



Apps for life change: Critical review and solution directions [☆]



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ABSTRACT

More and more users are using mobile apps to achieve changes in their lives related to their health. Given the complex task of accomplishing long-term behavioural change, developers have started to incorporate game elements into their apps as motivational tools and to increase user engagement. However, with increasing number of health-related apps available on mobile platforms every day, several issues have started to arise. In this paper, we critically review the health app landscape from several perspectives. We underline the current lack of scientific theory usage in app development, inefficient and selective embedding of gamification, low levels of personalization and potential privacy and trust issues in this domain. Given the multi-disciplinary nature of this set of problems, we propose integrated and user-centred frameworks as one potential solution direction to resolve problems both users and app-developers are facing today.

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1. Introduction

Smartphones are increasingly becoming the new central delivery vehicles for health interventions [1]. Developers have discovered gamification as a tool to increase their users' engagement with their apps by trying to transform challenging tasks related to physical activity (PA) or food-intake (FI) into fun experiences [2]. The rapid development in this area however has led to an increasing gap between consumer products and scientific validation [3]. Furthermore, developers are competing against each other and measure their success by revenue rather than the improvement of the users' health, which essentially leads to more strongly materializing goal conflicts as well as increasing skepticism among users towards commercial bias and app reliability [4].

Within the *PROJECTNAME* project,¹ an interdisciplinary team of partners is currently implementing a framework focusing on an integration of theories from psychology, behavioural science and game design for the improvement of users' health via mobile apps.

In this paper, the reader is introduced to work and findings with regards to serious games or mobile gamified apps related to health improvement from a number of several perspectives which underline the gap mentioned above. This includes the use of scientific

theories, gamification elements, implementation of personalization as well as privacy issues. Subsequently, we present a potential solution direction on how the described difficulties could be overcome, while finally we conclude the paper with ideas for future work in this domain.

2. The health app landscape

Apps for life-change within the health domain are generally scattered around different topics, hence addressing different behaviour change goals or intervention aims. They can be differentiated by the area they are covering, such as increasing levels of PA, providing guide or monitoring of FI or sleep quality for instance. Nevertheless, the usefulness of these apps from a user point of view is often questionable [5], as the success metric of these apps is often revenue rather than metrics dependent on the user's health [6].

In this section, we review apps and literature in this area from a number of different perspectives, each raising a number of issues needing further attention in future app development.

2.1. Use of motivational theories

The relationship between game engagement in general and motivational theories has been well-investigated in literature [7,8], and it has been suggested that games generally can be understood through a motivational lens.

[☆] This paper has been recommended for acceptance by Erik Malcolm Champion.

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¹ <http://www.projectname.eu>, removed due to double-blind review process.

Games or gamified apps can have substantial perceptual and cognitive impacts [8] by increasing selective attention [9,10] or emotional involvement [11], hence influencing levels of engagement with the app itself [12]. Particularly in the health domain, frequent use of an app can be then directly related to effects in behavioural change and thus achievement of the desired improvement of the user's health.

However, several studies showed that particularly in the field of gamified health, important elements of motivational and health behavioural theories have been overlooked in both development and implementation of mobile apps [6]. A study by West et al. [13] for instance showed that 58 dietary-related apps scored an average of 6.19 out of 100 possible behavioural constructs, the most present being providing general information and perceived benefits, two constructs from the *Health Behaviour Model* (HBM). Furthermore, 91% of these apps scored zero across all constructs related to feedback and assessment, whereas feedback loops and immediate feedback are often important determinants of the success of health interventions [14].

A study by Lister et al. [6] underlines these findings, where out of 132 evaluated health-related apps only 3.80 out of 13 tested possible behavioural constructs from various theories were found on average. Similarly, another large-scale study [15] showed that only 62 out of 3336 apps included all three factors (predisposing, enabling, and reinforcing) from the *Precede-Proceed Model* [16].

Another categorization metric are implemented *Behaviour Change Techniques* (BCT), as specified by the taxonomy of Michie et al. [17] based on previous work of [18,19]. A recent study by Yang et al. [5] found that out of 93 investigated BCTs, only 6.6 were implemented in top ranked PA apps on average. Another examination of the top 20 both paid and free PA and dietary behaviour apps showed an average score of 8.1 in terms of implemented BCTs [20] out of 28. Likewise, an earlier study of 127 top-ranked health-related apps revealed a score of 10.01 out of 100 on average with regards to items of four psychological theories [21]. An earlier qualitative analysis of 10 popular apps in five health-related categories by researchers also showed low levels of theory use [22].

