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The Effects of Collaboration and Competition on Players' Perceptions in Human Computation Games

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Abstract. Human Computation Games (HCGs) harness human intelligence through games to address computational problems. Collaboration and competition have emerged as the most commonly used HCG genres. Yet, little research has examined the effects of such genres on players' perceptions. Through an experimental study with 95 participants, this study investigates the effects of collaboration and competition on perceived enjoyment and output quality in mobile content sharing HCGs. The findings suggest that competition yielded better perception of output accuracy than collaboration. However, players derived more behavioral enjoyment from collaboration than competition in HCGs. The implications of these findings are discussed.

Keywords: Human computation games, location-based content, mobile multiplayer games, information sharing, enjoyment, output quality.

Introduction

Human Computation Games (HCGs) harness human intelligence through enjoyable gameplay to address computational problems that are beyond the power of computer programs but trivial for humans [5], [11]. One well-known example is the *ESP Game* [12] in which two randomly-paired players are tasked with creating tags for images, and awarded

points for every matching tag. HCGs also yield benefits for the creation of digital libraries. For instance, photo digital libraries, such as PhotoGeo [3], that enable users to annotate photos with metadata attributes so as to facilitate future retrieval could utilize games to motivate participation.

Recent studies suggest that players either collaborate or compete during HCG play [11]. In collaborative HCGs, players work together as a team, and the outcomes are shared among team members. In contrast, players develop strategies to play against others in competitive HCGs, and only one player at a time can achieve the winning condition [13]. It has been argued that collaboration can promote positive behaviors, which in turn influences enjoyment and performance in the task performed, whereas competition can promote negative behaviors and outcomes [10]. Accordingly, competitive HCGs may be more enjoyable than collaborative ones, but they may not yield high-quality outputs. Therefore, it is imperative to investigate the potential effects of these genres on players' perceptions.

Enjoyment is known to be as a success factor of hedonic systems while output quality is regarded as a significant factor of task-oriented systems [2]. As HCGs intertwine gaming with output generation [5], both enjoyment and output quality could be critical aspects. In addition, prior studies advocate the multidimensionality of enjoyment and output quality [6, 7], and hence, treating such constructs as unidimensional may overlook the importance of specific influential dimensions. Put differently, researchers have yet to examine whether the multiple dimensions of perceived output quality and enjoyment differ across HCG genres.

Thus, this study aims to examine the effects of HCG genres (collaborative vs. competitive) on perceived output quality and enjoyment, using three custom-developed mobile HCGs for location-based content sharing. Findings from our work will provide a better understanding of the influence of collaboration and competition in HCG play, and with such information, better design decisions can be made.

Perceived Output Quality and Perceived Enjoyment

Perceived output quality is defined as an individual's perception of the quality of output provided by an information system [2]. It has been suggested that accuracy, completeness, relevancy, and timeliness are significant dimensions of online social content [9]. As a HCG is a type of online system and the most visible feature is the quality of its shared content [8], such quality dimensions may also be relevant to HCGs. Prior studies found that individuals in collaborative gameplay situations exhibited more trust in their partners, leading to higher levels of performance [13]. In contrast, [11] argues that players may take advantage of collaboration by colliding with other players on unusable information, possibly resulting in lower levels of perceived output quality. Hence, we propose the following research questions:

RQ1: *What are the differences in perceived a) accuracy, b) completeness, c) relevancy, and d) timeliness between collaborative and competitive HCG genres?*

Perceived enjoyment refers to the degree to which an individual perceives fun or pleasure when performing an activity [2]. [7] argues that enjoyment consists of three dimensions: affective, cognitive and behavioral, which may mutually exert influence on each other. Scholars believe that competition undermines enjoyment as individuals are more likely to focus on winning rather than on the activity itself [10]. Other scholars have argued that competition poses exciting challenges, making individuals more involved in the activity, thereby promoting enjoyment [13]. With regards to collaboration, research has shown that working as a team could engender a sense of relatedness with other team members, which is a crucial source of enjoyment [13]. However, collaboration may hinder enjoyment when individuals perceive the group goal as controlling, resulting in a loss of autonomy [10]. These inconsistent findings warrant a further examination. Hence, the following research questions are asked:

RQ2: What are the differences in perceived a) affective, b) cognitive, and c) behavioral enjoyment between collaborative and competitive HCG genres?

