Integrating gamification into a system to improve diet compliance for elderly users

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ABSTRACT

Nowadays, gamification is applied in many areas, including healthy lifestyle promotion. In earlier work, a system has been proposed to stimulate diet compliance and adherence of participants of a trial within the PROMISS-project. In this paper, we describe the design of a gamified version of this system. The goal of the gamification is to further stimulate diet compliance and adherence to the system, but also to increase the knowledge about the diet and make the use of the system more fun. To do so, we implemented gamification elements (profile page, achievements, mini-games, and a reward garden) to address multiple behaviour change techniques. Based on a small evaluation, the system has been improved so that it can be used by participants of the PROMISS trial. At the end of this paper, future improvements are suggested in the future work section.

KEYWORDS

Gamification, diet compliance, elderly users

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1 INTRODUCTION

In an earlier work, a system used within the PROMISS-project was described, which aims to prevent malnutrition among elderly [17]. This system is used within a larger study towards a protein rich diet for elderly, which is part of the PROMISS-project. The system mainly aims to improve the diet compliance and adherence of a subset of participants of this study. The system uses persuasive communication to achieve its goal. Gamification – adding game elements to an existing task, in order to make it more motivating [12] – could further enrich the system and contribute to this goal. This paper describes how different game elements are used to enrich the existing system for the PROMISS trial.

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Gamification is applied in many different areas, among which is supporting a healthy lifestyle. Since more people of different ages own smartphones or other mobile devices, with their own stores for applications (apps), the number of apps to promote an healthy lifestyle has increased [9, 11]. The increasing number of 'internet of things'-applications, and the increased interest in preventive healthcare will further increase the popularity of such apps.

Earlier work described the basic system (without game elements) for the PROMISS-trial [17]. The current paper describes the design of the gamification for this system. In the next section, a literature overview of gamification will be given, as well as an overview of systems with a comparable goal or target group. In Section 3, the design of our gamification is explained. This paper will conclude with a summarizing conclusion and a future work section.

2 RELATED LITERATURE

This section explains in more detail what gamification is and how it can be achieved. Furthermore, it gives an overview of gamification of similar apps and the use of gamification for elderly users.

2.1 Gamification and game elements

Gamification can be described as *"the intentional use of game elements for a gameful experience of non-game tasks and contexts"* [12]. Foursquare[1], founded in 2009, is a successful and early example of the use of gamification. Foursquare added game elements to their location-based social network to encourage people to use their service. Even before Foursquare, gamification in the form of loyalty programs was used by organisations to create consumer loyalty.

Recently, gamification has gained more and more attention, both in commercial fields as well as in academia, as it has many opportunities in the rising number of digital applications. Gamification is nowadays applied in a wide variety of contexts, e.g. education, health, commerce, and sustainable consumption [3].

Game elements play an important role in gamification. These game elements, or also called game mechanics, form the motivational factors that are at the core of gamification. Examples of such mechanics are points, leaderboards, badges, and achievements [22].

Game elements are also used in another type of application with a serious purpose, a serious game: *"a game in which education (in its various forms) is the primary goal, rather than entertainment"* [10].

2.2 Apps for a healthy lifestyle

There are different types of apps in field of healthy lifestyle. The majority of the apps found in a review paper of gamification for

[1] https://foursquare.com/

health and well-being [6] focused on physical activity and (healthy) nutrition. The review mentions seven promises of gamification for health and well-being, and argues to what extent these promises are covered by the reviewed studies. The first promise is that it can intrinsically motivate the users, as games can do. However, in their review it was found that studies often look at behavioural measures, and gamification is mainly used as a positive reinforcement. Intrinsic motivation is not studied. The second promise is that it has a broad accessibility through mobile technology and ubiquitous sensors. Although these techniques are used in the reviewed apps, it is not researched if there are any differences with stationary delivery modes. The third and forth promises are that gamification has a broad appeal and a broad applicability. There is a large and broad target audience for health apps using gamification. Moreover, gamification is and can be applied to many different aspects of health. The fifth and sixth promises are the cost-benefit efficiency and the fit to everyday life. However, the reviewed paper do not study this. The seventh promise is that gamification supports well-being. Positive effects for this are found in different researches.

