

Designing Leaderboards for Gamification: Perceived Differences Based on User Ranking, Application Domain, and Personality Traits

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ABSTRACT

Leaderboards, a common gamification technique, are used to enhance engagement through social comparisons. Prior research has demonstrated the overall utility of leaderboards but has not examined their effectiveness when individuals are ranked at particular levels or when the technique is applied in different application domains, such as social networking, fitness, or productivity. In this paper, we present a survey study investigating how preferences for leaderboards change based on individual differences (personality traits), ranking, social scoping, and application domains. Our results show that a respondent's position on the leaderboard had important effects on their perception of the leaderboard and the surrounding app, and that participants rated leaderboards most favorably in fitness apps and least favorably in social networking contexts. More extraverted people reported more positive experiences with leaderboards despite their ranking or the application domain. We present design implications for creating leaderboards targeted at different domains and for different audiences.

Author Keywords

Gamification; leaderboards; motivational affordances; personality; user interface design.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

In the past few years, the trend of using gamification to provide gameful, engaging and fun experiences has proliferated into a variety of domains, such as education, health, social networking, fitness, and workplace productivity [22, 26]. Gamification is broadly defined as

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“using game elements in non-game contexts” [8]. By displaying ranks of comparisons of users' performances, *leaderboards* are one of the most widely used game elements in gamification [12].

Previous research has shown that leaderboards are an effective way to motivate users through competition [5, 12, 23]. Additionally, leaderboards have been identified as one of the ten key “ingredients” in game design [25], one of the “seven primary game mechanics” [31], and one of the “twelve things people like” from gamification [31]. However, studies have revealed that leaderboards were only effective in motivating some users; for some other users, they could actually become a demotivating factor [5, 12, 13]. For example, Codish and Ravid found that extraverted people perceived leaderboards as being less playful than people who were more introverted, based on their experiences in the education domain [5]. In contrast, Jia et al.'s survey study found that more extraverted people reported higher preferences for leaderboards in personal informatics systems [16]. Together, the results of these studies suggest that personality influences people's perceived preference for leaderboards and also implied that people are motivated differently by leaderboards when applied in different domains.

Zichermann et al. summarized multiple ways of presenting leaderboards in gamified applications, such as displaying the user in the middle of what they term a “no-disincentive” leaderboard, in or using a multilayered leaderboard when the space of leaderboard participants is infinite [31]. In game design, a study of leaderboards in the Olympic Games showed that bronze medalists reported higher levels of happiness with their performance than did silver medalists [14]. In studies on digital games, researchers also tested how players were motivated differently by appearing at different leaderboard positions. For example, Butler's study showed that players were more likely to re-play a game when they attained positions at the top or bottom of leaderboards [4]. Another study from Sun and colleagues identified an association between leaderboard positions and players' satisfaction ratings of a digital game. Players in this study reported higher levels of satisfaction when they appeared in the second, fourth or seventh position [27]. These studies demonstrated that people's perceived

preference for leaderboards was also influenced by how their performance was reflected by their positions on the leaderboards in digital games. However, there have been no studies of which we are aware on the topic of leaderboard positions in gamification.

In this study, we explored how people perceive leaderboards differently when they are ranked at different positions and when this technique is applied in different domains. We selected three positions on the leaderboard to study—top, middle and bottom—and three domains in which leaderboards have been widely applied but studied little—social networking, fitness, and productivity. We also examined the relations between personality traits and people’s preferences for leaderboards. Our three main research questions for this study are:

RQ1: *Are users’ subjective perceptions of leaderboards in gamified systems different when they are ranked at different positions on the leaderboard?*

RQ2: *Do these perceptions differ when gamification has been applied to different domains?*

RQ3: *What are the relations (if any) between users’ personality traits and their perceived preferences for leaderboards, and are these relations affected by position or application domain?*

RELATED WORK

Leaderboards in Games and Gamification

Gamification has been defined in the research literature as “the use of game design elements in non-game contexts” [8]. Deterding and colleagues defined “game elements” to include those elements used in most games, that are readily associated with games, and that play a significant role in gameplay [8]. From the literature on games and gamification, *leaderboards* were identified as one of the basic ingredients for designing a great game [25]; they were also one of the most-used game elements in gamification approaches [12]. Moreover, Reeves and Read listed leaderboards among “ten ingredients of a great game” in the context of massive multiplayer online (MMO) games. One of the “ingredients” was “competition under rules that are explicit and enforced,” which elicited an underlying motivation. Leaderboards also brought a sense of fairness for players during the competition [25].

In their book “Gamification in Design,” Zichermann and Cunningham list seven primary game mechanics drawn from the literature and existing gamified applications, including points, levels, leaderboards, badges, challenges/quests, onboarding, and engagement loops [31]. In addition to these core game elements, the authors noted that “feedback” critically influences players’ motivation and potentially ties in with many other elements, such as points and leaderboards. It implied that leaderboards can serve as a type of “feedback,” rather than an outcome of their own accord [31]. Based on the 42 different “fun” interactions listed by Radoff [24], Zichermann and Cunningham categorized “12 things people like from gamification” [31]. Three of these 12 were

associated with leaderboards. The book also proposed three underlying reasons why people were motivated by leaderboards: leading others, getting attention, and gaining status.

Mekler et al. conducted an empirical analysis to examine whether leaderboards affect users’ behavior and intrinsic motivation. Their findings indicated that leaderboard did not affect users’ intrinsic motivation, but it was one of the effective factors in increasing short-term performance in an image annotation task [18].

