Designing Personalised Gamification of mHealth Survey Applications

Paulina Adamczyk[1,2], Sylwia Marek[1,2], Ryszard Pręcikowski[1,2], Maciej Kuś[1,2], Michał Grzeszczyk[1,3][a], Maciej Malawski[1,2][b] and Aneta Lisowska[1,4][c]

[1]*Sano Centre for Computational Medicine, Krakow, Poland*

[2]*AGH University of Science and Technology, Krakow, Poland*

[3]*Warsaw University of Technology, Warsaw, Poland*

[4]*Poznan University of Technology, Poznan, Poland*

Keywords: User Interface Design, Gamification, Personalisation, mHealth, Survey, Patient Reported Outcome (PRO).

Abstract: To monitor patients' well-being and evaluate the efficacy of digital health intervention, patients are required to regularly respond to standardised surveys. Responding to a large number of questionnaires is effortful and may discourage mHealth app users from engaging with the intervention. Gamification might reduce the burden of self-reporting. However, researchers have adopted various approaches to the personalisation of gamification design: ranking of game elements by the user, Hexad Gamification User Types classification *(G)* and selection of preferred design mockups *(MU)* . In this paper we report on a small population study involving 54 healthy participants aged 17 to 60, and investigate if these alternative approaches lead to the same design choices. We find that different evaluation approaches lead to different choices of gamification elements. We suggest to use game element ranking in combination with mockup selection. Hexad player classification might be less useful in the context of mHealth applications design.

1 INTRODUCTION

Digital health interventions (DHI) rely on patient-reported outcomes (PRO) for evaluation of the efficacy of the intervention and monitoring of patients' physical and mental well-being. The PROs (Cella et al., 2015) are collected through standardised surveys targeting different dimensions of well-being. Unfortunately, surveys which contain numerous questions might be laborious to complete and discouraging for DHI study participants. Gamification of surveys might potentially reduce the burden of self-reporting. It has been shown to improve user experience (Harms et al., 2015) and participation (Cechanowicz et al., 2013) in online market research questionnaires. In the context of mobile health (mHealth) applications, game elements such as points or leaderboards has been leveraged to improved nutrition (Chow et al., 2020), increase physical activity (Xu et al., 2022) and support medication adherence (Tran et al., 2022). However, little research has been done in mHealth on designing gamification of self-reporting.

The design of gamification depends both on the application context and the target users (Hamari et al., 2014). Different users might prefer different game elements. Jia *et al.* suggested that personalisation is an important step in gamification design which could help avoid demotivating users by inadequate game element selection (Jia et al., 2016). There are various approaches to designing the personalisation of gamified health applications. For behaviour change applications researchers have utilised the best-worst scaling approach to rank game elements by user preference (Schmidt-Kraeplin et al., 2019; Berger and Jung, 2021). Carlier *et al.* , on the other hand, used the Hexad Gamification User Types (Tondello et al., 2016) questionnaire to group users according to their gameplay preferences, and designed survey application screens to suit each type of gamer (Carlier et al., 2021).

In this study we explore whether the alternative approaches to evaluating user preferences lead to comparable gamification design choices. We also investigate which game elements are the most preferable by users in the context of health and well-being surveys delivered through a mobile application. To address these questions we conduct a small study whcih utilizes game element ranking, the Hexad Gamification User Types questionnaire and design mockups.

[a] https://orcid.org/0000-0002-5304-1020

[b] https://orcid.org/0000-0001-6005-0243

[c] https://orcid.org/0000-0002-4489-5956

Adamczyk, P., Marek, S., Precikowski, R., Kuś, M., Grzeszczyk, M., Malawski, M. and Lisowska, A.
Designing Personalised Gamification of mHealth Survey Applications.
DOI: 10.5220/0011603800003414
In *Proceedings of the 16th International Joint Conference on Biomedical Engineering Systems and Technologies (BIOSTEC 2023) - Volume 5: HEALTHINF*, pages 224-231
ISBN: 978-989-758-631-6; ISSN: 2184-4305

2 RELATED WORK

Gamification refers to the use of game elements in a non-game setting (Deterding et al., 2011). In the context of mHealth applications, gamification might directly promote engaging in a target behavior (e.g. physical exercise, filling a health survey) or facilitate attitude change and learning (e.g. health education) (Johnson et al., 2016).

