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# Perceptions of virtual reward systems in crowdsourcing games

Dion Hoe-Lian Goh*, Ei Pa Pa Pe-Than, Chei Sian Lee

*Nanyang Technological University, Wee Kim Wee School of Communication & Information, 31Nanyang Link, SCI Building, Singapore 637718, Singapore*

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ABSTRACT

The gaming approach to crowdsourcing is a major way to foster engagement and sustained participation. Also known as crowdsourcing games, players contribute their effort to tackle problems and receive enjoyment in return. As in any game, a fundamental mechanism in crowdsourcing games is its virtual reward system. This paper investigates how virtual reward systems evoke intrinsic motivation, perceived enjoyment and output quality in the context of crowdsourcing games. Three mobile applications for crowdsourcing location-based content were developed for an experimental study. The Track version offered a points-based reward system for actions such as contribution of content. The Badge version offered different badges for collection while the Share version served as a control which did not have any virtual reward system. For each application, participants performed a series of tasks after which a questionnaire survey was administered. Results showed that Badge and Track enhanced enjoyment emotionally, cognitively and behaviorally. They also increased perceptions of the quality of outputs when compared to Share. As well, they better satisfied the motivational needs for autonomy and competence than Share. Interestingly, there were also significant differences in how Badge and Track were perceived.


## 1. Introduction

Crowdsourcing harnesses online users to address specific problems (Doan, Ramakrishnan, & Halevy, 2011), and in the domain of location-based content, it has become a major way of populating information-rich online environments. Examples include content creation to describe locations of interest using text, images and other multimedia formats, as well as creating and/or verifying maps. For instance, in the OpenStreetMap project (Haklay & Weber, 2008) volunteers collaboratively contribute and edit world map data which is accessible for free by the general public.

The success of crowdsourcing projects requires incentives to motivate participation. Apart from volunteerism and monetary rewards, computer games are another possible means to attract participants due to the growing number of game players worldwide (Entertainment Software Association, 2015). Thus, games layered upon crowdsourcing tasks have emerged, and these are known as human computation games, games with a purpose, or crowdsourcing games (Goh & Lee, 2011; von Ahn & Dabbish, 2004).

In essence, crowdsourcing games are dual-purpose artifacts which generate computational outputs and offer entertainment at the same time (Goh & Lee, 2011). Consequently, enjoyment and task completion are the striking features of such games. These characteristics distinguish them from games for pure entertainment where enjoyment is considered to be the single most important goal (Sweetser & Wyeth, 2005). In the context of crowdsourcing location-based content, Tidy City (Wetzel, Blum, & Oppermann, 2012) presents riddles that are displayed on a map. The player's task is to determine what real-world locations each riddle describes. Players are rewarded with points for solving riddles, and these solutions become descriptors for the corresponding locations.

As in any other game, a fundamental mechanism to engage players, reinforce gameplay behaviors, and foster enjoyment in crowdsourcing games is the virtual reward system (King, Delfabbro, & Griffiths, 2010; Lewis, de Salas, & Wells, 2013). Virtual rewards translate a player's investment in terms of time and effort spent in a game into a form that is quantifiable, comparable and communicable (Jakobsson & Sotamaa, 2011). Stated differently, rewards provide feedback to a player on his/her status within a game so that appropriate actions may be taken. Further, rewards facilitate social comparison, allowing a player to ascertain his/her performance against other players. Put together, rewards provide an enjoyable experience for individuals, possibly resulting in sustained gameplay (Wang & Sun, 2011). Among the many possible rewards

* Corresponding author.
*E-mail addresses:* ashlgoh@ntu.edu.sg (D.H.-L. Goh), ei1@ntu.edu.sg (E.P.P. Pe-Than), leecs@ntu.edu.sg (C.S. Lee).

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0747-5632/

available, two common types are points and badges (Farzan et al., 2008). Points represent a player's numeric score in a game and indicate achievement, progress, and/or wealth. Badges are awards that are non-numeric. They indicate a player's status, and also mark the achievement of goals and in-game progress.

Prior work has suggested that these virtual rewards may influence players' perceptions differently. For example, Richter, Raban, and Rafaeli (2015) argue that badges provide a kind of social shaping because they represent interactions that are shared among people who hold them. In contrast, points are typically used to indicate an individual's progression and performance, and hence likely to evoke self-efficacy and foster direct competition (Hamari, 2015). Thus, individuals may consider either badges or points as rewarding depending on their motivational needs. To date however, there is little research to how crowdsourcing games with different virtual reward systems are perceived. In particular, since crowdsourcing games generate outputs, do players perceive virtual reward systems differently when assessing output quality? This is important because if individuals do not perceive a crowdsourcing game as generating useful outputs, its primary aim is rendered ineffective, leading to potential non-usage. More fundamentally, how do virtual reward systems motivate players and evoke perceptions of enjoyment in crowdsourcing games? Understanding these issues are important since they are critical factors of sustained gameplay.

This paper argues that because of the entertainment-output generation duality of crowdsourcing games, prior results obtained for entertainment-only games may not provide an accurate assessment of this issue, and an updated perspective is needed. Crowdsourcing games are different from games for pure entertainment as the latter are generally considered autotelic or intrinsically motivating (Wu & Liu, 2007). Likewise, crowdsourcing games are not identical to task-oriented applications which provide instrumental value to users by assisting them to achieve intended goals (Doan et al., 2011). In the present research, the above questions are addressed by focusing on the influence of different virtual reward systems on motivational needs and perceptions of enjoyment and output quality among players of crowdsourcing games.

People play games for a variety of reasons. In this work, the self-determination theory (SDT), which explains that individuals can be intrinsically motivated when playing games, is employed. In the SDT, intrinsic motivation comprises three psychological needs—autonomy, competence, and relatedness (Deci & Ryan, 2000). Previous studies on entertainment-oriented games suggest that these needs vary across game genres and the mechanics used (e.g., Mekler, Brühlmann, Tuch, & Opwis, 2015; Przybylski, Rigby, & Ryan, 2010).