The following game elements, in order of frequency (high to low), were found in the review of gamification for health and well-being [6]: rewards, avatars, leaderboard, social interaction, levels, progress, story/theme, challenges, and feedback. It was found that apps often include different game elements. It is therefore not possible to determine the effect of single game elements. Overall, the conclusion of this review is that gamification for health and well-being apps has a positive effect on the affect, behaviour, cognition, and user experience. Often, it also has a positive effect on the user's health and/or well-being. When the latter effect is not found, this is often due to the context or the way in which gamification is used, or due to a mismatch of the game elements and the target group.

Apps for healthy lifestyle often have the goal to change their users' behaviour. In order to do so, behaviour change techniques (BCTs) can be used. A list of 26 BCTs is constructed by Abraham and Michie (2008) [1]. Reviews towards health interventions via websites showed that interventions including more BCTs are more effective [19, 20]. In a review of apps to improve healthy lifestyle of children and adolescents, it was found that an app uses, on average, 6 out of the 26 BCTs. According to this is comparable to the number of BCTs (4 - 8) found in reviews towards healthy lifestyle apps for adults. The most popular BCTs (found in $\geq$ 40% of the reviewed apps) that were found in apps for children and adolescents were: instructions, general encouragement, contingent rewards, feedback on performance, self-monitoring behaviour, and social comparison [11]. In many of the games within this review gamification is used.

It is found that the number of BCTs in an app is positively associated with the quality of an app [11], as well as on engagement and information scores but not for functionality and aesthetics scores. To measure this quality of health apps, the Mobile App Rating Scale (MARS) can be used [16]. Using this, it is found that the number of app features is only positively associated with the total and the engagement MARS score. Moreover, a positive correlation was found between the number of features and the number of BCTs. The reviewed apps score the highest on functionality, aesthetics, and engagement. However, they score lower on information. This could mean that the focus of developers is mostly on creating easy to use and functional apps [11].

The review of [9] is focused on health and fitness. Again, it was found that many games include gamification elements to motivate the users. Most used gamification element is social or peer pressure, followed by digital rewards, competitions, leaderboards, and levels of achievement or rank. In some apps it was found that real world prizes were used as game element. Next to gamification elements, elements that are more typical for games are also found. These include, among others, feedback, reinforcement, self representation with avatars, time pressure and narrative contexts. Moreover, behaviour measures such as self-monitoring, goals setting and peer pressure are found in the applications.

Overall, it has been found in multiple reviews that health apps often use gamification to achieve a behavioural goal with the user. A broad audience is reached by such games, as well as a large domain of different aspects of the health domain. The apps often use game elements such as rewards, leaderboards, social aspects and challenges. These game elements are used to include BCTs in the apps, which contributes to the quality of the app. The social aspects of apps do not only contribute to the integration of BCTs in apps, it is also a way to advertise apps to new users [14].

2.3 Gamification for elderly

Gamification can be and is used for elderly users, however this target group needs some special attention in the design process. For example, it is found that game elements can work differently for younger people compared to how they work for elderly [8]. Also, the ease of use of gamification declines with age [7]. Usability is important to keep in mind when designing for elderly. Using guidelines about motivational factors, such as making it fun and clearly defining the benefits of it, is important when designing for elderly [2]. In the design of the app itself, it is also important to keep in mind guidelines for elderly users. In the previous paper about this system [17], an overview of such guidelines is given. Remarks have been made about the need for larger screens, with bigger fonts and spacings to ensure readability for an older target group. The navigation of the system should be clear and reduce or avoid drag-and-drop interactions. Moreover, it is important to avoid an overload of information on one page, as well as scrolling.

Although the target group of elderly users needs some special attention, gamification is used in applications designed for them, but also serious games for elderly exist. Serious games for elderly are promising in the field of prevention and rehabilitation [21]. For example, many different games exist for fall prevention, such as [13, 15]. However, serious games and gamification is also used in different other areas relevant to elderly users. For example, there exists a serious game for elderly to train their verbal resilience to doorstep scams [18], and a gamified training for the cognitive functioning of elderly, in the context of safe driving [4]. As these examples show, gamification can be targetted at elderly users, if the design is tailored to their needs.

3 DESIGN OF GAMIFIED VERSION

This section explains the gamified system. First, the structure of the design process is explained. Next, the different steps from the design process, as well as the final gamified design, are explained.

