Gamification in a Physical Activity App: What Gamification Features Are Being Used, by Whom, and Does It Make a Difference?

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Abstract

**Background:** Gamification is purported to enhance engagement with health behavior apps, ultimately improving their effectiveness. This study aimed to examine (1) whether the inclusion of gamification features in a physical activity smartphone app was associated with improved app usage and goal adherence, describe (2) use of the gamification features, and (3) by whom, and determine (4) whether engagement was associated with increased physical activity.

**Methods:** Data from community-dwelling adult participants (mean age 42.1 years, standard deviation [SD 11.9], 74% female) in the gamified (n=134) and nongamified (n=155) conditions from a three-group randomized controlled trial were analyzed. Physical activity was assessed at baseline and 9 months using a survey and accelerometers. App usage (number of days steps were logged), goal adherence (number of days step count was ≥10,000), and behavioral engagement with gamification features were obtained from server logs. Multilevel modeling was used to examine the study aims.

**Results:** Participants who received the gamified app showed more days of usage than those who received the nongamified app (M=113 days [SD 88] vs. M=81 days [SD 54], P=0.006), whereas goal adherence did not differ between groups. The leaderboard and “status” gamification features were the most frequently used gamification features (M=83 [SD 114] and M=50 [SD 67] views, respectively). Older age (P=0.008) and lower body mass index (P=0.004) were associated with more status views. Participants who reported higher stress symptoms sent more gifts (P=0.04). The use of gamification features was associated with increased physical activity (P=0.04).

**Conclusion:** The gamified app was used substantially longer than the nongamified app. Use of gamification features was positively associated with change in physical activity. Leaderboards promoting social comparison may be a promising form of gamification. Research on different forms of gamification is warranted.

**Keywords:** Facebook, Smartphone, Online social networks, Gamification, Engagement, Physical activity
Introduction

Noncommunicable diseases, such as cancers, cardiovascular diseases, chronic respiratory diseases, and diabetes, create a massive worldwide health burden. Behavioral health risk factors, such as insufficient physical activity, smoking, and unhealthy diets, are pervasive and increase the risk of noncommunicable diseases. e-Health and m-Health approaches offer a convenient way to deliver health behavior interventions at scale, overcoming barriers of traditional delivery methods. However, e-Health and m-Health approaches often fail to achieve sustained engagement, hampering their effectiveness.

Gamification has been proposed as a promising method of addressing this challenge. Gamification refers to the use of “gameful” elements added to nongame contexts to enhance users’ motivation and outcomes. Examples of gamification include points, leaderboards, progress visualizations, teams, challenges, and virtual rewards. Interest in gamification has proliferated over the past 5–10 years, and it has been applied in a wide variety of online contexts, such as e-learning, marketing, business, and, increasingly, health. A 2017 systematic review found that gamification increased engagement with online programs (medium to large effect sizes). However, most studies only examined engagement over a short period (e.g., in a single sitting or up to a month). Thus, it is unclear whether gamification leads to sustained benefits in engagement.

A growing body of empirical research has focused on gamification for promoting physical activity. A 2019 systematic review identified 16 studies of gamified physical activity interventions. The interventions ranged widely, including commercial games such as Pokemon Go, and newly developed apps and software undertaken in a range of settings (e.g., gyms, workplace, community), across healthy and special populations (e.g., rheumatoid arthritis and diabetes patients). Four out of 16 studies showed fully positive results, 5 were partially positive, and 7 had null results.

However, many of the studies employed low-quality designs (e.g., pre–post designs), had small sample sizes, and, importantly, the majority had inappropriate comparators to attribute intervention effects to gamification (e.g., they compared a multicomponent intervention that included gamification to no intervention). Only four of the studies compared a gamified intervention with the same intervention without gamification. Of these, three studies were short, examining the effect during a single, or four, exercise sessions. A further study compared a gamified and nongamified version of a walking intervention for college students, and found that although both groups improved, the gamified version offered no additional benefit over the nongamified version.

However, the study sample was small (n = 59) and study duration short (10 days). Thus, there is a need for large-scale studies, designed to isolate the effect of gamification, and with long-term follow-up, to better understand the impacts of gamification for promoting physical activity.