Similarly, a recent user interview-based study of weight-loss apps [23] highlighted that even users themselves suggested BCT techniques to be included within future health-apps, with a focus on interaction speed, real time tracking and suggestions. Companies offering electronic activity monitors such as *Fitbit*, *Jawbone* and *Nike* have however improved their app-counterparts, and hitherto include many different empirically tested BCTs [24].

Another interesting study relates to an implemented mobile app named *Fitcity*, which was tested over a time-span of two years with the aims of improving levels of PA [25]. Constructs of *Self-Determination Theory* (SDT), one of today's most influential psychological theories assuming a universal set of basic needs, and *Trans-Theoretical Model* (TTM), a theory categorizing users in different stages during behavioural change, were found to be significantly related to engagement, performance and motivation, thus indicating that for instance a user state classification based on the suggested TTM stages can have a positive impact in terms of intrinsic motivation when designed accordingly. Earlier studies have already shown that autonomy and competence satisfaction, basic needs postulated by SDT, provide significant accounts of player motivation and enjoyment in solitary game play, and that multiplayer environments can support relatedness additionally [26], another SDT-based construct. *We4Fit* [27] is an example of a smartphone-app related to FI, and is for instance aiming at changing user behaviour through collaboration, thus appealing to relatedness constructs as well. Other authors have suggested general SDT frameworks based on testing of GPS-based exergames [28] for the creation of new health apps.

Overall, there appears to be a large gap between app and game development in the area of health and available scientific methods and findings from the area of psychology, behavioural health or clinical interventions [9]. All the evidence we found indicates the need for collaboration between health behaviour change experts and app developers [21], as nowadays apps are often developed with little involvement of health professionals. A study from 2012 [29] actually showed that more than half of all apps on the Android platform were designed for healthcare professionals rather than personal health. Hence, it could be argued that apps developed with health expertise in the background tend to be targeted at businesses rather than consumers.

Another issue that has also been discussed is health literacy of users, and whether user's safety could potentially take harm in case of frequent health-app usage [3] through wrong and unintentional medical suggestions. Also, in case of discovery of new evidence for alteration of medical practices, it is unclear whether new findings will be taken into account with regards to app updates, when most of available apps have no person with medical background integrated into their development [30].

Medical staff on the other hand needs evaluation tools to assess these mobile apps both in practice and education [31] in order to make further statements about their value and potential dangers. Multi-stakeholder design approaches as in [32] present one way to include key stakeholders within the design process, feasibility on the other hand might suffer in case of small, independent app developers.

Developers can make use of well-established protocols such as the *Intervention Mapping* (IM) protocol [33], or design contextually intelligent intervention suggestions – see for instance *Ecological momentary interventions* (EMI) [34] – when designing their apps. Without involvement of field experts, this could prove difficult for developers and furthermore entail significant costs.

2.2. Gamification

Implementing gamification in mobile apps related to health has emerged as a tool that aims at increasing an individual's engagement with an application and to transform obstacles preventing behavioural change into fun experiences [2]. Originally coined in 2008, the concept of including game elements in non-game contexts [35] has been applied for instance to issue non-tangible, collectible rewards or to create an embedded social context via leaderboards in order to enable comparison of effort or progress with others. Miller et al. [36] give great examples and explanations of the typical gamification mechanics as by [37], namely *badges*, *leaderboards*, *points and levels*, *challenges and quests* and *social engagement loops and onboarding*.

A recent, extensive study by Litser et al. [6] of 132 gamified health applications available in the *iOS Appstore* showed that today's apps generally still have low levels of integration of gamification components (around 50%), with most of the apps only possessing selective convenience components of games. This result underlines the substantial criticism the concept of gamification has hence received as not being systemic and deeply integrated into applications but rather being centred around the intentions and goals of developers instead of placing the focus around the user [38].

Rather than creating convincing, in-depth narratives and stories which essentially enable users to immerse in virtual contexts, mobile app developers tend resort to unrelated reward-oriented schemes or leaderboards and subsequently assume to achieve intrinsically motivated behavioural responses, where as external rewards have been found to reduce intrinsic motivation on a general level [39]. It has often been underlined that the combination of rewards and a meaningful framing yields the best results [40], yet

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