects have been used.

The notion of sharing achievements between users, which was mentioned in the Application section of the fun theme, needed some clarification. In particular, the researcher explained that the achievement element does not involve sharing private medical results. Instead, it concerns sharing the points collected or badges as a result of good self-management practices. Consequently, the guidelines were updated with this clarification.

Overall the developers were satisfied with the fun theme. One developer said:

"From a developer's point of view, I think these provide good guidelines; things to keep in mind while designing your app."

Another said:

"The guidelines are general enough to help developers create different gamified apps."

Esteem

The clarity of the theme is exemplified by what one developer stated:

"I think it is clear and it goes well with the fun theme."

However, one point that needed clarification is the leaderboard. The interviewer explained that it is not calculated based on test results (e.g., the blood glucose test results), but it is based on the activities of self-management (the tasks required) (e.g., the number of times the user entered their test results or the number of times the user achieved their goals). As indicated in the guidelines, the developer can add to this or change the leaderboard mechanism as long as they keep in mind the sensitivity of the data collected and do not compare users based on their test entries (e.g., their blood glucose levels).

Growth

One developer said:

"This is for me quite useful and the description is clear"

This is in accordance with the general impression of the other developers as can be seen in Table 2. One point that needed clarification is that feedback does not mean feedback from other users; this type of feedback could be a part of the socializing theme as a matter of peer support. The feedback referred to here is from the app itself. For example, when the user logs their test results, a doctor character or another character can show up and reassure the user that they are doing a good job, or it could simply be a notification that appears containing a relevant message.

Motivation

Next, even though the ease of implementation for the motivation theme was low compared to the other themes, developers managed to come up with a number of examples on how to implement intrinsic and extrinsic motivations after some discussion. One of the examples given by developers was asking the user about their favourite animal, which would be their companion throughout the app. The only way to take care of their companion is by logging their data and performing the self-management tasks. Another example was to provide users with tips and information on how to maintain a healthy lifestyle, which could enhance their motivation.

Overall, developers found the guidelines of the motivation theme useful. As one developer said:

"The information is useful for the developer that there are two types of motivation that they can implement."

Sustainability

The developers mentioned the challenge and difficulty of carrying out the elements of the sustainability theme and how the guidelines are helpful. They thought that if these elements were included in some of the apps they have used, they would have continued using them.

The trigger and nudge elements needed some clarification, as one of the developers could not distinguish between the two. Thus, the description of both elements in the guideline was edited to eliminate any future misconceptions. The trigger element occurs when a person is reminded to perform behaviour through visual or audio cues. On the other hand, the nudge element is positive reinforcement and an indirect signal toward an unenforced act.

The satisfaction with this theme is summarized with the following statement:

"The description of the storyline and theme is very helpful to me. And for the nudge it is useful because every time the user uses the app they get to enter their glucose level, which can help the users log everything daily and very intuitively. Also the reminders are useful for users, so if they forgot to use it they will remember. So I think this is very clear!"

Self-Representation

In this section, the ability element needed some clarification. Thus, it was clarified to show that when designing tasks or challenges, the developer should consider the varied abilities of users. For instance, some users might find it difficult to perform certain tasks. Therefore, simplifying the tasks is highly recommended. On using avatars, one developer said:

"It creates a link between the user and app and lets the user engage with the app more."

Overall, developers agreed that the self-representation part is clear (see Table 2). As one of the developers said:

"It completely connects with what we have been discussing and I know how to implement everything here."

Socializing

At this stage some developers started to see connections between the different themes of the whole set of guidelines. As one developer stated:

"This helps me understand the fun theme and esteem theme better because it means people will share their achievements so they can engage more with the app."

Other developers supported the notion that the social aspect enables users to not only share their achievement with their peers but also with family and friends. This was summarized in the following statement:

"It is useful to be connected with family, and they can see your progress and they will comment positively and then you will feel better."

Overall, the developers did not raise any issues regarding this theme and hence no modifications were made.

Self-Management

One of the developers said:

> "The points are quite clear, and I like the idea of adding the visualization aspect because obviously they can clearly see the trends."

Another developer stated:

> "I think this is important. The logbook will help users check their progress, and the visualization would give users a straightforward impression on their progress."

The concepts contained in this theme were familiar to many of the developers, as some of them expressed that they have applied many of its elements in developing projects that they have worked on previously. No clarification was required for this theme, and hence the content of the guidelines has not been changed.

Finally, at the end of each focus group session developers were presented with the snapshots of a non-gamified self-management app for diabetes. They were then asked if they could use the guidelines to suggest ways to implement gamification in this app. It was noted that developers were confident that the guidelines would enable them to transform a non-gamified app into a gamified one. This includes those developers who had some misconceptions on some of the elements (before being clarified by the interviewer).

5.6 Discussion

The use of gamification for health care purposes presents a tool that could enhance patient self-care (Mccallum, 2012; Primack *et al.*, 2012; King *et al.*, 2013). Gamification could be thought of as a motivational tool and incorporates a number of behavioural change methods (Cugelman, 2013; Hamari, Koivisto and Sarsa, 2014; El-Hilly *et al.*, 2016). In the context of the self-management of chronic illnesses, gamification could turn daily tasks of self-managing an illness into a rewarding and engaging activity (King *et al.*, 2013). However, as mentioned in the introduction, there is a shortage in specific frameworks and developer guidelines in this area. Current implementations of gamification in health care do not follow any specific guidelines (Seaborn and Fels, 2014). Hence, this work fills the gap by providing a set of guidelines for developers.

Before the creation of the guidelines a framework for the self-management of chronic illnesses (The Wheel of Sukr) was introduced (see Ch.4). The framework combines gamification with behaviour change methods, and the self-management of chronic illnesses. It filled a gap that existed in the literature. The framework was discussed with experts as mentioned in Ch.4. The experts supported the need for the incorporation of gamification in this area in the way presented

in the framework. This is because of the potential benefits that gamification can have on the self-management habits of individuals with diabetes. Moreover, the concepts of the framework were supported by individuals with diabetes (based in Saudi Arabia), and the study (in Ch.4) showed that the framework can potentially satisfy their needs. However, in order to enable developers to accurately incorporate the concepts of the framework into an app, it was essential to create a set of developer guidelines that reflect the framework in a clear, comprehensive, easy to use way.

In this chapter, we presented a set of guidelines for developers to gamify the self-management of chronic illnesses. The guidelines are based on the 8 themes of The Wheel of Sukr framework along with their elements. The methods chosen in this study are expert interviews and focus group sessions with developers. Interviews were chosen to enable in-depth discussion and assessment of the guidelines (Kaplowitz and Hoehn, 2001). The interviewees came from different, but relevant, backgrounds. This puts them in a position to give vital feedback on the guidelines based on their expertise. Likewise, the input from developers was necessary to ensure that the target group of the guidelines (i.e., developers) can comprehend the content of the guidelines and indicates that they are useful and easy to work with. To accommodate the different levels and backgrounds of these developers, a focus group method was most suitable (Asbury, 1995). Indeed, the developers managed to discuss the guidelines among themselves and answer each other's concerns and questions.

The findings of both studies (the expert interviews, and the developer focus group sessions) show that there is a great deal of support to the set of guidelines from both experts and developers. The expert interviews ensured that the content of the guidelines reflect the framework and are comprehensive and sound. Additionally, the focus group sessions with developers, who are the end user of the guidelines, showed that they agree on the on the clarity, usefulness, and ease of implementation of the guidelines. It is worthwhile mentioning that the validation of the guidelines was carried out in two sequential steps. The guidelines were updated on the light of the findings of the first study, and then confirmed by the second study.

The in-depth discussions with experts from academia in the fields of game and app design and user experience indicated that the guidelines cover adequate information. They also noted that the guidelines would be useful for developers of self-management apps. Moreover, the experts discussed the importance of the elements in the guidelines. In particular, the experts agreed that the themes encapsulate important parts of the creation of a gamified experience. They agreed that even though there are other core dynamics, PBL, competitions and challenges are relevant in the self-management of chronic illnesses, while others might not be due to the sensitivity of the subject. Furthermore, there was an agreement among experts that these elements would enable

developers to create apps that bring a positive spin on the daily self-management tasks of a chronic illnesses.

Furthermore, the focus group sessions with developers showed that the guidelines may well be useful in creating gamified self-management apps for chronic illnesses. The consensus amongst developers was that the guidelines are clear, easy to understand, and achievable. This was evident when developers were shown a self-management app that does not include gamification elements and they managed to use the guidelines to suggest specific ways to implement gamification in the app. Moreover, they were able to discuss the themes of the guidelines and draw similarities between them and some of the apps that they use. This indicates the clarity and ease of use of the set of guidelines. Additionally, the developers found that the guidelines are general enough to enable them to incorporate gamification into self-management apps for different chronic illnesses. This fills the gap in the literature regarding the lack of guidelines in this area.

Overall, there was an agreement from participants in both studies that such guidelines are needed in this area. This is also supported by the literature findings, where some researchers argued that the current implementations of gamification in health care do not adhere to standard guidelines (Lister, West, Cannon, Sax and Bordegard, 2014). Additionally, it was suggested that gamified apps do not reflect the theoretical frameworks and approaches found in the literature (Seaborn and Fels, 2014). In their paper, Seaborn and Fels (2014) argue that theoretical work is not studied empirically and that the apps and systems that applied some of the theories did not test their validity empirically. However, given that gamification is still considered to be at an early stage in terms of being applied to the self-management of chronic illnesses, there must be a starting point, and a theoretical framework along with comprehensive guidelines is needed.

Finally, it is worth mentioning that Nielsen (1994) pointed out that developers could feel intimidated by long guidelines (1000 rules for example), so it was important to take the opinions of the developers on the guidelines and whether they find it useful and clear. The developers agreed that the set of guidelines is concise and is not intimidating.