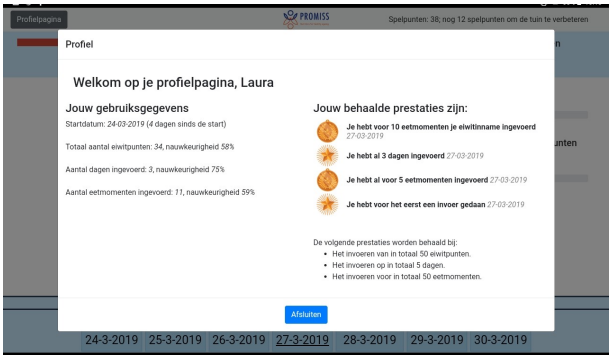


Figure 1: Example of profile page

3.1 Design process

The starting point of the gamified app is an existing system designed for the PROMISS-project. The design process starts with designing the goal(s) and determine which game elements suit the goal(s). Next, a first design of the gamification was implemented. To evaluate this version, an interview has been held with one person from the aimed target group. Moreover, feedback from dietitians and experts from the PROMISS-project is gathered. All feedback is used to make some changes after which the gamified version is used within the trail. More about this evaluation is explained in 3.4.

In the rest of this section, the goal of the gamification is discussed, then the final design of the gamified version, and finally the lessons that have been learned from a prototype evaluation.

3.2 Goal of gamified version

As stated in Section 2.1 gamification is the addition of game elements to an existing task. Therefore, it is important to first think about the goal of the gamification, the desired game elements that can achieve this, and how this can suit the existing task. In this case, the task to gamify is a food diary with the guidelines from the PROMISS-project diet included.

The goal of the gamification is trifold. On the one hand, the gamification should further enhance the compliance with the dietary advice and the adherence to using the app. As discussed in Section 2.2, gamification is often used in health related apps to increase the motivation of the user. By adding game elements to the app, the hypothesis is that the users will enjoy using the app more, and be more motivated to use the app. Moreover, game elements can be used to reward users for their diet compliance.

Secondly, it is of interest whether the gamification also improves the knowledge of the users. Users of the initial system passively work with the protein point system, the system calculates the points each meal is worth. With gamification it is possible to make users more actively work with the protein point system, which could enhance their knowledge. Finally, games are meant to be fun. The third goal is therefore to make the app (more) fun to use.

When thinking about gamifying the protein point system, one problem arises: users should not feel motivated to consume as many protein points as possible. This is represented in the colour scales used for the protein points and thresholds for each eating moment and the day total. However, it also needs to be taken into account in the mechanics of the gamified version.

The final gamified system consists of four components: a profile with usage statistics, achievements, mini-games and a reward garden. In Section 3.3 the functioning and rationale behind each component is explained. The lessons learned from the evaluation of the prototype are described in Section 3.4.

3.3 Gamified system

At the end of the section, Table 1 summarises how each game element is connected to the goals explained in Section 3.2 with a rating from 0-5 stars. Zero stars meaning no expected contribution, five stars meaning a very strong expected contribution. Moreover, Table 2, shows how different BCTs, based on the review of [11], are used within the app, again with the five star system.

3.3.1 Personal profile. Figure 1 shows a profile page for a user. On top of the profile page the user is greeted. This is personalised to the users preference for a form of address; informal or formal. This is followed by a list of statistics of their usage of the app:

- Start date and number of days since the start;
- Total number of protein points registered and accuracy[2];
- Total number of days for which some proteins are registered and accuracy[2];
- Total number of eating moments for which protein points are registered and accuracy[2].

The profile furthermore lists the achievements that the user has achieved, together with the date on which the player received it. Moreover, the next achievements in each category is shown. The achievements are explained in the next section.

The profile page contributes to the self-monitoring of the behaviour of the user, see Table 2. The profile summarises the user's performance over the full duration of the app, while they can only see their detailed performance for a few days. Moreover, the accuracy confronts users with their adherence directly. It is expected that the profile will mostly contribute to the adherence to the app, as it mainly shows the user statistics about this. However, it will also contribute to the diet compliance, as the statistics also give insight in this. Finally, to some users the profile can be seen as fun, as they like to follow their usage and loyalty to the app and diet.

3.3.2 Achievements. Consecutive achievements (42 in total) are created for three different categories: protein points (18 achievements), days of registration (15), and registration of eating moments (9). They have been designed in such a way that users can receive them during the full duration of the study, with a wide variety of description texts. When a player earns a new achievement, a notification is shown accompanied by a cheering sound effect.

