Gamification in Nutrition Apps – Users' Gamification Element Preferences: A Best-Worst-Scaling Approach

Michelle Berger
FIM Research Center, University of Augsburg
Project Group Business & Information Systems
Engineering of the Fraunhofer FIT
michelle.berger@fim-rc.de

Carolin Jung
FIM Research Center, University of Augsburg
carolin.jung@fim-rc.de

Abstract

An unhealthy diet has become a leading risk factor for many diseases. The use of gamification elements (GEs) in nutrition apps offers a promising approach to change the eating habit. But, the design of GEs is often insufficient, leading to low user retention. Hence, the consideration of the underlying context and the target users' preferences is essential. By conducting a survey with 220 possible users following the best-worst-scaling method, we found that goals, performance graphs, progress bars, rewards, and levels were the most preferred GEs in nutrition context. Leaderboards, narratives, social interaction, and badges were less desired. On average, five elements are perceived as optimal by most survey participants. Compared to users' preferences in education and physical activity contexts, similarities, but also differences, were found. Our findings contribute to a better understanding of contextual differences of GE preferences and provide starting points for further research on gamification.

1. Introduction

According to the World Health Organization [41], the combination of unhealthy nutrition with too little physical activity is one of the most significant risk factors for diseases such as obesity, diabetes, cardiovascular illnesses, or particular types of cancer. Besides the personal suffering, resulting health problems are associated with a substantial cost increase for a health system [34]. Nutrition decisions can be influenced by several factors including taste, price, convenience, but also familiarity, mood improvement or emotional comfort [49]. To change the complex nutrition behavior several barriers, including the lack of motivation and confidence, must be overcome [1].

Due to the ubiquity of smartphones in everyday lives, mobile applications (apps) and the use of gamification offers a promising opportunity to positively influence nutrition habits by strengthening self-regulation skills [2, 6]. While the number of health

behavior apps, including categories like weight loss, improving exercise, or smoking cessation adherence, is on the rise, only 4% include gamification elements (GEs) [12]. The most common health app categories are fitness and nutrition. Still, most apps fail in binding their users in the long term [30]. The use of GEs seems promising in supporting engagement and motivation to overcome user retention challenges and therefore might help to increase healthy behavior in the long term [13, 16, 17]. GEs refer to different types of gamification, such as collecting points or completing levels in non-game contexts and can be useful in establishing behavior changes [10, 46].

Nevertheless, GEs potentials are not fully exploited due to inappropriate usage like one-size-fits-all solutions regardless of the applied contexts and the users' preferences [8, 17, 53]. Hamari et al. [17] and Nacke et al. [37] point out that the effect of each element is highly dependent on its target user group and its context. Their studies suggest that the context in which the GE is applied, is a crucial precondition for engaging gamification.

Hence, to foster the usage of apps to help improve specific behaviors in the long-term, not only the implementation of gamification in general, but the usage of the preferred GEs of the users in the applied context seem promising to be effective. Prior research lacks context-specific analysis; instead, they focus on one specific system or target group (e.g., older adults [24]). Schöbel et al. [51] and Cheong et al. [3] examined the users' preferences of GEs in the context of education and learning management systems (LMS) without limiting it to a specific system or target group. Concerning healthy behavior, the study of Schmidt-Kraepelin et al. [50] deals with the users' preferences in health behavior change support systems (HBCSS) for physical activity [50]. They found that similarities concerning the users' preferences for GEs between the contexts of education and physical activity exist. Still, several disparities exist. Hence more research is needed in related contexts to understand better similarities and

HĮCSS

differences of users' GE preferences dependent on the underlying contexts [50].

Next to physical activity, nutrition behavior plays an essential role in improving the individual's healthiness. In both contexts, decisions are based on complex systems and are influenced by many different factors [11, 49]. Hence the users' preferences of GEs in a physical activity context might not simply be transferred to the nutrition context. Consequently, the consideration of users' preferences for GEs in nutrition-related health apps needs to be determined. Therefore, this study aims to answer the following research questions:

1. *Which particular gamification elements do users of nutrition apps prefer?*
2. *Which bundles of gamification elements do users of nutrition apps prefer?*
3. *To what extent do users' preferences of gamification elements differ between the application contexts nutrition, physical activity, and learning management systems?*

To answer our research questions, we first conducted a literature review to identify the most common GEs. Based on this, we conducted a survey following the best-worst-scaling (BWS) approach to analyze associated user preferences of GEs in the nutrition context. Secondly, we asked survey participants to select the preferred bundle size and GEs in a bundle. Lastly, we compared our results with insights of related fields, namely physical activity [50] and LMS [51]. Our research proceeding builds upon the research by Schmidt-Kraepelin et al. [50] for physical activity. Underlying work unfolds as follows: We first present the theoretical background compiled from Information Systems (IS) and behavior science literature. Subsequently, we present the methodology and results, which we discuss and conclude with implications, limitations, and proposals for future research.

2. Theoretical Background

2.1. Behavior Change and Motivation in the Context of Nutrition

Since nutrition behavior is highly habitual, traditional information-based approaches to enhance knowledge, that work for non-habitual behaviors, are insufficient when it comes to changing nutrition behavior [59, 61]. Instead, interventions targeting self-regulation skills are needed [59, 61]. Self-regulation describes the motivational, intentional, and action-oriented process of implementing and maintaining health-promoting behaviors [52]. Research on self-regulation techniques has so far not particularly focused on nutrition-related habit changes [59].