5.7   Summary

This chapter presented guidelines for the development of gamified self-management apps and system for chronic illnesses. The Wheel of Sukr framework was translated into a set of guidelines for developers. The set of guidelines contained eight themes: fun, motivation, growth, self-representation, self-management, sustainability, esteem, and socialising. Each theme of the guidelines was divided into 5 parts: the theme and its corresponding elements (from The Wheel

of Sukr), definition, goal, description, and application. The guidelines were designed such that they reflect the framework accurately, comprehensively, and be clear, easy to implement, and useful.

The set of guidelines was validated using a multi-method approach that triangulated expert interviews and focus group interviews sequentially. The content of the guidelines was discussed in depth with experts from academia using semi-structured interviews. The experts had experience in the areas of game development, user experience, and gamification. The findings from the expert interviews suggested that the guideline content is comprehensive and reflects the Wheel of Sukr. Moreover, the experts gave suggestions to enhance the guidelines and those were taken into consideration to update them. There was consensus from the experts that the guidelines are important.

After that, the updated version of the guidelines was discussed with developers in the focus group interview sessions to ensure the clarity, usefulness, and ease of implementation of the guidelines. The findings of the focus group interviews showed that there is an overwhelming agreement among the developers that the guidelines are useful, easy to implement, clear, and can be applied to create self-management gamification apps.

Providing the validated set of guidelines fills the gap in the literature and sets the stage for future studies.

Chapter 6: Conclusions

In this thesis, the concept of gamification, which borrows from games but is not a game by itself, was addressed. Gamification uses rewards, the urge for recognition, and the need for instant positive feedback in human nature to enhance motivation, increase engagement, and promote change in behaviour. As discussed in the literature review, gamification has been receiving a great deal of attention in both industry and academia, and it has been applied in many fields including healthcare. However, there is still a lack of frameworks and guidelines for its implementation in the self-management of chronic illnesses.

Diabetes is one of the most common chronic illness in many countries. Self-managing diabetes is a continuous effort that aims at managing and sustaining the advised level of blood glucose and avoiding complications in order to lead a healthy life. The nature of the self-management of diabetes could create a strain on individuals with diabetes. Monitoring blood glucose, adhering to medication (insulin), maintaining a healthy diet, managing social pressures, and other challenges of self-management could have a toll on diabetic individuals.

Incorporating gamification into the self-management of diabetes could have positive impacts on individuals living with the illness. Game elements and the psychology behind gamification could help to increase the motivation and engagement of individuals with diabetes in their daily self-management process. It could also turn the tedious and repetitive tasks of self-management into a rewarding and engaging activity.

Moreover, the literature review covered the three main areas of research: gamification, the psychology behind it, and the self-management of diabetes. The gap in the literature was identified as the lack of frameworks and guidelines for the gamification of the self-management of chronic illnesses. The first aim of the thesis was to provide an appropriate framework for the gamification of the self-management of diabetes. The second aim of the thesis involved designing a set of guidelines for developers who want to incorporate gamification in apps for the self-management of chronic illnesses.

The first part of the thesis set out to develop a framework that applies the concept of gamification in the self-management of chronic illnesses, specifically diabetes. Based on the literature review findings, twenty-eight elements were synthesised into eight themes to create the framework: The Wheel of Sukr. To the best of our knowledge, this is the first framework that is targeted towards the self-management of chronic illnesses. It combines gamification, behaviour change methods, and self-management practices.

Chapter 6

The Wheel of Sukr consists of eight themes, each encompassing a number of elements:

- The self-management theme, which includes the following elements: logbook, visualisation of data, and trend alerts.
- The socialising theme, which includes the following elements: community, social media, peer-support, and sharing.
- The self-representation theme, which includes the following elements: avatars, autonomy, ability, and purpose.
- The fun theme, which includes the following elements: badges, points, challenges, and competition.
- The esteem theme, which includes the following elements: leaderboards, levels, progress bar, and reputation.
- The motivation theme, which includes the following elements: intrinsic and extrinsic motivation.
- The sustainability theme, which includes the following elements: trigger, flow, storyline and themes, and nudge.
- The growth theme, which includes the following elements: feedback, achieving goals, and baby steps (tiny habits).

The Wheel of Sukr framework is illustrated in Figure 4-3. The framework is in the shape of a wheel, which was chosen in order to reflect the importance of all of the themes together. The themes and their elements combined create a gamified environment that could improve the self-management experience of individuals with chronic illnesses and make it an easier and more enjoyable activity.

The validation process of The Wheel of Sukr was done through a mixed-method approach. This consisted of two studies: the first involved expert interviews and the second took the form of a self-administered questionnaire.

In the first study, expert interviews were carried out with eight experts to validate the proposed framework from three different perspectives that reflect the areas of research (i.e. gamification, behaviour change, and self-management of diabetes). The experts in the study were carefully selected from three main fields:

- Diabetes doctors and educators based in Saudi Arabia.
- Psychologists and psychiatrists based in Saudi Arabia.
- Gamification experts from the University of Southampton.

Since this thesis is concerned with the gamification of the self-management of chronic illnesses, it was necessary to interview experts from the medical field. This is because they understand what is needed to self-manage the illness properly. They also have an immediate understanding of the struggles that individuals face living with diabetes (their patients) in terms of self-managing the illness. Moreover, the psychiatrists and psychologists would understand the psychological side of gamification and the framework involving the use of motivation and behaviour methods, and the importance of peer-support.

The second study conducted to validate The Wheel of Sukr was an online self-administered questionnaire. The questionnaire was filled in by individuals with diabetes based in Saudi Arabia. The questionnaire consisted of a Likert scale including thirty-four statements that cover the concepts behind the framework's themes.

Forty-two individuals participated in the study. However, the high stigma around diabetes in Saudi Arabia could have resulted in many people not willing to talk about their illness, and it was difficult to reach a larger number of participants. The existence of stigma around diabetes in Saudi Arabia was supported by the medical experts in the study, who indicated that individuals with diabetes do not usually participate in group events for diabetes. They also indicated that stigma influences their daily self-management negatively.

Nevertheless, it was essential to conduct this questionnaire and take into account the views of the target audience on the gamification of the self-management of chronic illnesses. It was also important to undertake the interviews with the experts from the three groups as indicated earlier. Both studies combined provided a well-rounded view regarding the use of gamification in this area and also validated the framework.

The interviews were transcribed and analysed using thematic analysis, while the questionnaire results were analysed using the statistical one sample t-test (2-tail) method. The results of both studies validated the themes of the framework. The findings of both studies suggest that there is a general acceptance of the notion of gamifying the self-management of diabetes. The studies also show that the themes of The Wheel of Sukr could contribute to improving the experience of the self-management of chronic illnesses for individuals with diabetes. This framework set the stage for creating specific guidelines for gamification in this area, which is the second aim of the thesis.

In particular, after the validation of The Wheel of Sukr framework, it was translated into a set of guidelines for developers to aid them in the development of gamified self-management apps and

systems for chronic illnesses. The framework consisted of eight guidelines based on the themes of The Wheel of Sukr. Each one of the guidelines was divided into five parts:

- Theme: a general construct containing elements that share the same goal.
- Definition: The general idea of the theme is defined.
- Goal: The purpose of the theme and its elements are stated.
- Description: The theme and its elements are elaborated.
- Application: The theme is translated into pointers to help in its implementation.

The set of guidelines were designed in a way to enable developers to tailor the themes to their individual projects (i.e. the goals, objectives, and the users of their app). For example, developers could implement different types of badges and points more so when they are targeting young users than when targeting adults.

The validation of the set of guidelines was carried out using a multi-method approach. It consisted of two sequential studies: expert interviews and focus group interviews.

In the first study, the content of the guidelines was discussed in depth with six experts from academia using semi-structured interviews. The experts were selected from the research staff at the University of Southampton. They are experienced in the areas of game development, user experience, and gamification. The interviews were conducted as a formative evaluation of the set of guidelines to ensure its accuracy, and to ensure that it represents the framework accurately and comprehensively. Each interview lasted 60 minutes and were audio-recorded. The interviews were then transcribed and analysed using thematic analysis.

The findings of the expert interviews suggest that the set of guidelines is comprehensive and reflects The Wheel of Sukr. Moreover, the experts gave suggestions to enhance the guidelines and these were taken into consideration when updating the guidelines. The insight of the experts was valuable given that they are very experienced and known researchers who contribute to the area of games. Their support to the formulation of the set of guidelines shows that it is needed and important.

After validating the set of guidelines using the expert interviews, it was a natural step to validate it using interviews with developers. It is worth mentioning that the set of guidelines was designed with developers in mind. Thus, it was important to consult the developers (i.e. the end users of the guidelines) and check the clarity, usefulness, and ease of implementation of the set of guidelines.

After the first study (expert interviews), the set of guidelines was modified based on the input of the experts. The second study then used the new version of the guidelines. In the second study, fifteen developers were interviewed in five focus group sessions to ensure the clarity, usefulness, and ease of implementation of the set of guidelines. The focus group sessions were around 90 minutes each. The interviews were audio-recorded to be subsequently transcribed and then analysed using thematic analysis.

The were presented with the set of guidelines of and snapshots of a generic non-gamified app for self-managing diabetes (which was chosen randomly). The developers read the guidelines during the interview and discussed them theme-by-theme. They were also asked to rate each theme from 0 to 9 (0 being the lowest rating and 9 the highest) in terms of clarity, usefulness, and ease of implementation. The findings showed that there is an overwhelming agreement between developers that the guidelines are useful, easy to implement, clear, and can be applied to create self-management gamification apps.

The developers were also presented with snapshots of a generic non-gamified app for self-managing diabetes (which was chosen randomly). The developers were asked to think of ways to gamify the generic app after reading the guidelines for all the themes. This was carried out to ensure that the guidelines can be used in the development of apps that incorporate gamification for the self-management of chronic illnesses. Indeed, the developers discussed many ways in which they can implement the different themes from the guidelines. This indicates that the set of guidelines is ready to be used by developers.

6.1 Contributions

This thesis adds to the growing body of research in the use of gamification in healthcare. It fills the gap in literature regarding gamification for the self-management of chronic illnesses. The thesis consisted of two major contributions:

- A validated framework for gamifying the self-management of chronic illnesses called The Wheel of Sukr framework.
- A validated set of guidelines for developers based on the validated framework to aid developers in creating gamified apps for the self-management of chronic illnesses.