Achievements give general encouragement, provide feedback on the performance and provide contingent rewards to the player, see Table 2. Players can be motivated by the fact that they can collect achievements. As is shown in Table 1, this mainly contributes to the app adherence, because the number of days of registration and the number of moments registered are awarded. It does not say much about the adherence to the diet, as the achievements are only related

[2]The accuracy shows the percentage of the expected registration that is registered by the user.

to the total number of protein points. Moreover, achievements will be perceived as fun to accomplish.

3.3.3 Mini-games. Five different short quiz-like mini-games, have been created for the gamified version. They are based on a subset of the products in the protein table used within the PROMISS trail; namely all specific products. General products (such as 'meat, fish, vegetarian component') are excluded from this subset. All games randomly choose products from this set of products, however some games have constraints on these choices, which are explained below. With each game the user can earn up to maximum 10 so-called 'game points'. These points are used to improve the reward garden, which is described in the next section. In each game sound effects are used to indicate right or wrong answers.

To make the games suitable for elderly users, the games have an easy navigation (e.g. no drag and drop actions or moving objects) and are text-based rather than relying on complicated visual components. Furthermore, there is no time pressure, so that players can read the texts and play the game at their own pace. Moreover, the games are easy to understand and play, which aims to reduce the threshold for people to play the games.

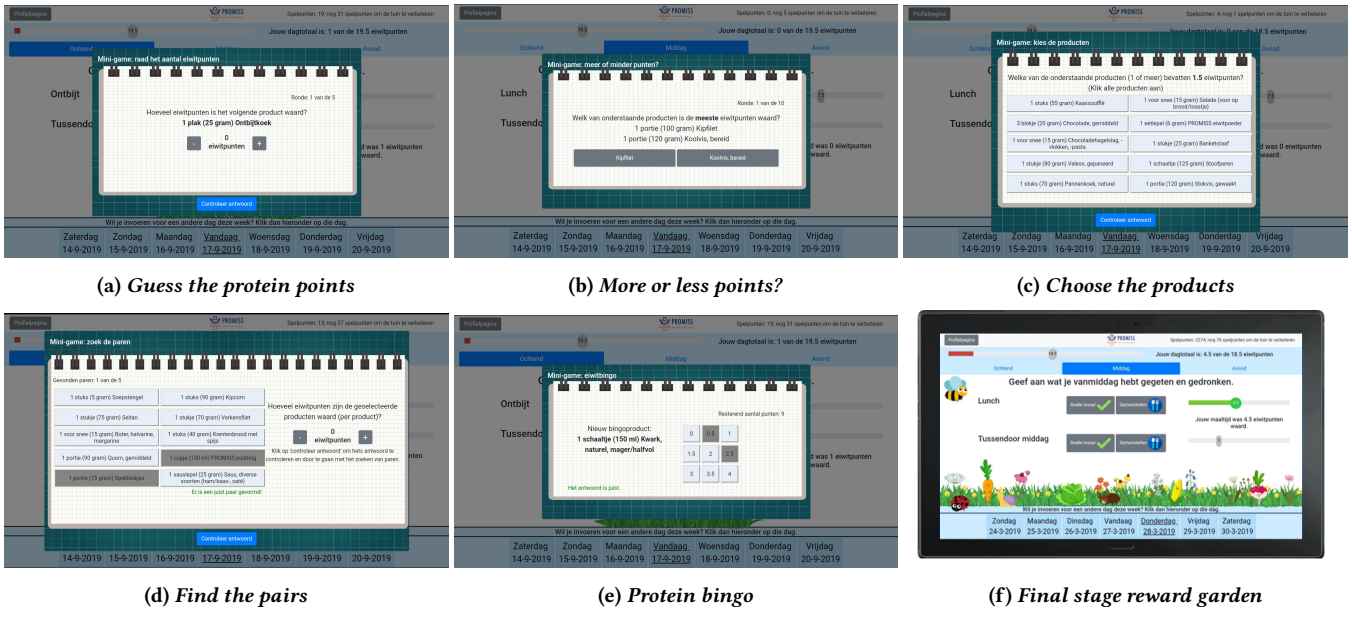
The mini-games serve as a reward for meeting the threshold for an eating moment. As discussed earlier, consuming more than the recommended number of proteins is not necessarily better and therefor not stimulated. After filling in its intake for an eating moment on the right level, the user is invited to play one of the five games (chosen at random). It is also possible to skip the game. An explanation is given at the beginning of each game. The printed manual that users received also includes an explanation for each game, as well as an explanation of the other gamification elements.