Game elements frequently utilised in health applications include: *goal setting, progress tracking, leaderboards, points, badges, social integration (connecting/sharing), levels* and *narratives* (Schmidt-Kraeplin et al., 2019; Berger and Jung, 2021). This list overlaps with the survey of gamification elements (Carlier et al., 2021) in DHI, with the exception of *goal setting* and *narratives*, which might be less adequate for responding to survey questions and for self-reporting.

To decide which game elements to include in the app researchers utilise various methods at the design stage, such as game element rankings (Schmidt-Kraeplin et al., 2019; Berger and Jung, 2021) and target app user surveys (Tondello et al., 2016; Carlier et al., 2021).

2.1 Game Elements Ranking

One way to obtain a ranking of user preferences is to use the best-worst scaling (BWS) approach, in which users are presented with a set of elements and asked to select the elements they consider the best and the worst. BWS is preferable to direct ranking mechanisms or rating scales, because it enables investigation of decision rules at different ranking depths, enforces discrimination between the available options, prevents scoring scale-related biases and ensures that the importance of each option is not rated equally (Louviere et al., 2015).

Schmidt-Kraeplie *et al.* utilised the BWS method for the design of a behavior change support system facilitating physical activity (Schmidt-Kraeplin et al., 2019), and found that in this context users tend to prefer *progress, goals, points* and *levels*. In turn, Berger and Jung (Berger and Jung, 2021) investigated user preferences in the context of nutrition apps and found that similar gamification features – namely, *goal setting, performance graph, progress, rewards and levels* – receive top ranks.

We carried out a study to determine the ranking of game elements in the context of a health PROs application and compare it with ranks obtained in other health application contexts.

2.2 The Gamification User Types Hexad Scale

Another approach to personalisation of gamification design is to use the Hexad Scale developed by Malczewski (Diamond et al., 2015) and later refined by Tondello *et al.* (Tondello et al., 2016) in which users are assigned to the following gamer types: *Socializer, Free Spirit, Achiever, Philanthropist, Player* and *Disruptor*. This classification is based on user responses to 24 statements, such as *"I like sharing my knowledge"* or *"Rewards are a great way to motivate me"*. The user indicates his/her agreement with each statement on a 7-point Likert scale.

Carlier *et al.* designed four different versions of surveys using game elements corresponding to four Hexad gamer types: *Free Spirit, Achiever, Philanthropist, Player* (Carlier et al., 2021). The authors carried out a small comparative study involving 28 users, where 16 participants filled out a gamified survey matched to their gamer type while the remaining participants filled out a non-gamified survey. They found that in gamified conditions, users perceived the time taken to respond to questions as shorter, and that gamification did not impact the quality of results.

We find these results encouraging and we extend the work of Carlier *et al.* with a study of personalised gamification of the full mHealth application with regularly repeated PROs, rather than a one-off survey (Carlier et al., 2021) . We investigate whether the classification of gamification user types using the hexad scale can guide personalisation of health PROs application design. Our goal is to encourage regular interaction with the PROs.

3 METHOD

In our study we consider two main approaches to gamification: 1) ranking of gamification features and 2) Hexad-based approach, which includes a choice of mockups *(MU)* designed to theoretically cater to different Hexad player types *(G)* .

Unlike Carier *et al.* who presented questions of gamificatied PRO to study participants, we focus our gamified mockup design on the “Thank you" screen (See Fig. 2). The final moments of each experience disproportionately affect its retrospective evaluation (Kahneman et al., 1993). The “Thank you" screen is the the last screen of the PRO incorporating gamification elements, and may strongly impact the user’s overall evaluation of the application, as well as their future engagement.

