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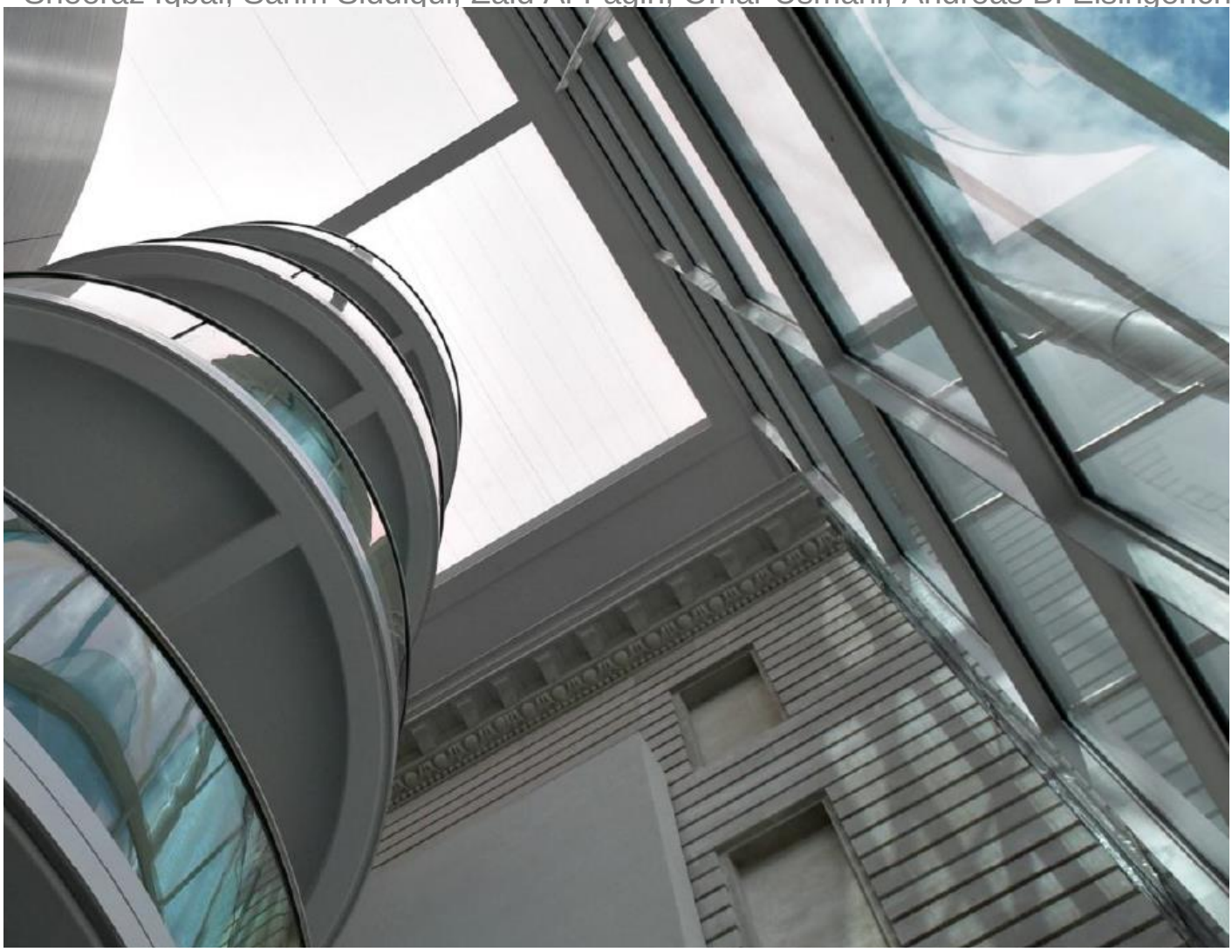

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EXAMINING THE ROLE OF GAMIFICATION AND USE OF MHEALTH APPS IN THE CONTEXT OF SMOKING CESSATION: A REVIEW OF EXTANT KNOWLEDGE AND OUTLOOK

BY

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Executive Summary

Smoking is the largest cause of preventable mortality in the United Kingdom, and whilst 68% of smokers want to quit, only 3% of them are successful. mHealth looks to join today's arsenal of smoking cessation techniques, with an increasing number of apps looking to gamification as a tool to drive positive behaviour change. Briefly, gamification is the use of game design elements in non-game contexts. Here we aim to review extant knowledge and offer an outlook in terms of avenues that may inform future work.

The Centre for Disease Control (CDC) regards smoking as the most important cause of preventable morbidity and premature mortality worldwide. Globally, it is responsible for 6 million deaths annually, with the figure projected to rise to 8 million by 2030 (Centers for Disease Control and Prevention, 2015). A British Medical Journal (BMJ) study reported that smoking was responsible for 19% of all deaths in the UK, with a direct cost of £5.2 billion to the NHS (Allender, Balakrishnan, Scarborough, Webster, & Rayner, 2009). Moreover, there is a significant gap between the number of individuals expressing a desire to quit smoking (estimated at 68%), and the number of smokers who manage to do so successfully (estimated at 3%); thereby suggesting a shortfall in existing smoking cessation techniques (Centers for Disease Control and Prevention, 2011).

