Association for Information Systems
AIS Electronic Library (AISeL)

ICIS 2019 Proceedings | IS in Healthcare

Users' Game Design Element Preferences in Health Behavior Change Support Systems for Physical Activity: A Best-Worst-Scaling Approach

Manuel Schmidt-Kraepelin
Karlsruhe Institute of Technology, manuel.schmidt-kraepelin@kit.edu

Scott Thiebes
Karlsruhe Institute of Technology, scott.thiebes@kit.edu

Sofia Schöbel
Information System, sofia.schoebel@uni-kassel.de

Ali Sunyaev
Karlsruhe Institute of Technology, sunyaev@kit.edu

Users' Game Design Element Preferences in Health Behavior Change Support Systems for Physical Activity: A Best-Worst-Scaling Approach

Completed Research Paper

Manuel Schmidt-Kraepelin
Karlsruhe Institute of Technology
76131 Karlsruhe, Germany
manuel.schmidt-kraepelin@kit.edu

Scott Thiebes
Karlsruhe Institute of Technology
76131 Karlsruhe, Germany
scott.thiebes@kit.edu

Sofia Schöbel
University of Kassel
34121 Kassel, Germany
sofia.schoebel@uni-kassel.de

Ali Sunyaev
Karlsruhe Institute of Technology
76131 Karlsruhe, Germany
sunyaev@kit.edu

Abstract

Over the last decades, physical inactivity has become one of the leading health risk factors in modern societies. To incentivize people to be more physically active, gamified health behavior change support systems (HBCSSs) are a promising approach. These systems often make use of gamification to keep their users engaged over a sustained period of time. However, despite its popularity, gamification often fails due to insufficient designs, which neglect users' needs. Building on extant research that investigated users' preferences in other gamification contexts, we conduct a survey among 447 potential users of HBCSSs for physical activity, using a best-worst-scaling approach. Our results indicate that users generally prefer the game design elements progress, goals, points, and levels, which is partially different from past research on preferred game design elements in other contexts. Thus, our research contributes to the understanding of contextual differences in users' gamification preferences.

Keywords: Gamification, Game Design Elements, User Preferences, Health Behavior Change, Health Behavior Change Support Systems, Best-Worst Scaling, Online Survey

Introduction

Over the last decades, physical inactivity has become one of the leading health risk factors in modern societies. Recent reports by the World Health Organization highlight that 5.5% of all deaths worldwide can directly be attributed to physical inactivity. In addition, the occurrence of other leading risk factors such as high blood pressure (12.8% of all deaths worldwide) and overweight and obesity (4.8% of all deaths worldwide) is directly linked to peoples' sedentary lifestyles (World Health Organization 2018). To incentivize people to change those harmful lifestyle behaviors, gamified health behavior change support systems (HBCSSs) are a promising approach (Oinas-Kukkonen 2013). Gamified HBCSSs aim to positively influence people's health through forming, altering, or reinforcing health-related attitudes, behaviors, or acts of complying (Alahäivälä and Oinas-Kukkonen 2016; Oinas-Kukkonen 2013; Stepanovic and Mettler 2018) by means of utilizing the motivational potential of game design elements such as leaderboards, points or avatars. By applying game design elements to HBCSSs for physical activity, providers of such systems seek to foster users' intrinsic motivation to use the system (Hamari and Koivisto 2015), and thereby promote the completion of certain physical activities or encourage users to use an HBCSS in a more regular manner (Alahäivälä and Oinas-Kukkonen 2016; Stepanovic and Mettler 2018). However, despite the broad application of gamification in HBCSSs (Lister et al. 2014; Schmidt-Kraepelin et al. 2019b) many of the gamified HBCSSs still fail to engage their users over a sustained period of time (Krebs and Duncan 2015).

A reason for this can be found in insufficient designs of the HBCSSs' gamification concepts, as they are often designed as one-size-fits-all solutions without considering users' preferences for certain game design elements (de-Marcos et al. 2016). In addition, developers of gamified HBCSSs often tend to clutter their user interfaces with too many game design elements leading to overwhelming user experiences (Schmidt-Kraepelin et al. 2019b). Such mindless approaches may not only hinder gamification to unfold its motivational potential, but might even result in serious negative side effects for users of gamified HBCSSs, including trivializing the health context or rewarding incorrect execution of physical activities (Schmidt-Kraepelin et al. 2019a). To this end, extant research highlights that it becomes increasingly important to evaluate the design of individual game design elements instead of solely focusing on developing and evaluating overarching gamification designs (Seaborn and Fels 2015). By investigating isolated game design elements, it becomes easier to better understand how they affect users' motivation and hence derive effective designs that are adapted to the needs of specific target groups. Ascertaining users' preferences for game design elements can support researchers in this process for two reasons. First, it helps to identify elements that are highly valued by users and thus particularly relevant for effective gamification designs. Second, it helps to shed light on such game design elements that are primarily rejected by users and thus call for examining alternative designs. Furthermore, established methods for designing successful gamification concepts (e.g., Deterding 2015; Morschheuser et al. 2018) highlight the importance of analyzing and considering user needs bound to the specific application context. This step contributes to the acceptance of gamification since users primarily encounter game design elements that they expect to be fun. In addition, it helps developers to choose such game design elements that fit the underlying core activities of the information system and thus potentially have a sustained impact on users' motivation.

Although extant research has started to investigate users' game design element preferences to some degree (e.g., Cheong et al. 2014; Kotsopoulos et al. 2018; Schöbel et al. 2016), the efficacy of gamification and thus also the adequacy of game design elements is highly dependent on contextual factors (Hamari et al. 2014; Nacke and Deterding 2017). Therefore, users' general preferences for game design elements might not be readily transferrable to the context of gamified HBCSSs for physical activity and their effectiveness cannot be guaranteed. Past research on gamified HBCSSs, on the other hand, has largely focused on the benefits and effects of employing gamification as a whole to increase such systems' effectiveness (e.g., Jones et al. 2014a; Koivisto and Hamari 2014), the investigation and evaluation of selected game design elements (e.g., Hamari and Koivisto 2015; Lewis et al. 2016), and the development of frameworks or processes for designing effective gamification concepts (e.g., Helf et al. 2015). Although the latter stream of research is closely related to the objective of this research, studies in this stream lack the explicit examination of users' game design element preferences which is necessary for designing effective user-centered gamification concepts that meet users' expectations and needs. Since we currently lack the necessary knowledge to integrate users' preferences for game design elements in the design of HBCSSs for physical activity, we aim to answer the following two research questions:

> RQ1: *Which game design elements do users of gamified HBCSSs for physical activity prefer?*
>
> RQ2: *Which combinations of game design elements do users of gamified HBCSSs for physical activity prefer?*

In order to address our lack of knowledge concerning users' game design element preferences in context of gamified HBCSSs for physical activity, we conduct an online survey among 447 potential users of such systems by using a best-worst-scaling (BWS) approach. The contribution of this research is three-fold. First, for research, we provide an overview of users' game design element preferences in HBCSSs for physical activity. We thereby add to the nascent stream of gamification literature concerned with the efficacy of individual game design elements (as opposed to the efficacy of gamification as a whole) (Nacke and Deterding 2017). Second, our research may also serve as a foundation for the development of more user-centered frameworks as it helps in better understanding users' attitudes towards game design elements in HBCSSs for physical activity. Third, for developers of gamified HBCSSs for physical activity, our research may also serve as a foundation for the design of meaningful and user-centered gamification concepts that explicitly consider users' preferences. Our research also creates a better understanding about which game design elements need to be further analyzed with regard to potential alternative designs.

This paper proceeds as follows. In the next section, we briefly introduce gamified HBCSSs and provide an overview of research on gamification preferences. Section three outlines the applied BWS approach, including our game design element selection, sampling strategy and data collection, and data analysis, whereas section four presents our results in form of users' preferred game design elements and game design element bundles. We discuss our results in section five and briefly conclude our paper in section six.

