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Why do people play human computation games? Effects of perceived enjoyment and perceived output quality

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Abstract

Purpose – The purpose of this paper is to investigate the effects of individuals' perceived enjoyment and output quality on their intention to play human computation games (HCGs) for location-based content sharing.

Design/methodology/approach – This study employed a cross-sectional survey method, and recruited 205 undergraduate and graduate students from a local university. Participants played the developed mobile HCG for content sharing named Seek, PLAy, SHare (SPLASH), and thereafter completed a questionnaire that measured their perceptions of enjoyment, output quality, and intention to play.

Findings – Results indicated that individuals derived enjoyment from the affective and cognitive dimensions, which further influenced their intention to play HCGs. Moreover, perceived output relevancy was significant in predicting individuals' intention to play HCGs such as SPLASH.

Practical implications – The design of HCG is complicated due to their entertainment-output generation duality. Understanding what factors contribute to HCG usage is therefore, an essential area of study. Based on the study's findings, designers should pay attention to HCG features that engender affective and cognitive experiences, and appropriately signify the relevancy aspect of HCG outputs.

Originality/value – Although similar in many ways, HCGs differ from entertainment-oriented games by generating output as byproducts of gameplay. Hence, results obtained from prior research in games may not be readily applicable to the HCG context, and further investigations are necessary. Moreover, the multidimensional aspect of HCG enjoyment and output quality, and how these dimensions influence usage intention has yet to be examined. The outcomes of this study can be exploited to drive further research in the field of HCGs, and similar games that are not just for pure entertainment.

Keywords Perceived enjoyment, Human computation games, Intention to play,
Mobile information sharing, Perceived output quality

Paper type Research paper

1. Introduction

Due to the growing popularity of social computing, understanding individuals' attitudes toward applications that leverage the activities of online users is an important issue in information systems literature. Through these applications, users are now generating a wealth of informational output as a byproduct of everyday activities on the web. One such application is the human computation system (HCS), exemplified by reCAPTCHA (Law and von Ahn, 2011). Typically, HCSs involve humans performing some form of computation to yield output that could be subsequently used to solve problems that neither humans nor computers can accomplish alone (Ipeirotis and Paritosh, 2011). One such problem can be found in the area of image labeling, which requires numerous well-annotated images for efficient retrieval. This could be achieved through crowd-driven image-labeling applications in which users perform the computation

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of image tagging, consequently generating tags for the images required to improve image searching on the web. Typically, HCSs employ paid human experts or volunteers to generate labels or annotations for images. However, hiring such experts is costly and volunteerism is dependent on individuals' willingness to devote their time and effort to such a project (Yuen *et al.*, 2009). Therefore, research is required to investigate how effective motivational strategies can be incorporated into HCSs in order to attract a large user base (Goh *et al.*, 2011a).

Recently, games have been used as a means of motivating users to partake in human computation. According to the latest statistics, computer and video games are played by 59 percent of Americans (Entertainment Software Association, 2014), and there are more than 200 million online game players worldwide (Casual Games Association, 2007). These statistics suggest that games can attract the attention of a vast number of people around the world and that gaming has possibly reached a critical mass of users. Therefore, utilizing games could be a promising strategy to attract individuals to participate in human computation. In particular, human computation games (HCGs) are those that harness human intelligence to tackle computational problems, which computers cannot yet perform effectively, and that provide enjoyment in return for output creation (von Ahn and Dabbish, 2008).

In essence, HCGs are built upon individuals' desire to be entertained while generating useful computations as byproducts of gameplay (von Ahn and Dabbish, 2004). As such, enjoyment and output creation are considered to be key factors in determining the success of HCGs. Due to this entertainment-output generation duality (Goh and Lee, 2011) and the reliance on voluntary effort of online users, HCGs have also been termed "games with a purpose" (von Ahn and Dabbish, 2008), "computainment" (Goh *et al.*, 2011a), and "crowdsourcing games" (Doan *et al.*, 2011). More recently, the use of game elements has become prevalent in non-gaming contexts to increase user participation, and this phenomenon is termed "gamification" (Deterding *et al.*, 2011; Koivisto and Hamari, 2014). In this regard, HCGs can be considered as a type of gamified application.

The ESP game (von Ahn and Dabbish, 2004) is one of the earliest HCGs, in which pairs of players are engaged to tag images independently, and are rewarded for their matching tags. The game produces tags for images as outputs that could be used in indexing the images to facilitate future retrieval. Similar types of HCGs are used in various computational problem spaces including, but not limited to, music annotation, language translation, ontology construction, and protein folding problem (e.g. Cooper *et al.*, 2010; Law and von Ahn, 2011). Although seemingly simple in design, these types of HCGs are able to yield large amounts of output, and maintain a reasonable level of replayability (Goh and Lee, 2011).

Due to their mobility and accessibility, the use of mobile devices has become pervasive which, in turn, opens an opportunity for garnering georeferenced content through HCG play. Correspondingly, HCGs have emerged in the mobile content-sharing context. These HCGs yield not only textual but also media content about physical locations. One example is the Gopher game (Casey *et al.*, 2007) in which users pick up the game agents, called gophers, and complete their specified missions by contributing photos and text descriptions about locations. Indagator (Lee *et al.*, 2010) is another example that entices users to create and rate location-based content by rewarding game points for their actions.