The study consists of four steps: 1) Introduction

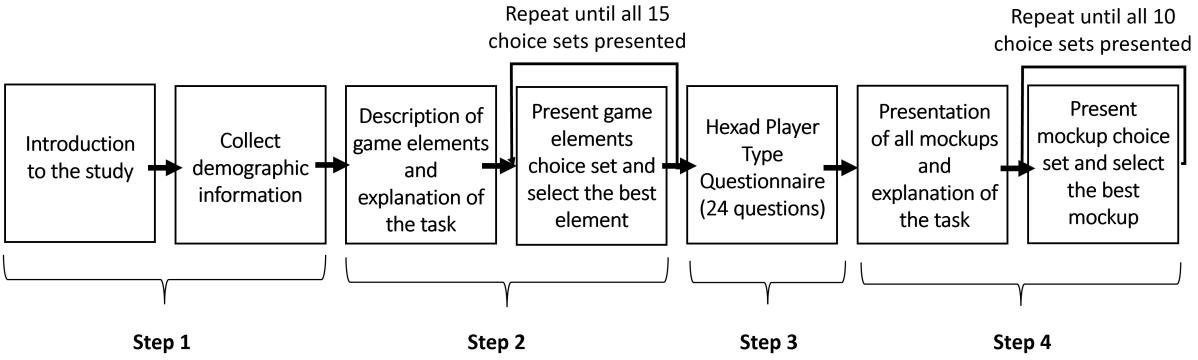


Figure 1: Overview of the Survey Process.

and collection of demographic information 2) Ranking of gamification elements 3) Hexad Player Type Questionnaire and 4) Paired Hexad Mockup comparison (See Figure 1). Note that the player type obtained from the Hexad questionnaire serves as a grouping factor. Therefore the experiment has two independent variables (gamification elements and Hexad Mockups *(MU)*) along with one covariate (Hexad Player Type *(G)*).

The study was conducted as an online survey and the participants were recruited via social media (Facebook) as well as via Sano's general internal Slack channel. Participation was voluntary and no financial compensation was provided. We included participants who own smartphones and were, in general, open to using mobile health applications.

3.1 Study Introduction

Participants are presented with study instructions, along with an explanation of the context of the study. In particular, the introduction highlights that the study focuses on personalisation and engagement with mobile health applications in order to reduce the burden of self-reporting. Afterwards, participants provide their demographic information, which includes gender and age.

3.2 Gamification Elements

The gamification features that we use in our "Thank you screen" designs are chosen from sets suggested by Malczewski (Diamond et al., 2015) and later refined by Tondello *et al.* (Tondello et al., 2016) (Table 1). Game elements which have been shown to increase user engagement when filling the survey but are not appropriate for the "Thank You" screen (such as the *progress bar*), were excluded from this analysis.

There are six gamification elements that we analyse. *Sharing* is a feature for distributing updates about user's progress to their friends and colleagues. In the context of the mHealth survey application, 'sharing' does not mean sharing replies to the PRO survey (these are intended to be shared only with the clinician who runs the study), but rather sharing an announcement that one has managed to complete the self-reporting task with their friends or family members. *Feedback* allows submission of remarks about the application to the developers, while *points* are a simple feature for keeping score through the whole process of interaction with the app – for example, every time the patient fills in the PRO questionnaire they receive a reward in the form of points. *Leveling up* involves gaining experience points after successfully completing some tasks within the application, and reaching new levels. For example, in an application where the patient is expected to complete multiple PROs, completion of each PRO may increase the user's level. Some people find *Voting and pointing drawbacks* engaging and this gamification feature might be used for assessing the application. *Leaderboards/ranking* enable users to compare their results with others, for example by visualising the number of tasks completed by the given user vs. the number of tasks completed by other users. Note that in the context of the mHealth app the user might prefer to choose a nickname so that they are not identifiable on the leaderboard.

In our study, participants choose one favoured game element from the pair presented to them. For example, one participant is presented with the following game elements: *points* and *sharing*, and they are asked *"Which game element do you prefer?"*. Participants reviewed all possible gamification element pairs, and had to select their preferred game element from each pair.