Background

Gamification in Health Behavior Change Support Systems

In accordance with extant literature, we refer to an HBCSS as an information system (IS) that has been designed to form, alter, or reinforce health-related attitudes, behaviors, or acts of complying without using coercion or deception (Alahäivälä and Oinas-Kukkonen 2016; Oinas-Kukkonen 2013). In terms of bringing behavioral interventions into real life context, HBCSSs are a promising approach to overcome barriers to health behavior change (Alahäivälä and Oinas-Kukkonen 2016). Such systems aim to elicit sustaining changes in peoples' health behavior (Oinas-Kukkonen 2013). Thus, HBCSSs need to ensure that their users use them in the manner intended and for a sufficient period of time. However, recent studies suggest that HBCSSs often fail to do so as they struggle with users that experience decreasing long-term motivation (Stepanovic and Mettler 2018). Thus, developers of HBCSSs need to find suitable motivational cues in order to motivate individuals to continue using the system more regularly or promoting the completion of certain activities or tasks that are associated with positive health-related outcomes (Stepanovic and Mettler 2018). For this purpose, developers of HBCSSs increasingly draw on gamification (Schmidt-Kraepelin et al. 2018).

The concept of gamification has started to gain widespread attention by IS researchers in 2009 (Thiebes et al. 2014), It is most commonly defined as an informal umbrella term for the use of game design elements in nongame contexts in order to improve the motivation and engagement of users to use an information system more regularly or in a certain manner (Deterding et al. 2011). The first wave of gamification research focused on answering the blanket question whether gamification works or not (Nacke and Deterding 2017), especially in context of HBCSSs (e.g., Dithmer et al. 2016). In order to do so, researchers tested a wide variety of different gamified systems including combinations of all kinds of game design elements. While these studies certainly helped to establish gamification as a scientific research stream, researchers increasingly call for research that advances from testing gamified systems that combine (and thus conflate the effects of) multiple game design elements to theory-driven studies that aim to tease out the effects of individual game design elements (Nacke and Deterding 2017). For this purpose, gamification researchers commonly differentiate diverse types of game design elements, the most prominent classification being the Mechanics, Dynamics, Aesthetics (MDA) Framework (Zichermann and Cunningham 2011). Game mechanics refer to functional components of gamified applications that provide various actions and control mechanisms to enable user interaction (e.g., *Points*, *Leaderboards*, *Levels*, and *Goals*) (Hunicke et al. 2004). Dynamics determine the runtime behavior of mechanics concerning players' inputs and outputs over time. Finally, game aesthetics refer to the "desirable emotional responses evoked in users when they interact with the gamified system" (Basten 2017). They try to satisfy fundamental needs and desires like the desire for reward, self-expression, or competition (Thiebes et al. 2014). In addition to calling for more rigorous examinations of single game design elements, many gamification researchers have cautioned the vital role of application context while designing gamification concepts (e.g., Hamari et al. 2014; Nacke and Deterding 2017). However, thus far gamification research predominantly focused on a examining the effects of individual game design elements in only few application contexts like education and traditional human-computer interaction scenarios such as calibrations (Nacke and Deterding 2017), leaving room for studying game design elements in other application contexts such as HBCSSs.

In HBCSSs, there are three major groups of application contexts for gamification (Stepanovic and Mettler 2018): (1) supporting individuals to realize healthy lifestyle habits (e.g., physical activity, healthy food consumption, reduction of unhealthy habits), (2) supporting individuals in the self-management of chronic diseases and rehabilitation (e.g., diabetes, cancer), and (3) supporting health professionals in their education or for daily tasks (e.g., education of apprentices, compliance to specific routines). Within each of these groups, HBCSSs can come in a variety of different forms, such as wearables, mobile applications or dedicated software (Schmidt-Kraepelin et al. 2019a). In this research, we focus our attention on the first group of application contexts. In particular, we investigate users' game design preferences for HBCSSs targeting changes in users' physical activities. Thus, we explicitly exclude such HBCSSs that deal with other health-related activities or aim to support the curative treatment of specific diseases (e.g., medication adherence apps, apps for diabetes treatment). As these HBCSSs represent a completely different and more serious context, it is likely that users would prefer other game design elements in such HBCSSs (e.g., fostering competition might be inappropriate in HBCSSs for curative treatment).

Gamification Preferences

Literature provides a variety of different approaches to elicit user preferences for game design elements. Plenty of studies exist that evaluate the design of specific gamified systems. To do so, developers of gamified systems often investigate their users' gamification preferences by utilizing some form of established methods for data collection and analysis such as focus groups (e.g., Nour et al. 2018), and questionnaires (e.g., Fitz-Walter et al. 2013; Kotsopoulos et al. 2018). However, the objectives of these studies are to evaluate and iteratively advance the gamification designs of specific systems with regard to their users' preferences. Thus, results of these studies are often bound to a very specific system and target group. Another related stream of literature focuses on the relationship between users' gamification preferences and personality traits (e.g., Codish and Ravid 2014; Jia et al. 2016; Tondello et al. 2016). A prominent outcome of this literature stream is the gamification user types hexad scale, which consists of six different gamification user types (Tondello et al. 2016). Yet, while these studies focus on individual differences of users' preferences, they do not account for the type of ISs and the underlying application context, which might influence gamification preferences (Hamari et al. 2014). In addition, some literature exists that investigates the influence of demographical factors on user preferences and perceptions (Koivisto and Hamari 2014). Studies within this stream often aim to identify suitable gamification designs for specific user groups such as elderly people (e.g., de Vette et al. 2015; Kappen et al. 2016) or children (e.g., de Vette et al. 2018). Overall, literature that examines user preferences for specific use contexts but is not bound to specific systems, groups of users, or applications remains scarce. To the best of our knowledge, there only exist a few studies in the context of education that aim to measure user preferences for game design elements without limiting the scope of their research to a specific system (e.g., Cheong et al. 2014; Schöbel et al. 2016).

Methods

Best-Worst Scaling

In this research, we decided to use a BWS-approach in order to measure users' preferences for game design elements in HBCSSs for physical activity. BWS was developed by Louviere and Woodworth (Louviere et al. 2013) and has proven to be a suitable method in marketing and related research to measure respondents' preferences for a set of objects or attributes. It describes a cognitive process by which individuals repeatedly choose two objects in varying sets of three or more (Lansing et al. 2013). Participants choose those objects that they feel exhibit the largest perceptual difference on a continuum of interests (Finn and Louviere 1992).

Our choice of BWS was mainly driven by two main advantages over traditional preference elicitation methods, such as direct ranking mechanisms or rating scales (e.g., Likert scales). First, in contrast to answering a series of rating-scaled questions, BWS enforces trade-offs, which ensures that respondents discriminate between objects. Thus, BWS prevents participants from rating each object equally important (Louviere et al. 2013). Consequently, each decision for a pair of objects provides implications not only for the chosen, but also for the nonchosen objects (Marley and Louviere 2005). Second, BWS is scale free and thus avoids potential response biases, which allows for robust statistical comparisons between respondents (Lee et al. 2013). Overall, comparisons with other rating methods show that BWS provides better results with regard to the discrimination between objects (Lee et al. 2007; Matzner et al. 2015). In analyzing the data, we applied the MaxDiff model, which assumes that respondents cognitively process all possible pairs of best-worst choices in each choice set and that they choose the most extreme options (Louviere et al. 2013). Each chosen pair of best and worst game design elements provides implicit information about the rank of the nonchosen game design elements compared with the chosen game design elements. Thus, data for each choice set may be expanded to the implicit pair-wise choices (Louviere et al. 2013). The estimated values represent the game design elements' relative weights in respondents' utility function and thus elucidate which game design elements are more or less preferred by the respondent. A recent study by Schöbel et al. (2016) demonstrated the utility of BWS to identify users' preferences for game design elements. The data provided by BWS is based on a so-called counting analysis, which can be further enriched by adding a regression analysis (Lansing et al. 2013; Orme 2005). Both the counting analysis as well as the regression analysis deliver a ranking of analyzed objects (in our case game design elements). The BWS counting analysis provides results that are a close approximation of the results of a regression analysis (Lansing et al. 2013). Thus, they can be used to verify the ranking results of the counting analysis.

Game Design Elements Selection

As pointed out before, literature often distinguishes different classes of game design elements (i.e., game mechanics, game dynamics, and game aesthetics). Thereby, game mechanics represent the functioning components of gamified applications (Thiebes et al. 2014). In contrast to game dynamics and game aesthetics, game mechanics are visible components of the application that can be easily valued by users. We therefore focused our investigations on user preferences for game mechanics and did not include game dynamics and game aesthetic. Game dynamics and game aesthetics are not presentable as functioning components of a system in an online survey and measuring their occurrence would require fundamentally different forms of operationalization. Since the number of required choice sets in BWS is highly dependent on the number of incorporated objects and to ensure feasibility of the study for participants, we had to limit our study on the most relevant game mechanics (henceforth used synonymously with game design elements) in the context of HBCSSs for physical activity. To identify the most relevant game design elements, we surveyed extant literature reviews that specifically reviewed studies investigating the effects of gamification in the context of HBCSSs. (Johnson et al. 2016; Matallaoui et al. 2017; Sardi et al. 2017). Table 1 summarizes the identified game design elements and provides a brief description for each of them.