The mini-games are the only game element that serves all different goals, as shown in Table 1. As it is a reward for registering a meal with the advised number of proteins, it stimulates both diet compliance as well as app adherence. This is also a way to give feedback on the performance of the user, as indicated in Table 2. Moreover, it stimulates the players' knowledge about the protein points, as all games are questioning this knowledge. This resulted in easy and quiz-like games, giving the users a way to both increase and show their knowledge on the protein points. Finally, the games are meant as a fun element within the application. The following paragraphs briefly discuss the different mini-games.

Guess the protein points. In this game there are five rounds in which the player is shown one product and its standard portion size. The player is asked how many protein points this portion is worth (see Figure 2a). Products can only be chosen by the system once per game. The player can indicate the number of protein points with a plus and minus button as (s)he is used to from entering its diet. The player earns two points for a correct answer and one point when the answer is 0.5 protein points off.

More or less points? This game consists of 10 rounds of one question: 'Which product contains more/less protein points?'. For each game, it is randomly chosen whether the question will be about *more* or *less* points. The first product of each question is randomly chosen. The second products needs to be worth a different number of points, within a 1.5 point range from the first product. The player is shown two products and their standard portion and is asked to choose the right answer (see Figure 2b). For each correct answer the player earns one point.

Choose the products. In this game the player is shown 10 products and their standard portion. The player needs to click all products with a specific number of points (see Figure 2c). The list consists of 10 unique products, chosen randomly. The number of points that the player needs to find is also chosen randomly, but needs to



(a) ***Guess the protein points*** **(b)** ***More or less points?*** **(c)** ***Choose the products***

(d) ***Find the pairs*** **(e)** ***Protein bingo*** **(f)** ***Final stage reward garden***

Figure 2: Screenshots of the five mini-games and reward garden

appear at least once in the list of 10 products. Each product that is in the right category (clicked or not clicked) is worth one point.

Find the pairs. In this game the player is shown 10 products and their standard portions. The player is asked to make five pairs of products with the same number of protein points. For this game a different subset of products is used, namely the set of products that can form a pair, so only point categories with at least two products are included. A pair should consist of two different products and for each number of points only one pair can appear in the list.

For each correctly formed pair the player receives one point. The player can try as many times as (s)he needs. The player therefor always earns a minimum of five points. When a correct pair is formed, the player is asked how many points the products are worth (separately). If this question is answered correctly, the player receives one extra point for each pair. In Figure 2d an example is shown of a formed pair and the bonus question.

Protein bingo. In protein bingo the player starts with 10 points and an empty bingo card. On this bingo card the following numbers are shown: 0, 0.5, 1, 1.5, 2, 2.5, 3, 3.5, and 4 (see Figure 2e). The player is shown a product and its standard portion. This product is chosen randomly, but products are only used once during the game and only products worth a number of points that is still available on the bingo card are selected. The player then needs to choose the right number of protein points by selecting an unused number on the bingo card. When the player chooses an incorrect number, one point is reduced from the player's points total for this game. When the player has no more numbers left on its bingo card, (s)he wins the remaining number of points. When there are no more points left, the game is over.

3.3.4 Reward garden. By playing the mini-games, the player earns game points which also improves its "reward garden". At the start, the background of the application is blank. The more game points are earned, the more of the background is filled garden elements. On the top right of the screen, the total number of game points is shown, as well as the next threshold for receiving an improvement. The garden has 37 stages. The first improvement is given after earning five game points, which is possible by playing one game. Each subsequent stage requires between 50 and 150 game points. If the player improves its garden (s)he will receive a notification, accompanied by the cheering sound that is also used for the achievements. Figure 2f shows the final stage of the reward garden.

The reward garden is used to increase the app adherence, as it mainly rewards playing the mini-games, and is meant as a fun aspect in the app (see Table 1). Previous research argued that using a garden in a game, either to look at or to do activities in, can have a stress reducing effect [5]. Next to reducing stress, the reward garden mainly provides a contingent reward (see Table 2).

