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Making work fun: Investigating antecedents of perceived enjoyment in human computation games for information sharing

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ABSTRACT

The advent of online games, crowdsourcing, and user-generated content has led to the emergence of a new paradigm called the Human Computation Games (HCGs) which utilize games as a motivator to encourage users' participation in human computation. HCGs are different from games for pure entertainment which emphasize play and fun, rather than output generation. Therefore, research has yet to fully explore the factors underlying players' perception of HCG enjoyment. In this paper, we study the influence of motivational needs satisfaction and perceived output quality on perceived HCG enjoyment using a survey ($N = 205$) of a location-based information sharing HCG called *SPLASH*, developed as part of our research. According to the results, perceived needs for autonomy, competence, and relatedness influence perceived enjoyment of HCGs, suggesting that HCGs that fulfill these three needs are more likely to be enjoyable, thereby encouraging players to make useful computations. The results also show that participants who perceive higher levels output relevancy report a greater level of enjoyment, indicating that HCGs that assist players in generating relevant outputs are more likely to be perceived as enjoyable.

1. Introduction

Human computation harnesses human intelligence to solve computational problems which are beyond the power of computer programs, but are performed well by humans (von Ahn & Dabbish, 2008). One such example is in the area of image labeling in which human users can easily create textual descriptions for them, while computer programs have yet to achieve the same level of performance. Human computation systems (HCSs) are traditionally operated by hiring human experts or asking volunteers to address computational problems. However, such approaches have two key drawbacks: costliness and a dependence on individuals' willingness to devote their time and effort (Yuen, Chen, & King, 2009). The growing popularity of social computing makes it easier for HCSs to harvest the brain power of online users. However, HCSs which lack motivational appeal to participants are still likely to result in insufficient participation (Doan, Ramakrishnan, & Halevy, 2011). Therefore, motivational mechanisms relevant to human computation contexts need to be examined.

Recently, utilizing the power of games to promote engagement and productivity has become a popular way of addressing real-world problems (de-Marcos, Domínguez, Saenz-de-Navarrete, & Pagés, 2014). This idea is grounded in the fact that games have become an integral part of daily life. According to the latest statistic reported by Entertainment Software Association (ESA, 2014), 59% of Americans play video games. Therefore, piggybacking computational tasks on games has a great potential to broaden user participation. Consequently, a novel paradigm called the Human Computation Games (HCGs) has emerged where users contribute their brain power to a given endeavor through enjoyable gameplay (Goh & Lee, 2011). In essence, HCGs are built upon individuals' desire to be entertained to generate useful computations as a by-product of gameplay (Goh, Ang, Lee, & Chua, 2011; Ho, Chang, Lee, Hsu, & Chen, 2009).

The past decade has seen an interest in the design and development of HCGs in various domain areas. The ESP Game (von Ahn & Dabbish, 2004) is one of the earlier examples, which aims to address the image-labeling problem. In this game, players are randomly paired with another player online, and tasked to generate labels for given images. Players were found to spend several hours on this game, thereby generating millions labels for images (Law & von Ahn, 2009). Consequently, other HCGs have been developed, attempting to address computational problems in areas such as music annotation, image tagging, ontology construction, protein folding, and even location-based information sharing

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(e.g., Barrington, O'Malley, Turnbull, & Lanckriet, 2009; Casey, Kirman, & Rowland, 2007; Cooper et al., 2010; Ho et al., 2009; Krause, Takhtamysheva, Wittstock, & Malaka, 2010). Nowadays, the concept of using games to promote user participation has been applied in several domain areas attempting to produce useful computations.

Although HCG play yields benefits, research has not fully explored individuals' perceptions toward such games. Much research on HCGs has paid attention toward design and implementation perspectives, output quality and performance differences across game genres, and gratifications derived from such games (Goh & Lee, 2011; Goh, Lee, Chua, Razikin, & Tan, 2011; Goh, Ang et al., 2011; Law & von Ahn, 2009). On the other hand, previous research on games for pure entertainment have examined players' enjoyment, and found its direct effect on individuals' attitudes toward such games (e.g. Hsu & Lu, 2007; Wu & Liu, 2007). Furthermore, enjoyment is considered to be a critical factor for task-oriented applications such as online shopping (Ahn, Ryu, & Han, 2007). As HCGs intend to yield valuable outputs while being entertained, enjoyment might be central to the success of such games. Consequently, it is important to examine how individuals derive enjoyment in HCGs to enhance their engagement, thereby offering a more enjoyable experience to them.