This is particularly important, given that the financial structure of healthcare systems in developed countries is at a critical stage, as a result of spiralling treatment costs. The 'Five Year Forward View' published by the NHS plans to tackle this by providing a "radical upgrade in prevention and public health" and to tackle "avoidable disease with national hard hitting action on […] smoking" (NHS England, 2014). This has led to an increased emphasis on mobile technologies as a delivery mechanism for preventative healthcare interventions. The advent of the iPhone in 2007, followed closely in 2008 by Google's open-source alternative, Android, led to the creation of a new category of devices; propelling smartphones from the domain of business users into a powerful mass consumer device. In the UK, smartphone penetration is estimated at 71.7%, and is forecast to climb to 80.9% by 2017 (eMarketer, 2015).

The ubiquity of smartphones has been of great benefit to medicine, leading to conditions that are ripe for a mobile health (mHealth) revolution. Smartphones boast a number of advantageous qualities over their traditional technology counterparts, by virtue of their geo-location capabilities, inbuilt accelerometer measuring daily activity and 'always-on' connectivity (King, Greaves, Exeter, & Darzi, 2013a). In short, there are two major categories for mHealth interventions. First, they can be designed to improve disease management; for example, by increasing medication adherence. Second, they can be used to promote positive health behaviour; for instance, by encouraging physical activity or smoking cessation. In both cases, the fact that individuals carry their mobile devices with them allows for temporal synchronisation of intervention delivery, where the intervention claims the user's attention at the right time (Free et al., 2013). For example, diabetics could use their smartphone to request immediate advice from their diabetes nurse regarding their insulin regime; subsequently, leader to better management and fewer hospitalisations.

As a result of the aforementioned reasons, mobile technologies are being increasingly regarded as the solution for preventative healthcare delivery. A report produced by The Economist's Intelligence Unit on the future of healthcare in Europe used existing trends to outline a future scenario centred on the use of mobile technology (Economist, 2011). There have been some notable mHealth applications where clinical studies have found positive results as adjuvants to medical therapy for a broad range of disorders. For example, mHealth has been used in combination therapy for neurological disorders (Bulaj, 2014) and has improved clinical outcomes for cystic fibrosis patients

who require complex self-management (Hilliard, Hahn, Ridge, Eakin, & Riekert, 2014).

Whilst thousands of mHealth applications have been released, with hundreds of pilot programmes attempting to improve efficacy, few have been able to meet their lofty expectations (Bacardit, 2015). This is reflected in smoking cessation apps that promise to provide the behavioural support necessary for smokers to successfully quit. However, few have proven effective, often due to lack of engagement; thus, finding ways to increase engagement with their target audience has become a significant focus of mHealth interventions (BinDhim et al, 2014).

Gamification, defined as "the use of game design elements in non-game contexts" (Deterding et al., 2011), seeks to borrow from the motivational ability of games. Gamification empowers users to complete tasks more efficiently whilst making them more enjoyable; consequently, increasing engagement. From the perspective of health behaviour, gamification has been successful in encouraging physical activity by turning the 'work of exercise' into a game, resulting in a flourishing market for 'exergames' (King et al., 2013, gamification). Many apps have attempted to replicate this success by promoting positive health behaviour in a wider context, particularly in relation to smoking, albeit with variable success (BinDhim et al., 2014). However, there is insufficient research upon which to base clinical advice. Our work aims to shed light on how gamified mHealth interventions may aid smoking cessation. Constructing an understanding of how gamification works in the context of health behaviour is critical as it allows us to propose a framework that enables

healthcare professionals to appraise critically the effectiveness of gamified mHealth interventions. Furthermore, it will equip mHealth developers and healthcare purchasers to design cost-effective gamified interventions with implications that span public policy. By this merit, we will be able to move towards more intelligent exploitations of gamification and mHealth to facilitate greater social impact.

Review of Extant Knowledge

A number of definitions have been given for gamification; as the field is still in its infancy, a consensus is yet to be reached on a dominant one. However, the most cited definition is that provided by Deterding; 'the use of game elements and game design techniques in non-game contexts' (Deterding, Dixon, Khaled, & Nacke, 2011). Caillois states that structure defines the continuum between ludus (gaming) and paidia (playing). Games are structured activities with explicit rules, whereas play is unstructured spontaneous activity (Caillois & Barash, 2001). The continuum between whole and partial implementation is explained most easily through the example of games. 'Whole' games are also known as serious games. These take real-world elements and transform them into serious games, with the intention to make them "more than entertainment"; for example, a flight simulation game. In contrast, gamification is considered a 'partial' game that takes elements of games and places them in a real-world context; for example, house-point systems in schools (Deterding, 2011).

Huizinga's 'Magic Circle' explains both of the aforementioned spectrums (Huizinga, 1971). More specifically, the Magic Circle delineates the separation between the real and game world; the circle represents the constituent rules that affix the game. Constituent rules are those used in the structure of the game and distinguish the activity as a game rather than play. Inside the magic circle, play describes the freedom a player has within these rules. Outside the magic circle, the rules and incentives of the game have no authority over an individual's activity. Therefore, the process of gamification concerns expanding the circle and applying the constituent rules of the game to real-life activities. Figure 1 (taken from Adams, 2010) uses football to illustrate the special meaning afforded to actions performed in a game.