Game Design Element	**Description**	**Source**		
		1	**2**	**3**
Points	Points are often gained for successfully completing a task or activity. They aim to quantify users' performance and participation (Sardi et al. 2017).	✓	✓	✓
Badges	Badges are a form of reward in gamification. They visually represent the completion of a certain goal or activity (Hamari 2013).	✓		✓
Leaderboards	*Leaderboards* visually represent a users' performance in comparison to their peers (Zichermann and Cunningham 2011).	✓	✓	✓
Goals	Goals provide users with a clear path of desired tasks and activities. They are often implemented as challenges or quests (Sardi et al. 2017).	✓	✓	✓
Progress	Progress refers to a mechanic that informs users about their advancement regarding a task or activity (Thiebes et al. 2014).	✓	✓	✓
Avatar	An Avatar visually represents the user. Users can design their Avatar regarding their own preferences (Cui et al. 2009).	✓	✓	✓
Social interaction	Social interaction refers to the existence of a social community of players where they can communicate and support each other (Sardi et al. 2017).	✓	✓	✓
Narrative	A Narrative enables users to experience a sequence of Narrative events while performing an activity or task (Seaborn and Fels 2015).	✓	✓	✓
Virtual goods	Virtual goods are intangible objects that can be earned. They are often implemented as an in-game currency (Jones et al. 2014b).	✓	✓	✓
Levels	Levels indicate the advancement of users regarding the overall performance (Gnauk et al. 2012).	✓	✓	
1: Johnson et al. (2016), 2: Mattallaoui et al (2017), 3: Sardi et al. (2017)				

Table 1. Description of Game Design Elements.

In order to be incorporated into our list of game design elements, a game design element had to be explicitly mentioned in the three literature reviews that we identified. In addition, we decided to not consider game design elements that could not be sufficiently represented in an online survey such as sound effects (Sardi et al. 2017) and real-time feedback (Matallaoui et al. 2017). As rewards can have various different forms of representation and in order to ensure feasibility of the study, we decided to only include the most common forms of rewards (i.e., *Points*, *Badges*, *Virtual goods*) in our study (Matallaoui et al. 2017).

Survey Procedure

We chose a scenario-based online survey to elicit users' preferences for game design elements in gamified HBCSSs for physical activity. Our survey consisted of four steps (see Figure 1).

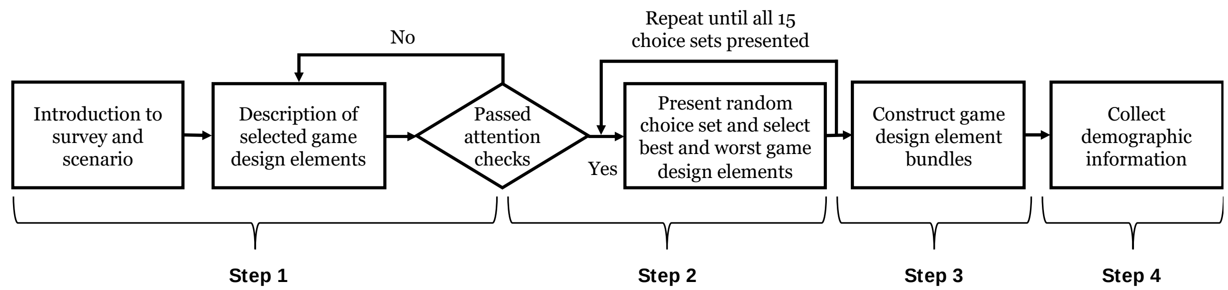

Figure 1. Overview of the Survey Process

First, we asked participants to imagine that they would use a mobile health application that aims to help them increase their level of physical activity. We decided for a mobile application scenario in order to facilitate participants to imagine the use of such a system. Our decision was thereby based on the rationale that through the proliferation of smartphones in people's everyday life and their ability to sense key indicators of physical activity (e.g., covered distances, movement speeds), mobile health applications have become the most prevalent form of gamified HBCSSs for physical activity. Furthermore, participants were provided with descriptions for all ten game design elements included in our study. It is noteworthy that in real world systems, game design elements allow a certain variance with regard to their design (e.g., *Badges* may be designed eye-catchy or rather unostentatiously). However, to ensure feasibility of our study, we limited our investigations on one specific manifestation for each game design element. To foster users' understanding of these manifestations, we provided mockups for each game design element in the context of a mobile application for physical activity. The mockups were designed using Balsamiq Mockups 3 (Balsamiq 2018) and can be found in Table A-1 in the appendix (since the survey was conducted in Germany, the original mockups were designed in German language; for this paper, we translated the text to English). To ensure that participants did not simply skip element descriptions, we added two knowledge questions regarding the game design elements *Points* and *Levels*. Participants were only allowed to proceed with the survey if both questions were answered correctly. In case participants answered the knowledge questions incorrectly, they had to read through the element descriptions again. In addition, we asked participants whether they were familiar with some of the presented game design elements prior to the survey.

In a second step and per requirement of the chosen BWS approach, participants were asked to select their most and least favored game design elements in the context of a HBCSSs for physical activity out of choice sets. Each choice set consisted of four varying game design elements. In order to receive valid results and to find a feasible amount of choice sets, we constructed a balanced incomplete block design (BIBD) (Flynn et al. 2007; Louviere et al. 2013). In a BIBD each choice option (in this study: a game design element) appears equally often. In order to define a suitable BIBD, we followed the guidelines by Orme (2005). He provides four criteria for construction of choice sets: (1) Display four or five items per choice sets. (2) Each item should be displayed at least three times. (3) Each Choice set should not contain the same item multiple times. (4) For ten or less items, use around 15 choice sets. In accordance with these criteria, we constructed a BIBD consisting of 15 choice sets where each game design element appeared six times. They can be found in Table A-2 in the appendix. Further on, participants had the option to see the descriptions and mockups of the four game design elements when answering a choice set. In the third step of the survey, we asked participants to freely construct bundles of those game design elements that they would like to have in an HBCSSs for physical activity. Finally, in the fourth step we asked participants for demographic information.

To ensure understandability and survey quality, we conducted a pre-test with ten fellow researchers experienced in the design of online surveys. This resulted in minor changes to the wording and usability of the survey. We also refined the description and mockup of the game design element *Virtual goods,* because the original description and mockup caused confusion among some pre-test participants. Participants of our online survey were recruited via consumer panels with the help of a market research agency. Study participants that successfully completed the survey and correctly answered a control question were rewarded with 0.10 EUR per minute.

Results

Sample Description

Overall, 464 participants completed the survey. 17 responses were excluded from data analysis because participants sped through the survey or were detected as straight-liners. Responses of 447 participants remained for data analysis. The average questionnaire duration was eight minutes. 224 of the participants were female (50.11%), 221 were male (49.44%), and two stated their gender as trans* (0.45%). The sample was mixed concerning highest educational qualification (no degree (1, 0.22%), middle school degree (136, 30.43%), high school degree (80, 17.90%), completed vocational training (128, 28.64%), university degree (100, 22.37%), prefer not to say (2, 0.44%)). The age of participants ranged from 18 to 84 years (M = 49.55, SD = 16.66, Mdn = 49).

Results of the Best-Worst-Scaling

We used the R programming language, which offers several options for statistical analyses, and the RStudio application to analyze our data. Overall, we conducted three different analyses to identify which game design elements users of HBCSSs for physical activity prefer (see Table 2). In a first step, we calculated a counting analysis. In the second and third step, we conducted two different kinds of regression analyses. More precisely, we conducted two versions of a conditional logistic regression analyses.