Individuals' enjoyment was found to be driven by the fulfillment of motivational needs in prior research on entertainment-oriented applications such as games (Bostan, 2009; Ryan, Rigby, & Przybylski, 2006), and task-oriented applications (Kim & Han, 2009). Additionally, enjoyment was 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). As HCGs are entertainment-oriented applications in which computational tasks are embedded, motivational needs and output quality may be relevant to HCG enjoyment. However, HCGs are different from games for pure entertainment which are generally considered autotelic or intrinsically motivated (Koivisto & Hamari, 2014). Likewise, HCGs are not identical to task-oriented applications which provide instrumental value to users by assisting them to achieve intended goals (van der Heijden, 2004). Therefore, without empirical investigation, it cannot be assured that factors driving the enjoyment of entertainment- and task-oriented applications are still valid for HCG context. The major goal of this study is to investigate the factors contributing to perceived HCG enjoyment from the perspectives of motivational needs and perceived output quality, using our developed HCG for mobile information sharing named, *SPLASH*. The scope of this study is limited to mobile information sharing HCGs but nonetheless of importance because sharing information on the go has increasingly become an inescapable part of everyday life.

The remainder of this paper is organized as follows. The next section provides an overview of HCGs, focusing especially on mobile information sharing games. The HCG used in this study is introduced next. We then present the research model and hypotheses of our work. The research method is then described, followed by our results covering individuals' perceptions of motivational needs and output quality. Finally, we discuss the implications of our findings for HCGs for information sharing, and identify opportunities for future research.

2. Human computation games for mobile information sharing

2.1. Related games

Although HCGs have been introduced in various domain areas, they share a commonality in that they embrace the underlying concept of utilizing games to make computational tasks more appealing and engaging to attract people's participation. As mentioned earlier, the ESP Game (von Ahn & Dabbish, 2004) is one of the pioneers designed to tackle the image labeling problem. Next, Herd It (Barrington, O'Malley, Turnbull, & Lanckriet, 2009) was deployed on Facebook to collect users' opinions on songs. Users described their opinions as labels or tags for a given song, and earned points based on the percentage agreement with others. HCGs have proliferated on Web platforms since, harnessing human intelligence in various domains.

With the increased popularity and widespread availability of mobile devices in recent years, a similar concept has been adopted in the location-based mobile information sharing context. In particular, mobile HCGs facilitate the co-creation, sharing, and seeking of location-based information by players anytime, anywhere (Lee, Goh, Chua, & Ang, 2010). One example is the *Gopher Game* (Casey et al., 2007), which allows players to contribute geospatial information by means of performing information creation tasks asked by a game agent called a gopher. Next, *PhotoCity* (Tuite, Snavely, Hsiao, Smith, & Popovic, 2010) is another example whose purpose is to collect photos of real-world locations for constructing 3D models. Players are asked to collect as many flags as possible by capturing the photos of buildings identified by flags. A player who accumulates the most flags will own the building. *EyeSpy* (Bell et al, 2009) generates useful photos and texts of geographic locations for map navigation, and players are tasked to take pictures of locations and share them with others. Points are earned only if other players can make correct guesses about the location of these contributions.

Further, *CityExplorer* (Matyas et al., 2008) employs the concept of a board game to encourage players to contribute geo-referenced photos and texts. To conquer a city segment, players must place as many markers as possible on a particular segment, achieved through contributing photos of the locations of their chosen categories such as food, cafés, and so on. Finally, *Indagador* (Lee et al., 2010) incorporates gaming elements into content-sharing activities. Players can share and browse media rich location-based content, and earn points by rating and creating content. Using these points they can play mini-games, lay traps, and obtain treasure.

2.2. Introducing SPLASH, The HCG used in the study

For the purposes of this research, we employed a custom-developed application called *SPLASH* (Seek, PLAy, SHare), a type of HCG in which players generate geo-referenced information as by-products of playing it on their mobile phones. Studying a mobile HCG is useful and appropriate because of the rapidly increasing number of mobile users and their role in information sharing. For instance, Facebook has 751 million monthly mobile users as of 2014, an increase of 34 percent year-on-year (Popper, 2014).

SPLASH is a location-based information sharing HCG that runs on the Android mobile platform. In particular, through gaming elements, *SPLASH* allows players to share location-based information, known as "comments" comprising title, tags, descriptions, media elements (e.g. photos), and ratings. *SPLASH*'s content model is comprised of two levels: "Places" and "Units". "Places" represent an arbitrary geographic area, and examples include buildings, parks, points of interest, and so on. Places may also be further divided into "units". Both places and units hold associated comments. For example, a library in a school (place) may be considered a unit which attracts comments. Fig. 1 shows an example *SPLASH*'s comment.

SPLASH adopts a pet-based game genre in which players "feed" location-based information to virtual pets which live in mushroom houses. In line with *SPLASH*'s content model, "virtual pets" represent "units" and "mushroom houses" signify places. The mushroom houses are visualized on the map interface for navigation