Other research categorized leaderboards into two types: “no-disincentive” and “infinite” leaderboards [27, 31]. Leaderboards, when used in social network websites like Facebook, aim to create social incentives rather than disincentives. One way to realize these kind of leaderboards are to organize the names such that the user appears in the middle, with better- and worse-performing individuals bracketing his or her position. These instantiations of leaderboards also often show the user how close he or she is to attaining the next best score. Infinite leaderboards are designed around the premise that a user’s score will be beaten by another player sooner or later. Since it would be impossible to allow every user to exist on the leaderboard forever, these kinds of leaderboards are designed to present rankings with multiple layers. For example, the mobile gaming app Doodle Jump includes a leaderboard with a local view, a friends view, and a global view [31].

Leaderboards in Different Domains

Leaderboards are widely used across multiple domains, including social network websites, fitness tracking, and productivity applications. To increase users’ engagement on social network websites, leaderboards are usually designed to present the rank of profile views or the number of online activities undertaken. For example, Klout, a popular social leaderboard, ranks its users according to their online social influence via Klout score [2, 31]. Farzan et al. conducted a study to understand the effects that a point-based incentive system (i.e., points, “status” levels, and a leaderboard) played in a social network site, and found that some users were driven by leaderboards to keep up with others—an effect that did not suffer significant decay even after the leaderboard was removed. Their findings suggest that the usage of leaderboards could play a role in transferring extrinsic incentives to intrinsic motivations—at least for some users [9].

Leaderboards are also popular in fitness applications (e.g., Fitbit’s companion app). In Wong and Kwok’s mobile health app, a leaderboard displayed all users’ and groups’ step records and rankings [30]. Anderson et al.’s study found that leaderboards introduced a sense of playfulness and indirectly induced participants to walk more [1].

Finally, some workplaces use gamification as a way of improving productivity within the organization, namely Enterprise Gamification [28]. Costa et al. found that

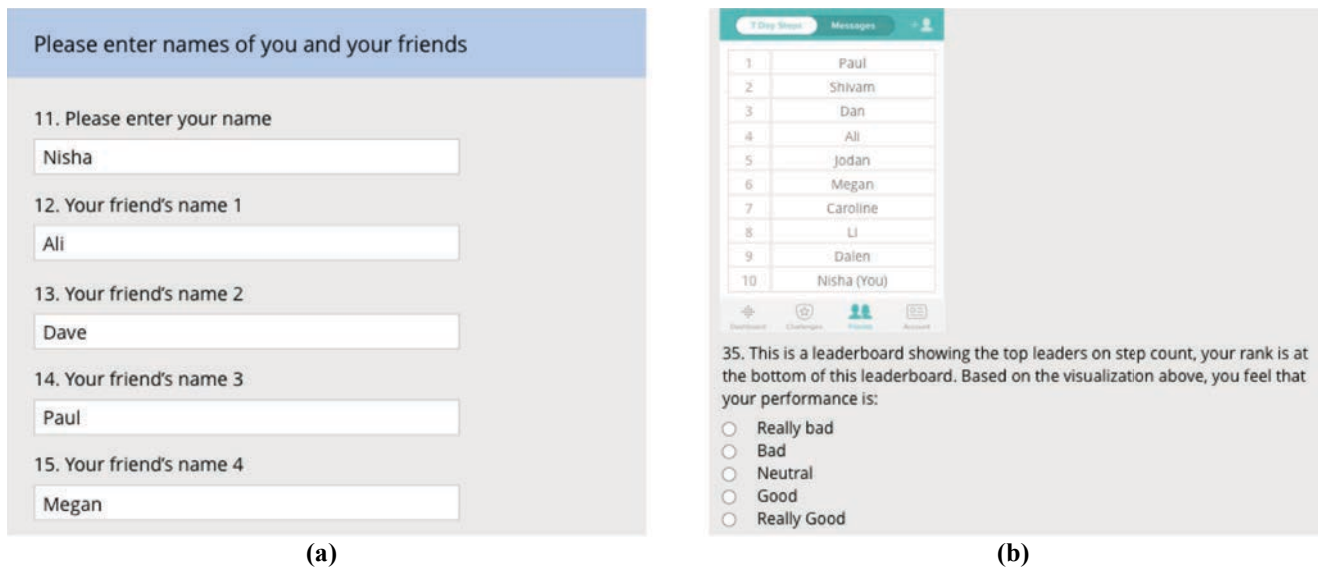


Figure 1. The respondents' experience of the mockups showing leaderboards applied to the fitness domain from our survey. (a) Each respondent was asked to enter his/her name and 10 names of his/her friends. (b) A screenshot of the survey illustrating the display configuration of the mock-up for the situation of bottom position in the Fitness domain and our survey questions.

leaderboards were effective for improving some employees' punctuality to regularly-scheduled work meetings [6]. However, several studies have also shown that leaderboards could reduce work performance rather than enhance it because they make the performance public for all to see in the workplace [28]. For example, Mollick and Rothbard's study used leaderboards to motivate employees when performing tedious and cumbersome tasks at work [21]. Their results showed that the usage of a leaderboard turned work into a more pleasurable activity and enhanced productivity when employees had provided consent to interact with the leaderboard. But the effects from the leaderboard were reversed in the no-consent condition [21].

Personality differences

Previous studies on gamification have found that leaderboards might only be effective for "some" users [5, 9, 16]. Some researchers studied personality differences and their influences on users' motivation and behaviors. Kaptei and Eckles studied personality and people's online purchasing behavior for e-commerce [15]. Arteaga et al. applied personality differences in app interface redesign [3]. Nov and Arazy found significant relations between conscientiousness and people's participation in online communities [23]. In a study of gamification applied to an educational context, researchers found that personality differences played a role in affecting people's preferences for leaderboards. For example, a learning-management system that featured leaderboards motivated some students to take extra courses and seek out more additional opportunities to demonstrate achievement [20]. Codish and Ravid found that extraverts reported a lack of playfulness in leaderboards when applied to a course setting [5]. In a more recent study

by Jia and her colleagues, an online survey study of personality and peoples' preference on 10 types of motivational affordances in gamification, results showed that more extraverted people tended to prefer leaderboards in the context of a habit-tracking application [16].