A second factor important to the success of crowdsourcing games is the perceptions of enjoyment derived among players. These perceptions have a significant role in continued gameplay, and form the core of the media consumption experience (Vorderer, Klimmt, & Ritterfeld, 2004). Further, perceived enjoyment has been found to be influenced by users' perceived quality of outputs in task-oriented contexts such as e-health and online travel information search (Chen, Shang, & Li, 2014; Hwang & Kim, 2007). Hence, a third influential factor is perceived output quality since this is the ultimate purpose of crowdsourcing games. Stated differently, players' behaviors and attitudes towards crowdsourcing games may be impacted by their perceptions of the quality of outputs generated by these games. Such an impact has been found in information-oriented applications that had no game elements (e.g., Kim & Han, 2009). Additionally, prior studies have assessed output quality through multiple dimensions comprising accuracy, completeness, relevancy, and timeliness (e.g., Alkhattabi, Neagu, & Cullen, 2010; Lee, Strong, Kahn, & Wang, 2002).

In summary, the present study investigates how virtual reward systems influence motivational needs satisfaction, perceptions of enjoyment and perceptions of output quality among players of crowdsourcing games, employing user-generated location-based content as a context. Three applications were developed: a mobile crowdsourcing game that employs a points-based reward system, another game that utilizes badges as rewards, and finally, a non-game-based mobile application to serve as a control. An experiment was then conducted to compare perceptions of the three applications in terms of the variables of interest, using frameworks derived from prior work.

## 2. Related work

### 2.1. Crowdsourcing games and location-based content sharing

Typically, crowdsourcing systems appeal for volunteers or pay for labor. However, recruiting and retaining volunteers are challenging tasks since volunteerism is dependent on the nature of the project, the design of the crowdsourcing task, as well as individuals' willingness to devote their time and effort to crowdsourcing projects (Yuen, Chen, & King, 2009). Paying for expertise is an alternative which has yielded positive outcomes but this is potentially costly. Further, the appropriate monetary amount to incentivize workers in relation to task complexity needs to be carefully considered, and concerns of fraud have also been raised due to the involvement of monetary transactions (Thomsen, 2013). Stated differently, people participate in crowdsourcing projects for a variety of reasons, of which volunteerism and monetary rewards alone cannot satisfy (Brabham, 2012). Consequently, alternative motivational mechanisms need to be investigated to widen the appeal of crowdsourcing projects, and games represent such an option.

Crowdsourcing games are a genre of crowdsourcing systems driven by the entertainment experience (Goh, Ang, Lee, & Chua, 2011). They are designed for people to perform a range of crowdsourcing tasks from simple, such as labeling an image, to complex, such as knowledge creation (von Ahn & Dabbish, 2004). Recently, because of the mobility and ease of use afforded by mobile devices, crowdsourcing games have been implemented on the mobile platform. In particular, work has been done on creating games for acquiring location-based content. For example, the Gopher Game (Casey, Kirman, & Rowland, 2007) facilitates geospatial content sharing through the performance of information creation tasks conducted by a game agent called a gopher. Players can either create a new gopher and assign tasks, or pick it up as they move around their physical world and help the gopher to complete its mission by supplying situated photographic and textual content. Players earn game points for good performance.

Next, the Hidden View Game (Lee, Kim, & Lee, 2013) gathers information to keep maps and street views up-to-date. Players are shown a street view image and tasked to identify whether the given labels exist or not in the latest street view. They earn game points based on the accuracy of their contributions and how quickly they accomplish the task. Additionally, PhotoCity (Tuite, Snavely, Hsiao, Tabing, & Popovic, 2011) provides multiple incentives to motivate gameplay. Players create images of real-world buildings at positions anchored by flags on a map, and earn points for their contributions. A player who contributes the most images of a building will capture it, with his/her name appearing as the owner.

### 2.2. Crowdsourcing games and virtual reward systems

The sustainability of a crowdsourcing game is dependent on players' participation. Prior research on entertainment-oriented

games and information systems suggests that rewards are able to support ongoing users' engagement even if they do not enjoy the activity itself (Wang & Sun, 2011). Accordingly, crowdsourcing games employ various forms of virtual rewards along with the intrinsic reward that players experience from gameplay such as enjoyment (Lewis et al., 2013).

Virtual rewards are in-game incentives awarded to players in recognition of activities performed and allow players to gauge their progress within a game (Zuckerman & Gal-Oz, 2014). They have also been argued to induce operant conditioning (Skinner, 1974) to promote desired gameplay behaviors Points are a commonly used reward system that awards numeric values for various player behaviors. In addition to being the most basic form of reward afforded by entertainment-oriented games (Wang & Sun, 2011), the points system has been shown to be effective in guiding players towards particular behaviors in various contexts such as enterprise social networking, peer-to-peer, and online learning communities (Farzan et al., 2008). Additionally, most location-based crowdsourcing games to date have been dominated by awarding points to players in exchange for their contributions of geospatial content. Geo-zombie (Prandi, Salomoni, Roccetti, Nisi, & Nunes, 2016) is one such example which awards points for defining categories of urban elements as well as for creating descriptions, notes, and photos for such elements. Players can exchange points for ammunitions to shoot zombies that are attacking them.

An alternative approach to incentivize players is the badge system. Rather than signifying achievement as a single aggregate value (i.e., points), badges represent a player's interests and experience because they are awarded for completing specific activities (Lewis et al., 2013). Badges can therefore be seen as goals that players can strive for, and they also provide clear indications about how far players have progressed towards these in-game goals. They also have varied visual representations and may appeal to those motivated by collecting in-game items. More generally, badges may be said to serve five functions: goal-setting, instruction, reputation, status/affirmation, and group identification (Antin & Churchill, 2011). In the crowdsourcing context, Yelp (http://www.yelp.com) is one example which guides users' behaviors through badges that are acquired by performing specific activities such as being the first reviewer of a location, and checking-in when in a particular country.

Intuitively, the different virtual reward systems in crowdsourcing games would have varying influences on players' behaviors. However, to the best of knowledge, there are few studies that make empirical comparisons across these systems. Instead, prior work have compared the relative effectiveness of virtual and financial rewards (e.g., Massung, Coyle, Cater, Jay, & Preist, 2013), compared a single reward system against non-reward systems, or simply examined the effects of individual reward systems without comparisons. For example, Mekler, Bruhlmann, Opwis, and Tuch (2013) found that in the context of crowdsourcing image tags, the use of points generated more tags than the use of messages to encourage participation. In a study of StackOverflow, an online question-answer community, results suggested that badges promoted increased answer activity (Cavusoglu, Li, & Huang, 2015). While these studies make important contributions, whether a particular virtual reward is more influential than another cannot be observed. In prior preliminary work done by the authors (Goh, Pe-Than, & Lee, 2015), points and badges were shown to be perceived as being more enjoyable and offered higher quality content in a location-based crowdsourcing task when compared against no rewards, but both reward systems were perceived equally. However, this work used only a small sample of participants ($n = 67$), and did not consider their influence on intrinsic motivation. The present study therefore extends existing research by not only comparing different virtual reward systems, but also examining their differential effects on constructs which are deemed important in the context of crowdsourcing of location-based content. These are described next.