Game Design Element	Counting Analysis				Conditional Logistic Regression				Rank
	B	W	Std.Mean	SD	MaxDiff Model		Linear Prob. Model		
					Coef.	SE	Coef.	SE	
Progress	1273	259	0.3781	0.3773	1.6046	0.0429	0.1156	0.0028	1
Goals	1254	405	0.3166	0.3959	1.4739	0.0424	0.1064	0.0028	2
Points	993	305	0.2565	0.3711	1.3349	0.0416	0.0974	0.0028	3
Levels	778	323	0.1686	0.3402	1.142	0.0413	0.0843	0.0028	4
Leaderboards	418	684	-0.1003	0.3612	0.5818	0.0404	0.0438	0.0028	5
Badges	369	736	-0.1368	0.3686	0.5251	0.0398	0.0384	0.0028	6
Narrative	411	836	-0.1585	0.438	0.4907	0.04	0.0351	0.0028	7
Virtual goods	398	837	-0.1637	0.4457	0.4715	0.0397	0.0344	0.0028	8
Social interaction	551	1004	-0.1689	0.554	0.4781	0.04	0.0336	0.0028	9
Avatar	144	1197	-0.3926	0.3926	-				10

Table 2. Counting Analysis and Conditional Logistic Regression of BWS.

To conduct our counting analysis, we calculated a standardized mean score for each of the ten game design elements. In doing so, we first calculated the difference between the number of times each game design element was chosen as most preferred (best) and the times it was chosen as least preferred (worst). In a next step, we divided the difference by the number of times each game design element was shown to participants in all choice sets (six times) and multiplied it with the total number of responses (Finn and Louviere 1992). For example, for the game design element *Points* the calculation was the following: ((993-302) / (6*447)) = 0.2565. The results for all game design elements can be seen in column "std.Mean" in Table 2. Its scale ranges from -1 to 1. Thus, a mean value that is closer to 1 implies that a game design element has a higher preference and vice versa. Overall, we can see, that most of our respondents prefer *Progress* (rank 1), *Goals* (rank 2), *Points* (rank 3), and *Levels* (rank 4). The game design elements *Virtual goods* (rank 8), *Social interaction* (rank 9), and *Avatar* (rank 10) were least preferred by our respondents. In addition, we split up the data to analyze female and male participants separately. For most game design elements, no significant differences were found. The largest deviation was found for the elements *Narrative* (female: std.Mean = -0.1257, male: std.Mean = -0.1968) and *Social interaction* (female: std.Mean = -0.1406, male: std.Mean = -0.1999).

MaxDiff data can be either analyzed by the means of a counting analysis or a conditional logistic regression analysis (Orme 2005). Both approaches deliver similar results: a ranking of the compared objects. Similar to other studies (e.g., Lansing et al. 2013; Marley and Louviere 2005), we decided to conduct both, the counting analysis to identify the ranking positions, and the regression analyses to verify ranking positions for each game design element. To conduct a regression analyses, a dependent variable is necessary. Therefore, we followed the guidelines provided by Flynn et al. (2007) and Hair et al. (2010). To conduct the regression analyses, we used a binary coded dummy variable and created one observation for each possible best-worst pair per respondent and per choice set. All ten game design elements were used as independent variables for the regression analyses. To avoid dummy variable trap, we had to choose one of our independent variables as reference category and subsequently exclude it from our analyses (Hair et al. 2010). We decided to exclude the game design element *Avatar*, because it had the lowest rank according to our counting analysis. By excluding it from the analysis, its coefficient was normalized to zero. Thus, the coefficients of other game design elements show the difference in utility to *Avatar* (Orme 2005). In summary, the results of both regression analyses and the counting analysis deliver the same ranking positions, thus confirming the results of our counting analysis.

Combination Analysis

Besides analyzing which kind of game design elements our participants preferred, we also included a combination task in our survey. Thus, each participant had to decide which game design element he/she would like to combine. Therefore, we presented the list of all ten game design elements to our participants and asked them to decide about which game design elements they like to choose in context of gamified mobile application for physical activity. To analyze this data, we first focused on how many game design elements our participants would combine. The results indicate that the number of combined game design elements varies from one element to all ten elements in total. The most frequent number of game elements chosen was three (113 participants; 25.28%), followed by four (84 participants; 18.79%), two (83 participants; 18.57%), and one (76 participants; 17%). In summary, most of our participants would combine not more than four game design elements in a bundle (356 of 447 participants) and the overall mean was 3.2617.

After we identified the frequency of combinations, we focused on the different combinations that were constructed by participants. In total, we identified 176 different combinations of game design elements. We furthermore analyzed how often the game design elements were included in the participant-constructed bundles. The results can be seen in Table 3. Most of the participants used *Goals* for their game design elements combinations. *Goals* were used in 62.19% of all combinations. *Points* were also used in many game design element combinations. More precisely, *Points* were used in 59.51% of all combinations, followed by progress, which was used in 59.06% of all combinations. The game design element *Levels* was used in 35.79% of all combinations. Finally, an *Avatar* was just used in 10.96% of all game design element combinations. Overall, the results of the combinations analysis are similar to the results of the counting and regression analyses. More precisely, the results of the BWS indicate, that users of gamified HBCSSs for physical activity would prefer to include *Progress*, *Goals*, and *Points* in such a system. This is similar to the results of the combination analysis. According to the results of the BWS, most participants would not prefer to have an *Avatar*, *Social interaction*, and *Virtual goods* in a gamified HBCSSs for physical activity. Based on the frequency of selections for each game design element in the different bundles that participants constructed, we can see that an *Avatar* as well as *Virtual goods* are not often selected in all combinations we identified. Summarizing this, the results of the combination analysis show similar results compared to the results of the BWS and the regression analyses.

Game design element	**Frequency**	**Frequency (in %)**	**Rank in BWS**
Goals	278	62.19%	2
Points	266	59.51%	3
Progress	264	59.06%	1
Levels	160	35.79%	4
Badges	104	23.27%	6
Leaderboards	100	22.37%	5
Social interaction	94	21.03%	9
Narrative	82	18.34%	7
Virtual goods	61	13.65%	8
Avatar	49	10.96%	10

Table 3. Frequency of Elements in Bundles.

In a last step, we focused on the frequency of the best-ranked game design elements identified in BWS and combination analysis. We therefore counted the number of participants that included the best-ranked game design elements *Goals*, *Points*, and *Progress* in the most preferred bundles of one, two, three, four and five game design elements. These frequencies can be seen in Table 4.

	Number of game design elements in a bundle	**1**	**2**	**3**	**4**	**5**
Number of participants who integrated these element combinations in their bundles	Goals	15	43	76	64	37
	Points	22	27	70	66	42
	Progress	12	40	59	69	41
	Goals & Points	0	10	47	51	34
	Goals & Progress	0	23	41	54	33
	Points & Progress	0	5	34	54	38
	All three elements	0	0	22	43	31
	Number of participants (total)	76	83	113	84	46

Table 4. Frequency of Best-Ranked Elements and Combinations of Best-Ranked Elements.

76 participants selected only one game design element in their bundles. 22 of these elements were *Points*, followed by *Goals* that were selected 15 times, and *Progress* that was selected 12 times. Thus, only 27 of the 76 bundles that contained only one element were not part of the most preferred game design elements. 83 participants constructed a bundle comprising two game design elements. In these bundles, *Goals* were selected 43 times, *Progress* was selected 40 times, and *Points* were selected 27 times. Most often *Goals* were combined with *Progress* (23 times). *Goals* and *Points* were combined ten times, and *Points* and *Progress* five times. Thus, overall 38 of the 83 combinations involved a combination of only the most preferred game design elements. Most participants selected a combination with three game design elements (118 participants). In total, 22 of the 113 combinations involved all three of our most preferred game design elements. Again, *Goals* were part of the most combinations (76 of 113 combinations), followed by *Points* (70 of 113 combinations) and *Progress* (59 of 113 combinations). *Goals* and *Points* together were used in 47 of the 113 combinations. Similar to this, many participants combined *Goals* and *Progress* (41 of 113 combinations) in a bundle of three game design elements. *Points* and *Progress* were used in 34 combinations. 84 participants constructed bundles containing four game design elements. *Goals* were used

in 64 of the 84 combinations, *Points* in 66 of all 84 combinations, and *Progress* in 69 of all 84 combinations. A combination of *Goals* and *Points* could be identified 51 times in a combination of four game design elements. *Goals* and *Progress* as well as *Points* and *Progress* could be identified in 54 of the 84 combinations. In 43 combinations, all of the three most preferred game design elements were used. Finally, 46 participants constructed a combination of five game design elements. Again, *Points* could be identified in 42 of all 46 combinations, *Progress* in 41, and *Goals* in 37. *Points* and *Progress* were most often combined in an overall combination of five game design elements (38 times). *Goals* and *Points* were in 34 of the 46 combinations, and *Points* and *Progress* in 38 of the 46 combinations.