HCI studies on personality traits often use the "Big-Five factors" as a primary scale [5, 16, 19]. The Big-Five is a descriptive model of personality, which includes *conscientiousness* (people actively organize and carry out tasks), *agreeableness* (people who help others and expect help in return), *neuroticism/emotional stability* (people who have difficulty managing stress), *extraversion* (people who seek out new opportunities and excitement), and *imagination/openness* (people who devise novel ideas) [19].

STUDY DESIGN AND METHODS

This study investigates the relations among people's self-reported preferences both on leaderboards and the corresponding applications when: 1) the user's name is shown at different positions on the leaderboard—namely at the top, near the middle, or at the bottom; 2) these leaderboards are applied to different domains, such as social networking, fitness, and productivity systems within organizations. We conducted a large-scale online survey with 286 participants by using dynamic leaderboard mockups, created with respondents' self-reported names and 10 of their friends' names. The survey was hosted via SurveyMonkey¹ and Amazon Mechanical Turk (AMT)².

Survey Design

The survey contained four sections. The first section featured a series of multiple-choice questions about the participant's demographic background, such as gender, age, educational

¹ <https://www.surveymonkey.com/home/>

² <https://requester.mturk.com/>

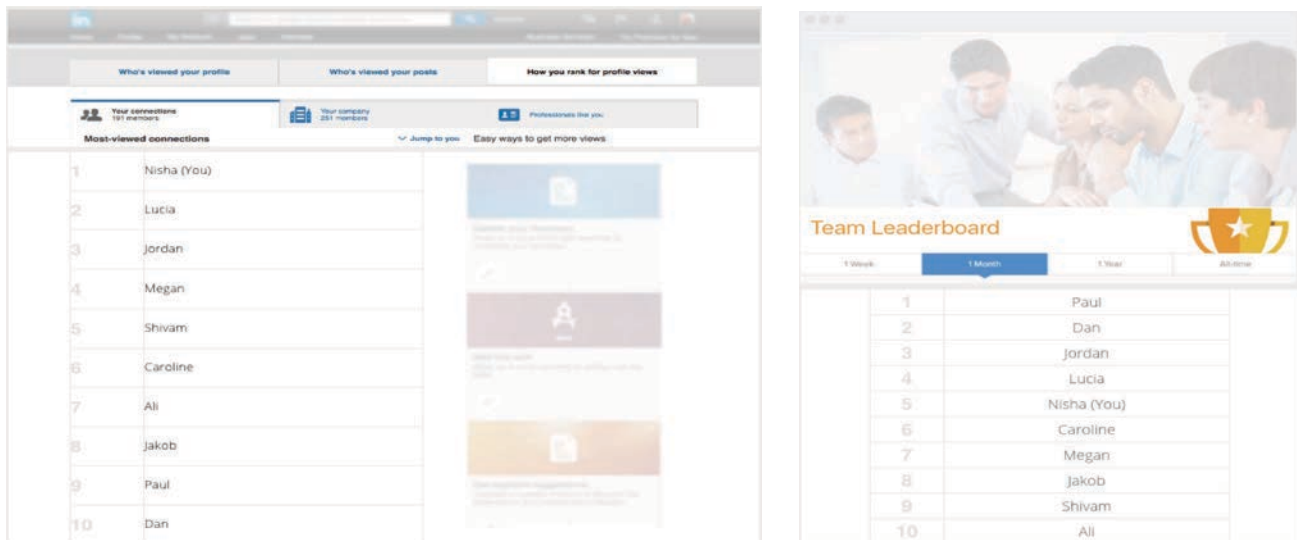


Figure 2. The interface of leaderboard mockups for social network and productivity domains in the survey.

background, occupation, and ethnicity. Next, we asked participants to complete an assessment of the Big-Five factors of personality [7, 17]. We used the 50-item set of IPIP Big-Five Factor Markers, which is a free and research community-developed inventory.

The third part of the survey was designed to elicit feedback regarding different leaderboards with the participant's name appearing at three different positions on leaderboards situated within three domains. At the beginning, each respondent was asked to enter his/her name and the names of ten of his/her close friends (Figure 1a). To help respondents understand the purpose of collecting names and how these names were going to be used (and protected), the following message was shown to all respondents:

In the following, you will be asked to give feedback on 9 different leaderboards. To generate leaderboards with names that you are familiar with, you will be asked to enter your name and any 10 of your friends' names in the next page. These names won't be saved or shared with researchers, and they are only used to generate the interface mockups for the rest of this survey.

Based on these names, we automatically generated 9 interface mockups of various leaderboards for the subsequent survey questions (Figure 1b). Specifically, each respondent's name was displayed in 3 positions on each leaderboard (top, middle, bottom), with leaderboards applied to one of three domains (social networking, fitness, and productivity). These dynamic leaderboard interfaces were generated by a SurveyMonkey feature called "Piping". We used the Latin Square method to counterbalance and avoid any potential ordering effects in the study.