### 2.3. Perceived enjoyment

Enjoyment is considered to be a critical aspect of any entertainment medium because individuals consume it to primarily seek fun or pleasure (Sweetser & Wyeth, 2005; Vorderer et al., 2004). Being an important factor, perceived enjoyment of games for pure entertainment and its influence on players' attitudes and behaviors have been extensively examined (e.g. Hsu & Lu, 2007; Wu & Liu, 2007). Beyond entertainment, perceived enjoyment has also been found to have a substantial impact on users' attitudes towards task-oriented applications such as online information sharing (Kim & Han, 2009).

Most studies to date have treated enjoyment as an unidimensional construct, assessed only through affective states such as fun, pleasure and excitement (e.g. Wu, Wang, & Tsai, 2010). However, there is support for the notion that enjoyment is not a monolithic attribute but a complex construct comprising multiple factors (Vorderer et al., 2004). In particular, Nabi and Krcmar (2004) view enjoyment as an attitude that consists of three dimensions. The affective dimension focuses on an individual's affective or emotional experiences, while the cognitive dimension centers on an individual's experiences gained through evaluative judgments in response to the media. The behavioral dimension focuses on individuals' behaviors when they are engrossed in the media. As noted above, because different virtual reward systems incentivize players in differently, they may have varying influences on players' perceptions of enjoyment affectively, cognitively and behaviorally. For instance, previous research (e.g., Nagle, Wolf, Riener, & Novak, 2014; Prestopnik & Tang, 2015) suggests that players seemed to have preferences for certain reward types such as fixed or variable, and story-based or point-based, and this may, in turn, influence their enjoyment. This will be investigated in the present study.

### 2.4. Perceived output quality

Prior research has underlined the vital role of individuals' perceptions of output quality in influencing their attitudes in user-generated content applications (Kim & Han, 2009). In common with these applications, crowdsourcing games generate output, and hence players' perceived output quality is another important factor that influences usage. Extant work on assessment of informational content suggests that output quality is a multi-faceted construct. Hence, the use of multiple quality dimensions is necessary (Lee et al., 2002). In particular, dimensions of accuracy, completeness, relevancy, and timeliness have been shown to be significant in affecting attitudes and perceptions of online information-oriented applications (Alkhattabi et al., 2010). Using a meta-analysis of existing quality frameworks, results showed that accuracy, completeness, relevancy and timeliness were the most frequently appearing dimensions in various output quality frameworks.

First, accuracy is defined as the correctness of outputs appropriate to the context where it is represented. It is regarded as a core intrinsic quality of information, and includes attributes such as correctness, reliability, believability, and other related concerns (Wang & Strong, 1996). Next, completeness represents sufficient breadth of scope and depth of detail of information (Lee et al., 2002). Relevancy is defined as the extent to which users perceive outputs to be applicable, relevant, usable, and helpful enough for the task at hand (Lee et al., 2002). Finally, timeliness refers to the

age of the output, representing the degree to which content is up-to-date (Wang & Strong, 1996). Prior work (e.g., Mekler et al., 2015) found that the quantity of content produced by players varied by reward systems. In particular, players were found to generate more outputs in games with leaderboards compared to those offering points and levels. This also suggests that different virtual reward systems may be perceived differently. This paper thus contends that by rewarding players differently, it is likely that virtual reward systems such as points and badges may convey varying impressions of output quality in crowdsourcing games.

### 2.5. Motivational needs

Games are recognized as an intrinsically motivated activity where individuals participate to yield pleasurable experiences (Deci & Ryan, 2000; Liu, Li, & Santhanam, 2013). Hence, player motivations have become one of the main concerns of entertainment-oriented games because they influence players' perceptions and behaviors. One of the theories that describe intrinsic motivation is SDT (Deci & Ryan, 2000). According to the SDT, intrinsic motivation varies depending upon the degree to which an activity affords three psychological needs: autonomy, competence, and relatedness. The autonomy need is the extent to which a person perceives a sense of freedom in his/her actions in an activity. For example, when an individual performs an activity for his/her personal value, perceived autonomy is high, and this in turn increases intrinsic motivation. Next, the competence need is the extent to which an individual perceives feelings of effectiveness when performing an activity. For instance, if an individual perceives that he/she is unable to perform an activity effectively, this person is less likely to feel motivated to do so. Finally, the relatedness need pertains to the desire to feel connected with other individuals. Therefore, if an activity allows interaction with others, an individual will likely experience a sense of connectedness thereby increasing intrinsic motivation.

In the context of gameplay motivations, research has consistently found that the perceived needs for autonomy, competence, and relatedness impact players' preferences for entertainment-oriented games (Reinecke et al., 2012; Ryan, Rigby, & Przybylski, 2006). Additionally, in task-oriented contexts such as performing work-related activities, individuals' attitudes and behaviors were found to be influenced by the satisfaction of these three needs (Boezeman & Ellemers, 2009). Therefore, the needs encapsulated by the SDT may be used to evaluate whether a crowdsourcing game, which comprises both entertainment and work-oriented elements, achieves its primary purpose of providing intrinsic motivation. However, the strength of influence in inculcating motivation may vary not only as a function of personal appeal, but game design elements as well (Ryan et al., 2006). For the latter, one element to consider in crowdsourcing games is the virtual reward system. Previous research (e.g., Mekler et al., 2015) suggests that certain forms of rewards may influence individuals' intrinsic motivation and performance. For example, a reward that is perceived as informational may promote intrinsic motivation whereas one that is perceived as controlling may diminish it (Hanus & Fox, 2015). In this present work, the differences in intrinsic motivation afforded by points and badges are therefore compared.

## 3. Methodology

In line with this paper's objective of investigating the influence of virtual reward systems in crowdsourcing games on players' motivational needs satisfaction, perceived enjoyment and perceived output quality, an experiment was conducted using mobile applications designed specifically for this study. This section elaborates on the methodology that was adopted.