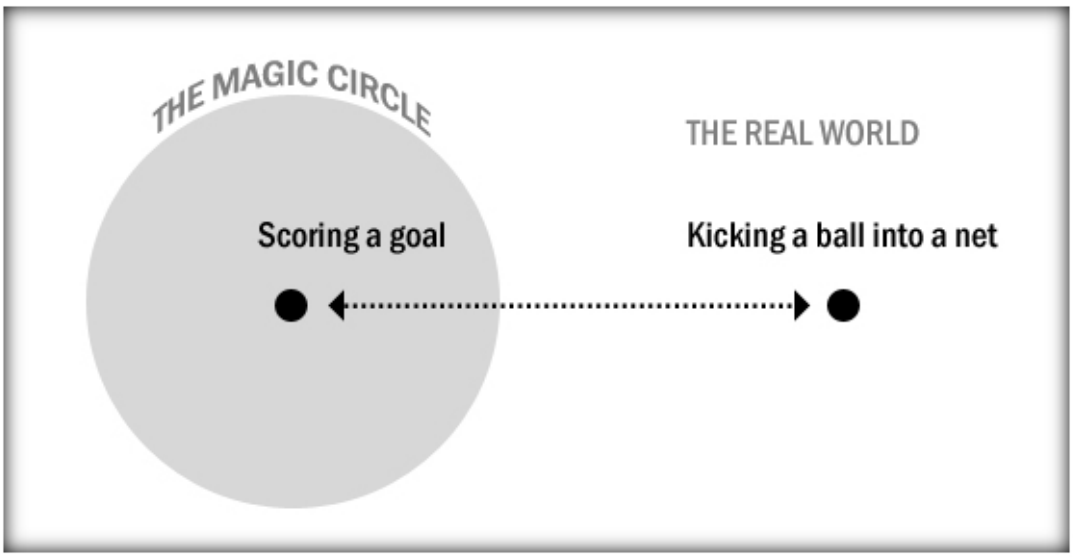


Figure 1. Huzinga's Magic Circle

The nuance in gamification lies in the lens an individual applies to the real world; one must approach real-world goals as games, with those involved

being players (Schell, 2014). Gamification, thus, requires an understanding of a game's design process. Traditionally, gamified environments offer a number of shared characteristics that work to aid engagement with, and enjoyment of, the platform. Players should feel they are the centre of the game and have the autonomy to make meaningful decisions bound by rules that enable maximum freedom to play (Werbach & Pennsylvania, 2015b). Gamification borrows from game design rules to address engagement using onboarding, scaffolding and a pathway to mastery; i.e. a beginning, middle and end (Werbach & Pennsylvania, 2015a). Onboarding deals with introducing the structure of the game in the simplest way possible. Scaffolding concerns elements such as power-ups and hints to nudge the player forward; thereby maintaining the game's flow. The pathway to mastery builds on the scaffolding to provide meaningful goals defined by having "a mastery" of knowledge and skill about a game.

Figure 2. The Game Element Hierarchy - (Werbach & Hunter, 2012)

Professor Werbach describes The Game Element Hierarchy (see Figure 2, taken from Werbach & Hunter, 2012) as the interrelationship between game dynamics, mechanics and components that, when combined, form the game experience. Dynamics provide the framing of the game and include its constraints, emotions, narrative, progression and relationships. Constraints are boundaries that support the player to play in a certain way and arrive at meaningful decisions.

A sense of progression is key to justify continued engagement with the game. Relationships form the final aspect of game dynamics and concern the people with whom the player is able to interact. Mechanics drive the game forward and represent the challenges, chance, competition, cooperation, feedback, resource acquisition, rewards, transactions, turns and win states. Components are the specifics that construct the dynamics and mechanics. These include: achievements, avatars, badges, bosses, collection, combat, unlockables, gifting, leaderboards, levels, points, quests, social graph, teams and virtual goods (Werbach & Hunter, 2012).

Cugelman reviewed the most popular gamification taxonomies to propose seven elements of gamification. We summarise these in Table 1.

Table 1 - Seven Elements of Gamification:

1. Goal setting: Committing to achieve a goal
2. Capacity to overcome challenges: Growth, learning, and development
3. Providing feedback on performance: Receiving constant feedback through the experience
4. Reinforcement: Gaining rewards, avoiding punishments
5. Compare progress: Monitoring progress with self and others
6. Social connectivity: Interacting with other people
7. Fun and playfulness: Paying out an alternative reality

A systematic literature review published by Hamari used existing studies to answer empirically whether gamification works (Hamari, Koivisto, & Sarsa, 2014). The authors indexed eight databases and collected 809 peer-reviewed papers, which were filtered down to 24 empirical studies for further analysis. In order to answer their research question, Hamari conceptualised gamification into three main parts: (1) Implementation of game elements that create motivational affordances, which are the motivational pull of single game design elements in varying contexts. (2) The resulting psychological outcomes measured by the studies. (3) Behavioural outcomes that follow. The research found that the majority of studies reported positive results for some of the motivational affordances, with only two of the 24 studies producing positive results for all of the motivational affordances. Based on the findings, Hamari suggested that engagement with gamification is dependent on a variety of factors, including a user's individual level of motivation (Hamari, 2014), and the

nature of the gamified system. Since visuals and design have been shown to take on an important role in engaging customers (Park, Eisingerich, & Pol, 2014), the graphics and visual design offered by a gamified app is likely to influence consumers' uptake and level of interaction with the app.