As HCGs blend gaming with output creation, they will likely fulfill both entertainment and utilitarian needs, which, in turn, makes these games different from purely hedonic- or utilitarian-oriented systems. In particular, HCGs provide the opportunity for players to learn new things from the generated output (Law and von Ahn, 2011). For instance, in

location-based content-sharing HCGs, players can utilize the content created by others to better understand real-world locations. In this regard, HCGs seem to be able to facilitate information discovery. Importantly, these games serve as a new outlet for user-generated content creation, sharing, and consumption (Nov, 2007). Despite having an ability to meet individuals' need for entertainment and information, a major question arises about whether they are willing to play HCGs and what factors determine their usage intention.

In fact, understanding behavioral intention is an important first step for researchers in their quest to motivate individuals to continue using an application, and to develop loyalty (Wu and Liu, 2007). Accordingly, a number of studies in the contexts of hedonic- and utilitarian-oriented systems have examined factors that influence individuals' usage intention. In the former context, prior studies regard enjoyment as a critical factor that could sustain users' engagement in entertainment media including games for pure entertainment (Wang and Wang, 2008; Wu *et al.*, 2010). However, in applications that offer utilitarian benefits, output quality seems to be an important factor that determines users' acceptance (Ahn *et al.*, 2007; Kim and Han, 2009). More importantly, output quality has been an issue for applications that yield user-generated content (Kim and Han, 2011). The importance of this concern has been underlined by recent studies (e.g. Tsai and Men, 2013) suggesting that perceived output quality influences individuals' behavior and attitudes toward online information-related services such as social media- and community-based knowledge sharing.

Although work in the broader contexts such as hedonic- and user-generated content suggests that usage intention could be influenced by enjoyment and output quality, there is a dearth of research on how enjoyment and output quality affect players' behavioral intentions in the HCG and other similar contexts. In particular, prior research on crowdsourcing and gamification has focussed on motivational factors and demographic differences such as age and gender (e.g. Raddick *et al.*, 2010; Chris Zhao and Zhu, 2014; Koivisto and Hamari, 2014), as well as the efficiency of such approaches in other non-gaming contexts such as exercise and e-learning (e.g. De-Marcos *et al.*, 2014). However, very few studies about HCG players' behavior have been conducted (e.g. Lee *et al.*, 2010; Goh *et al.*, 2011a), and none have examined the effects of perceived enjoyment and output quality in depth.

In particular, the gaps that warrant the present study are twofold. One, previous studies treated enjoyment and output quality as unidimensional although there are studies suggesting that such constructs are multifaceted (e.g. Fang and Zhao, 2010; Mekler *et al.*, 2014). Treating such constructs as unidimensional may overlook the importance of specific facets that are only related to the phenomenon of interest (Whitley and Kite, 2012). Two, the entertainment-output generation duality of HCGs (Goh *et al.*, 2011a) implies that HCG play is largely centered on a specified computational task and tightly aligned to it. Stated differently, HCGs aim to yield useful output by injecting fun into the computational task whereas games for pure entertainment primarily aim to maximize players' enjoyment by uniformly adjusting the difficulty level of the game task that is supposed to be fun by itself (Bostan and Öğüt, 2009; Koivisto and Hamari, 2014). Hence, the uniqueness of HCGs makes them a genre of their own (Krause *et al.*, 2010) which could be perceived differently from entertainment-oriented games. Therefore, findings from research which focusses only on either hedonic applications or those with user-generated content may not be readily applicable to the HCG context.

Therefore, the present study conducts a detailed investigation into the influences of perceived enjoyment and output quality on intention to play HCGs, using Seek, PLAy, Share (SPLASH), our developed mobile HCG for sharing location-based content, which

is described in detail in Section 3. Findings from the study will help to provide a better understanding of why people play HCGs or similar games that are not just for pure entertainment. Based on these findings, HCG design decisions can be made with the aim of improving players' experience during gameplay.

2. Conceptual background

In examining individuals' intention to play, the current study concentrates on two focal concepts of HCGs, namely, perceived enjoyment and perceived output quality. These constructs are drawn from previous research on acceptance and adoption of hedonic, task-oriented, and user-generated content applications, and are summarized as follows.

2.1 Perceived enjoyment and intention to play

Enjoyment seems to be a common construct that is used to evaluate individuals' hedonic experiences. However, the precise meaning of enjoyment has yet to be defined. Most of the studies in the information systems and human computer interaction literature have treated enjoyment as the extent to which performing an activity is perceived to be enjoyable in its own right, aside from performance consequences (Davis *et al.*, 1992; Wu and Liu, 2007). Stated differently, enjoyment is considered to be a single dimensional construct, and evaluated as a form of fun, pleasure, or excitement derived from performing an activity (e.g. Wu and Liu, 2007; Wu *et al.*, 2010). In line with this notion and the fact that games are a playful or hedonic activity, the majority of prior studies regard enjoyment as positive affective responses or emotions that can be designated by the feeling of satisfaction, contentment, empowerment, or other similar emotions (Fulton, 2009; Lin *et al.*, 2009).