This study aimed to address these gaps, with the aim to (1) determine whether the inclusion of gamification features in a physical activity smartphone app was associated with improved app usage and program goal adherence, (2) describe use of specific gamification features, (3) determine whether use of specific gamification features was associated with psychological and sociodemographic characteristics, and (4) determine whether use of gamification features was associated with program effectiveness.

Methods

Ethics approval was received from the [University of South Australia Human Research] ethics committee (protocol number [33967]) and the study was registered on the Australian and New Zealand Clinical Trials Register (ANZCTR) (ACTRN1261700113358). All participants provided written informed consent.

Intervention

The Active Team intervention has previously been described in detail. In brief, the Active Team is a physical activity program delivered through smartphone app (iOS and Android) with Facebook integration, designed to allow users to compete with their friends. Participants are encouraged to log their steps daily in the app, aiming for 10,000 steps per day for 100 days. Several gamification features are incorporated into the gamified app:

- A leaderboard, which allows participants to compare their performance with their friends’ (social comparison).
- Virtual gifts (e.g., gold running shoes, activewear, high five), which participants progressively unlock with continued usage, and can send to/receive from friends (social support).
- Hierarchical status (bronze, silver, gold, platinum, diamond), which is progressively achieved the more the steps a user logs in the program.
- Challenges: short-term challenges (e.g., taking 1–2 days) intended to enhance social support and program novelty. Users can pick from a list of challenges and send to a friend. All challenges are structured so that both participants can “win” them, assuming they complete them. The challenge tab displays a running tally of challenges completed with each friend.

Study context

This study is a secondary analysis of a three-group randomized controlled trial (RCT) that tested the effectiveness of a gamified physical activity app, relative to a nongamified version of the app (self-monitoring features only; gamified features removed) and a wait-list control. Full details of the RCT protocol and main findings have previously been reported. In brief, a total of 444 insufficiently active (200 minutes moderate-to-vigorous physical activity [MVPA] per week) adults aged 18–65 years and residing anywhere in Australia were recruited using free social media posts, mainstream news items, and paid Facebook advertising.

To enrol, participants needed to join the study in a team of three to eight existing friends. Once all members of the team had completed baseline assessments, the team was randomized (electronic random number generator using permuted blocks with allocation concealment) to either the gamified app (n = 141), the nongamified app (n = 160), or wait-list control (n = 143). Across the study period, participants who
received the gamified app increased their weekly self-reported MVPA by 223 minutes at 9 months relative to baseline and completed 147 and 78 more minutes of MVPA than the control group and nongamified app group at 9 months, respectively ($F = 3.1, p = 0.02$).20

Results for objectively measured MVPA were not significant, although participants in the intervention arm increased their weekly objectively measured MVPA by 11 minutes at 9 months relative to baseline, and completed 6 and 14 more minutes of weekly MVPA relative to the control and non-gamified groups at 9 months, respectively.20 Participants were able to continue using the app after the completion of the 100-day challenge.

The main findings paper from the RCT focused on group-based differences, and did not examine the gamification features in any detail. This article focuses on gamification aspects of the intervention, using data from the 289 participants from the RCT enrolled in the gamified (n = 134) and nongamified app conditions (n = 155) who had valid server data (Table 1).

### Outcomes

Physical activity, anxiety, depression, and stress were measured at baseline, 3 months, and 9 months. MVPA was measured objectively using 7-day wrist-worn (nondominant arm) GeneActiv accelerometers (Activinsights Ltd., Cambridge, United Kingdom). Acceleration was measured continuously at 50 Hz for a minimum of 10 hours of waking wear per day, on at least 4 days including at least one weekend day. Each 60-second epoch of waking time was classified using Esliger’s cutpoints.21 A 5:2 weighting was applied ([average of week days] + 2×[average of weekend days])/7) to calculate daily minutes of MVPA.

Self-reported minutes of MVPA in the past week was collected using the Active Australia Survey.22 Participants self-reported depression, anxiety, and stress (DASS-21).23

### Analysis

Differences in app usage and goal adherence between the gamified and nongamified conditions were examined using multilevel modeling with team as a random effect to account for clustering of participants within teams, adjusting for age, gender, and education. Within the gamified group only, associations between behavioral engagement with gamification features and participants’ characteristics (age, gender, education, baseline body mass index [BMI], stress, anxiety, and depression) were examined using multilevel modeling with team as a random effect.