Overall, extant research reports that gamification does indeed work, but there are certain factors to consider. These can be categorised into two main aspects: the context in which gamification is being used and the intrinsic qualities of the user being targeted (Hamari, 2014). In terms of intrinsic user qualities, studies have found that different individuals interact with games in varying ways and for differing reasons (Eickhoff, 2012; Hamari, 2013). As such, there is variability in the underlying motivations of individuals playing a game. This explains why gamification had far greater effects on specific users and in specific environments (Richter, G., Raban, D. R., Rafaeli, 2006). For effective gamification, the game must appeal to an individual's specific intrinsic motivation (Hamari, 2013), which is defined as 'an activity one does because it is inherently interesting or enjoyable' (Deci & Ryan, 2008; R. Ryan & Deci, 2000), for instance because it is enticing-, enabling, or enriching-the-self of consumers (Park, Eisingerich, & Park, 2013). Hamari suggests that any external pressures such as extrinsic rewards, for example money, will interfere with gamification by undermining an individual's intrinsic motivation (Deci, Ryan, & Koestner, 1999).

Research alludes to the context of gamification being an essential prerequisite for engagement, for example, effective gamification is far more common in education than in health (Hamari, 2014). Hamari comments that the

ideal way, to examine the impact of the context and how it affects the motivational affordance, is to implement an application of gamification where the motivational affordance is kept constant whilst the context is varied.

Participation and customer education have been shown to enhance consumers' adoption of a new product or service across consumer groups (Merlo, Eisingerich, & Auh, 2014) and trust (Eisingerich & Bell, 2008). In order to understand why individuals play games, Bartle proposed four player personality types based on player behaviour and pleasures: socialisers, achievers, explorers, and killers (Bartle, 1996). Whilst Bartle's observations have enjoyed a certain level of prominence as the first series of observations of digital game players, they are less useful when generalised outside of the "massively multiplayer online role-playing games" context, in which the research was conducted. Further studies have been carried out to broaden the scope of player types, and instead create a model of player mentalities for all digital game applications (Kallio, 2010). However, Dixon concludes that whilst it is certainly tempting to create a generalised model of player types, any study will be constrained to a particular game and players observed. Additionally, focusing on player types leads frequently to a myopic view, as it is necessary to also consider the social situation and external influences (Kallio et al, 2010; Dixon, 2011).

The term 'gamification' was first coined in 2002 by Nick Pelling (Marczweski, 2012), however, its use in a wide range of applications has been evident for many years. Gamification can be traced back a century, when Cracker Jack began placing surprise toys in each box of cereal; taking advantage

of unexpected rewards to gamify the process of purchasing food ("Brief History," 2003). In 1981, American Airlines pioneered the industry's first frequent-flyer programme. Whilst it was conceptualised originally as a method of offering special fares to returning customers, the programme soon morphed into something much more, with people frequently taking longer routes to their destination in order to accumulate more miles and unlock the next reward (Berger, 2013). More recently, Foursquare popularised the use of gamification in mobile apps with their location-based social network, which rewards users for 'checking-in' to restaurants, cafes and other locations (Deterding, 2011).

It has been noted that Gamification can help separate out the work somebody does from the work they consider they are doing (Werbach, 2014). For example, FoldIt, a game released by the University of Washington, asked the public to play a protein-folding exercise to elucidate structures of various proteins; in 10 days, the players were able to unlock the crystal structure of a monomeric retroviral protease that causes AIDS in Rhesus monkeys, a feat with which scientists had struggled for 15 years (Cooper et al., 2010; Eiben et al., 2012; Khatib et al., 2011).

Gamification can yield novel solutions to longstanding problems, such as speeding. Traditionally, drivers are penalised for breaking the speed limit, with no positive reinforcement for those who abide by the law. A speed camera lottery entered law-abiding drivers into a lottery funded by the fines collected from speeders. Volkswagen trialled the system in Stockholm, with the average speed decreasing from 32 to 25kph (Sorrel, 2010).

mHealth is involved largely in the management of disease or the promotion of healthy behaviour and has taken to gamification with great fervour. In 2006, the Nike+ app launched, encouraging people to track and compare their runs in return for fuel points. They targeted the one billion people estimated to be overweight worldwide by promoting healthy behaviour through its use of gamification elements such as competition and motivational messages (Padmasekara, 2014). Zombies Run is an alternative example of the gamification of running. The game plunges the player into a dystopian story where each run fulfils the mission of collecting supplies for your shelter, all while trying to outrun the pursuing zombies; the incorporation of a narrative and missions is a clear attempt to make the experience more game-like (Southeron, 2013).