Although affective enjoyment is the most widely used dimension in purely hedonic- and task-oriented contexts, there is increasing support for the notion that enjoyment is not a monolithic process but rather a complex construct comprising multiple factors (Vorderer *et al.*, 2004). In particular, some studies suggest that enjoyment is also attributable to the favorable thoughts derived from cognitive media appraisals, as well as spontaneous and timeless behavior evoked by the media (Weibel and Wissmath, 2011; Mekler *et al.*, 2014). Acknowledging these differences, Nabi and Krcmar (2004) advocate that enjoyment is an attitude that consists of three dimensions, namely, affective, cognitive, and behavioral enjoyment.

First, the affective dimension focusses on individuals' affective or emotional experiences in response to the media at hand, and it has been the most widely used construct to assess media enjoyment. Next, the cognitive dimension centers on individuals' experiences gained through evaluative judgments in response to media content. The rationale here is that enjoyment could also result from cognitive appraisals of media technology and its content, beyond merely affective responses (Reychav and Wu, 2015). Finally, the behavioral dimension focusses on individuals' behavior during media consumption. One such behavior is the effortless actions that result when individuals have become less aware of their surroundings and less self-aware due to their engrossment in the media and its content, which in turn gives rise to behavioral enjoyment (Jennett *et al.*, 2008; Weibel and Wissmath, 2011). In this regard, behavioral enjoyment resembles the experience of flow denoted by Csikszentmihalyi (1988); however, flow can be a more complex construct comprising other cognitive factors such as curiosity, and it can serve as a more intense form of enjoyment (Sweetser and Wyeth, 2005).

Due to the entertainment-output generation duality of HCGs (Goh *et al.*, 2011a), it is very likely that not only affect, but also cognition and behavior may be the driving forces behind enjoyment of such games. In particular, HCGs allow players to perform computations and deal with those generated by other players. Hence, in all likelihood, players would benefit from playing a HCG as a form of fulfilling personal goals and such situations may evoke positive thoughts and attitudes toward the game, thereby leading to cognitive enjoyment. Furthermore, as in other entertainment-oriented games, players may become engrossed in HCG play when such games allow them to concentrate on output creation while being entertained. This may in turn, drive their behavioral enjoyment. Taken together, this study argues that the experience of HCG enjoyment is a multifaceted phenomenon that needs to be assessed with multiple dimensions so as to better evaluate its consequences (Pe-Than *et al.*, 2012).

In addition, prior research drawing on intrinsic motivation suggests that enjoyment could evoke individuals' behavioral intention through their desire to engage in intrinsically motivating activities for the sake of pleasure and fun derived from performing them (Ryan and Deci, 2000; Wu and Liu, 2007). Indeed, prior research has supported the relationship between perceived enjoyment and individuals' intention to use a technology in both task- and entertainment-oriented contexts (e.g. Agarwal and Karahanna, 2000; Koufaris, 2002; van der Heijden, 2004; Wu and Liu, 2007; Magni *et al.*, 2010). For instance, Koufaris (2002) reported that users who perceive online shopping as enjoyable are more likely to intend to continue doing it. Similarly, Wu and Liu (2007) asserted that when individuals' gameplay behavior is prompted by their enjoyment, they are more willing to continue playing it. Here, as entertainment intertwines with task-related activity in HCGs, players' perceived affective, cognitive, and behavioral enjoyment might also be significant in determining their intention to play such games. Hence, the following research hypotheses are proposed:

H1a. Perceived affective enjoyment is positively related to intention to play HCGs.

H1b. Perceived cognitive enjoyment is positively related to intention to play HCGs.

H1c. Perceived behavioral enjoyment is positively related to intention to play HCGs.

2.2 Perceived output quality and intention to play

Perceived output quality can be regarded as "a judgment made by observing intermediate or end products of using the system" (Davis *et al.*, 1992). Output quality is considered as an important factor determining the success of information-oriented systems (e.g. Ahn *et al.*, 2007; Ho *et al.*, 2012), and hence HCGs that generate informational outputs as byproducts of gameplay are no exception. Numerous studies in the context of information sciences and systems have provided evidence that output quality is multidimensional, and therefore suggested that the importance of quality dimensions is context dependent (e.g. Wang and Strong, 1996; Lee *et al.*, 2002).

By examining different output quality frameworks, Alkhattabi *et al.* (2010) regarded accuracy, completeness, relevancy, and timeliness as the most recognized and important quality dimensions in the online context. Similarly, Rieh (2002) found that users paid a great deal of attention to accuracy, relevancy, and timeliness quality aspects while assessing online content. In the context of user-generated content, it was found that individuals were more concerned about the accuracy, completeness, and relevancy of such content (Kim and Oh, 2009; Schaal *et al.*, 2012). Taken together, these studies underline the importance of accuracy, completeness, relevancy, and timeliness in online

applications that support user-generated content. Since HCGs are a type of online application whose outputs are generated by players, this study contends that the quality dimensions important for online user-generated content may also be relevant to the HCG context.

Prior research has supported a link between users' perceived output quality of online content and their behavioral intention (e.g. Ahn *et al.*, 2007; Fichman, 2011; Kim and Han, 2011). For instance, Ahn *et al.* (2007) found that users who perceived a higher quality of content provided by online shopping applications were more likely to continue using them. In addition, perceived relevancy and timeliness were found to influence individuals' satisfaction with search output (Lee *et al.*, 2009). Logically, when individuals are satisfied with the output offered by an application, they are more likely to continue using it. In the context of mobile applications, Kim and Han (2011) found that highly accurate, complete, and current mobile content promoted users' perceived utilitarian value, which, in turn, determined their intention to use such applications.

