

Informing Personalised Gamification Interventions Through a Novel Gamified Quiz

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Abstract. Nonadherence to medical interventions and other advice leads to increased care costs and poorer health outcomes across a range of medical fields. An approach to increasing adherence is gamification. To maximize the benefits of gamification, a more structured and informed implementation is required. In this paper, a novel web-based personality determiner has been outlined, the integration of which could provide the personalisation required for an optimized gamification implementation.

Keywords. Personalised gamification interventions, quiz

1. Introduction

Gamification, defined as the use of game design elements in non-game contexts [1], has increased in popularity in recent years and has been employed to increase adherence [2], reduce attrition [3] and improve general enjoyment of interventions and self-management programs [4].

The Gamification User Types Hexad scale was first conceived and validated by Tondello et al. in 2016 [5], in which a 7-Point Likert scale was employed to determine which of the six personality types (Socialiser, Philanthropist, Disruptor, Free Spirit, Player, Achiever) the user best aligned with. This scale could be used to determine which gamification techniques, proposed by Hoffmann et al. [6], are appropriate per user and as a result, theoretically a gamified intervention could be given the level of personalisation needed to unlock the full benefit of gamification [6-8].

The need for more gameful approaches of determining gamification personality types was identified in 2020 with promising results from a web-based determining quiz [9]. Following a similar principle, the Online Personality Determiner (OPD) application was developed by our team, using questions from [5], with the intent to predict a user's personality type according to the Hexad. Designed to be a general, simplistic, and computationally lightweight, web-based application, OPD is planned to be integrated into the onboarding process of digital self-management interventions to determine the appropriate gamification techniques for use to promote increased treatment adherence and long-term usage of these interventions.

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2. Background

Nonadherence to interventions and other medical advice has been a widespread issue in healthcare for years, resulting in higher care costs and poorer health outcomes, [10]. In a systematic review of gamification across multiple disciplines, 19 out of 27 reported a positive effect on adherence, but also highlighted the need for better justification in the intended use and outcomes of gamification [2]. This is further expanded in [6] and [8], who indicate a need for personalisation and a link to behaviour change theories to optimize gamifications in digital health solutions.

In 2015 Andrzej Marczewski published a book in which he introduced the Gamification User Types Hexad [11], which categorized users according to six personality types: Socialiser, Philanthropist, Disruptor, Free Spirit, Player and Achiever. Each of these personality types vary based on motivation and suggested design elements [5]. Table 1 contains the name, letter representation and motivation of each of these personality types.

Table 1. Name and Motivation of the six personality types.

Personality Type^a	Motivation^b
Philanthropist (P)	Purpose
Socialiser (S)	Relatedness
Free Spirit (F)	Autonomy
Achiever (A)	Competence
Player (R)	Extrinsic Rewards
Disruptor (D)	Change

a. As given in [11]

b. As described by [5]

From the classification into these personality types, gamification techniques can be included or omitted, theoretically leading to better enjoyment, and optimizing the application of gamification in digital health solutions.

A questionnaire to determine the personalities of the Gamification User Types Hexad scale was developed in 2016 [5] and contained 30 questions (five per personality), which later became 24 questions (four/per personality) as the questions with the lowest reliability (according to Cronbach's α) were removed. This questionnaire was later empirically validated in 2019 in both English and Spanish [12].

In 2020, Altmeyer et al. [9] highlighted the need for a more gameful method of determining personality types, citing a potential negative impact on a user's immersion and experience from the use of a questionnaire. Two applications were investigated, 'Snowball Shooter' and the more successful 'Cloud Clicker', which could explain 34.1% (Snowball Shooter) and 74.37% (Cloud Clicker) of the variance between the application and the Hexad personalities. However, it was concluded that only Cloud Clicker could be used to reliably predict Hexad user types [9]. Cloud Clicker (available on GitHub²) has aspects of each personality type, such as 'Being part of a team' for Socialisers, paired with explanatory visual illustrations, and then compared against every other personality type in a round-robin format in which users were asked to select the more relevant option to them. As a result of an increased desire and use of gamification elements to improve adherence and inform behaviour change techniques in mobile based self-management and interventions [13] a simple, lightweight deterministic application was developed by our research team.

² Available at: <https://github.com/m-altmeyer/cloud-clicker>

3. Conceptual Design

This paper presents the OPD web-application developed at the Australian e-Health Research Centre, CSIRO. The application was built in Python 3.7.4³ using Flask 1.1.2⁴ and is comprised of two possible rounds, the first containing 15 interactions between six questions and a possible second, containing four interactions.