### 3.1. Applications developed for the study

As highlighted earlier, the context of the study was the crowdsourcing of location-based content. Three mobile applications (named Track, Badge and Share) were thus developed for the experimental study. The primary reason for developing our own applications as opposed to using existing ones was to have better control over the look-and-feel of the interfaces. This would not be possible with existing applications as changes to the user interfaces to establish consistency could not be performed.

All three applications had a similar purpose of crowdsourcing location-based content. To maintain consistency, the three applications offered a map interface that indicated locations with content that could be accessed. In Fig. 1, these locations are indicated by a house icon. Fig. 2 shows an example of content contributed by users. Other users are also able to review and/or rate these contributions. Through the map-interface, new content can be created, in which case, a form appears for users to complete.

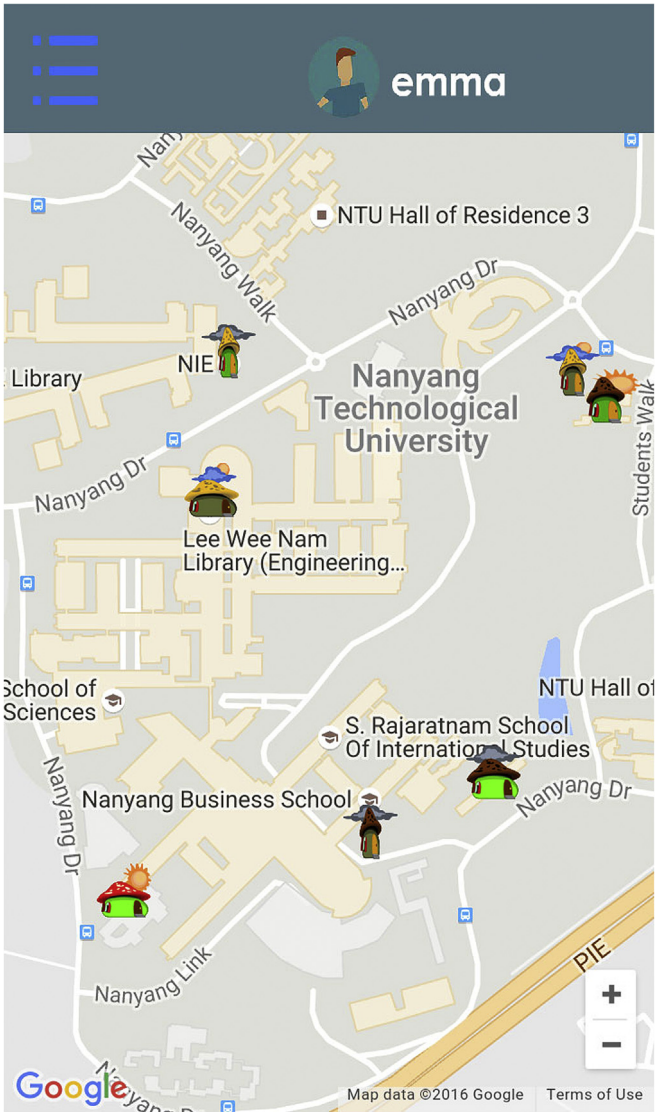


**Fig. 1.** Map-based interface for accessing location-based content.

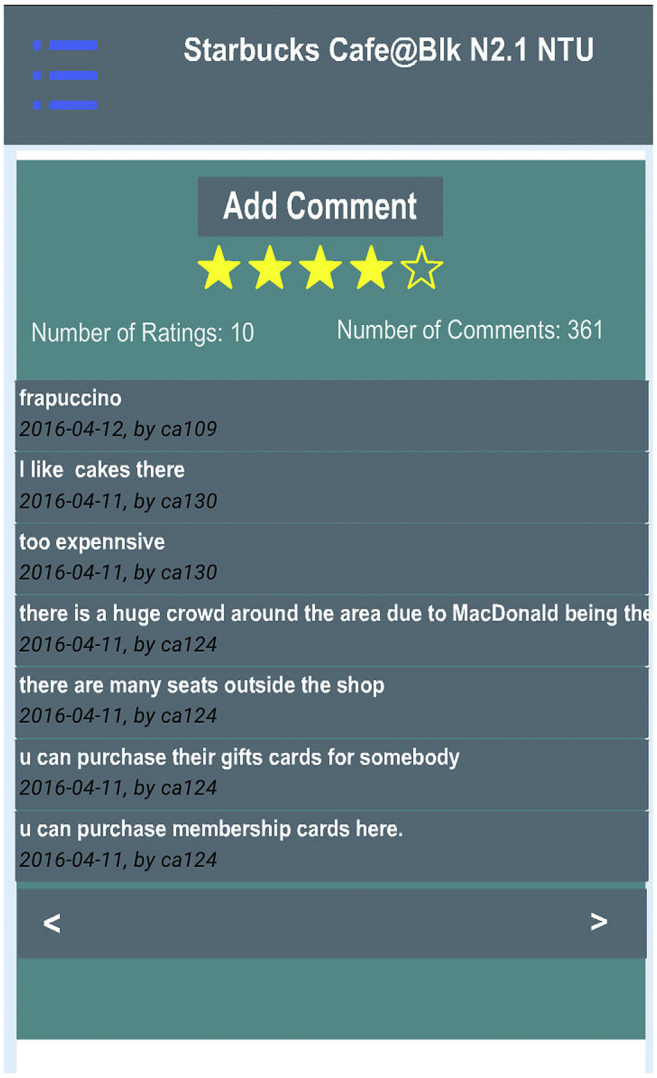


**Fig. 2.** Content contributed by users.

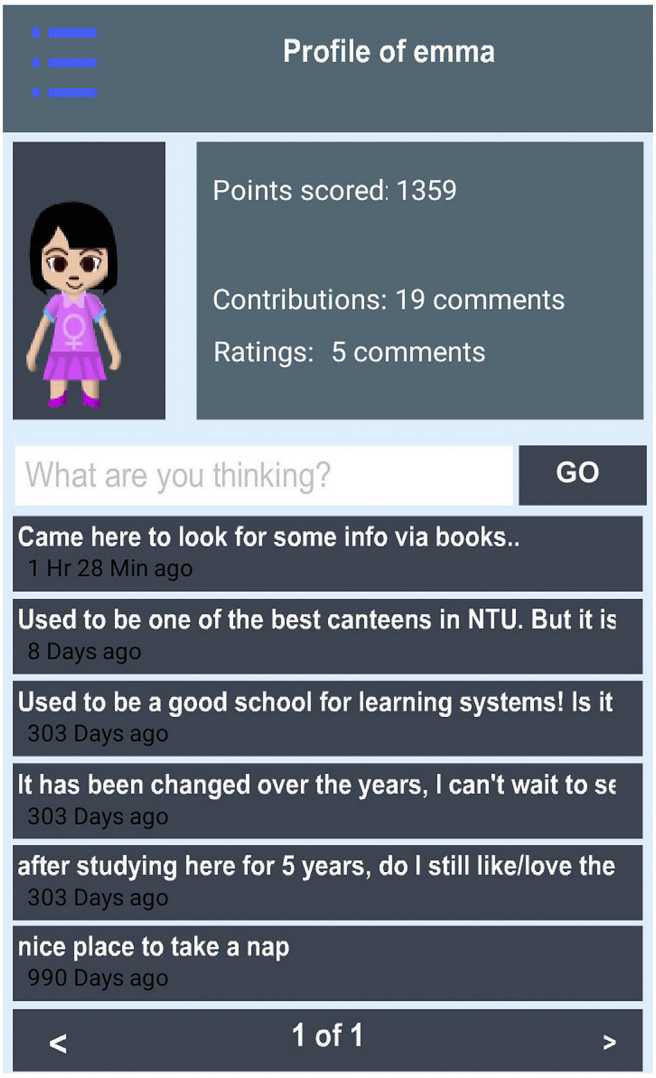


**Fig. 3.** Track's player profile page.

Besides these common features, the Track version was a crowdsourcing game that offered a points-based virtual reward system. Points were awarded based on actions such as contribution of content, responding to existing posts and ratings (see Fig. 3). The goal was to acquire as many points as possible, and this was encouraged via a leaderboard that ranked the top ten players.

Next, the Badge crowdsourcing game encouraged users to contribute location-based content by offering different badges for collection. Each badge was associated with actions concerning creation, responding or rating of location-based content. Badges were displayed on users' publicly accessible profiles, encouraging them to collect as many as possible. Put differently, a user's collection of badges would reflect his/her reputation and status in the game. Fig. 4 shows the badges available for collection, with the ones acquired by a user being highlighted. By selecting a particular badge, all users who had acquired it will also be displayed. It should be highlighted that Track and Badge offered simple gameplay styles for crowdsourcing, with each offering a specific virtual reward. This was a design decision to isolate the effects of virtual reward systems in the present study.

Finally, the Share version was a non-game-based mobile application that served as a control. It did not have any reward system and offered the basic features for contributing and accessing

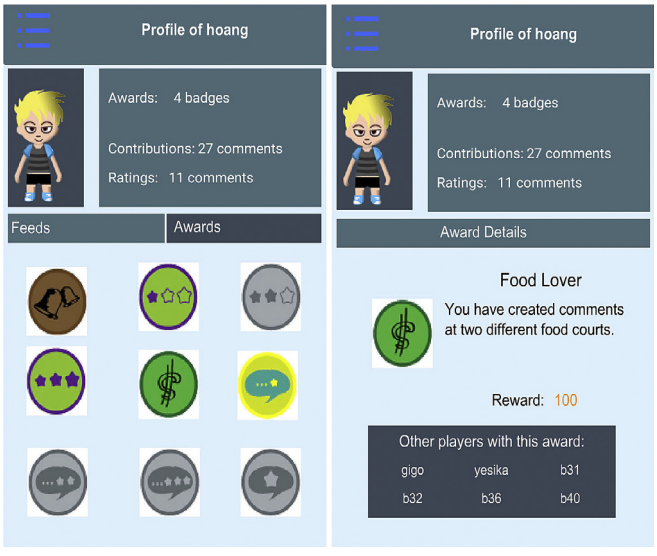


**Fig. 4.** Badge's list of badges.

location-based content described above. A user could access a page in Share that showed his/her number of contributions, comments and ratings performed. This information was made not available to other users.