To the best of our knowledge, this is the first study to provide a framework and guidelines for this specific area. Moreover, in the process of researching and designing the first contribution the researcher provided:

- A review on the literature of gamification in healthcare and the links between the areas of gamification, behaviour change, and the self-management of chronic illnesses.
- Established a gap in the literature with regards to frameworks and guidelines for the use of gamification in the self-management of chronic illnesses.
- Identified twenty elements from the above areas and synthesised them into eight themes to create the framework: The Wheel of Sukr.
- Validated the framework with experts in medicine, psychology and psychiatry, and gamification and games expertise, as well as, individuals with diabetes.

Moreover, the fact that it was positively viewed by these experts and the target users (i.e. individuals with diabetes) is one of the strengths of this study. The findings of both the interviews and questionnaire strengthen the idea that gamification could benefit individuals with chronic illnesses in their self-management process.

In the process of researching and designing the second contribution, the researcher:

- Recognised the need for guidelines for the development of gamified self-management apps for chronic illnesses.
- Translated the framework into a set of concise and clear guidelines for developers.
- Validated the set of guidelines with experts from academia and with developers.

The set of guidelines can be used by developers to create self-management apps for diabetes and other chronic illnesses. Such apps will properly implement gamification and meet the expectations of medical doctors and individuals with chronic illnesses.

6.2   Future work

The aim of this thesis was to fill the gap in the literature regarding the use of gamification for the purpose of self-managing chronic. Particularly, identifying the key elements from the literature of gamification, behaviour change, and self-management of chronic illnesses and developing a framework and developer guidelines. The thesis presented and validated The Wheel of Sukr framework and a developer set of guidelines for the gamification of self-management of chronic illnesses with a focus on diabetes. The framework and the set of guidelines were validated by a wide range of stakeholders. The framework was validated by medical doctors (including endocrinologists and psychiatrists), game and gamification experts and patients, while the set of guidelines were validated by academic experts in games, narrative, user experience, and developers who are computer scientists and software engineers. However, there is room and scope to develop this area of research further. The Wheel of Sukr framework and set of guidelines

can serve as a basis for future studies in the use of gamification in the self-management of chronic illnesses. Moreover, the use of gamification in health care and specifically patient self-care is an important research area that needs further investigation. The interdisciplinary nature of gamification will raise many questions that need to be answered in the future.

In this thesis we used the epistemology approach of positivism, empiricism, and criticism. This is a common information systems approach of being pragmatic and objective. However, there are different epistemology approaches that are used in social sciences and other fields. These include ethnography and grounded theory research, which are both appropriate strategies for inductive research (as opposed to the deductive approach we used). In future research these approaches can be used to explore many areas (e.g. stigma, age, gender, cultural...etc.) in the gamification of self-management of chronic illnesses. These studies can be conducted once a gamified application that follows the Wheel of Sukr is developed.

Now that we have shown the key component for the gamification of self-management of chronic illnesses, the next stage is to develop a prototype or an application that follows The Wheel of Sukr framework and the developer guidelines. This would be part of the development phase that will enable us to conduct further research. From the developed gamified application, we will be able to research the use of gamification in the self-management of chronic illnesses further. For example, we can ascertain whether all the eight themes of the Wheel of Sukr framework are equally important in different circumstances. The future research can be conducted in the following areas:

- **Cross-cultural:** future research could include investigating the importance and the effect of the eight themes of the Wheel of Sukr on different groups of people. For example, we can look at the use of the themes in the developed application in a cross-cultural setting, and investigate if there is a difference based on the culture of each group.

- **Other chronic illnesses:** in this thesis we focused on the common issues of self-management of chronic illnesses and we used diabetes as an example. This could be considered a limitation. However, there are common problems in managing chronic illnesses, which include keeping a logbook, adherence to medication, and peer support. Future work could investigate other chronic illnesses and find out if there is a difference in terms of gamifying the self-management of each illness. Moreover, we can investigate the importance of the eight themes of The Wheel of Sukr in the self-management of different chronic illnesses. Particularly, we can measure the weight of the themes in the self-management of different chronic illnesses by conducting a long-term longitudinal experiment and using control groups.

- Age groups: as pointed out by one of the medical, the the themes of the framework might be appealing to children and young adolescents, as opposed to other ages. Future work could explore the effects of the themes of the framework (in a gamified application for self-management) on different age groups. In particular, measuring the effects of gamification in improving the self-management habits in different age groups.

- Leaderboards in self-managing chronic illnesses: as discussed in sec.5.1 previous research (in different domains) suggests that Leaderboards might demotivate some users, while others find it motivating. This depends on the "player type", some users are competitive and other users could be socialisers. The effect of the themes of the framework on the different types of players should be investigated further in the specific domain of self-managing chronic illnesses.

- Stigma: one of the issues discussed by the medical experts was the issue of stigma on diabetes in Saudi Arabia, and how it affects the self-management of it. Once an application is developed based on the Wheel of Sukr set of guidelines, this area could be investigated further in a longitudinal study. In the study the effects of the rewarding element, peer support, autonomy and other elements of the framework on the patient and how they respond to stigma. This can be measured by studying the individuals with the diabetes before and after using the gamified app that applies the Wheel of Sukr themes.

- Best practices: In order to find the strengths and weaknesses of the Wheel of Sukr's themes and elements, an empirical study incorporating them within the context of self-managing chronic illnesses must be undertaken. This will help to determine the best practices in gamifying the self-management of chronic illnesses. For example, the type of badges and triggers that most effective in this specific area of gamification. Also, the type of storyline and themes that are effective based on age group or culture.

- Relationships between themes: the validated framework, The Wheel of Sukr, contains eight themes and each theme encompasses a number of elements. In the mixed method study, the themes of the framework were validated with a wide range of stakeholders including medical experts, gamification experts and individuals with diabetes. It was assumed that the themes of the framework are of equal weights and the findings of the studies did not affect this assumption. Further studies could seek to create relationships and hierarchy between the themes and elements (i.e. creating a model).

Gamification in healthcare is still considered a new area of research. The Wheel of Sukr framework and developer guidelines are amongst the first in this area. There are many other areas in healthcare that could benefit from gamification frameworks and guidelines as it is getting

an increased popularity in both academia and industry. We suggest exploring the use of gamification in healthcare education and awareness. As the medical expert interviews suggest that there are some issues with awareness and education. Future research can explore this area more and how gamification can benefit this.

Appendix A

This appendix shows the closed and open ended questions for the expert interviews for the validation of the framework.

The Closed-Questions:

- Using a reward system can be effective in managing diabetes.
- Awarding users for logging their test readings would encourage them to keep a record of their tests.
- Visualizing the user's test results can help them in determining patterns in their condition.
- Positive motivation can have a profound psychological impact on the patient's self-management of diabetes.
- Having an online community where patients can exchange information is beneficial.
- An online community can provide emotional and psychological support for diabetic patients.
- Being in a community helps diabetic patients in coping with their condition.
- Patients will benefit from an online peer support system.
- Social media and sharing successful results or sharing problems and concerns is important in the diabetic patient's life.
- Peer support is an essential element for a successful life with diabetes.
- Using rewards and game elements can satisfy self-esteem needs (Maslow's Hierarchy of Needs), which in turn positively affect the self-management of diabetes.
- The negative connotations associated with diabetes affect the patient's self-management and life overall.
- Saudi Arabian patients will benefit from the use of an electronic logbook for their blood glucose test results.
- Tailoring the online self-management support to individual users can create a bond with the user. Therefore, this will increase their engagement with the process and provide a meaningful experience.
- Providing consistent feedback to the user (about the glucose test results and other self-management skills) can lead to personal growth in terms of the management of diabetes.

Open-ended questions for Doctors:

1. How important is it to empower diabetic patients in taking care of their own lives?
2. What are the challenges that they face in Saudi Arabia?

3. What are the most common problems that diabetes patients face in terms of being motivated to self-manage and self-care?

Open-ended questions for Psychiatrists and Psychologists:

1. How important is it for diabetic patients to be part of a community (diabetic community or have friends with diabetes) and have peer support?
2. Does reward play a huge part in motivating patients?
3. How important is it to motivate diabetic patients?

Open-ended questions for Gamification and Game Experts:

1. Is self-representation critical in the use of gamification?
2. Is the use of triggers, flow, theme, and nudges sufficient for creating sustainability in a gamified system?

Appendix B

Participant Information for the expert interviews study for the validation of the guidelines

Study Title: Gamifying self-management of chronic illnesses (diabetes).

Investigator: Alaa Almarshedi

Please read this information carefully before deciding to take part in this research. If you are happy to participate will be be asked to sign a consent form. Your participation is completely voluntary.

What is the research about? This is a research project that aims to provide developers with guidelines to gamify the self-management of chronic illnesses (diabetes) based on The Wheel of Sukr. The study is sponsored by the Saudi Government.

Why have I been chosen? You have been approached because of your expertise in game development and user experience.

What will happen to me if I take part? The researcher will explain the aim of the study and the way it will be conducted. First you will be asked if you agree to participate, if so you will be asked to sign a consent form. Then you will be presented with the framework and the guidelines. After that, you will be asked to answer a number of questions. It will take about 40-50 mins in total.

Are there any benefits in my taking part? The study will add to current knowledge about gamification in self-management of chronic illnesses.

Are there any risks involved? There are no particular risks associated with your participation.

Will my data be confidential? The data collected will be held on a password-protected computer, and used only in accordance with the Data Protection Act (1998). If you would like to withdraw from the study, please contact the investigator (e-mail aaa3g12@soton.ac.uk) or the project supervisor (e-mail gbw@soton.ac.uk) who will arrange this.

What happens if I change my mind? You may withdraw at any time and for any reason.

What happens if something goes wrong? Should you have any concern or complaint, contact me if possible (investigator e-mail aaa3g12@soton.ac.uk) otherwise please contact the **Error! Unknown document property name.** Office (e-mail fpse-grad@soton.ac.uk) or any other authoritative body such as FPSE Research Support Officer, Dr Cecilia Di Chio, C.Di-Chio@soton.ac.uk).