3.1. Question Choice

The original study from Tondello et al. [5], and an additional three studies from [12], calculated and reported a rotated factor load for each question as a measure of fit with the corresponding personality type. These were then weighted with their population size to find a weighted average of the factor load of each question. In the current study, for every personality type, the question with the highest weighted average (where the weighting was the population size of the study) was used in the first round, and the second highest was used in the second round. See Table 2 for the questions used in the first and second rounds. It should be noted that only the top two questions per personality type were considered.

Table 2. Questions utilised in OPD.

Item Identifier ^a	Rotated Factor Load (Weighted Average) ^b	Question
First Round		
P1	0.74579	It makes me happy if I am able to help others
S4	0.74668	I enjoy group activities
F1	0.66288	It is important to me to follow my own path
A4	0.78244	I like mastering difficult tasks
R1	0.66665	I like competitions where a prize can be won
D2	0.79003	I like to question the status quo
Second Round		
P4	0.65926	The wellbeing of others is important to me
S2	0.69099	I like being part of a team
F4	0.52199	Being independent is important to me
A1	0.55775	I like defeating obstacles
R3	0.65006	Return of investment is important to me
D4	0.64871	I dislike following rules

a. As given in [5]

b. As described by [12]

3.2. Design and Implementation

Each question has an accompanying illustration which is intended to assist in the understanding of the question and increase visual interest, first implemented by Altmeyer et al. [9]. The first round involves a round-robin format where all 15 unique pairs of the questions are presented to the user. The order in which the pairs are presented, and the position of each question in the pair, either top or bottom, is randomised.

³ Available at: <https://www.python.org/>

⁴ Available at: <https://flask.palletsprojects.com/en/2.0.x/#>

The round-robin format allows for every question, representing their corresponding personality type, to be compared against each other, resulting in a ranking of the personality types. The users are also given visual feedback on how many pairs they have encountered out of the 15. Once all 15 pairs have been presented, there is either an outright most popular personality type, where one question is selected five times, or a tie in which two questions are chosen four times each. In the latter case, the user is taken to the second round.

In the second round, the two questions from each of the tied personality types with the highest rotated factor load are asked against each other, where the same personality type cannot be compared against itself, resulting in four possible question pairs. For example, if the first round determined Philanthropist and Socialiser to be tied, the question pairs would be P1 and S4, P1 and S2, P4 and S4 and, P4 and S2.

After the most popular, or two most popular, personality types had been determined, the user would be taken to a results page where they would be informed of their determined personality type and a short description. All personality types and their descriptors as found on the results page can be found in Table 3.

Table 3. Personality type descriptions as given on the results page of OPD.

Personality Type	Results Page Description
Philanthropist	Philanthropists are motivated by purpose; Character traits of Philanthropists include altruism and selflessness; Philanthropists are often willing to give without expecting a reward
Socialiser	Socialisers are motivated by relatedness; Character traits of Socialisers include great communication and teamwork skills; Socialisers will often seek community and connections
Free Spirit	Free Spirits are motivated by autonomy; Character traits of Free Spirits include self-expression and a desire for freedom; Free Spirits will often create and explore their surroundings
Achiever	Achievers are motivated by competence; Character traits of Achievers include tenacity and desire for progression; Achievers seek to progress by completing tasks or tackling difficult challenges
Player	Players are motivated by extrinsic rewards; character traits of Players include determination and are incentive-driven; Players seek to earn rewards regardless of the activity
Disruptor	Disruptors are motivated by change; Character traits of Disruptors include independence and flexibility; Disruptors seek to push the boundaries of what is possible

4. Discussion

The intent of this tool is to be simple, lightweight, easy to use and easily integrated into various digital health solutions that have been developed by CSIRO's AEHRC. These include solutions to support management of diabetes [13], stroke [14] and mental health [15]. The decision for OPD to be developed as a web-based application was made with the intent of device and user compatibility, and as a result could be completed either as a part of the onboarding processes, or at a time convenient to the user.

The information gained from OPD would then be used to inform which gamification techniques and other features, from those suggested by Tondello et al. [5], and outlined in the Gamification Technique Taxonomy by Hoffmann et al. [6], would be appropriate for inclusion in the digital health solution. Further investigation into the validity and user perceptions of OPD are required and are aimed to be investigated in a limited exploratory trial in a convenient sample of 100 participants. Results to be presented at MedInfo.