Referring to the *health action process approach* (HAPA) developed by Schwarzer [52], individuals, that struggle to transform initial motivation into consistent action, need assistance by strengthening their self-regulation skills to compensate for the motivation-action gap [52, 59]. Schwarzer [52] provides a framework for understanding behavior and deriving appropriate actions to enable change. Individuals go through two different processes to change their behavior by turning an intention into an action: (1) goal setting (motivation phase), that lead to behavioral intention, and (2) goal pursuit (volition phase), that lead to actual healthy behavior. These processes are influenced by the phase-specific self-efficacy, which describes the individuals' strength or believe in their capabilities to complete tasks successfully and overcome challenges [52]. People that already downloaded a health-oriented app seem to be motivated to improve their nutrition behavior but might suffer during the second phase (goal pursuit) to turn intention into action (intention-behavior gap). People at this stage are also called "intenders" [52]. The intention-behavior gap is often more significant for habitual behavior [61], as in the case of nutrition, which emphasizes the need for interventions in the volition stage [52]. Hence a supportive environment could remove this lack of self-efficacy.

The concepts of self-efficacy are also included in the *Self-determination Theory* (SDT) by Ryan and Deci [45], which provides further explanations for behavior changes. The SDT is based on the fulfillment of three needs that lead to one's well-being via its influence on motivation and can be addressed by gamified interventions [60]: the need for competence (also named mastery), autonomy, and social relatedness [45]. The fulfillment of the basic needs influences motivation in two different ways [47]: intrinsic and extrinsic motivation. Intrinsic motivation is rooted in the specific task itself because it is exciting or enjoyable, and extrinsic motivation is due to eternal outcomes like financial rewards. Hence, the satisfaction of the three needs enables intrinsically motivated behavior changes as well as the integration of extrinsically motivated behavior. Nevertheless, extrinsic motivators can also activate intrinsic motivation [45]. Supporting individuals by modifying the environment in respect to the fulfillment of the three basic needs, hence stimulating self-efficacy, behavioral change of even highly habitual behavior like nutrition can be assisted [2, 52].

Research in the area of psychological needs and GEs is still fragmentary [35, 53]. There are few approaches that investigate the relationship between GEs and the satisfaction of the needs for autonomy, competence, and

relatedness [47, 63]. For example, Sailer et al. [47] matched different GEs to the three psychological needs. They found that the elements *points, performance graph, badges,* and *leaderboards* fulfill the desire for competence. The GEs *narratives* fulfill the need for autonomy and the need for social relatedness. The GE *social interaction,* on the other hand, is only able to fulfill the need for social relatedness. Thus, each specific GE has a specific psychological effect that must be used in a targeted manner depending on the situation [47]. Xi et al. [63] categorized GEs into three categories, namely immersion-related features (e.g., narrative or avatar), achievement-related features (e.g., badges, points, levels), and social-related features (e.g., social network features). They analyzed whether they are positively associated with the satisfaction of each need. They found that achievement-related features are most important because they have a positive influence on all kinds of needs and are the strongest predictor for the satisfaction of the needs for autonomy and competence. In contrast, immersion-related gamification features were associated with the need for autonomy only [63]. Overall, in general, one can conclude that gamification has the potential to satisfy the needs for competence, autonomy, and social relatedness, hence improving motivation and facilitating both initial behavior change and the maintenance of it [36].

Research on the effect of GE on intrinsic and extrinsic motivation is similarly fragmentary. Mitchell et al. [36] has shown that while the use of GEs can help to change behavior and maintain it over time, GEs have no effect on the intrinsic motivation of individuals. Mekler et al. [35] came to similar conclusions when they examined the influence of *points*, *leaderboards* and *levels* on intrinsic motivation. An improvement in performance could be observed when using GEs in an image annotation task, but no increase in intrinsic motivation [35].

Another interesting gamification research stream started by Nicholson [38], who states that the problem of gamification is the elimination of intrinsic motivation the user has for the specific activity by replacing it with extrinsic motivation. He introduced the term of *meaningful gamification* in contrast to *reward-based gamification [39]. Meaningful gamification* focuses on the use of GEs to build intrinsic motivation. Instead of providing external rewards, the focus should rather lay on the connection between the needs or goals of the user's life and the non-game activity. If the user stops using the system, he or she no longer has any incentives to behave healthier if no rewards are guaranteed. User-centric *meaningful GEs* seem more promising for long-term changes and can be seen as a mid-term intervention; even if removed, the behavior change remains in the real-world-setting [39].

2.2. Gamification in the Context of Nutrition

Concerning the application of gamification in the context of nutrition, numerous studies showed a positive effect on the change in nutrition behavior of children and adults [7, 19, 23]. Rio et al. [7], for example, found that playful information and communication technologies contribute to improving nutrition in children. Holzmann et al. [19] found that the use of serious games can improve the nutrition of both children and adults. Furthermore, experiments were carried out in a primary school, in which a gamified approach successfully increased the consumption of vegetables and fruit by pupils [23]. Studies have also gone beyond the content of a healthy diet. Berger et al. [2] have investigated the use of gamification for a sustainable diet.

Overall, the use of GEs in the context of nutrition offers the potential to enable nutrition behavior change, if applied correctly.

2.3. Gamification Preferences

Analyzing the users' preferences is elementary to guarantee an appropriate app design, leading to enhancement of users' retentions, hence behavior changes [13, 16, 17]. Prior research used different approaches to determine the users' preferences of GEs [50]. One literature stream focuses on gamification preferences and personality traits [5, 21, 57]. Tondello et al. [57] found six different gamification user types. These studies do not consider different types of IS and the underlying context [50], which can influence the users' preferences [17]. Another stream deals with evaluating and improving GEs in a specific system [29, 40]. These studies are limited to the specific system and its target group [50]. Moreover, studies investigate the relationship between demographic factors such as age or professional background and their impact on users' preferences [24]. These examinations aim to create an optimal design for a specific target group, independent of the underlying context.

As pointed out by Schmidt-Kraepelin et al. [50], little to none prior research on users' gamification preferences exists that is independent of a specific system or groups of users but considers the underlying context and target users. So far, only the studies in LMS [51] and physical activity exist [50].