### 3.2. Participants and procedure

A total of 155 university participants (83 males and 72 females) with an average age of 26.93 were recruited for the present study. Most (64%) had used social network applications and shared information using mobile devices. Among them, 55% of them had a background in computer science, information technology or related disciplines, 33% were from engineering disciplines, while the remainder were from disciplines such as arts, social sciences and business. The majority of participants (67%) were online game players. Although a university-based sample does not reflect the entire population of potential users, it may reasonably represent the population that plays online games. Prior studies have shown that university students can represent an important age demographic of overall online game players and mobile Internet users (Wu & Liu, 2007).

The study was a within-subjects experiment where participants used all three applications (Track, Badge and Share), with Share serving as the control. This experiment was also counterbalanced to reduce carryover effects. Participants were divided into subgroups with each performing a different combination of the applications. Additionally, within each subgroup, participants performed a distractor task before using each new application to diminish recall of the previous application. This involved selecting a suitable category (e.g., food, transportation, and shopping) for each of ten comments given to them.

As the applications were developed for crowdsourcing location-based content, the experiment took place outdoors in a fixed location in the university grounds. Each participant was issued with a 3.7-inch screen Android-based mobile phone preloaded with the three applications. For each application, participants were given a familiarization session in which they used it for practice tasks similar to the actual experiment. Following this, the actual study began and participants performed a series of tasks that involved viewing of content, creation of content, rating existing content and either viewing the leaderboard (for Track), badge list (for Badge) or their personal status (for Share). Upon task completion, participants completed a questionnaire that measured the constructs relevant to the present study, namely, satisfaction of motivational needs, perceived information quality and perceived enjoyment. They then performed the distractor task. These steps were repeated for all three applications. Upon completion of the entire experiment, participants were given a modest monetary incentive in appreciation of their efforts. Due to the limited number of mobile phones available, the experiment was conducted over multiple days, but steps were taken to ensure consistency such as the use of the same researchers, a predefined set of instructions and tasks, and the use of the same environment for conducting the research.