Critical issues, such as suboptimal medication adherence, have been approached by apps using educational games (Brown et al., 1997; Chan, 2013); by rewarding patients adhering to medication with monetary gift cards (Mango Health, 2014) or even virtual monsters (Garde et al., 2015). Gamified physiotherapy and patient reporting have further tackled adherence. Cystic fibrosis patients perform breathing exercises each morning to clear the thick mucus from their airways. One intervention combines a facemask and an Android tablet to use the patient's breath to control a flying spaceship in the game; thus making the onerous task more enjoyable (Terrace, 2014). The daily reporting of pain scores has been made less arduous for young children with cancer, with the implementation of a game that puts the child in the shoes of a policeman. The daily pain reports of the policeman allows the player to rise

through the ranks of a police force dedicated to ridding the world of pain (Stinson, 2013). Even traditionally consultation-heavy treatment has been gamified with impressive results. Sparx a gamified intervention for depression in adolescents showed an improvement of 2.73 on the children's depression rating scale-revised in direct comparison to traditional face-to-face cognitive behavioural therapy in a 3 month study (Merry et al., 2012).

Criticism of Gamification. Whilst gamification is regarded widely as a useful tool for improving engagement, it has also been the centre of a great deal of criticism. Many commentators called it a 'hyped-up' buzzword for an age-old concept, where most implementations miss the crucial elements of storytelling and experiences that are central to enrich the game. It has been argued that whilst leaderboards, points and badges are effective tools for communicating progress, they are the least essential element in representing the core of the game (Robertson, 2010). Without true levels of participation by consumers engagement may be difficult to achieve (Eisingerich, Auh, & Merlo, 2014). Prominent gamification researcher Sebastian Deterding has criticised the practice of 'simple gamification' (aka 'pointsification'), for example simply assigning points, and instead emphasises the importance of 'meaningful play', defined as gamification with an underlying purpose (Deterding, 2011). This concept is further highlighted by Jane McGonigal in her book, Reality is Broken (McGonigal, 2011). Moreover, as Seifert and colleagues have shown, predicting the uptake of an entertainment product by consumers is notoriously difficult (Seifert, Siemsen, Hadida, & Eisingerich, 2015).

Psychology of Health Behaviour Change. The psychology of health behaviour change has been viewed traditionally from two schools of thought; behaviourism and cognitive psychology. John Watson, the father of behavioural psychology, stated that for any observable action, there exists an antecedent cause, known or unknown (Bargh & Ferguson, 2000). Behaviourists state that there is no difference between two states of mind if they do not lead to differing behavioural outcomes (Graham, 2000). Ivan Pavlov famously argued that the environment shapes human behaviour, when he posited his theory of 'classical conditioning'; highlighting how understanding behaviourism can help establish a desired behaviour (Baum, 1994).

Midway through the 20th century, psychology saw a shift in mind-set from behaviourism to cognitive psychology. Where behaviourists generally refuse to consider internal thought processes, due to their unreliability in predicting human behaviour, cognitive psychologists viewed the same internal thought processes as a mystery to be solved (Bargh & Ferguson, 2000). Cognitive psychologists study an individual's thought processes by making use of the scientific method as well as behavioural observations. Their work has advanced significantly in recent decades as our understanding of the mind has progressed. Both behaviourism and cognitive psychology have played an important role in shaping modern understanding of health behaviour change, leading to numerous proposed theories. One of the most widely implemented theories in health behaviour research is the health belief model, which examines why individuals undertake health-promoting activities through the lens of a

cognitive psychologist (Carpenter, 2010). The model states that engagement in health-promoting behaviour depends on the following four factors:

1. Perceived threat of health problem; comprising of perceived seriousness and perceived susceptibility of a health problem.
2. The perceived benefits of action and barriers to action.
3. Self-efficacy - referring to an individual's perception of his or her competence to successfully perform a behaviour (Glanz, 2008)
4. Cues to action (Cerkoney & Hart, 1980; Hayden, 2013).

As with many cognitive psychology models, the evidence suggests that the Health Belief Model is a weak predictor of health behaviour change (Taylor et al., 2007). Multiple studies have found this to be a result of poorly defined psychological constructs, and have concluded the 'Theory of Reasoned Action', to be a significantly better predictor of health behaviour (Armitage & Conner, 2007; Brewer et al., 2007). It can be said that the Health Belief Model may help to outline an intervention designed to influence health behaviour, but will not be adequate in providing a framework to structure the intervention (Taylor et al., 2007).

Theory of Planned Behaviour. The 'Theory of Planned Behaviour' was built on the theory of reasoned action (Ajzen, 1991) and makes use of both behaviourism and cognitive psychology. The theory states an individual's attitude towards behaviour, subjective norms and perceived behavioural control, together shape an individual's behavioural intentions; subsequently, these shape behaviour (Ajzen, 1985). Perceived behavioural control refers to a

person's perception of the ease or difficulty of performing the behaviour of interest.