3. Methods

3.1. Best-Worst-Scaling

Different methods, like conjoint analysis or simple ranking mechanisms, exist to analyze the GEs that are

most preferred by users [51]. We decided to use maximum distance (MaxDiff) scaling, which was developed by Thurstone [56] and extended to the BWS approach by Louvier and Woodworth [33]. BWS is a particular type of conjoint analysis and was first applied by Szeinbach et al. [55] in the context of health care. In this procedure, the participant repeatedly chooses two objects from a changing set of three or more objects - one they prefer most and the one they prefer the least [31]. MaxDiff scaling assumes that the participant chooses the most extreme options and cognitively proceed through all sets [33].

For our research, the BWS approach has several advantages compared to similar preference elicitation methods or simple rankings. First, each element is analyzed separately, forcing the participants to weigh between the objects [33]. The approach is also scale-independent; therefore, it does not suffer from potential order effects [50]. Applied to this research, the objects in the BWS method represent the ten different GEs. The most and least useful elements considered by the participant in a nutrition app are determined by selecting the elements in each set. Based on the recommendation of Orme [42], we created 15 different blocks, with each block consisting of four different GEs. Hence, each element occurs exactly in six different question blocks, and the same objects do not occur multiple times.

3.2 Literature Review

Even though the context of nutrition is closely related to the context of physical activity, we decided not to adapt the list of GEs found by Schmidt-Kraepelin et al. [50], who focused on literature in the context of gamification and HBCSS for physical activity. We restricted our research scope to the ten most relevant GEs in the context of nutrition. We found 23 papers, which primarily deal with gamification in general in the health sector or deal with GEs in the context of nutrition in particular. We used the search portals ScienceDirect, AIS Electronic Library, ACM Digital Library, MetaGer, and BASE to cover technical and medical databases. Using the search string *gamif* AND nutrition AND health AND (support systems OR applications OR Apps)*, we identified 283 papers. After the deduction of duplications and title and abstract screening, 18 relevant papers remained. By conducting an additional forward- and backward search, five additional relevant papers were identified. We analyzed each paper for the GEs mentioned to evaluate the GE's relevance. The more often a GE was part of a paper, the higher its relevance was rated. We combined GEs that have different names but the same function. Finally, we identified a total of 35 different GEs. Table 1 summarizes the ten most

Table 1. Result of literature review on GEs

Element	Times	Sources
Performance graph	17	[2, 4, 9, 12, 15, 17, 22, 27, 28, 32, 43, 44, 46, 48, 54, 58, 62]
Goals	16	[4, 12, 17, 22, 23, 25, 27, 28, 31, 43, 44, 46, 48, 50, 54, 58, 62]
Progress bar	14	[2, 4, 5, 12, 15, 17, 22, 27, 28, 44, 46, 50, 54, 58]
Rewards	14	[4, 5, 12, 17, 22, 23, 25, 27, 28, 44, 50, 54, 58, 62]
Narratives	13	[4, 9, 17, 22, 23, 27, 32, 43, 46, 50, 54, 58, 62]
Leaderboards	13	[2, 5, 9, 17, 22, 26, 27, 32, 46, 48, 50, 58, 62]
Points	12	[2, 5, 15, 17, 26, 27, 46, 48, 50, 54, 58, 62]
Levels	11	[9, 17, 22, 27, 28, 32, 48, 50, 54, 58, 62]
Social interaction	11	[9, 12, 22, 27, 28, 32, 43, 44, 50, 58, 62]
Badges	10	[2, 5, 9, 26, 27, 46, 48, 50, 54, 62]

relevant GEs and references. The column "times" indicates in how many papers the GE was mentioned.

Defining the ten GEs, *performance graph* compares the current performance with past performances [2]. *Goals* are challenges that must be mastered and are rewarded when completed [46]. On a *progress bar,* the user can read their progress and receive information about whether they have come closer to their goal[2]. On the other hand, *rewards* are items or other things that the user receives when he or she has completed a task [50]. *Narratives* are stories that a player lives through while using the app [46]. *Leaderboards* present a ranking where all players are listed dependent on their performances [46]. Furthermore, *Points* are abstracted things the user can collect during a game [48]. *Social interaction* is the exchange of experiences with other users via, for example, a forum or chat [22]. *Levels* represent different stages, in which the user can climb up if played successfully [50]. Lastly, *Badges* are symbolic awards the user can receive inside a game [46].

3.3. Creation and Realization of the Survey

The survey consists of an introduction and three question parts. Participants were asked to imagine that they decided to improve their nutrition behavior towards healthiness and support this by using a nutrition app. First, ten different GEs were explained, followed by

four control questions to ensure that participants carefully read the explanations.

Subsequently, the BWS procedure started. Participants first choose the element they like best and the element they like least in their nutrition app in a set of four GEs. This is done equally for all 15 choice sets in the same sequence for each participant, as explained in 3.1. For each GE, an exemplary screenshot was created and shown to increase imagination. For example, the GE *goals,* consisted of instructions such as "drink at least eight glasses of water to absorb enough liquidity." In contrast, the *leaderboard* showed a ranking of names of friends and one being ranked in between. The GE *rewards* displayed a coupon of a fruit basket that could be redeemed in the supermarket. The *performance graph* showed the change compared to the previous weeks. In the GE *points*, the participant could collect *points* by eating a healthy diet. Figure 1 shows screenshots of the GEs *performance graph*, *rewards,* and *points*.
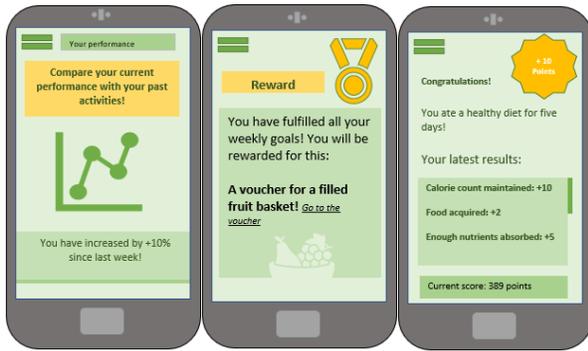
Figure 1. Example pictures of the GEs performance graph, rewards and points

Afterward, they were asked to put together their optimal bundle of GEs in a nutrition app. Participants are free to decide which elements and how many they would like to choose. Lastly, the demographic characteristics age, gender and educational level were queried. Five different people of the target group (three students and two young professionals aged between 21 and 32) conducted the survey on a trial basis before publication to ensure consistency and understandability of the survey. This resulted in minor changes, e.g., a more precise definition of the GE *leaderboard* and consistency in the use of words in the control questions.