After viewing each leaderboard, each respondent was asked to respond to questions that were designed to collect information regarding the respondents' opinions on (1) self-assessed performance (based solely on the leaderboard display), (2) the perceived enjoyment that the leaderboard

might impart, (3) the perceived feeling of motivation provided by the leaderboard, (4) the participants' willingness to use an application like the ones illustrated by the mockups, and 5) the participant's perceived willingness for recommending this application to their friends. Among these 5 questions, question 2 and 3 were designed to elicit feedback about the leaderboard, and questions 4 and 5 were designed to elicit feedback about the corresponding application domains. These questions were adapted from survey questions in previous research on people's preferences for game elements in gamification [16, 27].

At the end of each domain section (each containing 3 leaderboards), we asked 4 questions to elicit respondents' opinions on: (1) for what reasons (if any) that the leaderboards in that particular domain appeal to them, (2) for what reasons (if any) that their positions on the leaderboard appeal to them, (3) whether the inclusion of their friends' names on the leaderboard matters, and (4) whether the inclusion of their own names are on the leaderboard matters. The fourth part of the survey consisted of only one open-ended question: it was designed to gather respondents' opinions on: 1) whether they felt that leaderboards appealed to them differently in different domain, and, if so, why. The survey took approximately 12 minutes to complete. The full list of survey questions is included in the supplementary materials.

Participant Recruitment

We recruited 286 respondents through Amazon Mechanical Turk (MTurk). We chose to use MTurk for our study due to the need for a large participant sample, the efficiency of survey distribution, and its relatively low cost. Participants were paid USD \$1.00, the payment rate suggested by the AMT platform for survey studies of this duration.

Total Participants (<i>n</i> = 286)	
Age	18–24 (17.8%) 25–34 (50.3%) 35–44 (21.7%) 45–54 (8.0%) 55 and older (2.1%)
Gender	Female (47.2%) Male (52.8%)
Educational Level	Some high school (0.3%) High school graduate/GED (10.1%) Vocational/Associate degree (6.3%) Some college (24.8%) Bachelor degree (40.6%) Some graduate school (2.8%) Master degree (13.6%) Ph.D., law, or medical degree (1.4%)
Occupation	Employed for wages (60.5%) Self-employed (22.8%) Student (7.3%) Retired (0.7%) Other (9.8%)
Ethnicity	White (65.4%) Asian/Pacific Islander (19.2%) Hispanic or Latino (5.6%) Black or African American (7.3%) Native American or American Indian (0.3%) Other (2.1%)

Table 1. Participant Demographics

RESULTS

Participant Demographics

To summarize the demographic information of the respondents, we present their responses (expressed as percentages of the overall sample population) to questions regarding their age, gender, educational level, occupation, and ethnicity (see Table 1). To support our subsequent correlation analyses, respondents' demographic responses were coded into numerical variables. For age, 18–24 was coded as 1, 25–34 as 2, and so on. For gender, male was coded as 1 and female as 2; for educational level, the eight response levels were coded from 1 to 8 from lowest completed education level to the highest.

Before processing to our regression analysis, we used zero-order correlations to test for correlations among independent

variables and respondents' demographic variables (Table 2). The independent variables of interest, i.e., the five IPIP personality traits, were positively correlated with one another. This result was consistent with prior literature [10]. The strongest correlation that we saw was between conscientiousness and emotional stability ($r = .481, p < .01$). This means that our participants who reported high levels of emotional stability also tended to be more conscientious. Participants with higher agreeableness levels also tended to be more open to new experiences ($r = .384, p < .01$).

For gender, there was a positive correlation between the coded gender variable and agreeableness ($r = .271, p < .01$) and a negative correlation between the coded gender variable and emotional stability ($r = -.212, p < .01$). This result shows that for our sample ($n = 286$), males were more emotionally stable but less agreeable than females. We found no correlation between respondents' personality characteristics and their age, educational levels or ethnicity.

Positions on Leaderboards

A two-way ANOVA (repeated measure) with sphericity corrections for each perception (enjoyment, motivation, desire to use, and recommend to friends) was conducted. The results show that position and domain, as two factors, did play a role, individually, to affect people's perceived perceptions significantly on leaderboard and the corresponding application (Table 4). The results also show that the interaction between the two factors is significant for each perception. Thus, to further determine the difference between people's perception at each level of each factor, we conducted several *t*-tests. The detail of the ANOVA and *t*-test results are presented in the supplementary materials.

Across 9 types of leaderboards, 3 positions \times 3 domains, respondents consistently reported significantly higher preference for the leaderboards when their names appeared in the "top" positions than when they appeared in the "middle" positions, which were also consistently and significantly higher than when they appeared in the "bottom" positions, regardless of the application domain. This suggests that respondents were able to understand each mockup presented in the survey.

	Mean	Std. Deviation	1	2	3	4	5	6	7
1. Extraversion	29.30	9.16							
2. Agreeableness	38.19	7.05	.293**						
3. Conscientiousness	36.26	6.85	.167**	.285**					
4. Emotional Stability	32.86	8.62	.315**	.229**	.481**				
5. Imagination/Openness	38.40	5.86	.287**	.384**	.299**	.198**			
6. Age	2.26	0.91	.033	.114	.080	.070	.012		
7. Gender	1.47	.50	-.036	.271**	.044	-.212**	.120*	-.034	

Table 2. Correlation matrix and descriptive statistics ($n = 286$). * indicates cells with $p < .05$ (2-tailed), ** indicates $p < .01$.