3.4 Lessons from evaluation the prototype

As the core functionality of the system was not changed by the gamification elements, and to limit the time of the design phase, no additional pilot study has been performed. Instead, one participant (female) from the first pilot study [17] was invited to play the different mini-games and see the profile page with an explanation of the different gamification elements. Overall, she was positive about the gamification elements and she was enthusiastic about the rewarding garden. However, from her interaction with the mini-games it turned out that she quickly attempted playing the games, without fully reading the instructions. She also reported this. In the prototype the instructions were provided when the game started. To increase the attention to the instructions, they are moved to a separate screen at the start of each game. Participants have to click a button to move from the instruction page to the game. Moreover, the participant had some remarks about elements that were unclear to her. To address this, some explanations or visual elements in the games are changed or added.

The new version of the app is also shown to dietitians and experts from the PROMISS-project that were not involved in the development process. They were very enthusiastic about the mini-games as well and liked how it tests the knowledge about the protein point system. They mentioned that they would have liked such games during their education to learn about nutritional values.

4 CONCLUSIONS AND FUTURE WORK

Gamification is getting more attention in many fields, among which is the domain of healthy lifestyle promotion. This paper described how an existing system is extended with gamification elements to fulfil different goals: increase diet compliance, app adherence, knowledge about the diet, and as a way of making the usage of the app more fun. As earlier work suggests, using multiple BCTs in an app increases its potential. Therefore, different BCTs are addressed by the different game elements used within this gamified system.

By taking into account both the goals of the system, the requirements from the study, and design guidelines for elderly users, a design has been made for a gamified system, consisting of the following four components: profile with usage data, achievements, mini-games, and a reward garden. From an evaluation of the first design of this system with one of the earlier participants from a pilot study, it became clear that the visuals and instructions of the system were not clear enough to the user. Adjustments have been made so that the instructions could not be overlooked and visual indications of changes in the game were added.

The system is currently used within the large clinical trial. Both app usage data will be collected, as well as data about the usability of the system and the gamification elements. The overall appreciation of following the diet of all participants will be compared to see if the gamification has an effect on this.

The design of this system showed that on the one hand, it is important to match the goals with the chosen gamification elements when designing for a specific purpose. On the other hand, the target

		Goals			
		Diet compliance	App adherence	Knowledge	Fun
Game elements	Profile page	***	*****		*
	Achievements	**	*****		***
	Mini-games	****	****	*****	*****
	Reward garden		*****		****

Table 1: Overview of game element and the addressed goals

BCT	App element
Provide information about behaviour-health link	Messages * (only some strategy)
Provide information on consequences	Messages * (only some strategy)
Provide information about others' approval	Messages * (only some strategy)
Provide general encouragement	Achievements *** Coloured intake **
Provide instruction	Diet advice composer **
Model/demonstrate the behaviour	Diet advice composer *
Prompt specific goal setting	Thresholds diet ****
Prompt self-monitoring of behaviour	Food diary functionality ***** Profile page ***
Provide feedback on performance	Coloured intake ***** Achievements ***** Mini-games ****
Provide contingent rewards	Achievements ***** Mini-games **** Reward garden ****
Stress management	Reward garden *

Table 2: Overview of relation of BCTs and app elements

group requires to match the chosen gamification elements with their special needs. This has let to a simple, yet diverse gamified system, with multiple game elements using different BCTs.

4.1 Future work

The results of the currently running larger study are expected halfway 2020. It is expected that this results will give more insights in the usability of such a system in a diet program for elderly. This could result in new design guidelines and/or best practices, which can be used in future researches towards similar types of systems.

Moreover, in future research it can be interesting to test other variations on the current design. The mini-games in this design are mainly text-based. It is yet unknown whether these games would have a different effect and evaluation when they would include more visual components. Moreover, the mini-games are relying on random choices of products. However, it can be possible to create different difficulty levels for the games. This could be done manually, by determining products or product combinations that are harder to distinguish. It could however also be done with machine learning techniques by learning from the behaviour of users. Questions that are more often answers incorrectly could be classified as harder compared to questions that are often answered correctly.

Furthermore, it could be studied if achievements can be made adaptive to individual users. For example by ensuring that each next achievement is within a desirable distance in time of the current achievements so that players stay motivated.

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