To target the user group, we focused on younger people with higher education, who are the most common users of nutrition apps [30]. Therefore, we shared the survey via Facebook in university-related groups and via E-Mailing. Moreover, the survey was published in two portals; SurveyCircle and Pollpool, which facilitates students to answer the survey among each other. As an incentive, we raffled an Amazon voucher worth 15€ among all participants. The survey software "Google Forms" was used to create and conduct the survey.

220 people participated in the survey consisting of 128 women and 79 men. Three people did not provide any information about their gender. The data were comprehensively checked for completeness and meaningfulness. For each answer, it was checked if the survey was filled out completely and that not the same GE was selected as best and worst simultaneously in the same choice set. No answer had to be excluded. The average age of the participants is 27.06 years old. Approximately 45% of all participants have completed their schooling with a general qualification for university entrance or a comparable qualification from abroad. 25% hold a bachelor's degree and 22% a master's degree. The remaining 8% have written a state examination or have achieved a lower level of education.

3.4. Data Analysis

We calculated a counting analysis to define the ranking positions [42]. For the counting analysis, the difference of times an element was chosen as best and least preferred were calculated and divided by the times it appeared in a set (in our case six, see 3.2), multiplied by the number of total participants (in our case 220, see 3.2) [14]. The results of the counting analysis provide a standardized mean value (std. mean). The std. mean reflects the average preference of the participants for the GE and takes values between -1 and 1. The higher the value, the more an element is preferred by the participants [31, 50].

Also, we determined the number of elements that were selected on average into an optimal bundle. The Pearson correlation coefficient for the correlation between age and number of elements was determined, and a Man-Whitney U test was performed to determine possible differences between men and women concerning the preferred number of GEs. Next, we analyzed the occurrence of each GE in a preferred bundle in percent.

4. Results

The results of the counting analysis (see Table 2) show that *goals*, *performance graph,* and *progress bar* are by far the three most preferred elements with std. mean values reaching from 0.326 to 0.409. They are followed by *rewards* and *levels*. With a more considerable distance behind, the elements *points, leaderboards* and *badges* occupy places six, seven, and eight. The elements *social interaction* and *narratives* are the least preferred by the participants. Looking at the

raw best and worst, *performance graph* was most often selected as the best GE followed by *goals*. The GE *Narratives* was selected as the worst element, followed by *social interaction*. The column of Table 2 named "Best" contains the number of times an element was selected as best, and "Worst" contains the number of times an element was selected as the less preferred element.

Table 2. Counting analysis of BWS

GE	Best	Worst	Std. mean	SD	Rank-ing
Goals	583	43	0.409	0.513	1
Performance Graph	592	106	0.368	0.627	2
Progress Bar	530	100	0.326	0.609	3
Rewards	380	169	0.160	0.625	4
Levels	355	208	0.111	0.644	5
Points	218	234	-0.012	0.585	6
Leaderboards	246	563	-0.240	0.745	7
Badges	183	556	-0.283	0.693	8
Social Interaction	83	579	-0.376	0.600	9
Narratives	10	742	-0.464	0.668	10

A separate analysis of the data for males and females did not show a tremendous difference in preference for most GE. The most considerable differences were found in *leaderboards*, *narratives,* and *goals*. Men and women rated the element *narratives* the weakest. Women scored best on *goals, followed by performance graph* and *progress bar*. Men scored best on *performance graph* followed by *progress bar* and *goals*.

Participants selected every possible number of GEs in a bundle from one to ten at least once. Most often, five elements (33%), followed by four (22.73%), six (19.55%), three (11.82%), and seven (9.09%) were selected. 93.18% of all participants decided several at least three to a maximum of seven GEs optimal. The average optimal number of elements is 5.09. We found a negative correlation between the age of a person and the optimal number of elements in a bundle. Based on the Mann-Whitney U test, we found no significant difference between men and women concerning the optimal bundle size (U = 6174, critical value: 1.96, z-standardization: 1.6246).

The results of the selected GEs in one bundle agree almost entirely with the results of the counting analysis. Most often, participants chose the GEs *goals* (83.6%), *performance graph* (78.6%), and *progress bar* (76.4%) in a bundle. They were followed by the GEs *levels* (54%), p*oints* (53.6%), and *rewards* (50.5%).

Comparing our results to the results in the contexts of LMS and physical activity, we found that the participants in all contexts well evaluate *goals*, but best in nutrition, second-best in physical activity, and only third in LMS (s. Table 3). However, the GEs *points* and *levels* are rated worse in the context of nutrition. *Social interaction* is rated rather low in both health-related contexts, nutrition, and physical activity, but referring to the std. mean, it is even less preferred in the nutrition context. At the same time, *leaderboards* are rated highest in the context of physical activity.