Methodology

Applications Developed for the Study

Three location-based content sharing applications were developed. The reasons for developing our own applications were that we would have better control over the look-and-feel of the interfaces and the accessibility of the generated data. All three applications offer a map-based interface that indicates locations with content, which are overlaid with mushroom houses (see Fig. 1). Each house has a number of units, and each of these holds comments created inside. A comment comprises the title, tags, descriptions, media elements (e.g. photos) and ratings.

First, *Collabo* (collaborative HCG) enables players to form a team with other players to rescue the starving pets in their vicinity. The starving pets appear sad and have a darker tone (see Fig. 2). To rescue the pets, players need to feed them with comments or rate those created by others. All activities of players are shown on the “Activities tab” (see Fig. 3). Players earn an equal amount of points once a pet is rescued.

Fig.1. A map-based interface

Fig. 2. A list of pets residing in a location

Fig.3. Players' activities on the pet.

Fig.4. A pet owned by “gigo”.

Second, *Clash* (competitive HCG) allows players to compete with others for pet ownership. The name of the current pet owner is displayed on the nametag (see Fig. 4). The player can challenge the current owner to a duel, and he/she will win if the total of his/her strength and daily luck (i.e., a random number generated at the first login of each day) is greater than that of the challenged player. The strength of the player is based on the quantity and recency of comments, and the number of ratings.

Finally, *Share* is a non-game application that serves as a control. It does not have any game elements, and offers the basic features for contributing and accessing content. Players are not awarded with any game points or rewards for their activities. Instead, they can view statistics such as the number of comments and ratings created.

Participants and Experimental Procedure

Ninety-five participants (49 males and 46 females) with an average age of 23 were recruited from two local universities. The majority of the participants (81.3%) indicated that they were game players. Participants were from diverse educational backgrounds such as computer science (47.8%) and Engineering (38.8%).

A within-subjects experimental design was adopted. The experiment was conducted across separate sessions with each session having three to nine participants. Before the experiment began, participants were given instructions on how to use the applications together with a short 15-minute practice session. Participants used all three applications on Android-based mobile phones on three different days, each spaced one day apart. On each day, participants followed a given usage scenario which includes joining a team to rescue a pet (for *Collabo*), winning a pet (for *Clash*), and viewing the usage statistics (for *Share*) in addition to creating, viewing, and rating comments, and they completed a questionnaire for respective application. Participants were paid an incentive of \$20.

Measures Used

A questionnaire was developed to elicit participants' perceptions of the study's constructs. All question items were adapted from prior research [4], [6], [8], and measured on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). A principal component factor analysis with varimax rotation and reliability analyses were conducted. As suggested by prior research [1], items that were most highly loaded on their respective factors (0.5 and above) were retained in the analysis.

Perceived information quality was assessed with 12 items. Four factors were extracted from the factor analyses, namely, accuracy, completeness, relevancy, and timeliness. Similarly, perceived enjoyment was evaluated using 12 items. The three factors emerged were affective, cognitive, and behavioral enjoyment. All constructs exhibited acceptable internal reliabilities with a Cronbach's alphas of at least 0.93.

1 Results

Table 1 shows the means and standard deviations of participants' perceptions for all applications. The results of the ANOVAs indicated that there were significant differences with respect to accuracy [$F(2,282)=15.08, p<.01$], completeness [$F(2,282)=19.95, p<.01$], relevancy [$F(2,282)=10.86, p<.01$], affective [$F(2,282)=8.54, p<.01$], cognitive [$F(2,282)=11.09, p<.01$], and behavioral [$F(2,282)=10.81, p<.01$].