	TopSoc	TopFit	TopPro	TopAvg
Performance	4.3 (0.9)	4.5 (0.9)	4.6 (0.7)	4.5 (0.9)
Enjoyment	3.3 (1.4)	3.9 (1.2)	3.8 (1.3)	3.7 (1.3)
Motivation	3.3 (1.4)	4.0 (1.2)	3.9 (1.2)	3.7 (1.3)
DesiretoUse	3.3 (1.4)	3.9 (1.2)	3.7 (1.3)	3.6 (1.3)
Recommend	3.2 (1.4)	3.8 (1.2)	3.6 (1.4)	3.5 (1.3)
	MidSoc	MidFit	MidPro	MidAvg
Performance	3.2 (0.6)	3.3 (0.7)	3.2 (0.7)	3.2 (0.7)
Enjoyment	2.9 (1.2)	3.6 (1.1)	3.2 (1.2)	3.2 (1.2)
Motivation	3.0 (1.3)	3.6 (1.2)	3.5 (1.2)	3.4 (1.3)
DesiretoUse	2.9 (1.3)	3.6 (1.2)	3.2 (1.2)	3.2 (1.3)
Recommend	2.8 (1.3)	3.5 (1.2)	3.1 (1.3)	3.1 (1.3)
	BotSoc	BotFit	BotPro	BotAvg
Performance	2.1 (1.2)	2.0 (1.2)	1.7 (1.1)	1.9 (1.2)
Enjoyment	2.5 (1.4)	3.1 (1.4)	2.5 (1.4)	2.7 (1.4)
Motivation	2.6 (1.4)	3.4 (1.4)	3.0 (1.5)	3.0 (1.4)
DesiretoUse	2.5 (1.4)	3.2 (1.4)	2.6 (1.4)	2.8 (1.4)
Recommend	2.5 (1.4)	3.2 (1.4)	2.6 (1.4)	2.8 (1.4)

Table 3. Descriptive results—reported as mean (SD)—for respondents’ perceptions of leaderboards based on their name appearing at three positions (top, middle, and bottom) within three domains (social, fitness, and productivity).

Leaderboards in Different Domains

We found some interesting results when comparing the differences in reported preference based on position results across domains. To be more specific, respondents rated leaderboards highest in fitness apps and lowest in the social networking context. From Table 3, on a scale from 1 to 5 (1 indicating strong disagreement and 5 indicating strong agreement), we can see that when respondents’ names were shown on the top or in the middle of the leaderboards, participants provided significantly higher ratings for their perceptions of *Enjoyment*, *Motivation*, *Desire to Use* the application, and would *Recommend* to friends in the Fitness and Productivity domains than they did for leaderboards in the Social network domain. In addition, the only negative perceptions (i.e., given a score below 3.0) that the respondents reported when appearing in the middle position were in the Social Network domain. This suggests that for social network websites, people were only positively affected by leaderboards when can readily interpret their rank relative to other users.

People’s perceptions became much more negative when they saw their names at the bottom of the leaderboards. However, respondents still rated perceived *Enjoyment*, *Motivation*, *Desire to Use*, and *Recommend* to friends positively for leaderboards in the Fitness domain even when their perceived performance was low. These results indicate that people have positive experiences of leaderboards in the fitness domain, regardless of their ranking.

Perception	Factor	F value	p value
Enjoyment	Domain	0.97	3.29e-19 *
	Position	0.68	6.18e-42 *
	Domain: Position	0.88	2.39e-11 *
Motivation	Domain	0.94	1.33e-21*
	Position	0.71	3.23e-26*
	Domain: Position	0.92	8.93e-03*
Desire to use the app	Domain	0.96	1.26e-19*
	Position	0.72	2.54e-36*
	Domain: Position	0.89	7.22e-07*
Recommend to a friend	Domain	0.95	6.03e-20*
	Position	0.67	4.15e-29*
	Domain: Position	0.92	6.76e-08*

Table 4. Results from ANOVA. Significant codes (with Greenhouse-Geisser correction): p< .05 ‘’**

Respondents were also asked about their opinions about whether they would like to see their name on leaderboards and whether they prefer competing only with their friends. Figure 3 summarizes the results from these questions. This figure illustrates that 1) showing users’ name on the leaderboard was very important in both the fitness and productivity domains; 2) people had even higher preferences for seeing their names among the top three entries for leaderboards in productivity domain; 3) respondents generally rated leaderboards highly when competing among their friends; and 4) compared to the other two domains, respondents thought that the leaderboard feature in social networking websites was least appealing, regardless of whether their name or their friends’ names appeared in the list.

Personality Type and Leaderboard Preferences

To explore the relationship between personality and users’ perception, we used structural equation modeling (SEM), a mediational analysis, to test our proposed models. We developed two measurement models showing the relationship between exogenous variables and endogenous variables as well as a structural model showing the relationship between the latent personality traits and latent users’ perception. For the measurement model of personality, we used the test scores of the 50 questions from the Big-Five personality inventory as the exogenous variables. We assumed five latent variables (extraversion, agreeableness, conscientiousness, emotional stability, and imagination) for them. As to users’ perception, we assumed a latent variable (perception) for the 4 measurements (enjoyment, motivation, desire to use app, and recommend to friend) that we used in our survey.