Playing HCGs provides an opportunity for players to not only generate output but also consume it, as found by Lee *et al.* (2010) in their study that identified output discovery as a gratifying factor of HCG play. Furthermore, as players' success in HCGs is highly dependent on how effective they are at generating computational output, they are likely to be concerned about the quality of output that they produce through gameplay. Therefore, this study argues that players' perceived output quality might have an influence on their intention to play. Hence, the following research hypotheses are proposed:

H2a. Perceived output accuracy is positively related to intention to play HCGs.

H2b. Perceived output completeness is positively related to intention to play HCGs.

H2c. Perceived output relevancy is positively related to intention to play HCGs.

H2d. Perceived output timeliness is positively related to intention to play HCGs.

3. SPLASH: a mobile HCG for sharing location-based content

For the purpose of this research, we employed SPLASH, an Android-based multiplayer mobile HCG designed to facilitate creating, sharing, and accessing location-based content through gaming features. Recent statistics have revealed that Facebook has 1.9 billion active mobile users as of January, 2015, a 28 percent year-on-year increase (Noyes, 2015). Thus, studying mobile HCGs is useful and appropriate due to the increasing number of mobile users and their role in information sharing.

SPLASH's content is known as "comments," comprising titles, tags, descriptions, media (e.g. photos), and ratings (Figure 1). Players can contribute comments about arbitrary geographic areas that are termed as "places" in SPLASH. Places can be further divided into "units" which hold associated comments. For instance, if a school is a place, a library inside the school will be considered to be a unit that contains comments.

SPLASH adopts a pet-based game genre in which players "feed" location-based content to virtual pets. Pets represent units and they live in "mushroom houses" that in turn represent places. The pet's appearance is influenced by four different attributes of content. Specifically, a pet's size relates to the amount of content fed, while the ratings affect its color. Next, new content would make a pet look younger while older content would cause pets to age. Finally, pets fed with content that is generally positive in

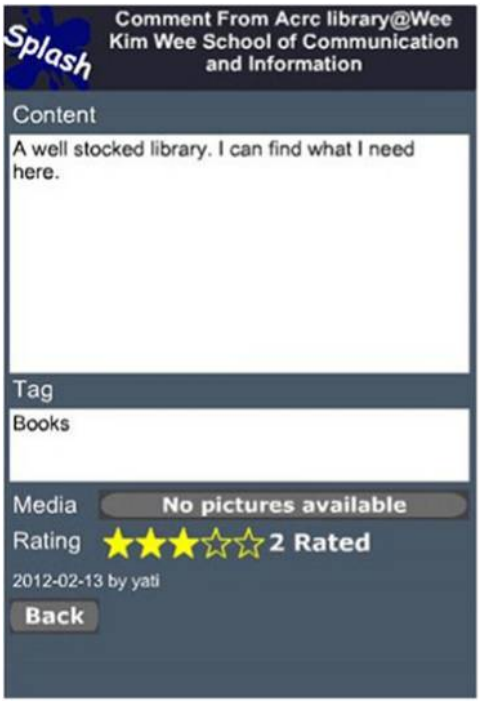

Figure 1.
A comment

sentiment are happier, while those fed with content that is negative will appear sadder. Figures 2 and 3 illustrate the visualization of a pet in SPLASH as well as its different appearances.

The mushroom houses are visualized on a map interface for navigation and access to the respective content (Figure 4). Similar to the pets, the mushroom houses change in appearance according to the amount (size), quality (wall color), recency (roof color), and sentiment (weather) of the content (Figure 5). The visualization of a pet is based on the values of the content attributes belonging to this particular pet, while that of a mushroom house is based on the overall values of the content attributes belonging to all the pets inside the house.

To foster socializing, players may visit each pet's apartments (virtual rooms) within the mushroom houses. These rooms are extensions of physical spaces (Figure 6) and players can decorate them with items purchased from a virtual game store, including mini-games for pure entertainment, and mini-HCGs. There is also a comment board enabling players to contribute comments while socializing. Finally, each player has his/her own customizable avatar that appears in the virtual room.

SPLASH's reward system includes in-game currency called gold, leaderboards, and awards. Players can earn gold by viewing, creating, and rating comments, as well as by playing mini-games inside the virtual rooms. Awards are won by completing specified missions (e.g. creating a certain number of comments). Leaderboards show the game's top players such as those with the most gold or those contributing the most comments.

There were a number of reasons for using SPLASH in this study, as opposed to using other information-sharing HCGs currently available. First, SPLASH was chosen

Figure 2.
Virtual pet

Figure 3.
Appearances of a pet

for its notable design features, as described above, and it has been relatively well received by users in prior work (Goh *et al.*, 2011b). Next, with our developed game, we had better control over its look and feel to ensure a more consistent user experience during the study. Finally, by using SPLASH, the content created by users could be easily accessed for further analysis.