Again, within the gamified group, the relationship between behavioral engagement with gamification features and intervention effectiveness (change scores for self-reported and objectively measured MVPA) was tested using multilevel modeling with team as a random effect, adjusting for age, gender, and education. Analyses were conducted in Stata 15.1 (StataCorp, College Station, TX).

Post hoc power analyses conducted for the research questions addressed in this secondary analysis suggested that the study had 93% power to detect a difference in usage (based on two groups, wanting to detect a 30-day difference

<table>
<thead>
<tr>
<th>Table 1. Participant Baseline Characteristics, Engagement, Adherence, and Usage of the Gamification Features</th>
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<tbody>
<tr>
<td><strong>Gamified (n = 134)</strong></td>
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<tr>
<td>Age, M (SD)</td>
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<tr>
<td>Female, n (%)</td>
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<tr>
<td>Male, n (%)</td>
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<tr>
<td>Education</td>
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<tr>
<td>High school or less, n (%)</td>
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<tr>
<td>Technical or further education, n (%)</td>
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<tr>
<td>University, n (%)</td>
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<td>BMI, M (SD)</td>
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<td>Depression, M (SD)</td>
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<td>Anxiety, M (SD)</td>
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<td>Stress, M (SD)</td>
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<td>Self-report MVPA (min/week), M (SD)</td>
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<td>Objective MVPA (min/day), M (SD)</td>
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<td>Engagement, M (SD)</td>
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<td>Adherence, M (SD)</td>
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<tr>
<td>Total gamification, M (SD), range</td>
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<td>Leaderboard views, M (SD), range</td>
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<td>Status views, M (SD), range</td>
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BMI, body mass index; MVPA, moderate-to-vigorous physical activity.
in usage [equating to an effect size $d=0.41$], an alpha of 0.05, and a sample size of $n=289$), and 53% power to detect a difference in adherence (based on two groups, wanting to detect an 8-day difference in adherence [equating to an effect size $d=0.24$], an alpha of 0.05, and a sample size of $n=289$).

Results

Participants who received the gamified app used the app over a significantly longer period than those who received the nongamified app (mean days logged = 113 standard deviation [SD] = 88 days vs. 81 days SD = 54; $B$ standard error [SE] = 27.95 [10.26], $P = 0.006$). However, goal adherence did not differ between the gamified and nongamified groups (mean days $\geq 10,000$ steps $= 29$, SD = 38 vs. 21, SD = 27; $B$ [SE] = 5.22 [4.52], $P = 0.248$) (Aim 1).

Behavioral engagement with the various gamification features was examined (Aim 2). The most commonly used gamification features was the leaderboard (mean 83 views [SD 114]) and status pages (mean 50 views [SD 67]). Virtual gifts and challenges were rarely sent (mean of 5 [SD 6] and 1 [SD 3] sent, respectively; Table 1).

Next, we examined the association between participant characteristics and behavioral engagement with gamification features (Aim 3; see results in Table 2). We found that age was positively associated with use of gamification features overall, whereas BMI was negatively associated with use of gamification features, and, in particular, the number of status views. Participants who reported higher stress symptoms sent more gifts.

Finally, we examined the relationship between behavioral engagement with gamification features and intervention effects (Aim 4). Results indicate that the overall use of gamification features was associated with greater improvement in objectively measured MVPA ($P = 0.04$), but not self-reported MVPA (Table 3). Use of the individual gamification features was not associated with change in physical activity.

**Table 2. Fixed Effects from Multilevel Models Examining the Association Between Participant Characteristics and Use of Gamification Features (n = 133)**