Besides analyzing the individual combinations, we looked at further control variables that might explain variation of users' preferences. First, we calculated the correlation between age and the preferred amount of game design elements in a bundle. A Pearson correlation indicated a significant negative relationship between participant age and preferred amount of game design elements ($r=-0.225$, $p<0.001$). In addition, a Chi-Square of independence was calculated comparing the frequency of elements reported as familiar prior to the survey and elements chosen in the bundle selection at the end of the survey. A significant interaction was found (Chi-Square(1) = 218.213, $p<.001$). Finally, a Mann-Whitney U test was calculated to investigate whether male and female participants would differ in the preferred amount of game design elements. The calculation did not result in a significant difference between male (Mdn = 3) and female (Mdn = 3) participants regarding the number of elements in bundles ($U = 24627.5$, $p = .926$).

Discussion

User Preferences for Game Design Elements

Existing research studies on gamified HBCSSs for physical activity developed and evaluated various considerable gamification concepts for different health-related usage scenarios. However, they provide little insight into user preferences for game design elements. In this study, we conducted an online survey and BWS analysis to answer the research questions which game design elements and which bundles of game design elements users of gamified HBCSSs for physical activity prefer.

In order to answer our first research question, we performed a BWS analysis. It resulted in a ranking of game design elements based on users' overall preferences. According to the results of our research, users of gamified HBCSSs for physical activity prefer the game design elements *Progress*, *Goals*, *Points*, and *Levels*. In particular, they favor those game design elements the most (i.e., *Goals* and *Progress*) that are by their nature closely related to the underlying health task or activity. That is because users of gamified HBCSSs for physical activity appreciate clear goals to understand what to do next and what their current status in pursuing their goals is. Our results indicate that *Points* are the most preferred form of rewards in gamified HBCSSs for physical activity. From our point of view, this is particularly interesting as using point systems in gamification concepts has been subject to intensive criticism in context of the "pointification" debate and is even suspected to jeopardize users' intrinsic motivation (e.g., Esteves 2017). One possible explanation is that points are probably the most common form of rewards and our study shows that users tend to prefer game design elements that they have experienced in other contexts before. However, as stated before, within this study we were not able to investigate all common forms of rewards and thus cannot entirely rule out that there might be other forms of rewards that users of gamified HBCSSs for physical activity prefer. Overall, and in line with results of studies in other contexts (Schöbel et al. 2016), users of gamified HBCSSs for physical activity prefer game design elements that let them play on their own and challenge their own results by progressing through tasks and activities or finishing clear goals. In other words, users primarily prefer game design elements that support them in their individual process to increase physical activity and health behavior change towards healthier lifestyles.

In contrast, game design elements that foster users' representation and communication to other users (e.g., *Leaderboards*, *Avatar*, *Social interaction*) were not highly valued by users of gamified HBCSSs for physical activity. Nevertheless, some of these elements still achieved a considerable amount of positive ratings, which is why we argue that users exist that would benefit from implementation of these elements. Especially the game design element *Social interaction* was highly contentious between participants of our study. Based on its standardized mean value, *Social interaction* was only ranked as the ninth preferred game design element although it received 133 more votes as best element in comparison to *Leaderboards* which was ranked as the fifth preferred element. That is because it also received 317 more votes as the worst element.

A possible explanation for this result may be found in social comparison theory (Festinger 1954) and the fact that peoples' needs for social comparison in HBCSSs for physical activity is highly volatile to individual factors such as self-efficacy and perceived competitive climate (Wu et al. 2015). In addition, in the age of social networks and data breaches, sharing data and connecting with others is always subject to intensive information privacy and data security discussions. Furthermore, and in line with the results of extant research on demographic influences on gamification perception (Koivisto and Hamari 2014), our results indicate that women have a higher preference for *Social interaction* than men. To this end, research highlights that there is no one-size-fits all design for competitive game design elements (Santhanam et al. 2016). A classical leaderboard might not be suitable for health applications, but may need more design variations and adaption to make it more meaningful to users of HBCSSs for physical activity. Another interesting finding pertains to the fact that the *Narrative* game design element did perform rather poorly with regard to users' preferences. This somewhat contradicts extant research that suggests using *Narrative*s and story-layers in order to achieve meaningful gamification (Nicholson 2015). The often cited mobile application "Zombies, Run!" (Six to Start 2018) is a famous example for successfully delivering story-based gamified HBCSS experiences. However, our results suggest that *Narrative*s are not for everyone and that such apps are only highly valued by a very specific target user group. Finally, our results seem not only to be influenced by contextual and demographic factors. Although we did our best to introduce all elements as sufficiently as possible, the results of a Chi-Square analysis of independence suggest that familiarity with a game design element also had a significant influence on whether users prefer it or not.

To answer our second research question, we asked participants to freely assemble their most preferred combinations of game design elements. On average, participants wanted to integrate 3.2 game design elements into their bundles. In line with extant studies in other contexts (Schöbel et al. 2016), the idiom "less is more" also seems to hold for gamified HBCSSs for physical activity. Strengthening the results of the BWS analysis, the elements *Goals*, *Points*, and *Progress* were the most favored game design elements in gamification bundles. With regard to gamification bundles, the combination of *Goals* and *Progress* was most favored by participants. This confirms the findings of the BWS analysis that users of gamified HBCSSs for physical activity want to pursue clear goals and wish to be informed about their current status in reaching those. Overall, our results confirm that users of gamified HBCSSs for physical activity appreciate such gamification concepts that focus on the combination of specific game design elements and do not simply integrate as many elements as possible. However, the number of game design elements integrated into bundles is not only limited to contextual influences. In line with extant research on the effects of demographic factors on perceptions of gamification (Koivisto and Hamari 2014), our results suggests that older users stated to prefer fewer gamification elements in gamified HBCSSs for physical activity than younger users.

By using a similar approach to Schöbel et al. (2016), our study also contributes to the understanding of contextual differences in users' gamification preferences between gamified LMSs and gamified HBCSSs for physical activity. First of all, it is noteworthy that the elements ranked one to four are the same for gamified LMSs and gamified HBCSSs for physical activity. However, participants ranked them in complete reverse order. As *Levels* were rated first for gamified LMS, it was only the fourth most important element for gamified HBCSSs for physical activity. Instead, users of gamified HBCSSs for physical activity prefer *Goals* and *Progress* over *Points* and *Levels* as stated before. This indicates that users of gamified HBCSSs for physical activity like more "incremental" gamification that focuses on gamifying a manageable portion of tasks and activities and are more tightly related to the underlying core activity of the system. Instead, users of LMS are more interested in the overall progression within the gamified system and thus prefer the elements *Points* and *Levels*. In addition, users of gamified HBCSSs for physical activity stated to prefer fewer gamification elements in their bundles than users of gamified LMSs. A possible explanation for that is that users' of LMSs regard the usage of a LMS and pursuing its tasks and activities (i.e., learning and passing tests) as mandatory and tedious. In HBCSSs for physical activity, on the other hand, in most cases users use such systems voluntarily and thus most likely possess higher levels of intrinsic motivation for pursuing the main tasks and activities within the system (i.e. being physically active). Consequently, participants stated higher needs to gamify LMS in comparison to HBCSSs for physical activity. Another possible explanation for this observation is that users do not want gamification to lead to a trivialization of the health-related context and thus wish developers to refrain from implementing too many game design elements (Schmidt-Kraepelin et al. 2019a). Further on, the study on user preferences for game design elements in LMS was conducted on the example of a desktop application, which naturally leaves more screen space for game design elements than mobile applications before users get the impression of cluttered and messy user interfaces. However, it might also be related to different demographical factors as users of LMSs are mostly students and thus younger (mean age in the LMS study: 26) than users of HBCSSs for physical activity (mean age in this study: 49.55). Finally, similarities between both contexts also arise. For example, both user groups stated to prefer individual gamification over competitive (e.g., *Leaderboards*) or collaborative and supportive gamification (e.g., *Social interaction*). In addition, for both user groups *Points* were the most preferred and *Virtual goods* the least preferred form of rewards.