Appendix

Participant Information for the focus group interviews study for the validation of the guidelines

Dear Participant,

Please read this information carefully before deciding to take part in this research. If you are happy to participate you will be asked to sign a consent form.

What is the research about? This research project aims to provide developers with guidelines to gamify self-managing chronic illnesses. The guidelines are based on the researcher's framework "The Wheel of Sukr".

Why have I been chosen? You have been approached because of your expertise in the research or development of serious games, user experience or app development.

What will happen to me if I take part? You will be asked to show your consent to participate in the study by signing the consent form on the next page. You will be part of a focus group (3 or 4 in each group). You will be presented with guidelines and an application and you will be asked a set of questions about the guidelines and discuss the use of the guidelines on the application. The interview will take a round 50 minutes.

Are there any benefits in my taking part? The study will add to current knowledge about gamification in self-management of chronic illnesses.

Are there any risks involved? There are no particular risks associated with your participation.

Will my data be confidential? The data collected will be held on a password-protected computer, and used only in accordance with the Data Protection Act (1998).

What happens if I change my mind? You may withdraw at any time and for any reason.

Where can I get more information? Should you have any concern or complaint, contact me if possible (investigator e-mail aaa3g12@soton.ac.uk) otherwise please contact the FPSE Office (e-mail fpse-grad@soton.ac.uk) or any other authoritative body such as FPSE Research Support Officer, Dr Cecilia Di Chio, C.Di-Chio@soton.ac.uk).

Thank you for your time and participation.

Appendix

Consent Form

1. I have read and understood the participant information sheet provided on the previous page.

2. I understand my participation is voluntary and I may withdraw at any time and for any reason.

3. By ticking this box you now give your fully informed consent to participate in this study.

Please Sign if you agree:

Appendix

Participant Information for the expert interview for the validation of the Framework

Study Title: The use of Gamification in Self-management of diabetes (in Saudi Arabia)

Investigator: Alaa Al Marshedi

Please read this information carefully before deciding to take part in this research. If you are happy to participate will be asked to sign a consent form.   Your participation is completely voluntary.

What is the research about? This study is part of a PhD research on the use of Gamification in the self-management of Diabetes in Saudi Arabia.

Why have I been chosen? You have been approached because of your experience in working with diabetic patients in Saudi Arabia (if you are a doctor/psychologists) or your experience in game research and gamification application (if you are a game/gamification expert).

What will happen to me if I take part? When you choose to take part in the study, you will be shown a participant information sheet and you will be asked to sign a consent form indicating your agreement to be part of the study. After that, the interviewer will ask you to fill in a short questionnaire, and then you will be asked a number of questions relevant to your field. The interview will take about 20-30 mins in total.

Are there any benefits in my taking part? The study will add to the current knowledge about Gamification and its use in diabetes self management.

Are there any risks involved? There are no particular risks associated with your participation.

Will my data be confidential? The data collected will be held on a password-protected computer, and used only in accordance with the Data Protection Act (1998). The interview will be recorded for accuracy and the recording will be destroyed once the data is transcribed. Any personal information such as name and phone number will be saved on a password protected personal organizer and it will be deleted after the interview is done.

What happens if I change my mind? You may withdraw at any time and for any reason.

What happens if something goes wrong? Should you have any concern or complaint, contact me if possible (investigator e-mail aaa3g12@soton.ac.uk), otherwise please contact the Dr Martina Prude, Head of Research Governance (02380 595058, mad4@soton.ac.uk).

Appendix

Consent Form

Please initial the box(es) if you agree with the statement(s):

I have read and understood the Participant Information and have had the opportunity to ask questions about the study.

I agree to take part in this study.

I understand my participation is voluntary and I may withdraw at

Data Protection

I understand that information collected during my participation in this study is will be stored on a password protected computer and that this information will only be used in accordance with the Data Protection Act (1998). The DPA (1998) requires data to be processed fairly and lawfully in accordance with the rights of participants and protected by appropriate security.

Signature of participant...

Appendix C

The table below shows the frequencies of the answers for each question in the Likert scale part of the questionnaire in the validation of the framework study.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Q1	47.62%	42.86%	7.14%	0.00%	2.38%
Q2	35.71%	26.19%	35.71%	2.38%	0.00%
Q3	59.52%	33.33%	4.76%	2.38%	0.00%
Q4	23.81%	40.48%	26.19%	7.14%	2.38%
Q5	28.57%	40.48%	23.81%	7.14%	0.00%
Q6	33.33%	30.95%	16.67%	16.67%	2.38%
Q7	7.14%	33.33%	23.81%	30.95%	4.76%
Q8	42.86%	35.71%	11.90%	9.52%	0.00%
Q9	45.24%	33.33%	11.90%	9.52%	0.00%
Q10	35.71%	33.33%	28.57%	2.38%	0.00%
Q11	30.95%	47.62%	16.67%	4.76%	0.00%
Q12	38.10%	35.71%	23.81%	2.38%	0.00%
Q13	28.57%	23.81%	14.29%	26.19%	7.14%
Q14	42.86%	33.33%	21.43%	2.38%	0.00%
Q15	28.57%	50.00%	11.90%	7.14%	2.38%
Q16	26.19%	42.86%	14.29%	16.67%	0.00%
Q17	50.00%	40.48%	7.14%	2.38%	0.00%
Q18	16.67%	40.48%	14.29%	23.81%	4.76%
Q19	30.95%	57.14%	11.90%	0.00%	0.00%
Q20	16.67%	30.95%	19.05%	26.19%	7.14%
Q21	57.14%	40.48%	2.38%	0.00%	0.00%
Q22	42.86%	42.86%	14.29%	0.00%	0.00%
Q23	23.81%	45.24%	16.67%	11.90%	2.38%
Q24	59.52%	30.95%	7.14%	2.38%	0.00%
Q25	45.24%	52.38%	2.38%	0.00%	0.00%
Q26	42.86%	54.76%	2.38%	0.00%	0.00%
Q27	45.24%	40.48%	14.29%	0.00%	0.00%
Q28	30.95%	23.81%	30.95%	14.29%	0.00%
Q29	7.14%	19.05%	57.14%	14.29%	2.38%
Q30	19.05%	28.57%	21.43%	28.57%	2.38%
Q31	38.10%	47.62%	14.29%	0.00%	0.00%
Q32	35.71%	45.24%	9.52%	9.52%	0.00%

Appendix

Q33	7.14%	30.95%	33.33%	28.57%	0.00%
Q34	28.57%	40.48%	26.19%	4.76%	0.00%

List of References

Aguiree, F., Brown, A., Cho, N. and Dahlquist, G. (2013) *IDF Diabetes Atlas*. 6th edn. International Diabetes Federation.

Ahola, R., Pyky, R., Jämsä, T., Mäntysaari, M., Koskimäki, H., Ikäheimo, T. M., Huotari, M.-L., Röning, J., Heikkinen, H. I. and Korpelainen, R. (2013) 'Gamified physical activation of young men--a Multidisciplinary Population-Based Randomized Controlled Trial (MOPO study).', *BMC public health*, 13, p. 32. doi: 10.1186/1471-2458-13-32.

Al-Herbish, A. and El-Mouzan, M. (2008) 'Prevalence of type 1 diabetes mellitus in Saudi Arabia children and adolescents', *Saudi Med J*, pp. 1285–1288.

Alberti, K. G. and Zimmet, P. Z. (1998) 'Definition, Diagnosis and Classification of Diabetes Mellitus and its Complications. Part 1: Diagnosis and Classification of Diabetes Mellitus Provisional Report of a WHO Consultation', *Diabetic Medicine: a Journal of the British Diabetic Association*, 15(7), pp. 539–553.

Allam, A., Kostova, Z., Nakamoto, K. and Schulz, P. J. (2015a) 'The effect of social support features and gamification on a web-based intervention for rheumatoid arthritis patients: Randomized controlled trial', *Journal of Medical Internet Research*, 17(1), p. e14. doi: 10.2196/jmir.3510.

Allam, A., Kostova, Z., Nakamoto, K. and Schulz, P. J. (2015b) 'The effect of social support features and gamification on a web-based intervention for rheumatoid arthritis patients: Randomized controlled trial', *Journal of Medical Internet Research*, 17(1), p. e14. doi: 10.2196/jmir.3510.

Alzaid, A. (2012) 'Diabetes: A tale of two cultures', *The British Journal of Diabetes & Vascular Disease*, 12(2), pp. 57–59. doi: 10.1177/1474651412444143.

Anderson, J. and Rainie, L. (2012) 'Gamification and the Internet: Experts Expect Game Layers to Expand in the Future, with Positive and Negative Results', *Games for Health Journal*, 1(4), pp. 299–302. doi: 10.1089/g4h.2012.0027.

Asbury, J.-E. (1995) 'Overview of Focus Group Research', *Qualitative Health Research*, pp. 414–420. doi: 10.1177/104973239500500402.

Association, A. D. (2013) 'Diagnosis and Classification of Diabetes Mellitus', *Diabetes Care*, 36(Suppl 1), pp. s67–s74.

BARGEN, T. VON, Zientz, C. and Haux, R. (2014) 'Gamification for mHealth-A Review of Playful

List of References

Mobile Healthcare', in Mantas, J., Househ, M., and Hasman, A. (eds) *Integrating Information Technology and Management for Quality of Care*. IOS Press, p. 225.

Barrera, M., Glasgow, R. E., McKay, H. G., Boles, S. M. and Feil, E. G. (2002) 'Do Internet-based support interventions change perceptions of social support?: An experimental trial of approaches for supporting diabetes self-management.', *American journal of community psychology*, 30(5), pp. 637–54.

Barrett, N., Swain, I., Gatzidis, C. and Mecheraoui, C. (2016) 'The use and effect of video game design theory in the creation of game-based systems for upper limb stroke rehabilitation', *Journal of Rehabilitation and Assistive Technologies Engineering*, 3(0), p. 2055668316643644. doi: 10.1177/2055668316643644.