<table>
<thead>
<tr>
<th></th>
<th>Total gamification</th>
<th>Leaderboard views</th>
<th>Status views</th>
<th>Gifts sent</th>
<th>Challenges sent</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>$B$ (SE)</td>
<td>$B$ (SE)</td>
<td>$B$ (SE)</td>
<td>$B$ (SE)</td>
<td>$B$ (SE)</td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td>2.91 (1.28)*</td>
<td>1.50 (0.88)</td>
<td><strong>1.35 (0.51)</strong>**</td>
<td>−0.01 (0.04)</td>
<td>−0.003 (0.02)</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>27.39 (32.79)</td>
<td>14.59 (22.44)</td>
<td>9.48 (12.98)</td>
<td>1.37 (1.02)</td>
<td>0.66 (0.50)</td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td>−23.48 (41.17)</td>
<td>−25.55 (28.16)</td>
<td>1.92 (16.29)</td>
<td>−0.53 (1.28)</td>
<td>−0.11 (0.63)</td>
</tr>
<tr>
<td>University</td>
<td>33.07 (37.52)</td>
<td>9.00 (25.71)</td>
<td>22.52 (14.87)</td>
<td>0.62 (1.18)</td>
<td>0.71 (0.57)</td>
</tr>
<tr>
<td><strong>BMI</strong></td>
<td>−4.42 (2.00)*</td>
<td>−2.04 (1.37)</td>
<td>−2.26 (0.79)**</td>
<td>−0.04 (0.63)</td>
<td>−0.05 (0.03)</td>
</tr>
<tr>
<td>Depression</td>
<td>3.79 (2.89)</td>
<td>1.88 (1.99)</td>
<td>2.07 (1.15)</td>
<td>−0.09 (0.09)</td>
<td>−0.01 (0.05)</td>
</tr>
<tr>
<td>Anxiety</td>
<td>−2.31 (3.23)</td>
<td>−2.37 (2.21)</td>
<td>0.20 (1.28)</td>
<td>−0.13 (0.10)</td>
<td>−0.06 (0.05)</td>
</tr>
<tr>
<td>Stress</td>
<td>−2.70 (2.91)</td>
<td>−1.32 (2.00)</td>
<td>−1.78 (1.15)</td>
<td><strong>0.19 (0.09)</strong>*</td>
<td>0.06 (0.04)</td>
</tr>
</tbody>
</table>

Bold used to highlight statistically significant results.

Comparison group male.

Comparison group completed year 12 (high school) or less.

$*P < 0.05$, **$P < 0.01$.

SE, standard error.

Discussion

This study found that a gamified physical activity app achieved engagement over a longer duration compared with a nongamified app. Some gamification features were well used (leaderboard and status), whereas others were infrequently used (challenges and gifts). Users who were relatively older and those with a lower BMI used the gamification features more, driven by high use of the status feature, whereas users with higher stress sent more gifts. Higher use of gamification features was associated with greater intervention effectiveness.

The finding that the gamified version of the app achieved higher engagement is consistent with Looyestyn et al.’s systematic review, which similarly reported that gamification prolongs engagement. However, many previous studies only examined engagement during a single sitting or over a short period, for example, Farrow et al., Chen et al., and Geelan et al.11,16,17 so our finding that gamification was associated with, on average, 32 days’ further use compared with a nongamified version (a 40% increase) is important.

There was no statistically significant difference between the gamified and nongamified groups for goal adherence (i.e., the number of days where the step count exceeded 10,000). However, there was some evidence of a trend, with over one-third more days adhering to the step goal in the gamified group compared with the nongamified group. Post hoc analyses suggest that this analysis only had 53% power, so there is a possibility that a type 2 error was at play (i.e., failure to detect a difference that exists in reality).

By far, the most commonly used gamification feature was the leaderboard. A recent systematic review of gamification across various disciplines similarly highlighted leaderboards as a popular and successful form of gamification.24 In contrast, the challenges and gifts were relatively underused. It is possible that this was related to time and effort—viewing the leaderboard could be done at a glance, whereas sending a challenge or gift required choosing the specific challenge...
or gift from a list of options, and selecting a friend to send it to. Although not arduous, this involved more effort than simply viewing the leaderboard.

Perhaps more importantly, these gamification features differed in their psychological underpinnings: the leaderboard facilitated social comparison, assisting people to evaluate their performance; the gift feature relied on either altruism, the pleasure of gift giving, or enhanced social closeness; while the challenge feature might have contrasting psychological effects—either enhancing social closeness or promoting competition. It is possible that the psychological rewards of viewing the leaderboard may outweigh those of the challenge or gift features.

A systematic review moreover demonstrated that gamification features differ in their strength of association with various forms of motivation to play and engagement with the intervention (e.g., interest, enjoyment, perceived helpfulness). A combination of several gamification features may, therefore, be needed to most effectively enhance engagement. Future research may explore the optimal trade-off between different forms of benefits users get from engaging with the intervention and the time and effort needed to achieve this benefit, and how this balance differs between people.