Implications

With regard to real world applications, the results of our research enable us to give some practical implications. First, our results suggest that sometimes less is more for developers of gamified HBCSSs for physical activity. Especially when designing gamification for older users and on devices with small screens (Kappen et al. 2016) designers need to be very careful how many game design elements they should implement in their gamified HBCSSs for physical activity. In particular, our results indicate that focusing on a few game design elements that are tightly related to the core activities of the HBCSS for physical activity is more promising than developing and implementing as many game design elements as possible. Thus, designers of gamified HBCSSs for physical activity should carefully select each game design element along with a fitting design of the elements for the intended target audience. Second, in general, users of gamified HBCSSs for physical activity seem to favor individual gamification over gamification that involves competition or cooperation with other users. Consequently, using *Levels* instead of *Leaderboards* might be more promising when it comes to challenging users of HBCSSs for physical activity to increase their performance. Yet, some game design elements have been shown to be highly contentious between participants. Especially the game design elements *Narrative* and *Social interaction* both received many selections as best and at the same time many selections as worst elements. Thus, although these elements performed rather poorly in the BWS ranking, some HBCSSs for physical activity might benefit from integrating these elements to their gamification concepts as long as they fit the targeted physical activity and the targeted audience (e.g., *Social interaction* was valued higher by women within this study). Developers might also think about implementing some of these game design elements as optional gamification in order to provide value for users who like these elements. However, developers would need to find a way to implement optional gamification in a way that it does not discourage or distract users who do not like to use such elements.

Concerning theoretical implications, our results mainly strengthen the theoretical assumptions that users' preferences for gamification elements are influenced by contextual and individual factors. With regard to context, our results show that user preferences between gamified LMS and gamified HBCSSs for physical activity differ to some extent but also exhibit similarities. From our point of view, this raises the question whether the application context should really be considered a major determinant of effectiveness across all game design elements. As gamification researchers, we are accustomed to believing in the uncontestable truth that application context is always key to answering the question whether gamification works or not. Our study, however, suggests that this possibly does not hold for every game design element and that not all game design elements are created equal. For example, while *Points* seem to be everybody's darling across multiple application contexts, *Leaderboards* may be more volatile to contextual factors since competitive game design elements are perceived less suitable in more serious contexts where social comparison may be inappropriate. In addition, our study strengthens extant research results in that individual characteristics such as age and gender are also important factors regarding the manifestation of gamification preferences. Our results indicate that women perceive "classical" gamification elements like *Points*, *Progress*, *Goals*, and Level as less valuable compared to men, although those elements still remain the most important to them. Instead, female participants seemed to be more open to try elements like *Narrative* and *Social interaction*. These findings are in line with extant research since men in general, have been found to be more task- and achievement-oriented than women (Hoffman 1972; Koivisto and Hamari 2014) and women tend to be more motivated by social factors and immersion in gamification and gaming (Koivisto and Hamari 2014; Williams et al. 2009). Nonetheless, we did not only find contextual and individual factors that shape users' gamification preferences. Familiarity with certain game design elements also seemed to have an influence on users' preferences and participants were more likely to prefer familiar game design elements. In order to overcome this obstacle in acceptance, researchers and developers alike will have to find sufficient ways to slowly introduce users to new and unfamiliar game design elements in order to foster their acceptance.

Limitations and Future Research

Our study is limited by a few factors which provide directions for future research. First, to ensure feasibility, we had to limit our study to ten game design elements. However, other elements exist that can provide valuable gamification experiences and might score high in user preferences. Future research could overcome this limitation by investigating user preferences with regard to additional game design elements. Second, due to the operationalization within an online survey and BWS rating, we focused our research on game design elements in form of game mechanics, only. User preferences regarding game dynamics or game aesthetics such as collaboration and competition (Thiebes et al. 2014) should therefore be subject to future research studies. Third, we only used game design elements descriptions and mockups to introduce game design elements to the participants of our study. Participants did not have the opportunity to try game design elements in a real system. Future studies could try to implement the game design elements used in our study into a real application and investigate whether our findings hold when participants have the opportunity to experience game design elements in a real application. Fourth, we focused our study on the context of gamified HBCSSs for physical activity. Although, we were able to make some comparisons to the context of LMSs, future research should investigate additional, different application contexts in order to strengthen the knowledge about contextual influences on users' gamification preferences. Even between different types of HBCSSs, fundamental differences in users' preferences for game design elements may exist. For example, we would expect that in more serious health contexts such as self-management of chronic diseases, competitive game design elements (e.g., *Leaderboards*) may be considerably less preferred than in HBCSSs for physical activity. Finally, our study did only investigate the preferences of users in a generic way. Future research could take a closer look at user archetypes with regard to gamification preferences and how they are influenced by different contexts. Furthermore, in our study potential users of HBCSSs for physical activity were only confronted with one specific design for each game design elements. While some game elements (e.g., *Points*) allow relatively little variance in their design, other game design elements (e.g., *Badges*) may be designed in various different ways. Our study thus highlights the need for additional research focusing on the design of each individual game design element to better understand users' preferences for such different designs. In line with this, research could aim to find new ways of varying the design of less preferred elements such as *Leaderboards* or *Narratives* to make them more attractive and meaningful to specific groups of users (Schöbel and Janson 2018).

Conclusion

The goal of our research study was to identify which game design elements users of gamified HBCSSs for physical activity prefer. The ranking that resulted from our BWS delivered the following results ranging from 1 (most preferred game design element) to 10 (least preferred game design element): (1) *Progress*, (2) *Goals*, (3) *Points*, (4) *Levels*, (5) *Leaderboard*, (6) *Badges*, (7) *Narratives*, (8) *Virtual goods*, (9) *Social interaction*, and (10) *Avatar*. Besides evaluating which game design elements users of gamified HBCSSs for physical activity prefer, we also asked participants to construct their own gamification bundles. The results of this task indicate that users of gamified HBCSSs for physical activity would like to have around three game design elements in a gamified HBCSSs for physical activity. Referring to the results of the combination analysis, we were able to strengthen the results of the BWS. The most preferred game design elements *Progress*, *Goals* and *Points* were most frequently used in the gamification bundles constructed by participants of the survey. The contributions of this study are manifold. First, by ranking game design elements with regard to users' preferences we were able to give precise implications to researchers and practitioners about the selection and combinations of game design elements in gamified HBCSSs for physical activity. Second, similar to the assumptions by Seaborn and Fels (2015), we suggest, that future research in gamification should concentrate on analyzing the meaning and relevance of individual game design elements. In particular, researchers may be interested in exploring new and innovative ways of designing game design elements that were least preferred by participants (e.g., *Social interaction* and *Avatars*) in order to increase users' interest in them and realize sustaining motivational impacts by for example getting a better understanding about the characteristics of each element. . Third, we contribute to the knowledge on contextual differences of gamification perception by comparing results from two of the most important application areas for gamification (i.e., education and health). Our results indicate that while users' preferences for some game design elements (e.g., *Points*) are robust across different application contexts, others (e.g., *Leaderboards*) are more volatile to contextual influences. Future research may draw on these results and further investigate the impact of different application contexts on such volatile game design elements. Finally, our study also shows that users tend to prefer those game design elements that they are familiar with. Thus, developers and researchers alike need to find ways of introducing unfamiliar game design elements to users without deterring them from using the system.

References

Alahäivälä, T., and Oinas-Kukkonen, H. 2016. "Understanding Persuasion Contexts in Health Gamification: A Systematic Analysis of Gamified Health Behavior Change Support Systems Literature," *International Journal of Medical Informatics* (96), pp. 62-70.

Balsamiq. 2018. "Balsamiq Products." Retrieved 1st of May, 2015, from https://balsamiq.com/products/

Basten, D. 2017. "Gamification," *IEEE Software* (34:5), pp. 76-81.

Cheong, C., Filippou, J., and Cheong, F. 2014. "Towards the Gamification of Learning: Investigating Student Perceptions of Game Elements," *Journal of Information Systems Education* (25:3), pp. 233-244.

Codish, D., and Ravid, G. 2014. "Personality Based Gamification: How Different Personalities Perceive Gamification," *European Conference of Information Systems*, Tel Aviv, Israel.

Cui, J., Aghajan, Y., Lacroix, J., van Halteren, A., and Aghajan, H. 2009. "Exercising at Home: Real-Time Interaction and Experience Sharing Using Avatars," *Entertainment Computing* (1:2), pp. 63-73.

de-Marcos, L., Garcia-Lopez, E., and Garcia-Cabot, A. 2016. "On the Effectiveness of Game-Like and Social Approaches in Learning: Comparing Educational Gaming, Gamification & Social Networking," *Computers & Education* (95), pp. 99-113.

de Vette, A., Tabak, M., and Vollenbroek-Hutten, M. 2018. "How to Design Game-Based Healthcare Applications for Children?," *11th International Joint Conference on Biomedical Engineering Systems and Technologies (BIOSTEC 2018)*, Funchal, Portugal, pp. 422-430.

de Vette, F., Tabak, M., Dekker-van Weering, M., and Vollenbroek-Hutten, M. 2015. "Engaging Elderly People in Telemedicine through Gamification," *JMIR serious games* (3:2), p. e9.