### 3.3. Measures used

All items in the questionnaire were adapted from prior research. Items were framed as statements, and each was measured along a 5-point Likert-type scale, with 1 representing strong disagreement and 5 representing strong agreement. Prior to analyzing the data, principal component factor analysis with varimax rotation was used to test the validity of all the constructs in the study. Items that were highly loaded (0.5 and above) were retained. Reliability analyses were then carried to ensure that items under each construct were interrelated.

First, perceived enjoyment was assessed along three dimensions using the tripartite media enjoyment model proposed by Nabi and Krcmar (2004). Twelve items were utilized and were adapted from prior studies (e.g., Fang & Zhao, 2010). As expected, three factors emerged from the factor analyses performed across participants' responses for the three applications. Good internal reliabilities were found for these factors with Cronbach's alpha values of $0.93_{Track}$, $0.93_{Badge}$, and $0.94_{Share}$ for affective, $0.85_{Track}$, $0.85_{Badge}$, and $0.93_{Share}$ for cognitive, and $0.93_{Track}$, $0.94_{Badge}$, and $0.97_{Share}$ for behavioral enjoyment. These factors are described as follows:

- **Affective**: Measures the extent to which the user perceives emotional experiences during gameplay.
- **Cognitive**: Measures the extent to which the user perceives favorable thoughts and beliefs about crowdsourcing games such as being worthy, effective, and interesting.
- **Behavioral**: Measures the extent to which the user perceives deep involvement in crowdsourcing games.

Next, perceived output quality was operationalized as information quality since this study's applications generate location-based information outputs. This was assessed with twelve items adapted from Lee et al. (2002). Four factors were extracted from the factor analyses performed for the three applications. Again, all factors were found to have good internal reliabilities with Cronbach's alpha values of $0.87_{Track}$, $0.88_{Badge}$, and $0.94_{Share}$ for accuracy, $0.90_{Track}$, $0.89_{Badge}$, and $0.95_{Share}$ for completeness, $0.86_{Track}$, $0.91_{Badge}$, and $0.93_{Share}$ for relevancy, and $0.87_{Track}$, $0.86_{Badge}$, and $0.92_{Share}$ for timeliness.

- **Accuracy**: Assesses the extent to which information generated is correct, reliable, and accurate.
- **Completeness**: Assesses the extent to which information generated contains sufficient details for one's needs.
- **Relevancy**: Assesses the extent to which information generated is appropriate, relevant, and useful.
- **Timeliness**: Assesses the extent to which information generated is current, timely, and up-to-date.

Finally, satisfaction of motivational needs was adapted from the Players Experience Need Satisfaction (Ryan et al., 2006) and Basic Psychological Need Satisfaction (Deci & Ryan, 2000) scales. A total of 12 question items were used to assess perceived motivational needs satisfaction. In line with the SDT, three factors emerged from the factor analyses conducted for the three applications. Good internal reliabilities were again found with Cronbach's alpha values of $0.91_{Track}$, $0.91_{Badge}$, and $0.90_{Share}$ for autonomy, $0.93_{Track}$, $0.92_{Badge}$, and $0.94_{Share}$ for competence, and $0.95_{Track}$, $0.91_{Badge}$, and $0.95_{Share}$ for relatedness. These factors are defined as:

- **Autonomy**: Assesses one's perceived feelings of freedom in their actions and choices offered in the application.
- **Competence**: Assesses one's perceived feelings of effectiveness while dealing with challenges encountered in the application.
- **Relatedness**: Assesses one's perceived feelings of connectedness with others in the application.

## 4. Results

Table 1 shows the means and standard deviations of participants' perceptions of the applications. One-way ANOVAs were performed to compare each variable across the three applications. Post-hoc comparisons using Tukey's test were then conducted with the results summarized in Table 2.

First, all the variables associated with perceived enjoyment

**Table 1**
Means and standard deviations for perceptions of output quality, enjoyment and motivational needs (N = 155).

| Variable | Application type Mean (SD) | | |
|---|---|---|---|
| | Track | Badge | Share |
| **Enjoyment** | | | |
| Affective[a] | 3.06 (0.78) | 3.19 (0.79) | 2.85 (0.73) |
| Cognitive[a] | 3.22 (0.80) | 3.45 (0.86) | 2.99 (0.72) |
| Behavioral[a] | 3.17 (0.71) | 3.38 (0.72) | 2.81 (0.76) |
| **Output quality** | | | |
| Accuracy[a] | 3.22 (0.69) | 3.17 (0.67) | 2.91 (0.75) |
| Completeness[a] | 3.13 (0.72) | 3.17 (0.72) | 2.91 (0.79) |
| Relevancy[a] | 3.19 (0.75) | 3.29 (0.76) | 2.98 (0.76) |
| Timeliness[a] | 3.26 (0.69) | 3.26 (0.65) | 2.97 (0.69) |
| **Motivational needs** | | | |
| Autonomy[a] | 3.06 (0.58) | 3.25 (0.60) | 3.03 (0.55) |
| Competence[a] | 3.34 (0.79) | 3.55 (0.71) | 3.10 (0.78) |
| Relatedness | 3.20 (0.75) | 3.27 (0.73) | 3.10 (0.77) |

[a] Statistically significant differences found between the three applications.

**Table 2**
ANOVA results (N = 155).

| Variable | App 1 | App 2 | Difference | F-value |
|---|---|---|---|---|
| Affective | Track | Share | 0.22* | F(2,462) = 7.87, p < 0.01 |
| | Badge | Share | 0.34** | |
| | Track | Badge | −0.12 | |
| Cognitive | Track | Share | 0.24* | F(2,462) = 13.53, p < 0.01 |
| | Badge | Share | 0.47** | |
| | Track | Badge | −0.24* | |
| Behavioral | Track | Share | 0.36** | F(2,462) = 24.50, p < 0.01 |
| | Badge | Share | 0.57** | |
| | Track | Badge | −0.21* | |
| Accuracy | Track | Share | 0.31** | F(2,462) = 8.57, p < 0.01 |
| | Badge | Share | 0.26 | |
| | Track | Badge | 0.04 | |
| Completeness | Track | Share | 0.22* | F(2,462) = 8.42, p < 0.01 |
| | Badge | Share | 0.26** | |
| | Track | Badge | −0.04 | |
| Relevancy | Track | Share | 0.21* | F(2,462) = 6.91, p < 0.01 |
| | Badge | Share | 0.31** | |
| | Track | Badge | −0.10 | |
| Timeliness | Track | Share | 0.29** | F(2,462) = 9.14, p < 0.01 |
| | Badge | Share | 0.28** | |
| | Track | Badge | 0.002 | |
| Autonomy | Track | Share | 0.03 | F(2,462) = 6.79, p < 0.01 |
| | Badge | Share | 0.22** | |
| | Track | Badge | −0.19** | |
| Competence | Track | Share | 0.24** | F(2,462) = 13.69, p < 0.01 |
| | Badge | Share | 0.45** | |
| | Track | Badge | −0.21* | |
| Relatedness | Track | Share | 0.10 | F(2,462) = 2.05, p = 0.13 |
| | Badge | Share | 0.17 | |
| | Track | Badge | −0.07 | |