3.3 Hexad Player Types Questionnaire

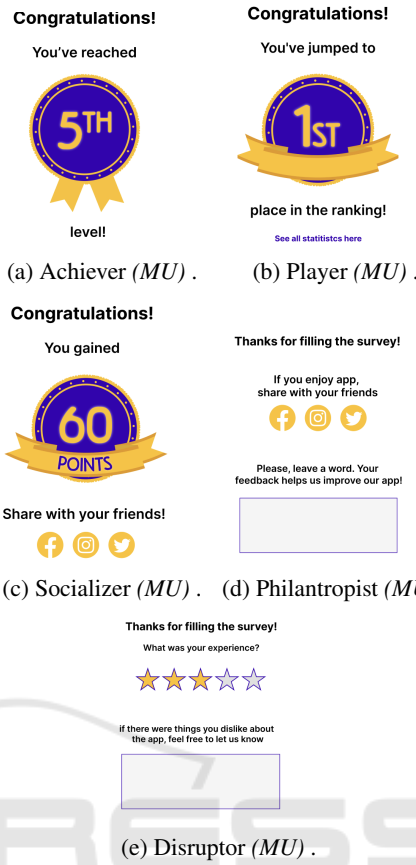
Personalisation of gamification elements can be supported by the Hexad Player Types survey, which consist of 24 personality questions such as *"I like defeating obstacles"* or *"It is important to me to feel like I am part of a community"* (Tondello et al., 2016). Participants were asked to rate their agreement with each statement on the 7-point Likert scale, where 1 means strong disagreement, 4 means no opinion, while 7 means strong agreement. Then, based on participants' responses, their corresponding gamer types were determined from among the following: *Socializer (G)* , *Achiever (G)* , *Disruptor (G)* , *Player (G)* , *Philanthropist (G)* and *Free spirit*.

3.4 Design of Mockups

We design mockups of the "Thank you screen" so that they contain gamification elements for five out of six types - *Achiever (MU)* , *Philanthropist (MU)* , *Disruptor (MU)* , *Player (MU)* and *Socializer (MU)* . The *Free spirit (MU)* user type was omitted, based on the observation that game design elements matching the *Free spirit (MU)* (e.g. *exploratory tasks*, *easter eggs* or *customization*) concern other screens of the application rather than the one displayed after completing the survey in the app. Applying it to the research questionnaire would make it inconsistent with other mockups containing the "Thank you screen". The mockups created for the questionnaire are shown in Fig. 2 and the gamification elements matching each user type are presented in Table 1. Similarly as in the case of game element selection, participants are asked to choose their favourite mockup from each presented pair. All combinations of mockup pairs are presented to each participant.

3.5 Data Analysis

Finally, we compare the results collectively and individually. We analyse game elements, mockups and player types with the highest response rate and check whether they correspond to each other. We perform quantitative and qualitative comparison of the outputs from the questionnaire in order to determine whether a specific user type selects features related to that type, as suggested by Tondello *et al.* (Tondello et al., 2016).



(a) Achiever *(MU)* . (b) Player *(MU)* .

(c) Socializer *(MU)* . (d) Philantropist *(MU)* .

(e) Disruptor *(MU)* .

Figure 2: Survey completion mockup screens for five Gamification User Types considered in the study.

4 RESULTS

We surveyed 54 users aged 17-60, (38.9% female and 61.1% male). There was no significant difference in responses between genders, and thus the division was ignored during further analysis. The majority of responses (74%) come from younger participants (≤ 30 yrs).

4.1 Hexad Gamification User Type

Table 1 shows the number of respondents for each gamification user type as classified using the Hexad scale. *Philanthropist (G)* was the most prominent gamer type in our study population and *Disruptor (G)* the least.

Note that some users had more than one dominant gamer type and were counted in all categories where they had top scores; therefore, the total number of users does not add up to the number of surveyed participants. Figure 3a demonstrates gamer type classification overlap. The thickness of the line between

Table 1: From left: Categorisation of gamification user types, number of study participants falling into each gamer type category, game elements associated with the gamer type in our mockups (See Fig. 2), top game elements selected by participants in each gamer category and top selected mockup.