4. Method

4.1 Participants

Participants were 205 undergraduate and graduate students recruited from a large public university in Singapore. There were 119 females and 86 males, with ages ranging from 19 to 41, and an average age of 26.4 years. In total, 49 percent of

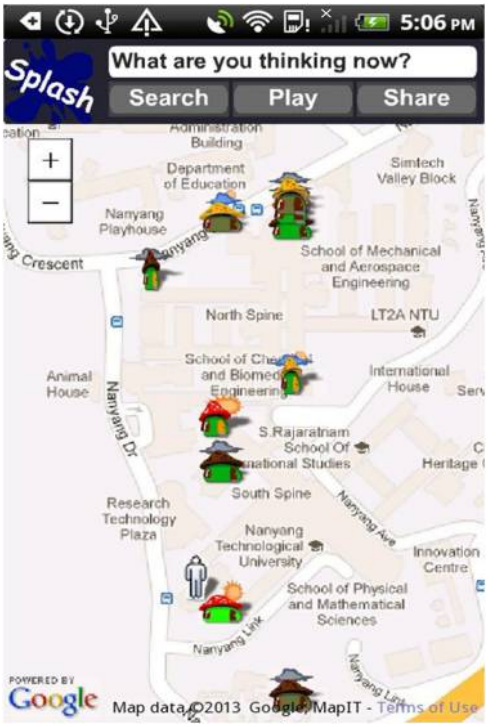

Figure 4.
Houses on the map

Figure 5.
Appearances of a house

participants had a background in computer science, information technology, or related disciplines, while 51 percent came from diverse disciplines such as arts, social sciences, or business. Approximately 67.3 percent of the participants were players of online games. All the participants reported that they understood the concept of sharing information about locations while 50.7 percent reported that they had previously used the location check-in features of social networking applications. In addition, 42.4 percent had experience of sharing information about locations via their mobile phones.

Prior studies suggest that university students in our sample's age range can fairly represent an important age demographic of not only overall online game players (Kirriemuir, 2005; Wu and Liu, 2007), but also mobile internet users (Zhou *et al.*, 2010). According to the latest statistics reported by the Entertainment Software Association (2014), a large proportion of online game players are aged between 18 and 35,

Figure 6.
Virtual room

as well as over 35. Therefore, this study contends that a sample consisting of undergraduate and graduate students in this age range is suitable for exploring player enjoyment of HCGs.

4.2 Data collection procedure

A questionnaire was developed to elicit individuals' perceived enjoyment, perceived output quality, and intention to play HCGs. The participants' demographic data, and gaming and information-sharing experiences were also collected. An initial pilot study was carried out on five graduate students to test questionnaire suitability, and, on the basis of the participants' feedback, minor revisions such as changes to wording were made to improve the clarity. The participants were recruited through the placement of advertisements via e-mail, pamphlets, and posters, and they were given a modest incentive of $5 for their effort.

This study was conducted across separate sessions, each of which consisted of a minimum of three and a maximum of ten participants, and it was organized on a university campus. As such, at least three participants played the game at the same time which facilitates a multiplayer environment. Each session began with the researcher explaining the purpose of the study, including information about SPLASH and its features. Next, the participants were loaned HTC Desire mobile phones with SPLASH preloaded and they were asked to test the game and its features. Once the participants familiarized themselves with the game, a usage scenario was presented. This scenario required the participants to perform a series of tasks which included using SPLASH to: find places on the map, feed pets, rate comments,visit a pet's

apartment, customize avatars, and view the leaderboards. Upon completion of the given tasks, the questionnaire described above was administered. The entire study took approximately 40 minutes.

4.3 Measures

The two independent variables were perceived enjoyment, and perceived output quality, while the dependent variable was intention to play. All the questions used to measure the variables were assessed on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). These questions were adapted from existing literature to suit the HCG context and they are described as follows:

- Perceived enjoyment. The measurement of perceived enjoyment was adapted from previous studies (e.g. Fang *et al.*, 2010; Fang and Zhao, 2010), and it was assessed using 12 items. Participants were asked to indicate the levels of affective, cognitive, and behavioral experiences derived from playing SPLASH. This scale has been utilized to assess individuals' perception of enjoyment in the context of pleasure-oriented games (e.g. Fang and Zhao, 2010).
- Perceived output quality. Perceived output quality was also assessed with 12 items and these were drawn from prior studies (e.g. Lee *et al.*, 2002), and modified to the current context. These scales have been employed to evaluate individuals' perception of output quality in various online information-sharing contexts (e.g. Kim and Han, 2009).
- Intention to play. Three question items were used to measure intention to play, and these were formulated on the basis of prior studies (e.g. Lee *et al.*, 2010) and adapted to suit the study's context. Specifically, participants were asked to indicate how likely they were to play SPLASH to create, rate, and view information.

4.4 Statistical analyses

A series of principal component factor analyses with varimax rotation were conducted to determine the potential groupings of the study's constructs. Next, reliabilities for each construct were assessed using Cronbach's α. The correlations among independent variables were then examined to ensure the absence of multicollinearity among them. The results (Table I) showed that there were no high correlations among the independent variables (0.6 and above).