Bassett, M. T. (2005) 'Diabetes is Epidemic', *American Journal of Public Health*, 95(9), p. 1496.

Van De Belt, T. H., Engelen, L. J. L. P. G., Berben, S. A. A. and Schoonhoven, L. (2010) 'Definition of Health 2.0 and Medicine 2.0: a Systematic Review.', *Journal of Medical Internet Research*, 12(2), p. e18.

Berg, B. (2009) *Qualitative research methods for the social sciences*, *Qualitative Research*. doi: 10.2307/1317652.

Bernard, R. (2006) *Research Methods in Anthropology: Qualitative and Quantitative Approaches*. 4th Editio. AltaMira Press.

Biesdorf, S. and Niedermann, F. (2014) *Healthcare's digital future*, *McKinsey & Company*. Available at: http://www.mckinsey.com/industries/ healthcare-systems-and-services/our-insights/healthcares-digital-future (Accessed: 28 April 2017).

Bland, J. and Altman, D. (1995) 'Multiple significance tests: the Bonferroni method', *Bmj*.

Blohm, I. and Leimeister, J. M. (2013) 'Gamification: Design of IT-based enhancing services for motivational support and behavioral change', *Business and Information Systems Engineering*, 5(4), pp. 275–278. doi: 10.1007/s12599-013-0273-5.

Bodenheimer, T. (2002) 'Patient Self-management of Chronic Disease in Primary Care', *Jama*, 288(19), p. 2469. doi: 10.1001/jama.288.19.2469.

Boyd, D. m. and Ellison, N. B. (2007) 'Social Network Sites: Definition, History, and Scholarship', *Journal of Computer-Mediated Communication*, 13(1), pp. 210–230.

Britten, N. (1995) 'Qualitative Research: Qualitative interviews in medical research', *Bmj*,

311(6999), pp. 251–253. doi: 10.1136/bmj.311.6999.251.

Brown, S. J., Lieberman, D. a, Germeny, B. a, Fan, Y. C., Wilson, D. M. and Pasta, D. J. (1997) 'Educational Video Game for Juvenile Diabetes: Results of a Controlled Trial', *Medical informatics*, 22(1), pp. 77–89.

Buie, A., Sizemore, M. and Jones, M. S. (2012) *Population Health Management : Using Technology to Cure What Ails Us*.

Bunchball (2014) *Bunchball Brings Gamification to Forefront at Dreamforce | Bunchball*, *Bunchball*. Available at: http://www.bunchball.com/news/bunchball-brings-gamification-forefront-dreamforce-2014 (Accessed: 2 January 2015).

Bunchball Inc (2013) *Gamification: A Cure For The Healthcare Industry?*

Cafazzo, J. A., Casselman, M., Hamming, N., Katzman, D. K. and Palmert, M. R. (2012) 'Design of an mHealth App for the Self-Management of Adolescent Type 1 Diabetes: a pilot study.', *Journal of medical Internet research*. Journal of Medical Internet Research, 14(3), p. 70.

Carlson, N. (2012) *Foursquare May Not Be Toast Yet, But It's Browning At The Edges | Business Insider*, *Business Insider*. Available at: https://www.businessinsider.com.au/foursquare-may-not-be-toast-yet-but-its-browning-at-the-edges-2012-4 (Accessed: 25 April 2017).

Castro-Cedeno, M. (2001) 'Human Needs, Motivation, and the Results of the NASA Culture Surveys', *Issues in NASA Program and Project Managment*, 6101(6).

Cawston, J. (2012) '2nd annual Games for Health Europe conference: let's start playing!', 19(12).

Cho, nam han, Whiting, D., Forouhi, N., Guariguata, L., Hambleton, I., Li, R., Majeed, A., Mbanya, J. C., Montoya, P. A., Motala, A., Narayan, K. M. V., Ramachandran, A., Rathmann, W., Roglic, G., Shaw, J., Silink, M. and Zhang, P. (2015) *IDF Diabetes Atlas*. Seventh Ed. Edited by D. Cavan, J. da R. Fernandes, L. Makaroff, K. Ogurtsova, and S. Webber. International Diabetes Federation.

Choi, B. C. K. and Pak, A. W. P. (2005) 'A catalog of biases in questionnaires.', *Preventing chronic disease*, 2(1), p. A13. doi: A13 [pii].

Chou, Y. (2014) *What is Gamification*, *Yu-kai Chou & Gamification*. Available at: http://www.yukaichou.com/gamification-examples/what-is-gamification/#.VKY8r0vVtuY (Accessed: 2 January 2015).

Chou, Y.-K. (2015) *Actionable gamification: Beyond points, badges, and leaderboards*, *Octalysis Media*.

List of References

Chromy, J. R. (2008) 'Snowball sampling', *Encyclopedia of Social Science Research Methods*, 10(2), pp. 824–825. doi: http://dx.doi.org/10.4135/9781412963947.n535.

Codish, D. and Ravid, G. (2014) 'Adaptive approach for gamification optimization', in *Proceedings - 2014 IEEE/ACM 7th International Conference on Utility and Cloud Computing, UCC 2014*, pp. 609–610. doi: 10.1109/UCC.2014.94.

Cohen, J. (1988) *Statistical Power Analysis for the Behavioral Sciences*. 2nd editio. New Jersy: Lawence Easlbaum Associates.

Coleman, M. T. and Newton, K. S. (2005) 'Supporting self-management in patients with chronic illness.', *American family physician*, 72(8), pp. 1503–10. Available at: http://www.ncbi.nlm.nih.gov/pubmed/16273817.

Creswell, J. (2003) 'Research design: Qualitative, Quantitative, and Mixed methods Approaches', pp. 1–26. doi: 10.4135/9781849208956.

Croson, R. and Gneezy, U. (2009) 'Gender Differences in Preferences', *Journal of Economic Literature*, 47(2), pp. 448–474. doi: 10.1257/jel.47.2.448.

Crotty, M. (1998) *The foundations of social research: meaning and perspective in the research process.* SAGE Publications.

Csikszentmihalyi, M. (1990) *Flow: The psychology of optimal performance*, *Optimal experience: Psychological studies of flow in consciousness*. New York: Harper and Row.

Csikszentmihalyi, M. (1997) *Finding flow: The Psychology of Engagement with Everyday Life*. BasicBooks.

Cugelman, B. (2013) 'Gamification: What It Is and Why It Matters to Digital Health Behavior Change Developers', *JMIR Serious Games*, 1(1), p. e3. doi: 10.2196/games.3139.

Cugelman, B., Thelwall, M. and Dawes, P. (2011) 'Online interventions for social marketing health behavior change campaigns: a meta-analysis of psychological architectures and adherence factors.', *Journal of medical Internet research*. Journal of Medical Internet Research, 13(1), p. e17. doi: 10.2196/jmir.1367.

Dale, S. (2014) 'Gamification : Making work fun, or making fun of work?', *Business Information Review*, 31(2), pp. 82–90. doi: 10.1177/0266382114538350.

Darejeh, A. and Salim, S. S. (2016) 'Gamification Solutions to Enhance Software User Engagement – A Systematic Review', *International Journal of Human-Computer Interaction*. Taylor & Francis,

7318(May), p. 10447318.2016.1183330. doi: 10.1080/10447318.2016.1183330.

Davison, K. P., Pennebaker, J. W. and Dickerson, S. S. (2000) 'Who Talks? The Social Psychology of Illness Support Groups.', *American Psychologist*, 55(2), pp. 205–217.

Denzin, N. K. (1978) 'The Research Act', in *Symbolic Interaction: A Reader in Social Psychology.*, pp. 58–68. doi: 10.2307/2092290.

Deterding, S. (2010) 'Pawned. Gamification and its discontents', *Playful 2010*. doi: 10.1007/s00256-005-0928-5.

Deterding, S. (2012) 'Gamification: Desinging for Motivation', *Interactions*, 19(4), p. 14. doi: 10.1145/2212877.2212883.

Deterding, S., Dixon, D., Khaled, R. and Nacke, L. (2011) 'From game design elements to gamefulness: defining "gamification"', in *Proceedings of the 15th*. ACM (MindTrek '11), pp. 9–15. doi: 10.1145/2181037.2181040.

Deterding, S., Sicart, M., Nacke, L., O'Hara, K. and Dixon, D. (2011) 'Gamification: Using Game Design Elements in Non-Gaming Contexts', in *CHI'11 Extended Abstracts on Human Factors in Computing Systems*. New York, USA: ACM Press, pp. 2425–2428.

Dicheva, D., Dichev, C., Agre, G. and Angelova, G. (2015) 'Gamification in education: A systematic mapping study', *Educational Technology and Society*, 18(3), pp. 75–88. doi: 10.1109/EDUCON.2014.6826129.

DiCicco-Bloom, B. and Crabtree, B. F. (2006) 'The qualitative research interview', *Medical Education*, pp. 314–321. doi: 10.1111/j.1365-2929.2006.02418.x.

Dunning, T. (2014) *Care of People with Diabetes: A Manual of Nursing Practice.* Fourth edi. Wiley-Blackwell.

Egede, L. E., Zheng, D. and Simpson, K. (2002) 'Comorbid Depression is Associated With Increased Health Care Use and Expenditures in Individuals With Diabetes', *Diabetes Care*, 25(3), pp. 464–470. doi: 10.2337/diacare.25.3.464.

El-Gayar, O., Timsina, P., Nawar, N. and Eid, W. (2013) 'Mobile applications for diabetes self-management: status and potential.', *Journal of diabetes science and technology*, 7(1), pp. 247–62. doi: 10.1089/dia.2014.1507.

El-Hilly, A. A., Iqbal, S. S., Ahmed, M., Sherwani, Y., Muntasir, M., Siddiqui, S., Al-Fagih, Z., Usmani, O. and Eisingerich, A. B. (2016) 'Game On? Smoking Cessation Through the Gamification of

List of References

mHealth: A Longitudinal Qualitative Study.', *JMIR serious games*, 4(2), p. e18. doi: 10.2196/games.5678.