5. Discussion and Conclusion

Regarding our first research questions *"Which gamification elements do users of nutrition apps prefer?"*, goals, performance graphs, and *progress bars* are the most preferred GEs in a nutrition app. The GEs *rewards* and *levels* follow on the fourth and fifths rank but with a considerable distance to *progress bar* (third rank). Hence, for most users, it is essential to have a clear, measurable target and to be able to see the progress towards this goal. If *goals* are contextually helpful, providing information concerning the "why" and "how" of changing nutrition behavior can lead to *meaningful GE* that enables long-term changes [38, 39]. *Goals* being the most preferred GE go in line with the results found by Hassan et al. [18], who state that goal-setting is the core of gamification design. Additionally, one might interpret that *goals* are already familiar to users in the context of nutrition, due to sayings like "5 fruits a day" and Schmidt-Kraepelin et al. [50] state that prior knowledge of a GE in the given context might explain the higher preference. Also, participants prefer to get sustained feedback about their performances by the integration of *performance graphs* and *progress bars*, which also enhances the satisfaction of the need for competence [47]. Additionally, the highest-rated GEs have a positive approach, meaning the more is better. This is an interesting result, because until now, counting systems in the context of healthy eating, like counting calories, is often instead associated with abstinence, meaning the more, the worse. These GEs might offer the chance to positively frame a healthy diet and allow focusing on eating the right food instead of blunt abstinence. Being aware of these mostly preferred GEs by the users offers the chance to test their effectiveness of enabling changes in habitual nutrition behavior. The three most preferred GE in a nutrition context belong to the category of achievement-related GEs, and were found to be positively associated with all three needs, and the strongest predictor for autonomy and competence need satisfaction [63].

Interestingly, *points* are rated on the sixth rank only, being the first GEs that is more often chosen as the worst than as best element, even though known nutrition programs like Weight Watchers are making use of this GE by counting points for the specific food you eat [20].

Table 3. Comparison between users' preferences in nutrition apps, physical activity [50] and LMS [51]

Ranking	Nutrition App		Physical Activity		LMS	
	Ranking	Std. mean	Ranking	Std. mean	Ranking	Std. mean
1.	Goals	0.409	Progress	0.378	Levels	0.432
2.	Performance Graph	0.368	Goals	0.317	Points	0.398
3.	Progress Bar	0.326	Points	0.257	Goals	0.379
4.	Rewards	0.160	Levels	0.169	Status	0.198
5.	Levels	0.111	Leaderboard	-0.100	Badges	-0.080
6.	Points	-0.012	Badges	-0.137	Leaderboard	-0.082
7.	Leaderboard	-0.240	Narratives	-0.159	Virtual Goods	-0.102
8.	Badges	-0.283	Virtual Goods	-0.164	Avatar	-0.26
9.	Social Interaction	-0.376	Social Interaction	-0.169	Time Pressure	-0.265
10.	Narratives	-0.464	Avatar	-0.393	Loss Aversion	-0.618

But based on our results, this is not a preferred GE, when it comes to nutrition behavior changes, which contradicts the assumption of Schmidt-Kraepelin et al. [50], who state that prior knowledge of a GE in the given context might explain the higher preference. Mekler et al. [35] found that next to *points*, *levels* and *leaderboards* might not function as intrinsic but only as extrinsic incentives. Mitchell et al. [36] came to similar conclusions. Therefore, it seems promising that these GEs are rather less preferred by users in the context of nutrition.

The element of *narratives* was rated the weakest. Participants might not see any meaningful use of *narratives* in a nutrition app. This contradicts the view of Nicholson [39] regarding his recipe for meaningful gamification, who recommends using *narratives* as a GE in apps to increase and maintain user engagement to create a personal connection to them. It indicates that the recipe for meaningful GEs might not be implemented in all contexts or might not go along with the users' preferences in general.

We found differences between men and woman in their preferences for GEs that include social aspects, namely *leaderboards* and *social interaction*. Gender-specific apps should consider the different preferences towards social GEs. *Leaderboards* were rated significantly better by men than by women, which shows that men prefer the comparison with other users than women [26]. On the other hand, women preferred the GE *social interaction* more than men. Generally, these elements were rated rather low, indicating that the need for social relatedness, which can be satisfied by GEs like *social interaction*, might not be urgent in nutrition-related contexts.

Regarding our second research questions, the saying "less is more" still seems to hold for GEs in nutrition

contexts similar to the contexts of LMS and physical activity. We found that, on average, five GEs are preferred in a nutrition app. Schmidt-Kraepelin et al. [50] found that three GEs is the most preferred number of GEs in the context of physical activity. Schöbel et al. [51] found four elements as the optimal number in LMS. The slightly higher number in nutrition-related apps might be because of the habitual characteristics of nutrition [59]. More support in modifying the environment by using GEs to fulfill the three basic needs of competence, authority, and social relatedness is needed to overcome challenges like the intention-behavior gap, which is often more significant for habitual behavior [52, 61].

Our results show contextual differences in user preferences between the contexts of LMS and physical activity regarding our third research questions. Participants prefer to have clear *goals* and see their progress towards achieving them, regardless of the context, implicating promising results regarding the preference of meaningful GEs enhancing long-term changes independent of the context. However, for in the context of LMS and physical activity, the GE *points* is rated better. The use of *points* is usually already familiar to users in sports and education, being a possible reason to lead to higher preferences [50]. Schmidt-Kraepelin et al. [50] found that *points* are robust through different contexts by comparing physical activity to LMS, but our results indicate that this is not the case in the context of nutrition. As stated above, our results indicate that GEs that *goals*, *performance graph*, and *progress bar* are preferred in a nutrition context, and points are only on the sixth rank. Social elements such as *social interaction* or *leaderboards* tend to be rated weakly in all contexts, indicating that the need for social relatedness might not be well addressed in GEs in the contexts. But, for

physical activity, *leaderboards* are rated best compared to nutrition apps and LMS, showing that the competitive spirit is more pronounced in a sports context. Whereas nutrition behavior might be perceived as more individual and private than physical activity, social relatedness is less admired.