Hexad Gamer Types	No. of users	Game elements associated with hexad type in mock-ups	Top 2 game elements	Top 2 selected mock ups
Philanthropist	22	sharing feedback	leveling up, points	player, socializer
Free Spirit	19	NA	leveling up, points/leaderboards	player, socializer
Player	13	leadboards	leveling up, leaderboards	player, socializer
Achiever	10	leveling up	leveling up, points	player, socializer
Socialiser	9	points sharing	leveling up, points	socializer, player
Disruptor	1	voting and pointing drawbacks feedback	leaderboards, points	socializer, player

each pair of gamer types corresponds to the frequency of participants being classified as both types. When there is no line between two types it means that not a single participant was classified as both – e.g. nobody was a strong match for the socializer and player types at the same time. *Free spirit (G)* was most frequently connected with other gamification user types, followed by *Philanthropist (G)* (see Fig.3a).

4.2 Game Element Ranking

Table 1 also shows the top game element and mockup chosen per user type. The top game element selected were: *levels, points* and *leaderboards*. The least preferred elements were *feedback* and *sharing*.

Figure 3b shows the frequency which which each combination of two game elements ranked in the top two. Note that almost all combinations of game elements achieved this ranking at least once, except for *sharing* and *voting/pointing drawbacks*. Users frequently preferred pairs of game elements which naturally match each other, e.g. *points* and *leveling up* or *leveling up* and *leaderboards*. Interestingly, the top-two selection of *points* and *leaderboards* was less common (See Figure 3b).

The ranking of game elements did not vary strongly between the gamification user types. The feature most frequently selected as the first preference was *leveling up* (see Fig 3c) for all player types except Disruptor *(G)* , who preferred leaderboards.

4.3 Mockup Selection

The *Player (MU)* ranked first, and the *Socialiser (MU)* second. The selection of *Player (MU)* corresponds to selection of the game element *leaderboards* which is associated with the *Player (G)* and points associated with the *Achiever (G)* . The top mockup selection is partly consistent with the ranking of top game elements. It includes game elements which ranked 2nd (*points*) and 3rd (*leaderboards*), but not 1st (*leveling up*).

Interestingly, the second favourite mockup, *Socialiser (MU)* , also does not include the favourite game element *leveling up* and is associated with one of the least represented gamer types in our study population. It also includes the least favourable feature of *sharing*. This result suggests that mockup selection might lead to different gamification design choices than game elements ranking.

4.4 Hexad Gamer Type vs Gamification Design Approaches

The co-occurrence heatmap in Fig. 4 shows that classification of the gamer type *(G)* does not strongly correspond to selection of game elements. The gamer type *(G)* also does not perfectly match the design mockup selection (See Fig. 5). Each gamer type is analysed in more detail below:

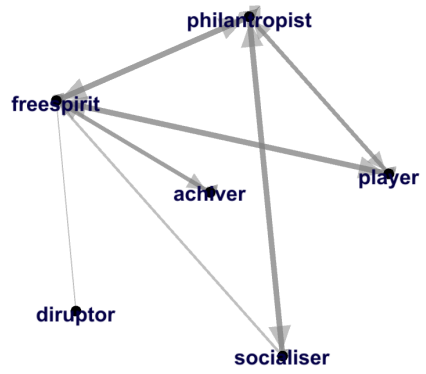
Socializer *(G)* - Respondents classified as *Socializers (G)* were responsive to *leveling up* or *points* and preferred *Socializers (MU)* . The Hexad gamer classification matched the top mockup selection but their top preferred game elements did not include *sharing*, which was expected to be associated with Socializer *(G)* .

Achiever *(G)* - Similarly to *Socializer (G)* , these users were mostly interested in *points* and *leveling up*. In terms of mockups they chose mainly *Player (MU)* or *Socializer (MU)* design, and not *Achiver (MU)* , which included their preferred game element and was designed to match their gamer type.