	AFF	COG	BEH	ACC	COM	REL	TIM
AFF	1						
COG	0.57**	1					
BEH	0.49**	0.47**	1				
ACC	0.38**	0.38**	0.18**	1			
COM	0.37**	0.47**	0.29**	0.57**	1		
REL	0.46**	0.51**	0.34**	0.45**	0.64**	1	
TIM	0.39**	0.50**	0.27**	0.56**	0.63**	0.66**	1

Table I.
Correlations among independent variables (Pearson)

Notes: AFF, perceived affective enjoyment; COG, perceived cognitive enjoyment; BEH, perceived behavioral enjoyment; ACC, perceived output accuracy; COM, perceived output completeness; REL, perceived output relevancy; TIM, perceived output timeliness. **Correlation is significant at the 0.01 level (two-tailed)

Subsequently, a multiple linear regression analysis was carried out to test the research questions. The three perceived enjoyment dimensions and four perceived output quality dimensions were entered as independent variables, while intention to play was treated as the dependent variable. The results of the statistical analyses are discussed next.

5. Results

5.1 Factor and reliability analyses

The results of the factor analysis for perceived enjoyment are shown in Table II. As expected, three enjoyment dimensions were revealed and they had good internal reliabilities with α values of 0.84 ($M = 2.9$, SD = 0.80) for affective enjoyment, 0.88 ($M = 3.5$, SD = 0.68) for cognitive enjoyment, and 0.82 ($M = 3.0$, SD = 0.81) for behavioral enjoyment. These three constructs are articulated as:

(1) affective: measures players' emotional experiences during gameplay;

(2) cognitive: measures players' cognitive judgment of the game and its content; and

(3) behavioral: measures players' awareness of their actions during gameplay.

Next, four factors were revealed from the factor analysis of perceived output quality, and all had good internal reliabilities with α values of 0.96 ($M = 0.34$, SD = 0.77) for accuracy, 0.96 ($M = 0.32$, SD = 0.78) for completeness, 0.91 ($M = 3.3$, SD = 0.75) for relevancy, and 1.0 ($M = 3.6$, SD = 0.81) for timeliness. The results are presented in Table III, and the constructs are described as follows:

(1) accuracy: assesses whether the information is correct, reliable and accurate;

(2) completeness: assesses whether the information contained sufficient details;

Perceived enjoyment	Factors 1	2	3	α
Affective				*0.84*
I felt emotionally involved in this game	*0.87*	0.25	0.16	
I felt emotionally attached to this game	*0.86*	0.23	0.20	
I felt emotionally affected while using this game	*0.86*	0.15	0.17	
I felt attracted to this game	*0.62*	0.48	0.28	
Cognitive				*0.88*
I think this game is a good way of sharing information	0.15	*0.84*	0.11	
I think this game is an interesting way of sharing information	0.21	*0.77*	0.19	
I think this game is an effective way of sharing information	0.26	*0.77*	0.19	
I think it is worthwhile to use this game	0.20	*0.71*	0.21	
Behavioral				*0.82*
I became less aware of my surroundings because I was engrossed in using this game	0.15	0.02	*0.82*	
I lost track of time while using this game	0.14	0.19	*0.75*	
I was able to quickly choose appropriate actions for my designated tasks in this game	0.12	0.30	*0.75*	
I was able to easily use the game to accomplish my designated tasks	0.27	0.26	*0.73*	
Variance explained (%)	12	47	11	
Eigenvalue	1.5	5.7	1.3	

Note: $n = 205$

Table II.
Factor analysis of perceived enjoyment

Perceived output quality	Factors 1	2	3	4	α
Accuracy					*0.96*
This game provides accurate information	*0.90*	0.21	0.16	0.24	
This game provides correct information	*0.90*	0.15	0.20	0.23	
This game provides reliable information	*0.90*	0.24	0.16	0.19	
Completeness					*0.96*
This game provides information that covers sufficient breadth and depth for my needs	0.23	*0.88*	0.28	0.18	
This game provides information that includes all necessary details	0.23	*0.87*	0.24	0.22	
This game provides information that is sufficiently complete for my needs	0.19	*0.85*	0.28	0.29	
Relevancy					*0.91*
This game provides information that is relevant to my needs	0.15	0.25	*0.89*	0.16	
This game provides information that is appropriate for my needs	0.20	0.23	*0.81*	0.29	
This game provides information that is useful for my needs	0.19	0.28	*0.79*	0.26	
Timeliness					*1.0*
This game provides information that is sufficiently up to date	0.24	0.23	0.25	*0.91*	
This game provides information that is sufficiently current for my needs	0.23	0.24	0.25	*0.91*	
This game provides information I need in time	0.25	0.23	0.24	*0.90*	
Variance explained (%)	13	11	8.4	60	
Eigenvalue	1.5	1.3	1.0	7.2	

Note: $n = 205$

Table III.
Factor analysis of perceived output quality

(3) relevancy: assesses whether the information is appropriate, relevant, and useful; and

(4) timeliness: assesses whether the information is current, timely, and up to date.

With regard to intention to play, the factor analysis yielded a single category with α value of 0.87 ($M = 3.2$, SD = 0.96), and this single category was used in subsequent analyses. The results are shown in Table IV, and the construct is operationalized as:

- intention to play: measure how likely it is that the player will use the HCG for creating, rating, and viewing mobile information.

	Factor	α
Intention to play		*0.87*
How likely are you going to play this game for creating information?	*0.91*	
How likely are you going to play this game for rating information?	*0.90*	
How likely are you going to play this game for viewing information?	*0.87*	
Variance explained (%)	80	
Eigenvalue	2.4	

Note: $n = 205$

Table IV.
Factor analysis of intention to play

5.2 Regression analysis

The results of the regression analysis in Table V reveal that 48 percent of the variance of intention to play HCGs was accounted for in our model.