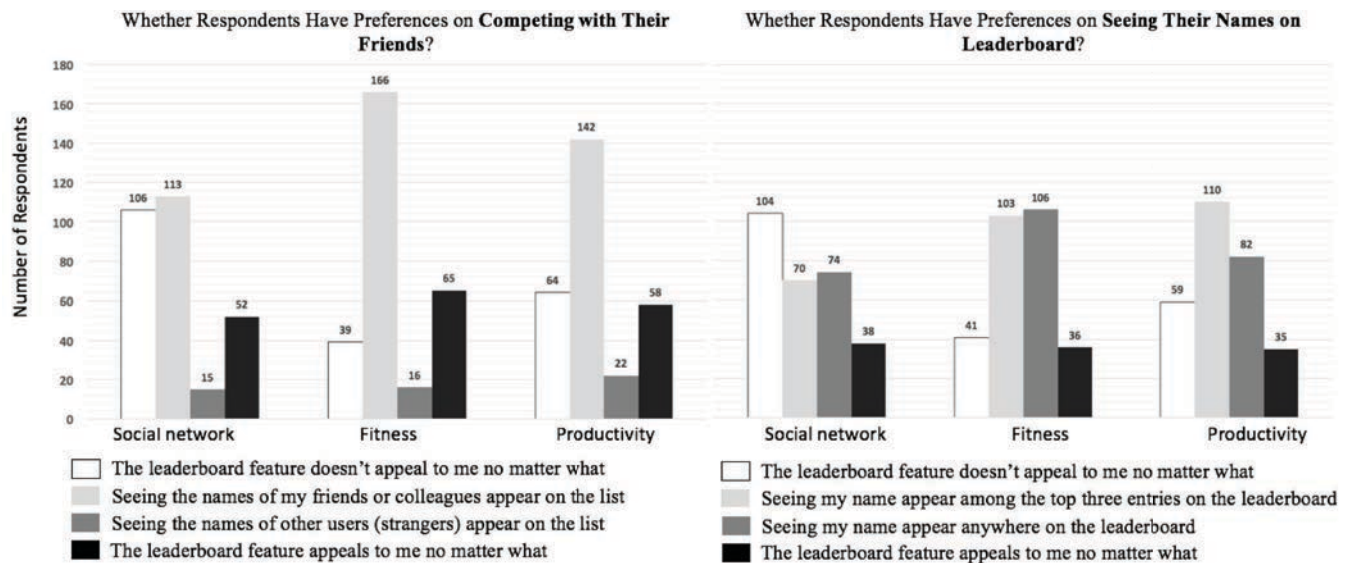


Figure 3. Summarized results of respondents' opinions on whether they would like to see their names on leaderboards and whether they have preferences on competing only with their friends.

For all the paths in the model, we estimated the path parameters based on maximum likelihood, and the process converged normally after 72 iterations. The overall badness-of-fit of our model is significant (Chi-square < 0.001). Based on examination of the path parameters, while the two measurement models showed strong factor loadings, the path parameters of the paths from the Big-Five personality traits to users' perception are fairly small, which suggests a weak impact of personality on users' perception of leaderboards. Thus, from the SEM analysis, we find no statistically significant casual relationships between personality traits and perception on leaderboard. The detailed results from the SEM analysis is included in the supplementary materials.

We also conducted a multiple regression analysis. All individual Beta (β) values from 36 regressions (4 perception types \times 3 positions \times 3 domains) are summarized, and the significant ($p < .05/36 = .001$) results presented in the supplementary materials. Overall, more extraverted people tended to have more positive perceptions of leaderboards in the domains of social networking and productivity; people with higher levels of agreeableness tended to express greater enjoyment of leaderboards in the fitness domain. We found no significant results for the personality traits of conscientiousness, emotional stability, or imagination.

In the remainder of this section, we report significant differences among perceptions (i.e., enjoyment, motivation, desire to use the application, and would recommend to friends) for each type of leaderboard. In addition, we also report the qualitative results from our open-ended survey questions.

For leaderboards in the **social networking domain**, when respondents' names were shown in the **middle** position, the more extraverted people expressed more desire to use the

social networking websites ($\beta = .216, p = .001$) and were more likely to recommend the websites to their friends ($\beta = .218, p = .001$). When respondents' names were at the **bottom** of the leaderboard on social networking websites, the more extraverted people reported stronger likelihood of being motivated by the leaderboard ($\beta = .218, p = .001$); in addition, for more extraverted people, they expressed more desired to use the websites ($\beta = .219, p = .001$) and were more likely to recommend it to their friends ($\beta = .232, p = .001$).

Our qualitative results from the open-ended questions show that leaderboards on social websites provide another mode of connection, help monitor social influence status, and increase communication among friends:

"Leaderboards on social networks help me assess the reputation of people I may not know all that well." (P146)

"I like the leaderboard just for the purpose of being able to identify who I am staying in contact with, and who wants to stay in contact with me." (P224)

However, respondents reported that they use social media to communicate with others rather than for competition, and the social influence showed from the leaderboard does not reflect reality since their social connections are not derived solely from social websites:

"It doesn't appeal to me because I don't see the point in such a ranking, specially between friends. Feels like added competition where there shouldn't be any." (P25)

"If I'm being honest, I don't think I care for the ranking system when it comes to a social network site. It doesn't seem like it belongs on a social site." (P105)

"The leaderboard feature in social networking websites doesn't appeal to me because it doesn't reflect

my real connections that I have people rather than on some networking websites.” (P172)

With regards to leaderboards in the **fitness domain**, when respondents’ names were shown at the **bottom** of the leaderboards in fitness apps, the more agreeable respondents rated *Enjoyment* of the leaderboard more highly ($\beta = .227$, $p = .001$). From our qualitative results, respondents reported that fitness itself can be competitive in nature. They also reported feeling a sense of motivation from leaderboards in this domain because leaderboards turn fitness activities into a more fun competition. The leaderboard can also be seen as a type of progress tracking, which is a good match to this domain. Some sample comments from the open-ended survey questions included:

“I always wanted to use a fitness app like this. It’s addicting to keep watching your rank go up as you work towards your fitness goals. It’s like when you work for hours leveling on a video game only with real life results.” (P118)

Consistent with the quantitative results, one reason that respondents reported enjoying the leaderboards was that people enjoy engaging in competition with their friends or families on fitness activities:

“I like the competitive nature of it, plus, having friends and family on the leaderboard is an extra incentive to do well.” (P207)