Statistically significant differences between the three applications at **p < 0.01, *p < 0.05.

showed significant differences across applications:

- **Affective enjoyment**: The differences between applications were statistically significant [F(2,462) = 7.87, p < 0.01]. Participants perceived the Track and Badge applications to provide higher levels of affective enjoyment than Share, while Badge was rated higher than Track. Thus, Badge, Track and Share were ranked in this order in terms of perceptions of affective enjoyment.
- **Cognitive enjoyment**: A similar pattern of findings was found for perceived cognitive enjoyment [F(2,462) = 13.53, p < 0.01]. All applications were significantly different from each other with Badge ranked highest, followed by Track and Share.
- **Behavioral enjoyment**: Likewise, all applications differed significantly from each other in terms of perceived behavioral enjoyment [F(2,462) = 24.50, p < 0.01]. Again, Badge was ranked highest, with Track and Share being second and last, respectively.

In terms of perceived output accuracy, significant differences across applications were also found:

- **Accuracy**: Differences in perceptions of accuracy were found to be statistically significant [F(2,462) = 8.57, p < 0.01]. Post-hoc tests indicated that participants perceived Track as providing more accurate information than Share. Differences in perceptions between Track and Badge, as well as Badge and Share were non-significant.
- **Completeness**: Participants using both Track and Badge were separately perceived to offer more complete information than Share [F(2,462) = 8.42, p < 0.01]. However, there were no significant differences between Track and Badge.
- **Relevancy**: The pattern of findings similar to completeness was found [F2,462) = 6.91, p < 0.01]. Track and Badge differed significantly when compared to Share, but were not significantly different from each other.
- **Timeliness**: Similarly, Track and Badge were perceived to offer more timely information than Share [F2,462) = 9.14, p < 0.01] but the differences were non-significant when the former two were compared.

Finally, the motivational needs for autonomy and competence were significantly different across applications, but the relatedness need was non-significant:

- **Autonomy**: Participants perceived that Badge satisfied the autonomy need better than Share and Track [F(2,462) = 6.79, p < 0.01]. However, there were no differences between Track and Share.
- **Competence**: Participants perceived Track and Badge as satisfying the competence need better than Share, while at the same time, Badge was better than Track at doing so [F(2,462) = 13.69, p < 0.01]. Stated differently, Badge, Track and Share were ranked in this order in terms of satisfying the competence need.

## 5. Discussion

This research advances the literature on virtual reward systems in crowdsourcing games by investigating their influence on perceptions of enjoyment, output quality and motivational needs satisfaction. The results suggest that virtual reward systems enhance enjoyment emotionally, cognitively and behaviorally. They also increase perceptions of the quality of outputs when compared to applications with no reward systems. As well, they satisfy the motivational needs for autonomy and competence.

### 5.1. Enjoyment

Unsurprisingly, participants in the study derived greater enjoyment from the applications that used either virtual reward system (Track and Badge) as opposed to the one without (Share). This is in agreement with related research (Farzan et al., 2008) demonstrating that reward systems result in enjoyment during gameplay. This bodes well for crowdsourcing games in that they have the potential to serve as motivators for harnessing human

intelligence over non-game-based approaches.

Taking a more nuanced perspective, virtual reward systems enhance affective enjoyment as the actual and/or anticipated rewards received evokes emotions (Lee & Doh, 2012) such as happiness, pleasure, excitement, frustration, to name a few. These emotions in turn translate into greater investment in terms of time and effort, and hence enjoyment. Reward systems also result in greater levels of cognitive enjoyment likely because players have to be more mentally involved. That is, a player not only has to perform crowdsourcing tasks, but also develop strategies to attain the various rewards offered (Antin & Churchill, 2011). As well, virtual reward systems enhance behavioral enjoyment when compared to non-rewards-based applications. This is expected since these incentives would motivate players into deeper gameplay, resulting in greater immersion (Sweetser & Wyeth, 2005) as they become more engaged in the quest to acquire more points or badges. Interestingly, the results show that between the two reward systems, participants using Badge derived more cognitive and behavioral enjoyment than Track. One possible explanation is that acquiring badges require more strategizing because of the mental effort involved. In particular, players have to select the badge(s) they desire and then perform the corresponding crowdsourcing tasks in a manner to achieve their aims, resulting in more cognitive enjoyment. In doing so, these tasks potentially translate into more involvement in the game than simply collecting points, resulting in higher behavioral enjoyment.

### 5.2. Output quality

In terms of output quality, virtual reward systems appear to have a positive influence as well. Track (which offered points) outperformed Share on accuracy, completeness, relevancy and timeliness, while Badge (which offered badges) outperformed Share on the latter three attributes. Both virtual reward systems were rated similarly by participants, suggesting that points and badges are comparable in terms of influencing perceptions of output quality.

Put differently, the results indicate that the use of reward mechanisms conveyed the impression that the quality of outputs generated was better than applications that did not provide incentives. One possible explanation may be found in what is termed as the "effort heuristic" (Kruger, Wirtz, Van Boven, & Altermatt, 2004), which essentially says that effort is used as an indication for quality. In Track, participants had to compete with other players for points while executing their crowdsourcing task of content generation. In Badge, participants had to determine their desired badges and then perform the corresponding crowdsourcing tasks to acquire them. Given the additional activities executed beyond creating content, participants perhaps felt that this extra effort expended translated into higher quality outputs. In contrast, the Share application provided only statistics on the number of contributions made by a participant, and the lack of rewards and/or the simpler approach to crowdsourcing could have led to a perceived lack of quality in the outputs generated.