Using PRIME Theory to Explain Smoking Cessation. PRIME theory, a theory of motivation which has been cited widely in relation to smoking cessation, further reinforces the concept of intention shaping behaviour as stated by the Theory of Planned Behaviour. PRIME - an acronym for Plans, Responses, Impulses, Motives and Evaluations - refers to each level of motivation. The theory argues that a formal quit attempt is necessary for smoking cessation and that successive quit attempts will accumulate benefit. However, an attempt to quit smoking will occur only when the desire to quit outweighs the perceived benefits of not quitting (Smith, Roberts, & Kerr, 2013). This corroborates with the general consensus amongst smokers that an intrinsic desire to quit is necessary for a quit attempt to succeed (Balmford & Borland, 2008). Whilst this may appear common sense, PRIME theory helps provide a clear framework to apply to smoking cessation. One study found that the intrinsic motivators, desire and intention, were both significant independent predictors of quit smoking attempts. In contrast, although duty (an extrinsic motivator) is the most commonly reported motive for quitting smoking, it had the counterintuitive effect of mitigating the predictive power of either intrinsic motivator (Smith et al., 2013). This is further supported by the self-determination theory of motivation, which states that extrinsic motivators - ‘doing something because it leads to a separable outcome’ - will diminish the positive effects of intrinsic motivators; ‘an activity one does because it is inherently interesting or enjoyable’ (Deci & Ryan, 2008; Ryan & Deci, 2000).

Self-Determination Theory. Deci and Ryan's concept of intrinsic and extrinsic motivation has cemented self-determination theory as one of today's most dominant theories of motivation, (Edward, Deci, & Ryan, 2002) and it has been used to explain the concepts of rewards and achievements in gamification (Brühlmann, 2013). In the context of gamification, it is important to differentiate between the external regulation and integrated regulation forms of extrinsic motivation. External regulation extrinsic motivation involves using operant conditioning, which is the change of behaviour through the use of reinforcement given after the desired response (Skinner, 1938) to control motivation and subsequent behaviour. However, research shows this undermines the individual's intrinsic motivation. In contrast, extrinsic motivation through integrated regulation occurs when the regulation, for instance a gamified achievement, is in line with one's values; thereby permitting the regulation to be assimilated to the psychological self and thus instilling intrinsic motivation (Brühlmann, 2013). Further studies also reinforce the findings that verbal-informational rewards increase intrinsic motivation, and perhaps more importantly, rewards which do not contain a verbal-informational component are in fact a threat to intrinsic motivation (Deci, Koestner, & Ryan, 2001).

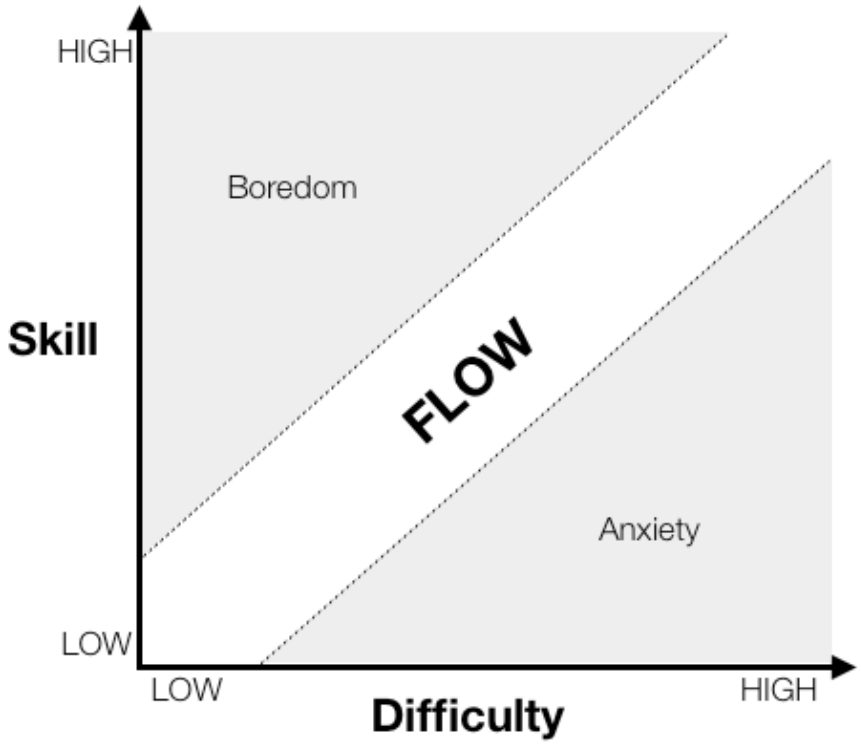
Achieving a State of Flow. In the context of gamification, whilst self-determination theory is a useful way of understanding the effect of motivational affordances on intrinsic motivation, the theory of flow takes a more practical approach. Csikszent proposed the concept of flow (see Figure 3, taken from Csikszent, 1991) as the principle reason explaining why individuals play games,

describing it as a state of optimal experience, characterised by a loss of self-awareness and time, where an individual feels perfectly challenged in relation to their ability (Csikszent, 1991).

A correct skills-difficulty balance is essential to avoid boredom or anxiety, and ensure the gamer remains within the flow channel. Jackson further adds that providing clear goals and feedback are both necessary to allow individuals to monitor their progress which has been shown to keep individuals in the state of flow (McNamara, Jackson, & Graesser, 2009). It is important to note that implementing clear goals and unambiguous feedback in a gamification intervention, should not conflict with the concept of variable rewards and challenges stated by self-determination theory.

The more users know about a product the more comfortable they will be using it and the more extensively the product will be relied upon (Bell & Eisingerich, 2007). And under certain circumstances consumers may be willing to adopt even despite product side-effects (Wheelock et al., 2013). Additionally, a perceived sense of control helps maintain flow and can be achieved either by reducing the fear of failure or by creating a heightened sense of empowerment (McNamara et al., 2009).