Engelgau, M. M., Narayan, K. M. V., Saaddine, J. B. and Vinicor, F. (2003) 'Addressing the Burden of Diabetes in the 21st Century: Better Care and Primary Prevention.', *Journal of the American Society of Nephrology : JASN*, 14(7 Suppl 2), pp. S88-91.

Entertainment Software Association (2016) 'Essential Facts: About the computer and video game industry', *Entertainment Software Association*, p. 11. Available at: http://essentialfacts.theesa.com/Essential-Facts-2016.pdf.

Ewais, S. and Alluhaidan, A. (2015) 'Classification of Stress Management mHealth Apps Based on Octalysis Framework', *AMCIS 2015 Proceedings*, (March), pp. 1–8. Available at: http://aisel.aisnet.org/amcis2015/HealthIS/GeneralPresentations/16.

Eysenbach, G. (2008) 'Medicine 2.0: Social Networking, Collaboration, Participation, Apomediation, and Openness.', *Journal of Medical Internet Research*, 10(3), p. e22. doi: 10.2196/jmir.1030.

Farzan, R., Dimicco, J. M., Millen, D. R., Brownholtz, B., Geyer, W., Dugan, C. and Street, R. (2008) 'Results from Deploying a Participation Incentive Mechanism within the Enterprise', in *In Proceedings of CHI*. Florence, Italy.

Faul, F., Erdfelder, E., Buchner, A. and Lang, A.-G. (2009) 'Statistical power analyses using G*Power 3.1: tests for correlation and regression analyses.', *Behavior research methods*, 41(4), pp. 1149–60. doi: 10.3758/BRM.41.4.1149.

Faul, F., Erdfelder, E., Lang, A.-G. and Buchner, A. (2007) 'G*Power: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences.', *Behavior Research Methods*, 39(2), pp. 175–191. doi: 10.3758/BF03193146.

Flores, E., Tobon, G., Cavallaro, E., Cavallaro, F. I., Perry, J. C. and Keller, T. (2008) 'Improving patient motivation in game development for motor deficit rehabilitation', *Proceedings of the 2008 International Conference in Advances on Computer Entertainment Technology - ACE '08*, 7(8), p. 381. doi: 10.1145/1501750.1501839.

Fogg, B. (2009) 'A behavior model for persuasive design', *Proceedings of the 4th International Conference on Persuasive Technology*. New York, New York, USA: ACM Press, p. 1. doi: 10.1145/1541948.1541999.

Fogg, B. (2011) *Tiny Habits w/ Dr. BJ Fogg - Behavior Change*, *Tiny Habits*. Available at:

http://tinyhabits.com/ (Accessed: 18 November 2014).

Fogg, B. J. (2013) *Fogg Method*, *Fogg Method: 3 steps to changing behaviour*. Available at: http://www.foggmethod.com/ (Accessed: 27 December 2014).

Frith, J. (2013) 'Turning life into a game: Foursquare, gamification, and personal mobility', *Mobile Media {&} Communication*, 1(2), pp. 248–262. doi: 10.1177/2050157912474811.

Frutos-Pascual, M., Zapirain, B. G. and Zorrilla, A. M. (2014) 'Adaptive tele-therapies based on serious games for health for people with time-management and organisational problems: preliminary results.', *International journal of environmental research and public health*, 11(1), pp. 749–72. doi: 10.3390/ijerph110100749.

Fuchs, M., Fizek, S., Ruffino, P. and Schrape, N. (2014) *Rethinking Gamification*, *Rethinking Gamification*.

Goasduff, L. (2011) *Gartner Says By 2015, More Than 50 Percent of Organizations That Manage Innovation Processes Will Gamify Those Processes*, *Gartner*. Available at: http://www.gartner.com/newsroom/id/1629214 (Accessed: 2 January 2015).

Göbel, S., Hardy, S. and Wendel, V. (2010) 'Serious Games for Health - Personalized Exergames', *Proceedings of the 18th ACM international conference on Multimedia*, pp. 1663–1666. doi: 10.1145/1873951.1874316.

Goyal, S., Morita, P., Lewis, G. F., Yu, C., Seto, E. and Cafazzo, J. A. (2016) 'The Systematic Design of a Behavioural Mobile Health Application for the Self-Management of Type 2 Diabetes', *Canadian Journal of Diabetes*. Elsevier Inc., 40(1), pp. 95–104. doi: 10.1016/j.jcjd.2015.06.007.

Griffiths, M. D., Davies, M. N. O. and Chappell, D. (2004) 'Demographic factors and playing variables in online computer gaming.', *Cyberpsychology & Behavior*, 7(4), pp. 479–87. doi: 10.1089/cpb.2004.7.479.

Gruman, J. C. (2013) *An Open Letter to Mobile Health App Developers and Their Funders*, *Center for Advancing Health*. Available at: http://www.cfah.org/blog/2013/an-open-letter-to-mobile-health-app-developers-and-their-funders#.UfrAXJJORu0 (Accessed: 26 July 2014).

Guest, G. and Johnson, L. (2006) 'How Many Interviews Are Enough? An Experiment with Data Saturation and Variability', 18(1), pp. 59–82. doi: 10.1177/1525822X05279903.

Guion, L. A., Diehl, D. C. and Mcdonald, D. (2002) 'Triangulation : Establishing the Validity of Qualitative', *University of Florida/IFAS*, pp. 1–3. doi: #FCS6014.

List of References

Hagglund, P. (2012) 'Taking gamification to the next level', p. 37.

Haltiwanger, E. P. and Brutus, H. (2012) 'A Culturally Sensitive Diabetes Peer Support for Older Mexican-Americans', *Occupational Therapy International*, 19(2), pp. 67–75. doi: 10.1002/oti.320.

Hamari, J. and Koivisto, J. (2013) 'Social motivations to use gamification: an empirical study of gamifying exercise', *Proceedings of the 21st European Conference on Information Systems SOCIAL*, (JUNE), pp. 1–12. doi: 10.1016/j.chb.2015.07.031.

Hamari, J. and Koivisto, J. (2015) '"Working out for likes": An empirical study on social influence in exercise gamification', *Computers in Human Behavior*, 50, pp. 333–347. doi: 10.1016/j.chb.2015.04.018.

Hamari, J., Koivisto, J. and Sarsa, H. (2014) 'Does gamification work?--a literature review of empirical studies on gamification', *System Sciences (HICSS), 2014 47th Hawaii International Conference on*, pp. 3025–3034. doi: 10.1109/HICSS.2014.377.

Heisler, M., Bouknight, R. R., Hayward, R. A., Smith, D. M. and Kerr, E. A. (2002) 'The Relative Importance of Physician Communication, Participatory Decision Making, and Patient Understanding in Diabetes Self-Management', *Journal of General Internal Medicine*, 17(4), pp. 243–252.

Heisler, M., Vijan, S., Makki, F. and Piette, J. D. (2007) 'Overview of Peer Support Models to Improve Diabetes Self-Management and Clinical Outcomes', *Diabetes Spectrum*, 20(4), pp. 214–221. doi: 10.2337/diaspect.20.4.214.

Hertel, N. T., Vedel, K., Rohde, L. and Olesen, J. B. (2013) 'Serious disease-serious game', *Studies in Health Technology and Informatics*, 192(1–2), p. 1166. doi: 10.3233/978-1-61499-289-9-1166.

Hochleitner, W., Lankes, M., Nacke, L. E., Tscheligi, M., Busch, M., Mattheiss, E., Orji, R. and Marczewski, A. (2015) 'Personalization in serious and persuasive games and gamified interactions', in *CHI PLAY 2015 - Proceedings of the 2015 Annual Symposium on Computer-Human Interaction in Play*, pp. 811–816. doi: 10.1145/2793107.2810260.

Holmes, D., Charles, D., Morrow, P., McClean, S. and McDonough, S. (2016) 'Rehabilitation Game Model for Personalised Exercise', *Proceedings - 2015 International Conference on Interactive Technologies and Games, ITAG 2015*, pp. 41–48. doi: 10.1109/iTAG.2015.11.

Hughes, B., Joshi, I. and Wareham, J. (2008) 'Health 2.0 and Medicine 2.0: Tensions and Controversies in the Field.', *Journal of Medical Internet Research*, 10(3), p. e23.

Hunicke, R., LeBlanc, M. and Zubek, R. (2004) 'MDA: A Formal Approach to Game Design and Game Research', *Workshop on Challenges in Game AI*, pp. 1–4. doi: 10.1.1.79.4561.

Jick, T. (1979) 'Mixing Qualitative and Quantitative Methods: Triangulation in Action', *Administrative Science Quarterly*, 24(4).

Johnson, D., Deterding, S., Kuhn, K.-A., Staneva, A., Stoyanov, S. and Hides, L. (2016) 'Gamification for health and wellbeing: A systematic review of the literature', *Internet Interventions*, 6, pp. 89–106. doi: 10.1016/j.invent.2016.10.002.

Johnson, R. B. and Onwuegbuzie, A. J. (2004) 'Mixed Methods Research : A Research Paradigm Whose Time Has Come', *Educational Researcher*, 33(7), pp. 14–26. doi: 10.3102/0013189X033007014.

Juul, J. (2005) *Video games between real rules and fictional worlds*, *Video games between real rules and fictional worlds*. doi: 10.1353/cj.0.0107.

Kamel Boulos, M. N., Gammon, S., Dixon, M. C., MacRury, S. M., Fergusson, M. J., Miranda Rodrigues, F., Mourinho Baptista, T. and Yang, S. P. (2015) 'Digital Games for Type 1 and Type 2 Diabetes: Underpinning Theory With Three Illustrative Examples', *JMIR Serious Games*, 3(1), p. e3. doi: 10.2196/games.3930.

Kaplowitz, M. D. and Hoehn, J. P. (2001) 'Kaplowitz, Hoehn (2001)- Do focus groups and individual interviews reveal the same information for natural resource valuation', 36, pp. 237–247.

Kapp, K. M. (2012) *The Gamification of Learning and Instruction: Game-based Methods and Strategies for Training and Education*. John Wiley & Sons.