References

- [1] Deterding S, Dixon D, Khaled R, Nacke L. From game design elements to gamefulness: defining “gamification”. In: *Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments*; 2011 Sep 28, p. 9-15, doi: 10.1145/2181037.2181040.
- [2] De Croon R, Geuens J, Verbert K, Vanden Abeele V. A systematic review of the effect of gamification on adherence across disciplines. In: *HCI in Games: Experience Design and Game Mechanics: Third International Conference, HCI-Games*; 2021 July 24–29, Cham: Springer International Publishing, p. 168-84, doi: 10.1007/978-3-030-77277-2_14.
- [3] Litvin S, Saunders R, Maier MA, Lüttke S. Gamification as an approach to improve resilience and reduce attrition in mobile mental health interventions: a randomized controlled trial. *PloS One*. 2020 Sep;15(9):e0237220, doi: 10.1371/journal.pone.0237220.
- [4] Kelders SM, Sommers-Spijkerman M, Goldberg J. Investigating the direct impact of a gamified versus nongamified well-being intervention: an exploratory experiment. *J Med Internet Res*. 2018 Jul;20(7):e247, doi: 10.2196/JMIR.9923.
- [5] Tondello GF, Wehbe RR, Diamond L, Busch M, Marczewski A, Nacke LE. The gamification user types hexad scale. In: *Proceedings of the 2016 Annual Symposium on Computer-Human Interaction in Play*; 2016 Oct 15, p. 229-43, doi: 10.1145/2967934.2968082.
- [6] Hoffmann A, Christmann CA, Bleser G. Gamification in stress management apps: a critical app review. *JMIR Serious Games*. 2017 Jun;5(2):e7216, doi: 10.2196/games.7216.
- [7] de Oliveira LW, de Carvalho ST. A gamification-based framework for mHealth developers in the context of self-care. In: *2020 IEEE 33rd International Symposium on Computer-Based Medical Systems (CBMS)*; 2020 Jul 28, IEEE, p. 138-41, doi: 10.1109/CBMS49503.2020.00033.
- [8] Seixas AA, Olaye IM, Wall SP, Dunn P. Optimizing healthcare through digital health and wellness solutions to meet the needs of patients with chronic disease during the COVID-19 era. *Front Public Heal*. 2021 Jul;9:667654, doi: 10.3389/fpubh.2021.667654.
- [9] Altmeyer M, Tondello GF, Krüger A, Nacke LE. Hexarcade: predicting hexad user types by using gameful applications. In: *Proceedings of the Annual Symposium on Computer-Human Interaction in Play*; 2020 Nov 2, p. 219-30, doi: 10.1145/3410404.3414232.
- [10] World Health Organization, *Adherence to long-term therapies: evidence for action*. World Health Organization, 2003.
- [11] Marczewski A. *Even ninja monkeys like to play: gamification, game thinking and motivational design*. London: Blurb Inc; 2015.
- [12] Tondello GF, Mora A, Marczewski A, Nacke LE. Empirical validation of the gamification user types hexad scale in English and Spanish. *Int J Hum Comput Stud*. 2019 Jul;127:95-111, doi: 10.1016/j.ijhcs.2018.10.002.
- [13] Varnfield M, Redd C, Stoney RM, Higgins L, Scolari N, Warwick R, Iedema J, Rundle J, Dutton W. M^oTher, an mHealth system to support women with gestational diabetes mellitus: feasibility and acceptability study. *Diabetes Technol Ther*. 2021 May;23(5):358-66, doi: 10.1089/dia.2020.0509.
- [14] Cameron J, Silvera-Tawil D, Li J, Redd C, Varnfield M, Lannin N, Cadilhac D. Utility of digital health technologies to support secondary prevention of stroke: survey feedback from clinicians and people after Stroke or transient ischaemic attack (TIA). *Int J Stroke*. 2021 Oct;16(1):7.
- [15] Varnfield M, Rajesh K, Redd C, Gibson S, Gwillim L, Polkinghorne S. Health-e minds: a participatory personalised and gamified mhealth platform to support healthy living behaviours for people with mental illness. In: *2019 41st Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC)*; 2019 Jul 23, IEEE, p. 6943-7, doi: 10.1109/EMBC.2019.8857286.