Figure 3. Flow



Crucial to gamification, it must be understood that people will exhibit a variation in their individual starting abilities. Thus, it can be induced that an element of personalisation, where the difficulty is modulated based on their skill, is crucial to avoid boredom or anxiety. A gamification intervention that achieves a state of flow will in theory become an autotelic experience; whereby the experience is so rewarding that it leads to intrinsic motivation as one gains enjoyment from the task itself (Csikszent, 1991).

Table 2. Cross-reference of Cugelman's game elements with psychology literature		
Gamification Strategies (Cugelman, 2013)	**Validated behaviour change ingredients** (Cugelman 2013) (Cugelman 2011)	**Psychological theory** (Ajzen, 1991) (Fogg, 2009,) (Bandura, 1986) (Carpenter, 2010) (Skinner, 1938)
Goal setting	• Agree behavioural contract • Goal setting	• Theory of Planned Behaviour • Social Cognitive Theory • Prime Theory
Capacity to overcome challenges	• Time management • Action planning • Provide instructions on how to perform the behaviour • Barrier identification and problem solving	• Health Belief Model • Theory of Planned Behaviour • Fogg - Ability
Providing Feedback on performance	• Prompt self-monitoring of behaviour outcome • Prompt self-monitoring of behaviour	• Health Belief Model • Theory of Planned Behaviour • Operant Conditioning • Fogg - Triggers
Reinforcement	• Provide rewards contingent on successful behaviour • Provide information on consequences of behaviour	• Operant conditioning • Health Belief Model
Compare progress	• Provide normative information about others' behaviours	• Theory of Planned Behaviour • Social Cognitive Theory
Social connectivity	• Social influences (norms) • Plan social support/social change • Facilitate social comparison	• Social Cognitive Theory • Theory of Planned Behaviour

A major criticism of many health behaviour models is their single-minded focus on addressing motivation, and failing to consider other elements crucial to behavioural change. Fogg proposed the Fogg Behaviour Model (FBM) to explain why behaviour change occurs. The FBM advances the idea that behavioural change is driven by three factors: ability, motivation and a trigger.

Moreover, the FBM has been used to analyse how gamification can drive behavioural change. Wu comments that gamification can be used to influence behaviour positively by instilling intrinsic motivation, high ability in the form of a simple action and a trigger such as a notification (Wu, 2011). To the extent that gaming is frequently social in nature, using heavy gamers as 'extreme consumers' for app promotion may facilitate uptake (Eisingerich, Bhardwaj, & Miyamoto, 2010) and promotion on social sites such as Facebook may be considered taking into account levels of social risk (Eisingerich, Chun, Liu, Jia, & Bell, 2015).

Applying Health Behaviour Psychology to Gamification. Cugelman proposed seven gamification elements that are linked directly to proven interventional behavioural change techniques (Cugelman, 2013). In turn, we have cross-referenced these techniques to the current body of literature regarding health behaviour models and psychological theory. This is summarised in Table 2.

Difficulty of Smoking Cessation. Smoking cessation presents a number of challenges. As with all addictive drugs, nicotine elevates dopamine levels within the nucleus accumbens, with the result of reinforcing the effects associated with reward. This can lead to both physiological and psychological/behavioural consequences. Physiological effects may include symptoms of withdrawal, such as irritability, poor concentration, increased anxiety and appetite, restlessness, depression and insomnia (Reus & Smith, 2008).

Furthermore, a variety of learned and social behaviours is associated with smoking, and can impact negatively on the habits of an abstinent smoker.

These triggers can range from environmental cues, such as eating a meal or drinking alcohol, to social cues, such as observing a friend smoking. Consequently, the personal cost of quitting can be extremely high. Therefore, clinical guidelines suggest that smoking cessation interventions should include a combination of behavioural support and pharmacotherapy (Coleman & West, 2001; García-Vera, 2004; Smith et al., 2013).

Use of Pharmacotherapy. The National Institute for Clinical Excellence (NICE) recommends Nicotine Replacement Therapy (NRT) to reduce the cravings associated with smoking. However, it is important to note that pharmacotherapy alone has proven to have a limited impact, as it neither addresses the sources of the desire to smoke, nor instils a wish not to smoke. Moreover, there are limitations to the amount of pharmacotherapy interventions that can be administered (Reus & Smith, 2008). Psychological interventions for smoking cessation usually take either a cognitive or behavioural perspective. Cognitive therapy aims to change a person's view of smoking and encourage patients to take a positive approach to cessation. This is achieved by employing distraction techniques, relaxation methods or mental imagery (Reus & Smith, 2008). Behavioural therapy aims to help smokers recognise the stimuli associated with the act of smoking and avoid such triggers by modifying their behaviour; incorporating techniques, such as aversion therapy or exercise therapy. Therefore, behavioural therapy can also help patients address the consequences of nicotine withdrawal, such as cravings and weight gain. There is evidence that the effectiveness of counselling in smoking cessation increases with intensity (Reus & Smith, 2008).