These findings are noteworthy because they depart from prior work showing that game-based approaches to crowdsourcing and human computation resulted in poorer perceived and actual quality (Goh et al., 2011; Pe-Than, Goh, & Lee, 2015). Further analysis suggests that the differences in results could be due to the design of the underlying games. In the present study, Track and Badge offer simple gameplay styles which are single-user in nature and rewards are directly tied to the outputs generated whereas the games in prior work were more complex, requiring multiple collaborating or competing players. There is thus a possible fine line that needs to be treaded wherein a crowdsourcing game needs to incorporate enough engaging elements so as to attract usage and foster enjoyment, but it cannot be too complex so as to distract users from the crowdsourcing task. This calls for more research to investigate game design elements that facilitate and impede players' perceptions.

### 5.3. Motivational needs satisfaction

Further, the results suggest that virtual reward systems perform better in terms of motivational needs satisfaction, although this is not as straightforward as the other constructs in the present study. Badge was able to satisfy the needs for autonomy and competence better than Track and Share, while Track only satisfied the competence need better than Share. None of the applications could meet the relatedness need.

A possible reason for Badge's better performance in autonomy is the nature of badge collecting (Lewis et al., 2013). As mentioned, participants could decide for themselves what badges they desired, and then work on their acquisition. In other words, although the underlying crowdsourcing tasks were similar across all three applications, Badge gave participants more freedom or methods to execute this task through the requirements set by the different badges. It is this flexibility that appealed to participants. In contrast, both Track and Share did not offer differential pathways to task completion. Interestingly, even though Track offered points, participants did not perceive this to be enough to offer a better sense of autonomy over Share because there was still only one way to perform the crowdsourcing tasks. Hence, it may be argued that virtual reward systems alone are not sufficient for affording autonomy in crowdsourcing games, and careful task design is still required (Doan et al., 2011).

Nevertheless, the virtual reward systems in this study were able to satisfy the need for competence. This is expected since both badges and points provide feedback, status and progress (Zuckerman & Gal-Oz, 2014), and participants were thus able to ascertain their performance better than Share, fostering the feelings of achievement and competence. While Share offered usage statistics as a form of performance feedback, this feature appeared to be inadequate to support the need for competence. Further, Badge was rated better than Track, which again points to the richness of the badge reward system in gameplay. Specifically, badges are used to represent various achievements, and their successful acquisition signifies a participant's competence in multiple aspects of a game. Points also indicate competence but only in a single dimension. In the case of Track, points represented an aggregated reward for all crowdsourcing tasks completed with no breakdowns for individual tasks available. Hence, this likely lowered participants' sense of competence in comparison with Badge.

## 6. Conclusion

### 6.1. Implications

The present study was motivated by the relative lack of work done in examining the effects of virtual reward systems for crowdsourcing, and provides several implications for research and practice. First, the study examined enjoyment derived from virtual reward systems in crowdsourcing tasks from a multidimensional perspective and importantly showed differences in two dimensions between points and badges. This demonstrates that enjoyment should not be conceptualized as a single construct as doing so would compromise understanding of this phenomenon. In addition, results showed that badges appear to induce a greater sense of cognitive and behavioral enjoyment, which helps shed light on the utility of different virtual reward systems.

Second, the findings indicate that the layering of virtual reward systems upon crowdsourcing tasks enhances perceptions of output quality. When considered with prior work, applications incorporating points and badges do not distract players from their crowdsourcing tasks if the overall game design is not overly complex. The challenge is to find the right balance between game and task design. Third, understanding the role played by needs satisfaction in virtual reward systems helps researchers explain the motivational process underlying players' engagement in crowdsourcing games. Given the results, badges lead to higher needs satisfaction, followed by points. As well, this work highlights the importance of considering motivational differences in the context of crowdsourcing games.

Finally, the findings of this study have implications for designing crowdsourcing games and similar applications. One, because badges play an important role in influencing players' perceptions as suggested by the results, it is important to offer a variety of types to attract and sustain usage. Multiple options are available here. These could include badges for different types of tasks, badges that increase in acquisition difficulty, those that are obtained by meeting fixed criteria, as well as those that are awarded through competition with others. Two, points also have an important role to play in crowdsourcing games but rather than offering a single, aggregated score for task completion, developers may consider incorporating different sets of points for activity types. This finer-grained approach to scoring may enhance players' perceptions of enjoyment and motivational needs satisfaction. Finally, developers should consider incorporating elements of virtual reward systems to attract users and sustain usage even if their intention is not to develop complete games. Thus for example, simply awarding points for contributions made, awarding badges for various tasks completed, and allowing these achievements to be shared within the community may be sufficient enough to engage users.

It should however be noted that while the scope of this study focuses on virtual rewards, recent research has suggested that punishment features in games, such as losing a life or restarting a level, may also intensify the flow state of players (Laffan, Greaney, Barton, & Kaye, 2016). This is because punishment may make an in-game task appear more difficult, and hence more challenging, inducing flow (Csikszentmihalyi, 1990). Thus, punishment features likely have an influence on intrinsic motivation, perceived enjoyment and output quality in crowdsourcing games. These features could interact with the available virtual rewards in interesting ways, representing a rich avenue for further investigation.

### 6.2. Limitations and future work

Although this study has yielded useful insights, there are several limitations which may be addressed in future work. First, data was collected from one crowdsourcing domain in location-based content sharing. It is uncertain whether the results will generalize to other crowdsourcing contexts. Second, as noted above, this study employed basic gameplay styles for content creation. It is possible that other game genres, each of which presents specific gameplay styles comprising unique game elements, may influence perceptions of the virtual reward systems differently. For better generalizability, it would be instructive to carry out investigations in different crowdsourcing domains using different game genres. This includes comparing the games developed in this research against existing/commercially available ones.

Third, the present study was framed using the SDT where intrinsic motivation accounts for gameplay behavior. There could be other factors beyond the scope of the SDT that warrant further investigation. Next, participants were university students who were technologically-inclined and open to playing games. Replicating this study with more diverse participant profiles such as different age groups and occupational backgrounds will help ascertain the stability of the results. The experiment also used a counterbalanced within-subjects design but carryover effects may still exist. An alternative between-subjects experimental design may be considered in future work. Finally, this study employed a cross-sectional data collection method, and players' perceptions were elicited based on fixed scenarios of use. Conducting a longitudinal study as well as observing players' behaviors in an actual context of use would be helpful in validating this study's results.

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