5.1. Implications

Our work contributes to knowledge regarding gamification in general and specifically users' preferences and contextual differences and similarities in five ways. (1) We found the most preferred GE of target users in a nutrition app to foster healthy nutrition behavior. Especially meaningful GEs in the form of *goals*, *performance graphs,* and *progress bars* should be considered. *Performance graph* and *progress bar* might have been familiar in a negative context so far when it comes to healthy nutrition behavior representing avoidance and reduction. Therefore, it is promising that the results offer an opportunity to create a positive attitude towards nutrition, meaning eating more of the right instead of suffering by eating less. We also found that competition in the form of *leaderboards*, as well as *social interaction* and *rewards,* are not necessarily needed in the context of nutrition. Still, *rewards* might be useful at the beginning of the volition process to facilitate action. (2) We found that context-related differences exist. *Points* are not robust through all contexts, as Schmidt-Kraepelin et al. [50] state, because in the nutrition context, users prefer *points* less than in the contexts of education and sports. Also, users prefer *leaderboards,* especially in sports contexts, which might be due to competition, whereas nutrition may be a more individual and private concern. (3) We found that users prefer meaningful GEs in a nutrition-related context. Still, not all requirements of the recipe to create meaningful GEs [39] fit all of our results. For example, the fact of implementing the GE *narratives,* which is supposed to increase user engagement, is not preferred in the nutrition context. Therefore, separate consideration of the application of the recipe is necessary. (4) Similar to prior research focusing on users' preferences, we found evidence for the separate reflection of each GE since differences of the users' preferences exist. (5) Lastly, we found differences in the preferences between men and women regarding elements with a social aspect. Hence, future research should continuously consider analyzing these preferences separately.

Our results have a broad practical application in the field of nutrition. Nutrition-related issues are a severe concern leading to personal suffering and rising costs of the healthcare system [34]. Many stakeholders are concerned about health. These include the individuals themselves and public institutions such as health insurance companies or politicians or organizations whose business model aims to promote health, such as life coaches or gyms. The individual benefits from better use of a nutrition app because it corresponds to their preferences. Health insurance companies can promote health-oriented behavior by designing the app correctly and, for example, enter into cooperation agreements with supermarkets to redeem "rewards." App designers can focus on the most popular elements to promote the use and acceptance of the app.

5.2. Limitations and Future Research

This paper is limited concerning several aspects that require further research. First, by analyzing the users' preferences, nothing can be concluded about the elements' effectiveness. Acceptance is the first required step for the usage of an app, but separate considerations of the effectiveness of the most preferred elements are necessary. Next, the study was limited to the ten most frequently dealt elements within prior research. It is still conceivable that additional elements that have been excluded so far may cause a change in the ranking of preferred elements. In future research, more elements should be included, allowing a more comprehensive statement about the preferences of GEs in nutrition apps.

Other limitations relate to the design of the survey. Within the survey, the participants were offered one possible design for each of the ten elements based on a picture. The survey participants may have made their decision partly dependent on whether they liked this design. As it can be assumed that there is an unlimited number of optical variations for an element in a nutrition app, it would be useful to present several optical variations of an element in the future.

The use of a physical reward distorted the structure of the experiment. It would be interesting to see if the implementation of virtual rewards, for example, free healthy recipes, would lead to a different rank position.

Also, previous experiences with GEs, behavioral variables such as the usage behavior of apps, or information about the personal goal and motivation stage were not considered in the evaluation of the results. As it has been identified in similar research, previous experience with some GEs influence the preferences of the survey participants towards GEs [50]. In the future, control variables such as behavior variables concerning the usage of apps, including previous experience with GEs, as well as the nutrition type (e.g., vegetarian), and the personal goal as well as motivational state (HAPA question construct) should be queried in the survey and used as control variables.

Furthermore, the preferences regarding GEs were compared across contexts. However, the comparability

of the preferences towards GEs in the areas of HBCSS, LMS and nutrition is limited, as the selection of the elements examined differs in some respects. To fully compare the preferences, the same GEs should be studied. This should be considered in future research.

Overall, we have linked the need for healthy nutrition with the promising use of gamified nutrition apps. As this study shows, user preferences can differ depending on the context, therefore, we call on research in related contexts. For example, further research is needed in other health-related contexts like medication misuse, blood glucose monitoring, smoking, or stress reduction. But also, in nutrition-related contexts like sustainable nutrition instead of healthy nutrition. Even in the field of healthy nutrition, different apps focusing on, for example, weight loss or special diets, exit and can be regarded separately. Such investigations can help to increase general understanding and knowledge about GEs in different areas as well as the dependency of preferences on the context. Lastly, healthier, or more sustainable behavior can be reached.

6. References

[1] Asp, E.H., "Factors Affecting Food Decisions Made by Individual Consumers", Food Policy, 24(2-3), 1999.

[2] Berger, V. and U. Schrader, "Fostering Sustainable Nutrition Behavior through Gamification", Sustainability, 8(1), 2016.

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

[4] Chow, C.Y., R.R. Riantiningtyas, M.B. Kanstrup, M. Papavasileiou, G.D. Liem, and A. Olsen, "Can Games Change Children's Eating Behaviour? A Review of Gamification and Serious Games", Food Quality and Preference, 80, 2020, p. 103823.

[5] Codish, D. and G. Ravid, "Personality Based Gamification: How Different Personalities Percive Gamification", Research in progress, 2014.

[6] Cugelman, B., "Gamification: What It Is and Why It Matters to Digital Health Behavior Change Developers", JMIR serious games, 1(1), 2013, e3.

[7] Del Río, N.G., C.S. González-González, R. Martín-González, V. Navarro-Adelantado, P. Toledo-Delgado, and F. García-Peñalvo, "Effects of a Gamified Educational Program in the Nutrition of Children with Obesity", Journal of medical systems, 43(198), 2019, pp. 1–12.

[8] de-Marcos, L., E. Garcia-Lopez, and A. Garcia-Cabot, "On the effectiveness of game-like and social approaches in learning: Comparing educational gaming, gamification & social networking", Computers & Education, 95, 2016.