Deterding, S. 2015. "The Lens of Intrinsic Skill Atoms: A Method for Gameful Design," *Human–Computer Interaction* (30:3-4), pp. 294-335.

Deterding, S., Dixon, D., Khaled, R., and Nacke, L. 2011. "From Game Design Elements to Gamefulness: Defining Gamification," in: *Proceedings of the 15th international academic MindTrek conference: Envisioning future media environments*. Tampere, Finland: ACM, pp. 9-15.

Dithmer, M., Rasmussen, J. O., Grönvall, E., Spindler, H., Hansen, J., Nielsen, G., Sørensen, S. B., and Dinesen, B. 2016. "“The Heart Game”: Using Gamification as Part of a Telerehabilitation Program for Heart Patients," *Games for Health Journal* (5:1), pp. 27-33.

Esteves, J. M. 2017. "The Perils of Gamification Triviliazation: How and Why Gamification Is Failing to Deliver Loyalty," *Academy of Management Proceedings* (2017:1), p. 13560.

Festinger, L. 1954. "A Theory of Social Comparison Processes," *Human relations* (7:2), pp. 117-140.

Finn, A., and Louviere, J. J. 1992. "Determining the Appropriate Response to Evidence of Public Concern: The Case of Food Safety," *Journal of Public Policy & Marketing* (11:2), pp. 12-25.

Fitz-Walter, Z., Wyeth, P., Tjondronegoro, D., and Scott-Parker, B. 2013. "Driven to Drive: Designing Gamification for a Learner Logbook Smartphone Application," *Proceedings of the First International Conference on Gameful Design, Research, and Applications*, University of Waterloo, Stratford, Ontario: ACM, pp. 42-49.

Flynn, T. N., Louviere, J. J., Peters, T. J., and Coast, J. 2007. "Best–Worst Scaling: What It Can Do for Health Care Research and How to Do It," *Journal of Health Economics* (26:1), pp. 171-189.

Gnauk, B., Dannecker, L., and Hahmann, M. 2012. "Leveraging Gamification in Demand Dispatch Systems," *Proceedings of the 2012 Joint EDBT/ICDT Workshops*, Berlin, Germany: ACM, pp. 103-110.

Hair, J., Black, W., Babin, B., and Anderson, R. 2010. *Multivariate Data Analysis: A Global Perspective*. Upper Saddle River: Prentice Hall.

Hamari, J. 2013. "Transforming Homo Economicus into Homo Ludens: A Field Experiment on Gamification in a Utilitarian Peer-to-Peer Trading Service," *Electronic Commerce Research and Applications* (12:4), pp. 236-245.

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.

Hamari, J., Koivisto, J., and Sarsa, H. 2014. "Does Gamification Work?--a Literature Review of Empirical Studies on Gamification," in: *47th Hawaii International Conference on System Sciences (HICSS), 2014* Waikoloa, HI: pp. 3025-3034.

Helf, C., Zwickl, P., Hlavacs, H., and Reichl, P. 2015. "Mhealth Stakeholder Integration: A Gamification-Based Framework-Approach Towards Behavioural Change," *Proceedings of the 13th International Conference on Advances in Mobile Computing and Multimedia*, Brussels, Belgium: ACM, pp. 268-274.

Hoffman, L. W. 1972. "Early Childhood Experiences and Women's Achievement Motives," *Journal of Social Issues* (28:2), pp. 129-155.

Hunicke, R., LeBlanc, M., and Zubek, R. 2004. "Mda: A Formal Approach to Game Design and Game Research," in: *Proceedings of the Nineteenth National Conference of Artificial Intelligence Challenges in Games AI Workshop*. San José, California.

Jia, Y., Xu, B., Karanam, Y., and Voida, S. 2016. "Personality-Targeted Gamification: A Survey Study on Personality Traits and Motivational Affordances," *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*, San Jose, California, United States: ACM, pp. 2001-2013.

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.

Jones, B. A., Madden, G. J., and Wengreen, H. J. 2014a. "The Fit Game: Preliminary Evaluation of a Gamification Approach to Increasing Fruit and Vegetable Consumption in School," *Preventive Medicine* (68), pp. 76-79.

Jones, B. A., Madden, G. J., Wengreen, H. J., Aguilar, S. S., and Desjardins, E. A. 2014b. "Gamification of Dietary Decision-Making in an Elementary-School Cafeteria," *PLoS One* (9:4), p. e93872.

Kappen, D. L., Nacke, L. E., Gerling, K. M., and Tsotsos, L. E. 2016. "Design Strategies for Gamified Physical Activity Applications for Older Adults," *2016 49th Hawaii International Conference on System Sciences (HICSS)*, Kauai, Hawaii, United States, pp. 1309-1318.

Koivisto, J., and Hamari, J. 2014. "Demographic Differences in Perceived Benefits from Gamification," *Computers in Human Behavior* (35), pp. 179-188.

Kotsopoulos, D., Bardaki, C., Lounis, S., and Pramatari, K. 2018. "Employee Profiles and Preferences Towards Workplace Gamification for Energy Conservation," *International Journal of Serious Games* (5:2), pp. 65-85.

Krebs, P., and Duncan, D. T. 2015. "Health App Use among Us Mobile Phone Owners: A National Survey," *JMIR mHealth and uHealth* (3:4), p. e101.

Lansing, J., Schneider, S., and Sunyaev, A. 2013. "Cloud Service Certifications: Measuring Consumers' Preferences for Assurances," *ECIS*, p. 181.

Lee, J. A., Soutar, G. N., and Louviere, J. 2007. "Measuring Values Using Best-Worst Scaling: The Lov Example," *Psychology & Marketing* (24:12), pp. 1043-1058.

Lee, J. J., Ceyhan, P., Jordan-Cooley, W., and Sung, W. 2013. "Greenify: A Real-World Action Game for Climate Change Education," *Simulation & Gaming* (44:2-3), pp. 349-365.

Lewis, Z. H., Swartz, M. C., and Lyons, E. J. 2016. "What's the Point?: A Review of Reward Systems Implemented in Gamification Interventions," *Games for health journal* (5:2), pp. 93-99.

Lister, C., West, J. H., Cannon, B., Sax, T., and Brodegard, D. 2014. "Just a Fad? Gamification in Health and Fitness Apps," *JMIR Serious Games* (2:2), p. e9.

Louviere, J., Lings, I., Islam, T., Gudergan, S., and Flynn, T. 2013. "An Introduction to the Application of (Case 1) Best–Worst Scaling in Marketing Research," *International Journal of Research in Marketing* (30:3), pp. 292-303.

Marley, A. A., and Louviere, J. J. 2005. "Some Probabilistic Models of Best, Worst, and Best–Worst Choices," *Journal of Mathematical Psychology* (49:6), pp. 464-480.

Matallaoui, A., Koivisto, J., Hamari, J., and Zarnekow, R. 2017. "How Effective Is 'Exergamification'? A Systematic Review on the Effectiveness of Gamification Features in Exergames," in: *Proceedings of the 50th Hawaii International Conference on System Sciences*. Big Island, Hawaii, United States: pp. 3316-3325.

Matzner, M., von Hoffen, M., Heide, T., Plenter, F., and Chasin, F. 2015. "A Method for Measuring User Preferences in Information Systems Design Choices," *Proceedings of the European Conference on Information Systems*, Münster, Germany, pp. 1-16.

Morschheuser, B., Hassan, L., Werder, K., and Hamari, J. 2018. "How to Design Gamification? A Method for Engineering Gamified Software," *Information and Software Technology* (95), pp. 219-237.

Nacke, L. E., and Deterding, C. S. 2017. "The Maturing of Gamification Research," *Computers in Human Behaviour*), pp. 450-454.

Nicholson, S. 2015. "A Recipe for Meaningful Gamification," in *Gamification in Education and Business*. Springer, pp. 1-20.

Nour, M. M., Rouf, A. S., and Allman-Farinelli, M. 2018. "Exploring Young Adult Perspectives on the Use of Gamification and Social Media in a Smartphone Platform for Improving Vegetable Intake," *Appetite* (120), pp. 547-556.