Results revealed that relatively older users and those with lower BMI used the gamification features more, driven predominantly by their higher use of the status feature, while users with higher stress sent more gifts. The finding that older users and those with lower BMI used the gamification features more is consistent with literature showing that older and nonobese participants show higher engagement with digital behavior change programs. This may be because older people are more health conscious and thus more motivated to change their health, and that people with a lower BMI find it easier to increase their physical activity (since they are less likely to experience negative impacts of physical activity, such as joint pain).

This may set up a virtuous cycle, whereby greater success in the program leads to increased engagement, leading to more rewards (“higher status”) being unlocked within the program. Previous psychology research has shown that “giving behavior” can lead to various benefits for the donor, including “feeling good” and improved self-image. Thus, one explanation of the associations between stress and gift giving in our study may be that participants with higher stress sent virtual gifts for these ancillary psychological benefits.

Overall behavioral engagement with gamification features was positively associated with change in objectively measured physical activity, concurring with some earlier studies that have also reported positive associations between gamification and intervention effectiveness. Somewhat surprisingly, the positive association between use of gamification features and intervention effectiveness was only present for objectively measured physical activity, and not self-reported physical activity.

It is possible that this may be due to an interaction with BMI; previous research has suggested that people with higher BMI and age tend to over-report their physical activity. Given that participants with higher BMI tended to use the gamification features less, this may have dampened the relationship between change in self-reported physical activity and gamification features.

To our knowledge, this is the largest randomized experimental study anywhere in the world that compares the engagement and effectiveness of a gamified versus a nongamified but otherwise analogous physical activity intervention. Further strengths are that we collected high-quality outcome data (particularly, objectively measured MVPA) and follow-up data across 9 months.

A study limitation is that we did not experimentally manipulate the various specific gamification techniques, that is, we compared gamification with no gamification, but did not compare various forms or combinations of gamification. Furthermore, the gamification in our app was reasonably simple in its execution and social in nature. It is possible that more sophisticated implementation of gamification, and gamification designed to generate stronger rivalry, may have different impacts. It is important to recognize that these data were collected in the context of an RCT. It is difficult to know whether the engagement, adherence, and usage data collected under RCT conditions reflect these data in real-life conditions.

In addition, this study predominantly attracted well-educated women, and it is unclear whether findings are generalizable to the general adult population. Finally, in this study we operationalized engagement based on page views. Alternative quantitative measures based on system usage data, such as time, could have been used. Furthermore, although quantitative engagement measures are common for e-Health and m-Health interventions (because they are objective and can be captured easily and noninvasively), they do not provide insights into the more qualitative aspects of engagement, such as affect, attention, interest, and depth.

From the perspective of behavioral intervention and software development, there are some key lessons.

1. Gamification appears to be effective for increasing program engagement and physical activity behavior change. This suggests that gamification may be particularly useful in both applications where greater engagement in itself is an end goal (e.g., in educational software), and where greater engagement is being used to bring about a distal goal, such as health behavior change.

2. The leaderboard was relatively simple (and, therefore, cheap) to build/implement and was well used. Taken together with previous evidence, it appears that
leaderboards are a helpful gamification technique for boosting engagement.

3. Our experience of the challenges feature provides a cautionary example for software developers. This feature was added based on a feature request in our earlier pilot study. The challenge feature was complex and expensive to implement, yet usage data suggest this was not a worthwhile software improvement. This provides a lesson that users may request features that seem like a good idea, but may not reflect use in practice.

4. Future research examining the psychological mechanisms underpinning the use of gamification features is warranted.

5. Future studies should also examine optimal implementation of gamification in behavior change programs.

In conclusion, our results suggest that a gamified physical activity app achieved 40% higher app usage than a non-gamified physical activity app and that greater use of the gamification features was associated with greater improvements in physical activity. The leaderboard and status gamification features were well used, whereas the challenges and virtual gifts were used very little. Future research is needed to experimentally examine the effectiveness of different gamification techniques. For now, leaderboards appear to be a particular appealing and easy to implement form of gamification.

Author Disclosure Statement

No competing financial interests exist.

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References


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