Kharrazi, H., Faiola, A. and Defazio, J. (2009) 'Healthcare Game Design : Behavioral Modeling of Serious Gaming Design for Children with Chronic Diseases', pp. 335–344.

King, B. (2011) *Recyclebank, Google Explain How to Game Environmental Behavior*. Available at: https://www.recyclebank.com/corporate-info/newsroom/in-the-news/254 (Accessed: 5 May 2017).

King, D., Greaves, F., Exeter, C. and Darzi, A. (2013) '"Gamification": influencing health behaviours with games.', *Journal of the Royal Society of Medicine*, 106(3), pp. 76–8. doi: 10.1177/0141076813480996.

Kitzinger, J. (1995) 'Qualitative research: Introducing focus groups.', *BMJ : British Medical Journal*, 311(7000), pp. 299–302. doi: 10.1136/bmj.311.7000.299.

List of References

Kleek, M. Van, Smith, D. A., Hall, W. and Shadbolt, N. R. (2013) '" The Crowd Keeps Me in Shape ": Social Psychology and the Present and Future of Health Social Machines', in *Proceedings of the 22nd international conference on World Wide Web companion*. International World Wide Web Conferences Steering Committee, pp. 927–931.

Koivisto, J. and Hamari, J. (2014) 'Demographic Differences in Perceived Benefits from Gamification', *Computers in Human Behavior*. Elsevier Ltd, 35, pp. 179–188. doi: 10.1016/j.chb.2014.03.007.

Krippendorff, K. (2004) 'Intrinsic Motivation and Human-Centered Design', *Theoretical Issues in Ergonomic Science*, 5, pp. 43–72.

Krueger, R. a. and Casey, M. A. (2009) *Focus groups: A practical guide for applied research*, *Qualitative Social Research*.

Lazem, S., Webster, M., Holmes, W. and Wolf, M. (2015) 'Games and Diabetes: A Review Investigating Theoretical Frameworks, Evaluation Methodologies, and Opportunities for Design Grounded in Learning Theories.', *Journal of diabetes science and technology*, 10(2), pp. 447–52. doi: 10.1177/1932296815604634.

Lee, D. T. F., Woo, J. and Mackenzie, A. E. (2002) 'The cultural context of adjusting to nursing home life: Chinese elders' perspectives.', *The Gerontologist*, 42(5), pp. 667–675. doi: 10.1093/geront/42.5.667.

LeHong, H. and Fenn, J. (2013) *2013 Hype Cycle for Emerging Technologies Maps Out Evolving Relationship Between Humans and Machines [Online]*, *Gartner Incorporated*. Available at: http://www.gartner.com/newsroom/id/2575515.

Lin, R. J. and Zhu, X. (2012) 'Leveraging social media for preventive care- A gamification system and insights', in *Studies in Health Technology and Informatics*, pp. 838–842. doi: 10.3233/978-1-61499-101-4-838.

Lister, C., West, J. H., Cannon, B., Sax, T. and Bordegard, D. (2014) 'Just a Fad? Gamification in Health and Fitness Apps', *JMIR Serious Games*.

Lister, C., West, J. H., Cannon, B., Sax, T. and Brodegard, D. (2014) 'Just a fad? Gamification in health and fitness apps', *Journal of Medical Internet Research*, 16(8), p. e9. doi: 10.2196/games.3413.

Llagostera, E. (2012) 'On Gamification and Persuasion', *Proceedings of SBGames 2012*, pp. 12–21.

Logie, C. (2014) 'The sage encyclopedia of action research- focus groups', *Action Learning: Research and Practice*. doi: http://dx.doi.org/10.4135/9781446294406.n145.

Lynch, C. (2013) *What do Accenture, Microsoft, IBM, Oracle and Deloitte Employees Have in Common?*, *Badgeville Blog*. Available at: http://badgeville.com/2013/12/03/is-gamification-in-your-profile (Accessed: 2 January 2015).

Mack, N., Woodsong, C. and MacQueen, K. (2005) 'Qualitative research methods: A data collector's field Guide', *mprcenter.org*. Available at: http://mprcenter.org/qualitative-research-methods-overview/ (Accessed: 31 August 2015).

Malone, T. (1982) 'Heuristics for Designing Enjoyable User Interfaces: Lessons from Computer Games', in *Proceedings of the 1982 Conference on Human Factors in Computing Systems*. ACM, pp. 63–68.

Maslow (1943) 'A Theory of Human Motivation'.

Mccallum, S. (2012) 'Gamification and Serious Games for Personalized Health', pp. 85–97. doi: 10.3233/978-1-61499-069-7-85.

McCallum, S. (2012a) 'Gamification and serious games for personalized health.', *Studies in health technology and informatics*, 177, pp. 85–96.

McCallum, S. (2012b) *PHealth 2012: Proceedings of the 9th International Conference on Wearable Micro and Nano Technologies for Personalized Health*. Edited by B. Blobel, P. Pharow, and F. Sousa. Porto, Portugal: IOS Press.

McGonigal, J. (2011) *Reality Is Broken: Why Games Make Us Better and How They Can Change the World*. 2011th edn, *New York*. 2011th edn. Penguin Books. doi: 10.1075/ni.10.1.03bro.

Mekler, E. D., Brühlmann, F., Opwis, K. and Tuch, A. N. (2013) 'Disassembling Gamification: The Effects of Points and Meaning on User Motivation and Performance', in *CHI '13 Extended Abstracts on Human Factors in Computing Systems on - CHI EA '13*, p. 1137. doi: 10.1145/2468356.2468559.

Mendenhall, W., Beaver, B. and Beaver, R. (2006) *Introduction to Probability and Statistics*. Duxbury Press.

Mendenhall, W., Beaver, R. and Beaver, B. (2012) *Introduction to Probability and Statistics*. 14th Editi. Duxbury Press.

Miller, A. S., Cafazzo, J. a and Seto, E. (2014) 'A game plan: Gamification design principles in

List of References

mHealth applications for chronic disease management.', *Health informatics journal*, pp. 1–10. doi: 10.1177/1460458214537511.

Mora, A., Riera, D., González, C. and Arnedo-Moreno, J. (2015) 'A literature review of gamification design frameworks'.

Morgan, D. L. (1997) 'Focus Groups as Qualitative Research.', *Sage Publications*, pp. 32–46. doi: 10.4135/9781412984287.

Morris, A. (2014) 'Why Apple Wants to Help You Track Your Health', *MIT Technology Review*, June. Available at: http://www.technologyreview.com/news/527921/why-apple-wants-to-help-you-track-your-health/.

Morschheuser, B., Werder, K., Hamari, J. and Abe, J. (2017) 'How to gamify? A method for designing gamification', *Proceedings of the 50th Annual Hawaii International Conference on System Sciences (HICSS), Hawaii, USA, January 4-7, 2017*, (January), pp. 1–10.

Morse, J. M. (2003) 'Principles of mixed mehtods and multimethod research design', in *Handbook of mixed methods in social and behavioural research*, pp. 189–208.

Muntean, C. C. I. (2011) 'Raising engagement in e-learning through gamification', *The 6th International Conference on Virtual Learning ICVL 2011*, (1), pp. 323–329. Available at: http://icvl.eu/2011/disc/icvl/documente/pdf/met/ICVL_ModelsAndMethodologies_paper42.pdf.

N.I.C.E (2007) *Behaviour Change: The Principles for Effective Interventions*. NICE. Available at: http://www.nice.org.uk/guidance/ph6 (Accessed: 15 December 2014).

Nacke, L. E. and Deterding, S. (2017) 'The maturing of gamification research', *Computers in Human Behavior*. Elsevier Ltd, 71(January), pp. 450–454. doi: 10.1016/j.chb.2016.11.062.

Nacke, L. E., Klauser, M. and Prescod, P. (2015) 'Social Player Analytics in a Facebook Health Game', *HCIK '15 Proceedings of HCI Korea*, pp. 180–187.

Nelson, M. J. (2012) 'Soviet and American precursors to the gamification of work', *Proceeding of the 16th International Academic MindTrek Conference on - MindTrek '12*, p. 23. doi: 10.1145/2393132.2393138.

Nguyen, V. C. K. (2015) 'Gamification Framework for Marketing Courses', p. 61. Available at: http://www.theseus.fi/handle/10024/97069.

Nicholson, S. (2012) 'A User-Centered Theoretical Framework for Meaningful Gamification A Brief Introduction to Gamification Organismic Integration Theory Situational Relevance and Situated

Motivational Affordance', in *Games+Learning+Society 8.0*.

Nielsen, J. (1994) 'Guerrilla HCI: Using discount usability engineering to penetrate the intimidation barrier', *Cost-justifying usability*, pp. 245–272. Available at: http://www.nngroup.com/articles/guerrilla-hci/.

Nodhturft, V. and Schneider, J. (2000) 'Chronic Disease Self-Management', *Nursing Clinics of North America*, 35(2).

Openakker, R. (2006) 'Advantages and Disadvantages of Four Interview Techniques Used in Qualitative Research', *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research*, 7(4). Available at: http://www.qualitative-research.net/index.php/fqs/article/view/175/391%3E.

Pettey, C. (2011) *Gartner Predicts Over 70 Percent of Global 2000 Organisations Will Have at Least One Gamified Application by 2014*, *Gartner*. Available at: http://www.gartner.com/newsroom/id/1844115 (Accessed: 2 January 2015).

Peyrot, M., Rubin, R. R., Lauritzen, T., Snoek, F. J., Matthews, D. R. and Skovlund, S. E. (2005) 'Psychosocial problems and barriers to improved diabetes management: results of the Cross-National Diabetes Attitudes, Wishes and Needs (DAWN) Study.', *Diabetic medicine : a journal of the British Diabetic Association*, 22(10), pp. 1379–85. doi: 10.1111/j.1464-5491.2005.01644.x.

Phillips, A. (2016) 'Improving self-management of type 1 and type 2 diabetes', *Nursing Standard*, 30(19), pp. 52–60. doi: 10.7748/ns.30.19.52.s44.

Pink, D. (2009) *Drive: The Surprising Truth about What Motivates Us*. Riverhead Hardcover.