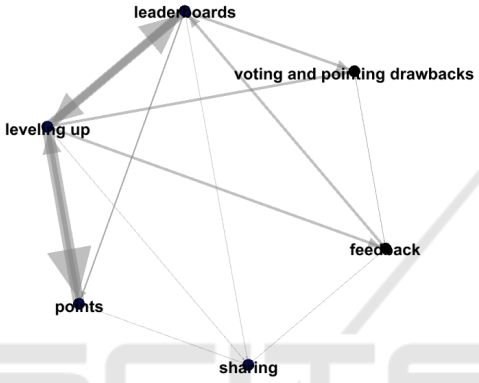
Disruptor *(G)* - This user actively chose *leaderboards* or *points* game elements and *Socializer (MU)* or *Player (MU)* . There was only one *Disruptor* respondent and therefore they could have significantly distorted the results. After detailed investigation it turned out that they were probably straight-lining (continuously selecting the same answer).

Philanthropist *(G)* - The analysis reveals that *Philanthropists* prefer *leveling up* or *points*. This is unexpected for this gamer type but might be explained considering that users were frequently classified as *Philanthropist (G)* in combination with other gamer types: *Socialiser (G)* and *Players (G)* (See 3a).

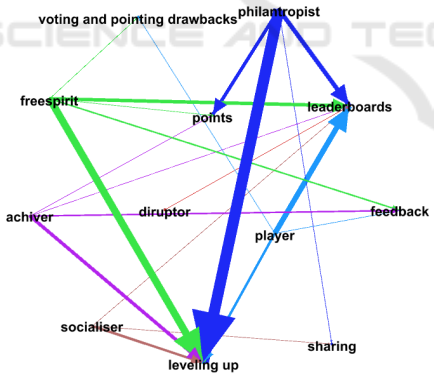
Player *(G)* - *Player (G)* shows the highest co-occurrence with *leaderboards*, which were designed precisely for this gamer type. The same observation is noticeable in relation to the mockups where *Player(G)* shows the strongest preference for the



(a) Gamer Type.



(b) Selected Top 2 game elements.



(c) Hexad Player Type *(G)* and Top 1 game element selection.

Figure 3: Co-occurrence graphs.

Player (MU) mockup.

Free spirit *(G)* - Results for this gamer type were very close to those obtained for the *Philanthropist (G)* . This is another case where the most frequently chosen game elements do not match the association of game elements and gamer type suggested by Tondello *et al.* (Tondello et al., 2016).

Regardless of gamer type classification, a surprisingly large number of respondents chose *points* and *leveling up* as their preferred gamification elements, and *Socializer (MU)* or *Achiever (MU)* as their favorite. The less frequently selected mockups (*Disruptor mockup, Philanthropist mockup*) are potentially less eye-catching, no matter what type of gamer the study participant is.

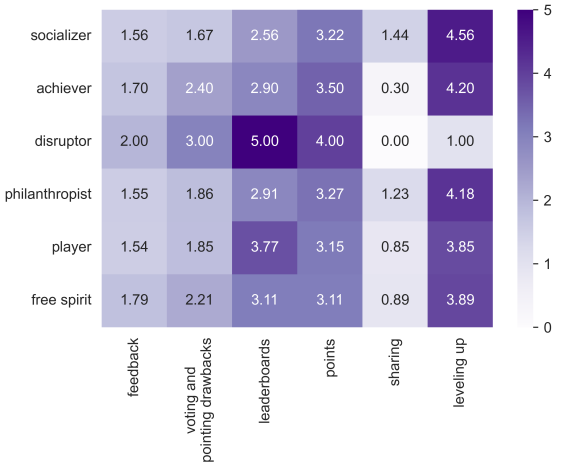


Figure 4: Co-occurrence of gamer types *(G)* and gamification elements.

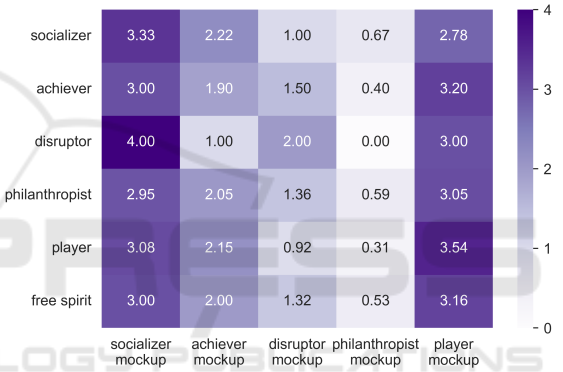


Figure 5: Co-occurrence of gamer types *(G)* and chosen mockups *(MU)* .