The results of Tukey's test revealed that participants felt that the output from *Share* was more accurate, complete, and relevant than from both HCGs. They recognized a higher level of accuracy in *Clash* than in *Collabo*. However, the differences in completeness and relevancy between both HCGs were not significant. Next, participants perceived that *Collabo* and *Clash* provided higher levels of affective and cognitive enjoyment than *Share*, but no differences in ratings between both HCGs were found. In terms of behavioral enjoyment,

Collabo performed better than both *Clash* and *Share*, though differences in perceptions between the latter two applications were non-significant.

Table 1. Means and standard deviations for perceived output quality and enjoyment (N=95).

Variable	Type of application / Mean (SD)		
	<i>Collabo</i>	<i>Clash</i>	<i>Share</i>
Accuracy*	2.89 (0.91)	3.13 (0.98)	3.43 (0.75)
Completeness*	2.88 (0.83)	2.80 (0.83)	3.36 (0.97)
Relevancy*	3.02 (0.85)	2.86 (1.00)	3.36 (1.08)
Timeliness	3.01 (0.82)	2.98 (0.93)	3.09 (0.93)
Affective*	3.21 (0.99)	3.01 (1.08)	2.62 (0.94)
Cognitive*	3.64 (0.95)	3.34 (1.06)	2.99 (0.89)
Behavioral*	2.99 (1.09)	2.62 (1.08)	2.30 (0.90)

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

Discussion and Conclusion

This experiment yielded the following findings. First, *Share* was perceived to offer more accurate, complete, and relevant outputs than both *Collabo* and *Clash*. Here, both HCGs required players to perform gaming activities, and such extra work could have been perceived to be deviating from output generation, leading to a lack of confidence in quality. Next, the output of *Clash* was perceived to be higher in accuracy than that of *Collabo*. Perhaps, competition that drives players to strive for victory [15] conveyed an impression that more accurate output would be generated than via collaboration. This offers an explanation for the finding of prior work [8] where the relationship between accuracy and HCG enjoyment was non-significant, suggesting that game genres could have moderated such a relationship. Interestingly, timeliness was perceived similarly across all three applications. Perhaps, due to

the assumption that online environments provide current information [9], HCGs appeared to instill confidence that their outputs were as timely as that of the non-game variant.

Second, participants derived greater enjoyment from HCGs as opposed to the non-game application. This underlines the potential of the game-based approach for human computation. Both game genres were found to be equally effective in evoking positive emotions and thoughts, giving rise to affective and cognitive enjoyment. Our results show that participants using *Collabo* derived more behavioral enjoyment than *Clash*. Perhaps, participants experienced the benefit of being part of a team, which may have spurred them to be more committed to the gameplay [15], thereby inducing behavioral enjoyment. Compared to prior work in which enjoyment is treated unidimensionally [8], this study provides a detailed understanding that HCG enjoyment comes from multiple sources that may vary due to the game mechanics employed. Hence, multiple dimensions (e.g., affective, cognitive, and behavioral) should be used when assessing HCG enjoyment and its impact.

This study yields the following implications. One, we discovered that collaboration has a similar effect on perceived affective and cognitive enjoyment, and even presents a greater impact on behavioral enjoyment, compared to competition. This provides evidence for the need to create different strategies to evoke enjoyment of HCGs. Two, this study indicates a gap between gaming and output quality and hence, better design strategies to bridge these two aspects need to be sought. Three, our results suggest that a co-op mode where people form long- or short-term groups is needed to make them more deeply involved in HCGs. Further, competitive elements are needed to influence perceptions of output accuracy. Taken together, the study bodes well for digital libraries that may wish to consider using games to enhance user engagement.

Although this study yields valuable findings, some limitations should be addressed. For instance, this study relied on basic, but commonly used, gameplay mechanics in HCGs.

Future research may investigate the differential effects of a larger set of gameplay mechanics such as those used in adventure and simulation games.

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