Primack, B. a, Carroll, M. V, McNamara, M., Klem, M. Lou, King, B., Rich, M., Chan, C. W. and Nayak, S. (2012) 'Role of video games in improving health-related outcomes: a systematic review.', *American journal of preventive medicine*. Elsevier Inc., 42(6), pp. 630–8. doi: 10.1016/j.amepre.2012.02.023.

Rao, A., Hou, P., Golnik, T., Flaherty, J. and Vu, S. (2010) 'Evolution of Data Management Tools For Managing Self-Monitoring of Blood Glucose Results: a Survey of iPhone Applications.', *Journal of Diabetes Science and Technology*, 4(4), pp. 949–957.

Reeves, B. and Read, J. (2009) 'Total Engagement: Using Games and Virtual Worlds to Change the Way People Work and Businesses Compete', *New York, USA*, (Apr 1).

Rego, P., Moreira, P. M. and Reis, L. P. (2002) 'Serious Games for Rehabilitation A Survey and a Classification Towards a Taxonomy'.

List of References

Roepke, A. M., Jaffee, S. R., Riffle, O. M., McGonigal, J., Broome, R. and Maxwell, B. (2015) 'Randomized Controlled Trial of SuperBetter, a Smartphone-Based/Internet-Based Self-Help Tool to Reduce Depressive Symptoms', *Games for Health Journal*, 4(3), pp. 235–246. doi: 10.1089/g4h.2014.0046.

Rogers, Y., Sharp, H. and Preece, J. (2011) *Interaction design: Beyond human computer interaction*. Wiley.

Rose, K. J., Konig, M. and Wiesbauer, F. (2013) 'Evaluating Success for Behavioral Change in Diabetes Via mHealth and Gamification mySugr's Keys to Retention and Patient Engagement', *Diabetes Technology & Therapeutics*. Paris, France, 15. doi: 10.1089/dia.2012.1221.

Rothbauer, P. (2008) 'Triangulation.', *The SAGE Encyclopedia of Qualitative Research Methods.*, p. 892–894. doi: http://dx.doi.org/10.4135/9781412963909.n468.

Rowley, J. (2014) 'Designing and using research questionnaires', *Management Research Review*, 37(3), pp. 308–330. doi: 10.1108/MRR-02-2013-0027.

Runeson, P. and Höst, M. (2009) 'Guidelines for conducting and reporting case study research in software engineering', *Empirical Software Engineering*, 14(2), pp. 131–164. doi: 10.1007/s10664-008-9102-8.

Ryan, R. M. and Deci, E. L. (2000) 'Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being.', *The American psychologist*, 55(1), pp. 68–78. Available at: http://www.ncbi.nlm.nih.gov/pubmed/11392867.

Saudi Arabia | International Diabetes Federation (2015) *International Diabetes Federation*. Available at: http://www.idf.org/membership/mena/saudi-arabia (Accessed: 3 May 2016).

Schultz, W. (2006) 'Behavioral Theories and the Neurophysiology of Reward.', *Annual Review of Psychology*, 57, pp. 87–115.

Seaborn, K. and Fels, D. I. (2014) 'Gamification in theory and action: A survey', *International Journal of Human Computer Studies*, 74, pp. 14–31. doi: 10.1016/j.ijhcs.2014.09.006.

Seeman, T. E. (1996) 'Social Ties and Health: The Benefits of Social Integration', *Annals of Epidemiology*, 6(5), pp. 442–451.

Shaw, R. J. and Johnson, C. M. (2011) 'Health Information Seeking and Social Media Use on the Internet among People with Diabetes.', *Online journal of public health informatics*, 3(1), pp. 1–9. doi: 10.5210/ojphi.v3i1.3561.

Simões, J., Redondo, R. D. and Vilas, A. F. (2012) 'A social gamification framework for a K-6 learning platform', *Computers in Human Behavior*, (June 2015). doi: 10.1016/j.chb.2012.06.007.

Sizemore, M. and Jones, M. S. (2011) *Healthcare Gamification: Is it time for physicians to prescribe gaming to patients?*

Skinner, B. F. (1938) *The Behavior of Organisms: an Experimental Analysis.* Edited by R. Elliott.

Somekh, B. and Lewin, C. (2005) *Research Methods in the Social Sciences*. London: SAGE Publications.

de Sousa Borges, S., Durelli, V. H. S., Macedo Reis, H. and Isotani, S. (2014) 'A systematic mapping on gamification applied to education', *Proceedings of the 29th Annual ACM Symposium on Applied Computing - SAC '14*, (Icmc), pp. 216–222. doi: 10.1145/2554850.2554956.

Steinhardt, M. A., Mamerow, M. M., Brown, S. A. and Jolly, C. A. (2009) 'A resilience intervention in African American adults with type 2 diabetes: a pilot study of efficacy.', *The Diabetes educator*, 35(2), pp. 274–84. doi: 10.1177/0145721708329698.

Stott, A. and Neustaedter, C. (2013) 'Analysis of gamification in education', *Surrey*, pp. 1–8. Available at: http://carmster.com/clab/uploads/Main/Stott-Gamification.pdf.

Sudan, J. (2013) *Gamification - Extrinsic vs. Intrinsic Rewards*, *Playful Wingmen*. Available at: http://www.slideshare.net/playfulwingmen/gamification-extrinsic-vs-intrinsic-rewards-17681228 (Accessed: 3 January 2015).

Superbetter Labs (2013) *Results of A Randomized Controlled Trial: The Effects of SuperBetter on Depression*. Available at: http://janemcgonigal.com/learn-me/.

Susi, T., Johannesson, M. and Backlund, P. (2007) 'Serious Games – An Overview', *Elearning*, 73(10), p. 28. doi: 10.1.1.105.7828.

Swan, M. (2009) 'Emerging patient-driven health care models: An examination of health social networks, consumer personalized medicine and quantified self-tracking', *International Journal of Environmental Research and Public Health*, 6(2), pp. 492–525. doi: 10.3390/ijerph6020492.

Tashiro, J. (2009) 'What really works in serious games for healthcare education', *Proceedings of the 2009 Conference on Future Play on @ GDC Canada - FuturePlay '09*. New York, New York, USA: ACM Press, p. 3. doi: 10.1145/1639601.1639604.

Tessmer, M. (1993) *Planning and conducting formative evaluations: Improving the quality of education and training*, *Planning and Conducting Formative Evaluations*. Available at:

List of References

http://books.google.com/books?hl=en&lr=&id=GZbe0pOj4FUC&oi=fnd&pg=P
A7&dq=Planning+and+Conducting+Formative+Evaluations&ots=HilZ3PiNWC&sig=j
Hf9OVbV88BBSj6X9--n5KnxK-0.

Thaler, R. H. and Sunstien, C. R. (2009) *Nudge: Improving Decisions About Health, Wealth and Happiness*. Penguin.

The Diabetes Control and Complications Trial Research Group (1993) 'The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus.', *New England Journal of Medicine*, pp. 977–986.

Thurmond, V. a (2001) 'The point of triangulation.', *Journal of nursing scholarship : an official publication of Sigma Theta Tau International Honor Society of Nursing / Sigma Theta Tau*, 33(3), pp. 253–8. Available at: http://www.ncbi.nlm.nih.gov/pubmed/11552552.

van der Ven, N. (2003) 'Psychosocial Group Interventions in Diabetes Care', *Diabetes Spectrum*, 16(2), pp. 88–95. doi: 10.2337/diaspect.16.2.88.

de Vette, F., Tabak, M., Dekker - van Weering, M. and Vollenbroek-Hutten, M. (2015) 'Engaging Elderly People in Telemedicine Through Gamification', *JMIR Serious Games*, 3(2ga), p. e9. doi: 10.2196/games.4561.

Watters, C., Oore, S., Shepherd, M., Abouzied, A., Cox, A., Kellar, M., Kharrazi, H., Liu, F. and Otley, A. (2006) 'Extending the Use of Games in Health Care', 0(C), pp. 1–8.

Werbach, K. and Hunter, D. (2012) *For the Win: How Game Thinking Can Revolutionize Your Business*. Wharton Digital Press.

White, M. (2001) 'Receiving Social Support Online: Implications for Health Education', *Health Education Research*, 16(6), pp. 693–707.

Williams, D., Yee, N. and Caplan, S. E. (2008) 'Who plays, how much, and why? Debunking the stereotypical gamer profile', *Journal of Computer-Mediated Communication*, 13(4), pp. 993–1018. doi: 10.1111/j.1083-6101.2008.00428.x.

Wortley, D. (2014) 'Gamification and geospatial health management', in *IOP Conference Series: Earth and Environmental Science*. doi: 10.1088/1755-1315/20/1/012039.

Wu, M. (2014) *The Power of a Nudge—Part 2: Little Nudges with Big Impact, Lithium Community*. Available at: http://community.lithium.com/t5/Science-of-Social-blog/The-Power-of-a-Nudge-Part-2-Little-Nudges-with-Big-Impact/ba-p/166463 (Accessed: 28 December 2014).

Yoon, J.-W. and Jun, H.-S. (2005) 'Autoimmune Destruction of Pancreatic Beta Cells.', *American Journal of Therapeutics*, 12(6), pp. 580–591.

Zichermann, G. and Cunningham, C. (2011) *Gamification by Design: Implementing Game Mechanics in Web and Mobile Apps*. O'Reilly Media, Inc.

Zichermann, G. and Joselin, L. (2013) *The Gamification Revolution: How Leaders Leverage Game Mechanics to Crush the Competition.* McGraw-Hill Education.

Zimmerman, E. and Salen, K. (2003) *Rules of Play: Game Design Fundementals*. Massachusetts Institute of Technology.

Zimmet, P., Alberti, K. G. and Shaw, J. (2001) 'Global and Societal Implications of the Diabetes Epidemic', *Nature*. Nature Publishing Group, 414(6865), pp. 782–787.

Zrebiec, J. F. (2005) 'Internet communities: do they improve coping with diabetes?', *The Diabetes educator*, 31(6), pp. 825–8, 830–2, 834, 836. doi: 10.1177/0145721705282162.