5 DISCUSSION

We conducted a small scale study investigating two different approaches to personalised gamification design: ranking of game elements by the user and selection of preferred design mockups containing game features related to different Hexad Gamer Types. We found that these approaches lead to a choice of different game elements. *leveling up*, the game element which ranked the highest, was not present in the favorite mockup *Player (MU)* . This suggests that a sim-

ple ranking of game elements in isolation from full-screen design might be insufficient for guiding decisions on personalisation of gamification design.

Interestingly, the top game elements, selected regardless of gamer classification, were: *levels, points* and *leaderboards*. The least preferred elements were *feedback* and *sharing*. This ranking is in line with rankings obtained in other mHealth applications (Schmidt-Kraeplin et al., 2019; Berger and Jung, 2021). Both in applications focused on physical activity(Schmidt-Kraeplin et al., 2019) and nutrition (Berger and Jung, 2021), the *levels* game element ranked highly, while game elements relying on *social connections*, such as sharing or user forums, were the least favorable. This finding suggest that preference for game elements might be consistent across some mHealth applications, including even seemingly different settings for PROs apps. In the mHealth context, users might not wish to share their progress since they regard such information as too sensitive. Further research is required across different digital health interventions to validate these findings, establish a general understanding of what is preferred and what is not, and uncover the rationale behind ranking certain game elements as preferred and others as undesirable in various mHealth app gamification contexts.

In our study the Hexad Gamer Type classification was not helpful in uncovering the gamification design that the user might prefer. The links discovered in a larger population by Tondell *et al.* (Tondello et al., 2016) between gamer types and game element selection were not fully replicated in our small-scale study. The main limitation of our study is potential participant selection bias. The majority of our participants fell into the *Philanthropist* game user type, which is in line with Carlier *et al.* , who also found that users volunteering to evaluate their design were mostly *Philanthropist (G)* (Carlier et al., 2021). This gamer type distribution, however, might not necessarily be representative of all future users of our mHealth app.

The gamer type classification resulting from the Hexad questionnaire also did not correspond to selection of the mockups. This might be due to the fact that a large proportion of our respondents had two dominant gamer types, e.g. *Philantropists (G)* were frequently also *Socializers (G)* and *Freespirts (G)* were also *Players (G)* (See Fig 3a). The Hexad Gamer classification might be more appropriate for more sophisticated gameplay than typically present in mHealth applications. Therefore, to drive gamification design in the health application context we suggest using a combination of game element ranking and mockups rather than the Hexad questionnaire.

The results show that game element ranking should not be done in the isolation. It would have been advantageous to also obtain a ranking of paired game elements to better match the mockup, such as *Socialiser*, including two game elements: *points* and *sharing*. The *Achiever* mockup, even while including elements favored by users, i.e. *leveling up*, might have been disadvantaged due to the lack of combination with other game elements.

6 CONCLUSION

We conducted a study with 54 participants investigating different approaches to personalised gamification design: ranking of game elements by the user, Hexad Gamification User Types classification and selection of preferred design mockups. We found that these approaches lead to the choice of different game elements. A simple ranking of game elements obtained in isolation from full-screen design might be insufficient for guiding decisions regarding gamification design. Therefore, we suggest to obtain user rankings of paired game elements alongside mockup selection. In the context of mHealth survey applications, the Hexad player classification has been shown to be less helpful in guiding gamification design. We found that in the context of PROs applications, the range of preferred gamification options could be narrowed down to mockups tailored to *Socialiser* and *Player* gamer types.

In future work we intend to follow Carlier *et al.* (Carlier et al., 2021) and perform an experimental evaluation of the preferred gamification designs (*Socialiser* and *Player (MU)*) vs. a non-gamified survey, in terms of user experience, data quality and cognitive load measured by wearable devices (Lisowska et al., 2021). The ultimate goal is to encourage users to retake the surveys regularly; therefore, we aim to reduce the burden of self-reporting through gamification. The survey must remain reflective of users' well-being, hence we need to be mindful of the impact of gamification on the quality of data captured.