[9] Deterding, S., D. Dixon, R. Khaled, and L. Nacke, "From Game Design Elements to Gamefulness", in Proceedings of the 15th International Academic MindTrek Conference on Envisioning Future Media Environments, Finland. 2011.

[10] Deterding, S., D. Dixon, R. Khaled, and L. Nacke, "Gamification: Toward a Definition", in Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments, USA. 2011.

[11] Dishman, R.K., J.F. Sallis, and D.R. Orenstein, "The determinants of physical activity and exercise", Public health reports, 100(2), 1985, p. 158.

[12] Edwards, E.A., J. Lumsden, C. Rivas, L. Steed, L.A. Edwards, A. Thiyagarajan, R. Sohanpal, H. Caton, C.J. Griffiths, M.R. Munafò, S. Taylor, and R.T. Walton, "Gamification for Health Promotion: Systematic Review of Behaviour Change Techniques in Smartphone Apps", BMJ open, 6(10), 2016, 1-9.

[13] Ezezika, O., J. Oh, N. Edeagu, and W. Boyo, "Gamification of Nutrition: A Preliminary Study on the Impact of Gamification on Nutrition Knowledge, Attitude, and Behaviour of Adolescents in Nigeria", Nutrition and health, 24(3), 2018, pp. 137–144.

[14] Finn, A. and J.J. Louviere, "Determining the Appropriate Response to Evidence of Public Concern: The Case of Food Safety", Journal of Public Policy & Marketing, 11(2), 1992.

[15] Fuchs, K., V. Huonder, D. Vuckovac, and A. Ilic, "Swiss Foodquiz: Inducing Nutritional Knowledge via Avisual Learning Nased Serious Game", Protoypes, 1, 2016.

[16] de Guinea and Markus, "Why Break the Habit of a Lifetime? Rethinking the Roles of Intention, Habit, and Emotion in Continuing Information Technology Use", MIS Quarterly, 33(3), 2009, pp. 433–444.

[17] Hamari, J., J. Koivisto, and H. Sarsa, "Does Gamification Work? - A Literature Review of Empirical Studies on Gamification", in Proceedings of the 47th Hawaii International Conference on System Sciences. 2014.

[18] Hassan, L., N. Xi, B. Gurkan, J. Koivisto, and J. Hamari, "Gameful Self-Regulation: A Study on How Gamified Self-Tracking Features Evoke Gameful Experiences", in Proceedings of the 53rd Hawaii International Conference on System Sciences. 2020.

[19] Holzmann, S.L., H. Schäfer, G. Groh, D.A. Plecher, G. Klinker, G. Schauberger, H. Hauner, and C. Holzapfel, "Short-Term Effects of the Serious Game "Fit, Food, Fun" on Nutritional Knowledge: A Pilot Study among Children and Adolescents", Nutrients, 11(9), 2019.

[20] https://www.weightwatchers.com/us/how-it-works.

[21] Jia, Y., B. Xu, Y. Karanam, and S. Voida, "Personality-targeted Gamification", in 34th Annual CHI Conference on Human Factors in Computing Systems, USA. 2016.

[22] Johnson, D., S. Deterding, K.-A. Kuhn, A. Staneva, S. Stoyanov, and L. Hides, "Gamification for Health and Wellbeing: A Systematic Review of the Literature", Internet interventions, 6, 2016, pp. 89–106.

[23] Jones, B.A., G.J. Madden, H.J. Wengreen, S.S. Aguilar, and E.A. Desjardins, "Gamification of Dietary Decision-Making in an Elementary-School Cafeteria", PloS one, 9(4), 2014,.

[24] Kappen, D.L., L.E. Nacke, K.M. Gerling, and L.E. Tsotsos, "Design Strategies for Gamified Physical Activity Applications for Older Adults", in 49th Hawaii International Conference on System Sciences, USA. 2016.

[25] King, D., F. Greaves, C. Exeter, and A. Darzi, "'Gamification': Influencing Health Behaviours with Games", Journal of the Royal Society of Medicine, 106(3), 2013, pp. 76–78.

[26] Koivisto, J. and J. Hamari, "Demographic Differences in Perceived Benefits from Gamification", Computers in Human Behavior, 35, 2014, pp. 179–188.

[27] Koivisto, J. and J. Hamari, "The Rise of Motivational Information Systems: A Review of Gamification Research", International Journal of Information Management, 45, 2019, pp. 191–210.

[28] Kostopoulos, P., A.I. Kyritsis, V. Ricard, M. Deriaz, and D. Konstantas, "Enhance Daily Live and Health of Elderly People", Procedia Computer Science, 130, 2018.

[29] Kotsopoulos, D., C. Bardaki, S. Lounis, and K. Pramatari, "Employee Profiles and Preferences towards IoT-enabled Gamification for Energy Conservation", International Journal of Serious Games, 5(2), 2018, pp. 65–85.

[30] Krebs, P. and D.T. Duncan, "Health App Use Among US Mobile Phone Owners: A National Survey", JMIR mHealth and uHealth, 3(4), 2015, e101.

[31] Lansing, J., S. Schneider, and A. Sunyaev, "Cloud Service Certifications: MeasuringConsumers' Preferences For Assurances", 2013.

[32] Lister, C., J.H. West, B. Cannon, T. Sax, and D. Brodegard, "Just a fad? Gamification in Health and Fitness Apps", JMIR serious games, 2(2), 2014, e9.

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

[34] Meier, T., K. Senftleben, P. Deumelandt, O. Christen, K. Riedel, and M. Langer, "Healthcare Costs Associated with an Adequate Intake of Sugars, Salt and Saturated Fat in Germany", PloS one, 10(9), 2015, 1-21.