Consistent with our predictions, the perceived affective enjoyment ($\beta = 0.31$, $p < 0.001$) and the perceived cognitive enjoyment ($\beta = 0.21$, $p < 0.01$) had significant positive associations with intention to play SPLASH, supporting *H1a* and *H1b*. In particular, the affective dimension showed the most impact on individuals' intention to play SPLASH. That is, the more a player was emotionally engaged with the game, the more likely it was that he/she will play it. For the cognitive dimension, the more the game was perceived to be valuable and interesting, the more likely it was that a player would continue to play it. The non-significance of behavioral dimension indicates that players' behavior during SPLASH play did not determine their usage intention, which is inconsistent with *H1c*.

Consistent with *H2c*, perceived output relevancy showed a significant positive association with intention to play SPLASH ($\beta = 0.25$, $p < 0.01$). This indicated that the more HCG output was perceived to be relevant, the more likely it was that a player will play the game. However, no significant relationship existed between the quality dimensions of accuracy, completeness, and timeliness, and intention to play. Therefore, *H2a*, *H2b*, and *H2d* were not supported.

6. Discussion

Our results suggest that the most salient driving factor of intention to play HCGs is perceived affective enjoyment, indicating that although HCGs are not primarily intended for entertainment, they are able to evoke participants' emotional experiences, thereby increasing their intention to play. Given the dual nature of HCGs, the effects of perceived affective enjoyment may be twofold. One, players experience various emotions and feelings by interacting with supported gaming elements in HCGs, which is consistent with previous research on online games for pure entertainment (e.g. Wu and Liu, 2007). Two, the integration of gaming and computation in HCGs facilitates the easiness and effectiveness of creating output, which in turn drive players' emotional experience. Drawing upon affective and emotional design research (e.g. Lopatovska and Arapakis, 2011), designers should consider how to engender various positive

Independent variables	Dependent variable = intention to play Standardized β	*t*-values
Perceived enjoyment		
Affective	0.31	4.60***
Cognitive	0.21	2.90**
Behavioral	0.02	0.26
Perceived output quality		
Accuracy	0.13	1.90
Completeness	0.07	0.93
Relevancy	0.25	3.20**
Timeliness	−0.09	−1.20
Adjusted R^2	0.48***	

Notes: $n = 205$. **$p < 0.01$; ***$p < 0.001$

Table V.
Multiple linear regression analysis

affective states as a result of performing human computation tasks through HCG play. Examples include presenting emotionally expressive in-game characters and creating in-game dynamics, such as offering unique badges at unpredictable intervals, relative to HCG tasks. In our study, SPLASH induces players' emotions by varying the appearance of the pets according to the four attributes of content fed to them.

Interestingly, this study revealed statistically significant effects of perceived cognitive enjoyment on intention to play HCGs. This finding indicates that the participants played HCGs not merely for entertainment, and that they were involved cognitively in gameplay. In other words, they appeared to recognize HCG play as a meaningful activity, thereby enjoying these games cognitively which in turn determined their intention to play. In our work, the SPLASH players derived cognitive enjoyment from making value judgments on whether the game served as an effective means of creating useful output, thereby fueling their intention to play. This finding also reinforces the assertion that media entertainment experience involves more than affective reactions and comprises various reactions that mutually influence each other (Nabi and Krcmar, 2004). Thus, features that augment individuals' perceived value of HCGs are crucial in inducing cognitive enjoyment, such as making the quality and creativity aspects of output more visible to players. Here, SPLASH's ratings indicate the quality of output produced by its players, which may have an impact on their assessment of gameplay and further enhancing cognitive enjoyment.

Notably, a significant influence of perceived output relevancy on intention to play HCGs was observed. A possible explanation for this is that playing these games provides players with an opportunity for serendipitous information discovery (Foster and Ford, 2003), meaning that players encounter new content that is relevant to them, but not anticipated. The chance of encountering relevant information further determines usage intention. By browsing and searching SPLASH's content, players may discover a new place of interest and new information about locations that they may not have otherwise found. This study therefore extends the work of Lee *et al.* (2010), which reported that players of a content-sharing HCG were concerned about the quality of its output, by providing a more nuanced perspective of the role of output relevancy and how it leads to usage intention. This finding also underlines the importance of situations that facilitate the creation and discovery of relevant output in HCGs. In SPLASH, the visualization of the four content attributes through on the display of mushroom houses and pets facilitates the players' relevance judgments of output relative to their needs.

However, perceived behavioral enjoyment was not a significant predictor of intention to play HCGs. One plausible explanation for this is that, in contrast to multiplayer role-playing games that require a long duration to complete a game session (Sweetser and Wyeth, 2005), HCGs are casual in nature. That is, players do not need to spend much time to successfully perform computational tasks, and hence behavioral enjoyment is unlikely to occur in HCGs. This finding could also be attributable to SPLASH's approach of gameplay in which sharing location-based content could be completed within a short duration. Although SPLASH facilitates long-term goals through the missions of its badges, players are not required to complete these missions with continuous gameplay, which probably impedes them from being immersed in the game (Agarwal and Karahanna, 2000). Evidence for this view can be found in the work of Fang and Zhao (2010) which suggests that players' perceived behavioral enjoyment varied among different game genres. Our results suggest that the link between behavioral enjoyment and intention to play is not straightforward, and this therefore calls for more nuanced research that includes different HCG genres.