ACKNOWLEDGEMENTS

This publication is supported by the European Union's Horizon 2020 research and innovation programme under grant agreement Sano No. 857533 and the International Research Agendas programme of the Foundation for Polish Science, co-financed by the European Union under the European Regional Development Fund.

REFERENCES

Berger, M. and Jung, C. (2021). Gamification in nutrition apps–users' gamification element preferences: A best-worst-scaling approach. In *Proceedings of the 54th Hawaii International Conference on System Sciences*, page 1335.

Carlier, S., Coppens, D., De Backere, F., and De Turck, F. (2021). Investigating the influence of personalised gamification on mobile survey user experience. *Sustainability*, 13(18):10434.

Cechanowicz, J., Gutwin, C., Brownell, B., and Goodfellow, L. (2013). Effects of gamification on participation and data quality in a real-world market research domain. In *Proceedings of the first international conference on gameful design, research, and applications*, pages 58–65.

Cella, D., Hahn, E. A., Jensen, S. E., Butt, Z., Nowinski, C. J., Rothrock, N., and Lohr, K. N. (2015). Patient-reported outcomes in performance measurement.

Chow, C. Y., Riantiningtyas, R. R., Kanstrup, M. B., Papavasileiou, M., Liem, G. D., and Olsen, A. (2020). Can games change children's eating behaviour? a review of gamification and serious games. *Food Quality and Preference*, 80:103823.

Deterding, S., Sicart, M., Nacke, L., O'Hara, K., and Dixon, D. (2011). Gamification. using game-design elements in non-gaming contexts. In *CHI'11 extended abstracts on human factors in computing systems*, pages 2425–2428.

Diamond, L., Tondello, G., Marczewski, A., Nacke, L., and Tscheligi, M. (2015). The hexad gamification user types questionnaire: Background and development process.

Hamari, J., Koivisto, J., and Sarsa, H. (2014). Does gamification work?–a literature review of empirical studies on gamification. In *2014 47th Hawaii international conference on system sciences*, pages 3025–3034. Ieee.

Harms, J., Seitz, D., Wimmer, C., Kappel, K., and Grechenig, T. (2015). Low-cost gamification of online surveys: Improving the user experience through achievement badges. In *Proceedings of the 2015 Annual Symposium on Computer-Human Interaction in Play*, pages 109–113.

Jia, Y., Xu, B., Karanam, Y., and Voida, S. (2016). Personality-targeted gamification: a survey study on personality traits and motivational affordances. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*, pages 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*, 6:89–106.

Kahneman, D., Fredrickson, B. L., Schreiber, C. A., and Redelmeier, D. A. (1993). When more pain is preferred to less: Adding a better end. *Psychological science*, 4(6):401–405.

Lisowska, A., Wilk, S., and Peleg, M. (2021). Is it a good time to survey you? cognitive load classification from blood volume pulse. In *2021 IEEE 34th International Symposium on Computer-Based Medical Systems (CBMS)*, pages 137–141. IEEE.

Louviere, J. J., Flynn, T. N., and Marley, A. A. J. (2015). *Best-worst scaling: Theory, methods and applications*. Cambridge University Press.

Schmidt-Kraeplin, M., Thiebes, S., Schöbel, S., and Sunyaev, A. (2019). Users' game design element preferences in health behavior change support systems for physical activity: A best-worst-scaling approach.

Tondello, G. F., Wehbe, R. R., Diamond, L., Busch, M., Marczewski, A., and Nacke, L. E. (2016). The gamification user types hexad scale. In *Proceedings of the 2016 annual symposium on computer-human interaction in play*, pages 229–243.

Tran, S., Smith, L., El-Den, S., Carter, S., et al. (2022). The use of gamification and incentives in mobile health apps to improve medication adherence: Scoping review. *JMIR mHealth and uHealth*, 10(2):e30671.

Xu, L., Shi, H., Shen, M., Ni, Y., Zhang, X., Pang, Y., Yu, T., Lian, X., Yu, T., Yang, X., et al. (2022). The effects of mhealth-based gamification interventions on participation in physical activity: Systematic review. *JMIR mHealth and uHealth*, 10(2):e27794.