[35] Mekler, E.D., F. Brühlmann, A.N. Tuch, and K. Opwis, "Towards understanding the effects of individual gamification elements on intrinsic motivation and performance", Computers in Human Behavior, 71, 2017.

[36] Mitchell, R., L. Schuster, and J. Drennan, "Understanding how gamification influences behaviour in social marketing", Australasian Marketing Journal (AMJ), 25(1), 2017.

[37] Nacke, L.E. and S. Deterding, "The Maturing of Gamification Research", Computers in Human Behavior, 71, 2017, pp. 450–454.

[38] Nicholson, S., "A User-Centered Theoretical Framework for Meaningful Gamification", 2012.

[39] Nicholson, S., "Recipe for Meaningful Gamification", 2015.

[40] Nour, M.M., A.S. Rouf, and M. Allman-Farinelli, "Exploring Young Adult Perspectives on the Use of Gamification and Social Media in a Smartphone Platform for Improving Vegetable Intake", Appetite, 120, 2018.

[41] https://www.who.int/en/news-room/fact-sheets/detail/obesity-and-overweight, accessed 7-5-2020.

[42] Orme, B., "Accuracy of HB Estimation in MaxDiff Experiments", Sawtooth Research Paper Series, 2005.

[43] Robinson, D. and V. Bellotti, "A Preliminary Taxonomy of Gamification Elementsfor Varying Anticipated Commitment", 2013.

[44] Rohde, A., A. Duensing, C. Dawczynski, J. Godemann, S. Lorkowski, and C. Brombach, "An App to Improve Eating Habits of Adolescents and Young Adults (Challenge to Go): Systematic Development of a Theory-Based and Target Group–Adapted Mobile App Intervention", JMIR Mhealth Uhealth, 2019.

[45] Ryan, R.M. and E.L. Deci, "Self-Determination Theory and the Facilitation of Intrinsic Motivation, Social Development, and Well-Being", American Psychologist, 55(1), 2000.

[46] Sailer, M., J. Hense, H. Mandl, and M. Klevers, "Psychological Perspectives on Motivation through Gamification", Interactive Design and Architecture(s) Journal(19), 2013, pp. 28–37.

[47] Sailer, M., J.U. Hense, S.K. Mayr, and H. Mandl, "How Gamification Motivates: An Experimental Study of the Effects of Specific Game Design Elements on Psychological Need Satisfaction", Computers in Human Behavior, 2017.

[48] Sardi, L., A. Idri, and J.L. Fernández-Alemán, "A Systematic Review of Gamification in E-Health", Journal of biomedical informatics, 71, 2017, pp. 31–48.

[49] Scheibehenne, B., L. Miesler, and P.M. Todd, "Fast and frugal food choices: uncovering individual decision heuristics", Appetite, 49(3), 2007, pp. 578–589.

[50] Schmidt-Kraepelin, M., S. Thiebes, S. Schöbel, and A. Sunyaev, "Users' Game Design Element Preferences in Health Behavior Change Support Systems for Physical Activity: A Best-Worst-Scaling Approach", in 40th International Conference on Information Systems. 2019: Germany.

[51] Schöbel, S., M. Söllner, and J.M. Leimeister, "The Agony of Choice Analyzing User Preferences Regarding Gamification Elements in Learning Management Systems", SSRN Journal, 2016.

[52] Schwarzer, R., "Modeling Health Behavior Change: How to Predict and Modify the Adoption and Maintenance of Health Behaviors", Applied Psychology, 57(1), 2008, pp. 1–29.

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

[54] Stepanovic, S. and T. Mettler, "Gamification Applied for Health Promotion: Does It Really Foster Long-Term Engagement? A Scoping Review", 26th European Conference on Information Systems, 2018.

[55] Szeinbach, S.L., J.H. Barnes, W.F. McGhan, M.M. Murrawski, and R. Corey, "Using Maximum Difference Conjoint and Visual Analog Scaling to Measure Patients´ Utility for a Particular Health State", Journal of Research in Pharmaceutical Economics, 1998.

[56] Thurstone, L.L., "A Law of Comparative Judgment", Psychological Review, 34(4), 1927, pp. 273–286.

[57] Tondello, G.F., R.R. Wehbe, L. Diamond, M. Busch, A. Marczewski, and L.E. Nacke, "The Gamification User Types Hexad Scale", in Association for Computing Machinery, USA. 2016.

[58] van Lippevelde, W., J. Vangeel, N. de Cock, C. Lachat, L. Goossens, K. Beullens, L. Vervoort, C. Braet, L. Maes, S. Eggermont, B. Deforche, and J. van Camp, "Using a Gamified Monitoring App to Change Adolescents' Snack Intake: The Development of the Reward App and Evaluation Design", BMC public health, 16, 2016, p. 725.

[59] van't Riet, J., S.J. Sijtsema, H. Dagevos, and G.-J. de Bruijn, "The Importance of Habits in Eating Behaviour. An Overview and Recommendations for Future Research", Appetite, 57(3), 2011, pp. 585–596.

[60] Wang, C.K.J., A. Khoo, W.C. Liu, and S. Divaharan, "Passion and intrinsic motivation in digital gaming", Cyberpsychology & behavior: the impact of the Internet, multimedia and virtual reality on behavior and society, 11(1), 2008, pp. 39–45.

[61] Webb, T.L. and P. Sheeran, "Does Changing Behavioral Intentions Engender Behavior Change? A Meta-Analysis of the Experimental Evidence", Psychological bulletin, 132(2), 2006, pp. 249–268.

[62] Wenjie, H., C. Hailiang, and K. Juhee, "The Impact of Gamification Design on the Successof Health and Fitness Apps", in 22nd Pacific Asia Conference on Information Systems,.2018: Japan.

[63] Xi, N. and J. Hamari, "Does gamification satisfy needs? A study on the relationship between gamification features and intrinsic need satisfaction", International Journal of Information Management, 46, 2019.