Finally, the non-significance of perceived output accuracy, and completeness, and timeliness suggests that players are not concerned about these issues while playing HCGs, which is inconsistent with prior research (e.g. Lee *et al.*, 2009). One possible explanation for this is that the types of HCG output may contribute to this result as the importance of quality dimensions varies among output types (Rieh, 2002). In our work, SPLASH may attract more opinion and social content types in which accuracy and completeness quality aspects may not be so important (Fichman, 2011), thus diminishing the roles played by these output quality aspects on intention to play. Next, the non-significance of perceived timeliness of output could be attributable to the mobility of SPLASH where players are more likely to share information about current events. Therefore, it could be that the output produced by mobile HCGs like SPLASH is assumed to be current by players such that its timeliness quality aspect may be underemphasized (Kim and Han, 2009), resulting in non-influence on usage intention.

7. Conclusion

This study provides several important implications for both research and practice. First, the present study posited the multidimensional nature of HCG enjoyment instead of a traditional approach to recognizing enjoyment as a unidimensional construct (e.g. Lin *et al.*, 2009; Wu *et al.*, 2010). In the light of this finding, researchers focussing on HCGs and similar games should no longer be content with the conceptualization of enjoyment as a single dimension, regarding enjoyment as simply fun or pleasure. In fact, HCG enjoyment comprises affective, cognitive, and behavioral components that may exert mutual influence on one another. Failing to recognize these enjoyment components might result in an incomplete understanding of the consequences of HCG enjoyment.

Second, our study is novel in that it investigated and identified various perceived enjoyment and output quality dimensions that drive individuals' intention to play HCGs. We argue that perceived affective and cognitive enjoyment, and perceived output relevancy, are important factors influencing individuals' HCG usage intention. More generally, our findings further shed light on how the sustainability of social computing applications can be enhanced through the use of HCGs. Third, as one of the few attempts to investigate the determinants of intention to play HCGs, our findings help researchers to clarify the critical issues of HCG use, and in particular why an individual plays such games. Specifically, the non-significant link between behavioral enjoyment and intention to play indicates the need for future research to examine whether different HCG genres affect perceived behavioral enjoyment. Individuals' personality factors may also play a role in behavioral enjoyment of HCGs as neurotic individuals are more likely to be absorbed in gameplay, as reported by Johnson and Gardner (2010).

Fourth, our work suggests that organizations and businesses could implement HCGs for services which require enhancing the engagement and participation of employees and customers. In particular, while prior studies suggests that the removal of gaming elements in enterprise social networks could reduce users' contributions (e.g. Fulk and Yuan, 2013), our findings provide a more nuanced explanation that gaming elements that provoke affective and cognitive experiences are essential in attracting the attention of employees. Consequently, understanding how to integrate emotions in HCG design to induce more effective and pleasurable experiences is an important area of work.

Finally, our findings provide designers with important guidelines on design and implementation of HCG features that augment individuals' perceived enjoyment, thereby increasing usage intention. Specifically, designers should focus on strategies

that could engender affective and cognitive experience in HCGs. Strategies from affective computing and emotional design may be employed (Lopatovska and Arapakis, 2011). For instance, offering emotionally expressive avatars and unique rewards for output contribution at variable time intervals, and depicting the quality and creativity output, may evoke positive feelings and cognitive experiences. Designers should also pay attention to devising features that signify various quality aspects of HCG output. As quality relates to the needs of users (Wang and Strong, 1996), representing output which caters to different users' needs may be useful.

Although this study yields meaningful findings, it is not without limitations. First, since this study employed a cross-sectional survey method, it may not fully capture the dynamism and complexity of the process of HCG usage intention. Future research adopting a longitudinal approach is required to validate our findings. Second, the results should be interpreted carefully, given that the data were obtained from just one study that focussed only on a mobile content-sharing area using a single HCG genre. Thus, future research is needed to investigate different HCG genres in different human computation domains to confirm the generalizability of these results. Third, despite studying multiple dimensions of perceived enjoyment and output quality, it cannot be guaranteed that all possible dimensions have been considered. For instance, enjoyment can be attributable to the fulfillment of motivational needs such as autonomy, competence, and relatedness (e.g. Ryan *et al.*, 2006). This stipulates the importance of exploring other aspects of enjoyment and output quality in the context of HCGs.

Fourth, the scope of the study did not include control variables such as gender, participants' prior experience, and personality. The inclusion of these variables may either strengthen or weaken the effects of perceived enjoyment and output quality on intention to play HCGs. Future research will therefore be necessary to investigate what potential intervening variables are, and how they mediate the relationships identified by this study. Furthermore, given the non-significant effects of perceived output accuracy, completenesss, and timeliness, it would be instructive to examine if such quality dimensions influence HCG usage intention indirectly through other variables such as perceived trust and satisfaction (e.g. Kim and Han, 2009). Finally, the participants in our study were primarily undergraduate and graduate students. It would therefore be helpful to replicate the study with people from diverse occupational or educational backgrounds to uncover other factors influencing intention to play HCGs.

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