“I have a Fitbit on my hand right now and I look at the leaderboard from time to time to make sure my steps don’t get too low. It really does motivate me because I know my mom will get worried if she sees my numbers go too low.” (P 32)

“It’s just interesting to know how well my performance is compared to my friends. It makes doing activities more exciting and motivating, to me. It motivates me to compete.” (P256)

The results of leaderboards in the **productivity domain** reveal that when respondents’ names were at the **top** of the leaderboard, people who are more extraverted were more likely to have positive perceptions of the leaderboards ($\beta = .222$, $p = .001$) and the surrounding system ($\beta = .233$, $p = .000$); for the personality traits of agreeableness, emotional stability and imagination, people rated leaderboards in this domain negatively, but this was not a statistically significant difference. When respondents’ names were shown in the **middle** of the leaderboard in productivity applications, the more extraverted people still provided positive ratings of the leaderboard and the application. From our qualitative results, our respondents reported that they liked the idea of incorporating leaderboards into team work because it offers an incentive for doing a good job, it provides a visual representation of work performance, and it might be especially valuable when a deadline is approaching:

“This leaderboard lets me know how well I am doing within my team and if I need to improve my performance.” (P10)

“Gives real, easily quantifiable feedback on my performance.” (P175)

“It is fun to see how well you are doing and makes work feel a little more like a game which makes it a little easier to enjoy what you are doing and feel motivated.” (P148)

“I really do like to know how my output and quality of work (of any kind) measures up to my peers. It’s good to know whether I need to work harder or if I can relax a bit and maintain.” (P192)

On the other hand, many negative comments from respondents mentioned that the competition derived from a leaderboard in a working environment reads more like a “name-and-shame” feature instead of a “game-like” feature since employees don’t have other options. They also felt that employees should cooperate to reach a common goal instead of competing with one another, that leaderboards might foster animosity at work, and that some work cannot be judged in a fair and objective manner upon which a leaderboard visualization could be built:

“when I am down at the list I will have a motive to work better, it’s a job, it’s not optional...” (P12)

“This leaderboard does not appeal to me as I do not feel my work can be judged adequately through it.” (P74)

“It does not appeal to me because I feel that productivity in the workplace should be a matter between each employee and their employer and not a public matter between employees.” (P47)

DISCUSSION

In this section, we discuss the link between differences in a person’s position on a leaderboard and their preferences for leaderboards. We also delve into the relations between their rank or position and their preferences for leaderboards across different domains. Finally, we discuss how personality differences could help to inform the design of leaderboards in gamified applications.

Leaderboard Position and Domain Differences

In the gaming literature, leaderboard position was found to be a factor that affects players’ game experiences. In the example of leaderboards in Olympic games, researchers explained the finding that bronze medalists reported higher levels of happiness than silver medalists because of the notion of “what could have been,” which implies that silver medalists framed their thinking about the fact that they *could* have won a gold medal, while and bronze medalists understood their ranking as being better than not having received any medal at all [14]. For leaderboards in digital games, in the example of Gold Mine, Sun and colleagues found that players reported higher satisfaction when they appeared in positions 2, 4, and 7 [27].

Our results showed that respondents rated leaderboards differently when they are ranked differently in different domains. It indicates that unlike event-based competitions like the Olympics or short-time-repetitive competitions in digital games, leaderboards in gamified applications typically present long-term competitions of various types of domain-related activities. Thus, to design leaderboards in gamified contexts, in addition to leaderboard position, designers should also consider the impact of domain differences.

For rankings on leaderboards, our results show that respondents reported positive perceptions of leaderboards only when they appeared in the top positions of the leaderboard in the social-networking domain. However, the results from the fitness and productivity domains revealed that people liked leaderboards in fitness applications no matter what their rank; and people had only negative perceptions of leaderboards when ranked in the bottom of leaderboards in the productivity domain. From our qualitative results, one of the key differences among these domains is the perceived fairness of the leaderboard in the social and productivity domains. Unlike step count, the metric typically used to determine ranking on fitness-oriented leaderboards, respondents reported that their social influence cannot be quantifiably reflected by the leaderboard on social websites since not all of their contacts occurred in a single social network application; and for productivity domain, respondents reported that significant facets of their work are simply not rank-able. In the research literature, a design guide for leaderboards in game design mentioned about that competition under rules should be fair and explicit [25]. Thus, we suggest that **the competitive activity used to seed the leaderboard should be designed to bring a sense of fairness for users.**

In our results, respondents provided the lowest ratings for leaderboards in the social networking domain. From our qualitative results, respondents expressed a common concern that they use social network sites primarily for communication instead of a site for competition with others. This finding is consistent with the findings from previous studies of people's experiences with social network games. Wohn et al. mentioned that competition in social games indirectly facilitate social interaction: people passively obtained information about others' performance from leaderboards and treated this interaction as a "friendly competition" [29]. Leaderboards introduce the concept of competition to gamified systems, but social network domains tend to emphasize an ultimate goal of facilitating interaction among friends. It appears that among members of a close social circle, it is not easy to encourage serious competition; rather, competition manifests as friendly banter or a lighthearted game. Thus, we suggest that **leaderboards in social networking contexts should be intentionally designed to serve the purpose of facilitating communication rather than just showing results of a metricized competition.** For example, leaderboards could

be designed to be less competition-oriented and instead focus on expanding one's social circle; showing long-time, no-contact friends or shared-interest strangers on the board might be a more effective use of these features than when they simply display the performance of a close, stable group of friends.