Oinas-Kukkonen, H. 2013. "A Foundation for the Study of Behavior Change Support Systems," *Personal and ubiquitous computing* (17:6), pp. 1223-1235.

Orme, B. 2005. "Accuracy of Hb Estimation in Maxdiff Experiments." *Sawtooth Software Research Paper* Retrieved 1st of May, 2018, from http://www.sawtoothsoftware.com/download/techpap/maxdacc.pdf

Santhanam, R., Liu, D., and Shen, W.-C. M. 2016. "Gamification of Technology-Mediated Training: Not All Competitions Are the Same," *Information Systems Research* (27:2), pp. 453-465.

Sardi, L., Idri, A., and Fernández-Alemán, J. L. 2017. "A Systematic Review of Gamification in E-Health," *Journal of Biomedical Informatics* (71), pp. 31-48.

Schmidt-Kraepelin, M., Thiebes, S., Baumsteiger, D., and Sunyaev, A. 2018. "State of Play: A Citation Network Analysis of Healthcare Gamification Studies," in: *European Conference of Information Systems*. Portsmouth, UK.

Schmidt-Kraepelin, M., Thiebes, S., Stepanovic, S., Mettler, T., and Sunyaev, A. 2019a. "Gamification in Health Behavior Change Support Systems-a Synthesis of Unintended Side Effects," in: *WI 2019*. Siegen, Germany.

Schmidt-Kraepelin, M., Thiebes, S., and Sunyaev, A. 2019b. "Investigating the Relationship between User Ratings and Gamification – a Review of Mhealth Apps in the Apple App Store and Google Play Store," in: *52nd Hawaii International Conference on System Sciences*. Maui, Hawaii: pp. 1496-1505.

Schöbel, S., and Janson, A. 2018. "Is It All About Having Fun?-Developing a Taxonomy to Gamify Information Systems," in: *European Conference on Information Systems*. Portsmouth, UK.

Schöbel, S., Söllner, M., and Leimeister, J. M. 2016. "The Agony of Choice–Analyzing User Preferences Regarding Gamification Elements in Learning Management Systems," in: *International Conference on Information Systems*. Dublin, Ireland: Association for Information Systems, pp. 1-21.

Seaborn, K., and Fels, D. I. 2015. "Gamification in Theory and Action: A Survey," *International Journal of Human-Computer Studies* (74), pp. 14-31.

Six to Start. 2018. "Zombies, Run!" Retrieved 1st of May, 2018, from www.zombiesrungame.com

Stepanovic, S., and Mettler, T. 2018. "Gamification Applied for Health Promotion: Does It Really Foster Long-Term Engagement? A Scoping Review," in: *European Conference on Information Systems*. Portsmouth, UK.

Thiebes, S., Lins, S., and Basten, D. 2014. "Gamifying Information Systems-a Synthesis of Gamification Mechanics and Dynamics," in: *European Conference on Information Systems*. Tel Aviv, Israel: pp. 1-17.

Tondello, G. F., Wehbe, R. R., Diamond, L., Busch, M., Marczewski, A., and Nacke, L. E. 2016. "The Gamification User Types Hexad Scale," *Proceedings of the 2016 Annual Symposium on Computer-Human Interaction in Play*, Austin, Texas, United States, pp. 229-243.

Williams, D., Consalvo, M., Caplan, S., and Yee, N. 2009. "Looking for Gender: Gender Roles and Behaviors among Online Gamers," *Journal of Communication* (59:4), pp. 700-725.

World Health Organization. 2018. "Global Health Risks - Mortality and Burden of Disease Attributable to Selected Major Risk."

Wu, Y., Kankanhalli, A., and Huang, K.-w. 2015. "Gamification in Fitness Apps: How Do Leaderboards Influence Exercise?,").

Zichermann, G., and Cunningham, C. 2011. *Gamification by Design: Implementing Game Mechanics in Web and Mobile Apps*. Gravenstein Highway North, Sebastopol, CA: O'Reilly Media, Inc.

Appendix

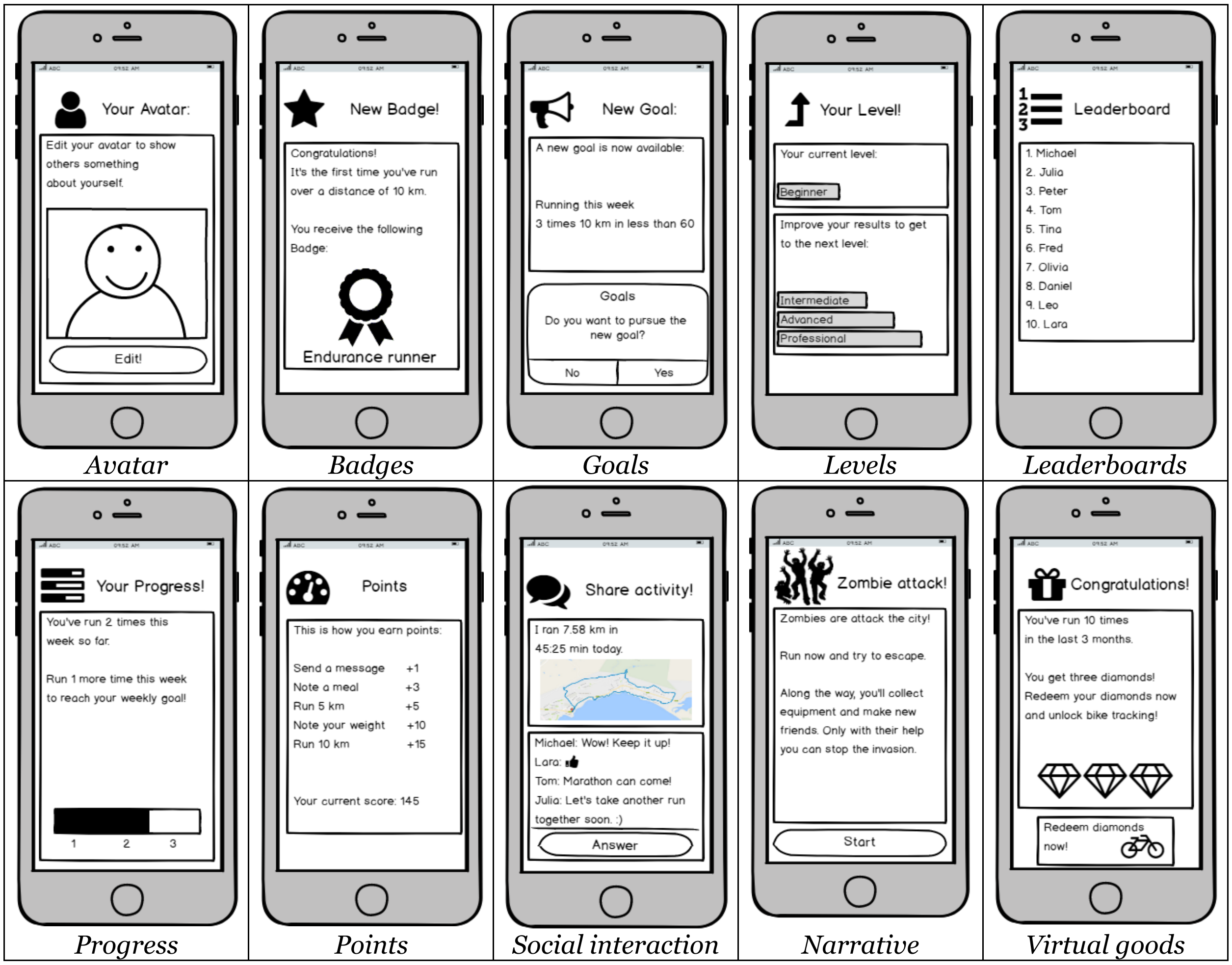

Table A-1. Mockups for game design elements used in the online survey.

Game design element	Choice set ID															Total Appearances
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Leaderboard		✓			✓	✓				✓				✓	✓	6
Social interaction	✓	✓		✓						✓		✓	✓			6
Virtual goods		✓	✓	✓	✓			✓			✓					6
Goals	✓		✓						✓	✓	✓				✓	6
Narratives				✓		✓			✓		✓	✓		✓		6
Badges	✓	✓				✓	✓	✓	✓							6
Points							✓	✓		✓	✓		✓	✓		6
Levels			✓	✓		✓	✓						✓		✓	6
Avatar	✓		✓		✓		✓					✓		✓		6
Progress					✓			✓	✓			✓	✓		✓	6

Table A-2. Choice Sets.