Positive psychotherapy, a form of cognitive behavioural therapy, has been demonstrated to impact significantly on smoking cessation. Individuals exhibit a reduction in positive mood during the weeks prior to quitting, with an even lower positive mood felt on the quitting day; thereby contributing to smoking lapses. Moreover, it has been shown that a greater positive effect on individuals at the beginning of a smoking cessation treatment will result in more successful quit rates. Incorporating mood management is a proven key factor in ensuring improved quit smoking outcomes (Kahler et al., 2014).

Barriers & Shortfalls to Current Smoking Cessation Techniques. Cigarette smoking has been identified as the most important source of preventable morbidity and mortality (Association, 2011). In the UK, it has been shown that the cost to society is £12.9 billion a year (Ash, 2015). Although 68% of smokers have the desire to quit, and one-third make at least one attempt to stop in a given year, only 2-3% of smokers achieve long-term success (Tonks, 2014). This illustrates a shortfall in the current approach to smoking cessation.

Current techniques for smoking cessation face numerous barriers. Firstly, current techniques do not have the scope to reach a widespread audience. Moreover, as an increasing number of people are undertaking public and private cessation programmes, their efficacy decreases as these become overloaded. This is due to the reduced time available for clinicians with each patient, as well as a lack of appropriate clinical training of staff; both key factors in the psychological component of quitting. Furthermore, these programmes do not allow treatment in the moment when high-risk situations arise.

Consequently, existing techniques have a success rate lower than 20% and studies have shown adherence across behavioural domains in smoking cessation decreases by 34.7% after eight weeks (Persky, Spring, Vander Wal, Pagoto, & Hedeker, 2005). This illustrates a need for a time-efficient, cost-effective and evidence-based smoking cessation tool (Smith et al., 2013).

Enhancing motivation is an important part of the overall treatment for nicotine addiction as it increases smokers' enthusiasm, sense of purpose and will to quit (Smith et al., 2013). Gamification has been demonstrated to increase intrinsic motivation and engagement, causing more sustained behavioural changes (Brühlmann, 2013). As mentioned previously, gamification has been implemented successfully in a number of other fields. Our project aims to illustrate how the elements within gamification can be utilised to aid in the process of smoking cessation.

An Outlook: Avenues for Future Research

Whilst gamification shows promise and has proven effective in many fields, currently, there is insufficient high-quality evidence of the beneficial effects on clinical outcomes to warrant implementation of such interventions within the areas of health behaviour change and disease self-management (Free et al., 2013). However, by taking a cognitive approach to increase our understanding of the underlying drivers and barriers for gamification in mHealth, research can provide an avenue to inform developers and clinicians in

creating and recommending apps to individuals. These findings may then be used to propose a framework for developers, healthcare practitioners and healthcare payers with a view to improve the market of gamified mHealth interventions to achieve greater social impact. Furthermore, a gap exists with regards to the long-term impact of gamification. Implementing a longitudinal study can provide insight into how the effects of gamification on behaviour change over time.

The literature review has established the immense burden placed on healthcare and society at large by smoking and the shortfall in existing smoking cessation techniques. While it might be an effective intervention in smoking cessation, evidence suggests that behavioural support incurs prohibitively high costs due to the levels of intensity required to achieve success that cannot be achieved presently due to budgetary constraints (Reus & Smith, 2008). The implications of a solution to help tackle this problem are therefore clear. We pose the use of gamification in the mHealth context as a potent contender to be considered. Gamification shares elements with proven health behaviour change theories (Cugelman, 2013); therefore, gamified mHealth interventions confers the benefits of behavioural therapy while transforming the large expensive interface of patient-doctor consultations to one between patients and an app, with the potential to significantly increase cost-effectiveness. Currently, the ability to drive behaviour towards a desired and healthy lifestyle is paramount to the healthcare system and has the potential to be achieved through gamification.It must be noted that one of the greatest challenges in the

implementation of new technologies, such as gamified mHealth interventions, is the acceptance from both healthcare professionals and patients.

Healthcare technology is a rapidly evolving field displaying increasingly innovative ways of exploiting smartphone hardware and creating peripherals to collect a wide variety of health-related data (Intel, 2014). Progress in this area may help to resolve issues such as user inconvenience of recording cigarettes smoked. Sazonov demonstrated a proof of concept combining data about breathing patterns with hand movements to automatically detect how many cigarettes were smoked (Sazonov, Lopez-Meyer, & Tiffany, 2013). Additionally, smokers exhibit clear, consistent and predictable daily peak nicotine craving patterns (ChronoTherapeutics, 2014), and a well-developed app can process these patterns into an engaging game element.

Furthermore, whilst the focus of our research concerned cigarette smokers, we suggest insights can be used to inform research and app development targeting other health behaviours. For instance, gamification has proven useful in encouraging adherence to medication (Chan, 2013; Mango Health, 2014)

Whilst currently the future looks bright for mHealth, it is important to note that gamification should not be used in isolation, but rather be considered as a single tool in a developer's arsenal to help improve healthcare outcomes. The successful implementation of gamification will require a marriage of emerging technologies to optimise success, including wearable sensors, intelligent data and the seamless sharing of information between all

stakeholders. However, the importance of subjecting new technologies and applications of technology to the scientific process must not be underestimated, and must be considered an important area of future research.

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