We also found that respondents rated leaderboards positively in the fitness domain regardless of their position on those leaderboards. Additionally, respondents reported significantly higher preference for seeing their friends or colleagues on these leaderboards and the lowest preference for seeing strangers on them. Our qualitative results reinforce these quantitative findings: people expressed more enjoyment and motivation when competing against people with whom they were familiar, such as family, friends, or close colleagues. One reason is that the activity people are competing with in this domain is almost always reflective of their personal, daily routines. This may be why people are more comfortable competing with their closer friends and family members in this context. Competing with close acquaintances leverages people's universal desire to interact with and be involved in the lives of their friends and family members; additionally, it provides motivation for improving one's fitness levels because making unhealthy decisions can in some ways be perceived as "letting down" those close friends and family members. This duality is unique in the fitness domain because fitness activities are both deeply personal and influenced by the behavior of others. The finding is consistent with the previous study from Hamari and Koivisto, which found that users felt more attached to gamified applications when they have more friends participating in the gamified system [11]. Our finding also supports Wong and Kwok's hypothesis that people's fitness- or exercise-related motivation could be positively satisfied through human-relatedness needs, such as social recognition and affiliation [30]. People care more about who the individuals are on these leaderboards than his/her own ranking. Thus, we suggest that when designing a leaderboard for a fitness app, **designers should first understand *who* should appear on the leaderboard rather than *where* to position the user, focusing on supporting constructive competitions among a small circle of close friends.**

The results from the findings about productivity-oriented leaderboards reveal that it is very important for respondents to see their name on the leaderboard in this domain. And people have even higher preferences for seeing their names among the top three entries of these leaderboards. From our qualitative results, respondents expressed the most negative perceptions of these leaderboards when their names appeared towards the bottom of the ranked list. Instead of introducing a sense of "fun," respondents thought that the competitive tasks used to seed the rankings on productivity-oriented leaderboards spur serious competition. They also expressed concern that appearing at a low rank might have negative consequences for how they were perceived among their colleagues, or even to strain their relationship with their

employer. Our finding is consistent with the study by Mollick and Rothbard, which found that employees experienced less positive affect from leaderboards at work in the “no-consent” condition [21]. Werbach and Hunter also noted the negative effects of leaderboards in working environments, pointing out that leaderboards can play a role in “reducing the richness of a game to a zero-sum struggle for supremacy [and] therefore inherently turns off some people and makes them behave in less desirable ways” [28, p76]. This might due to the sensitivity associated with introducing (additional) competitiveness into workplaces. On the other hand, in those successful documented examples of using leaderboards in the productivity domain, the competitive tasks around which rankings were based were usually repetitive and boring [28]. For example, to reduce the death rate from hospital-acquired infections, leaderboards have been successfully applied in hospitals to motivate staff to compete with one another in washing their hands often and well, which turns hand washing into a competitive game. Thus, we suggest that **when designing leaderboards for the productivity domain, the competitive tasks should be selected from the set of simple and repetitive tasks associated with the job.** Additionally, designers might strive to **avoid showing the lowest-ranking employees on workplace leaderboards.** It is desirable that at workplaces the design of the leaderboard should consider the dynamics among co-workers and the impact that their introduction might have on the overall office culture.

Personality-targeted Leaderboards

Our results show that more extraverted people tended to have more positive perceptions of leaderboards. This finding is consistent with previous studies by Jia et al. [16] and Nov & Arazy [23]. Werbach and Hunter also mentioned that leaderboards have the capability of showing progress that other motivational affordances like *points* and *levels* cannot [28]. One reason for extraverted people to prefer leaderboards is because of their dynamic nature—they reflect the ever-changing social landscape constituted by the gamified system’s participants. Thus, we suggest, to **appeal to more extraverted users, designers should not only design leaderboards as a way of showing rankings, but also emphasizing changes.**

In summary, based on the findings from our study, we can provide several concrete suggestions for the design of leaderboards in gamified applications. For these interfaces, we propose that there are five questions that designers should consider:

1. In what domain is the leaderboard going to be applied?
2. Does the competitive task on the leaderboard feature rules that are fair and equally applicable to all participants?
3. What are the relationships among the participant-competitors?
4. Where should the active user be displayed on the leaderboard — at the top, middle, or bottom of the list,

or does it not matter? In other words, how should the user’s performance be communicated relative to the other users of the system?

5. Will the task or activity that will be measured to seed the leaderboard provide a dynamic enough competitive landscape?

Limitations

Our study used regression results from an online survey. The mockup leaderboards did not capture the wide range of possible leaderboards application domains. Leaderboards could be used in multiple domains and the social dynamics between leaderboard players could vary among these domains. Additionally, the results were gathered from a one-time survey and thus our findings might not reflect actual “after-use” user experiences. In order to constrain the number of questions in our survey, we manipulated the user’s ranking on the generated leaderboards to be at the top, in the middle, and at the bottom, which does not reflect a person’s real relationship to the domain or the task, given that he/she did not put real effort into improving his/her ranking. Finally, this study uses personality traits as indicator of preference on leaderboard designs. In reality, other factors might play a larger role in determining perceptions of gamification designs.

CONCLUSION AND FUTURE WORK

Overall, this study contributes to the understanding of how leaderboard positions affect people’s experiences of leaderboards across different domains. We discovered that for leaderboards in gamified applications, competition is a media rather than purpose. We found that one primary personality trait affect people’s perceived preferences on leaderboards by a small amount—and did so in different ways: *extraversion*. We developed several design guidelines for leaderboards in specific domains and for specific personality types.

In future work, we plan to explore the relations between the dynamism of different leaderboard implementations and people’s perceptions of those leaderboards. We anticipate that this research will continue to guide the application of motivational affordances to enhance users’ experiences with a variety of gamified applications across many potential domains.

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