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Player Acceptance of Human Computation Games: An Aesthetic Perspective

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Abstract. Human computation games (HCGs) are applications that use games to harness human intelligence to perform computations that cannot be effectively done by software systems alone. Despite their increasing popularity, insufficient research has been conducted to examine the predictors of player acceptance for HCGs. In particular, prior work underlined the important role of game enjoyment in predicting acceptance of entertainment technology without specifying its driving factors. This study views game enjoyment through a taxonomy of aesthetic experiences and examines the effect of aesthetic experience, usability and information quality on player acceptance of HCGs. Results showed that aesthetic experience and usability were important contributors of player acceptance. Implications of our study are discussed.

Keywords: Human computation games, aesthetic experience, usability, information quality, acceptance.

1 Introduction

Human Computation Games (HCGs) are applications that utilize human intelligence to perform computations that cannot be effectively done by software systems alone [1]. Specifically, game elements in HCGs can serve as motivators to accomplish tasks or solve problems in various domains [2]. In the context of digital libraries, HCGs may be harnessed to involve users in contributing content or metadata such as tags for images and music [e.g. 1, 3]. One example is *Herdit* [4] in which players listen to a music clip and are then quizzed about its content. These short text-based answers describe various aspects of the music clip which can be used as annotations for it. *Herdit* makes this game format attractive by utilizing visually pleasing design, intuitive interfaces, and by fostering a sense of community.

Previous HCG research has found that usability, quality of generated outputs, and enjoyable game experience are significant predictors of player acceptance [e.g. 5, 6]. These studies are useful to understand why players are motivated to complete

computation tasks in a game environment but they do not clarify the concept of terms such as “fun” and “game enjoyment”, which are central issues in entertainment technologies [7]. Put differently, although previous studies have demonstrated that HCGs can provide enjoyable experiences [e.g. 1, 4], empirical research on what exactly makes these games enjoyable has been lacking. This is of considerable value since an understanding of these factors will be beneficial for HCG development [8].

In particular, games for pure entertainment delve into the notion of the aesthetic experience as critical for enjoyment. Game aesthetics deals with the general pleasures that players feel as a result of interacting with a game [9]. Here, the mechanics-dynamics-aesthetics (MDA) model defines the aesthetic experience as the emotional responses evoked in players during gameplay [10]. This model specifies a taxonomy of aesthetic elements, providing a concrete way of examining game enjoyment, thus facilitating the design and evaluation of game enjoyment [11]. In many ways, aesthetics is fundamental to good game design. Yet it has been overlooked in HCGs, and the MDA model has not been applied in this context, thus representing a research gap.

In the light of this, the present study investigates players’ perceptions of HCGs through an aesthetic perspective. Two objectives will be addressed. First, we develop a HCG based on the MDA model. Secondly, we examine the effect of perceived aesthetic experience on player acceptance of HCGs. We compare the strength of the effects of perceived aesthetic experience against perceived usability and the perceived information quality, which have been previously examined in the context of HCGs.

2 Acceptance of Human Computation Games

Acceptance research seeks to examine the contributing factors that affect user’s willingness to use a system or product [12]. It has attracted attention from both practitioners and researchers since the understanding of user acceptance can imply better methods for evaluating and predicting users’ response to a system [12]. User acceptance has thus been an important topic in information systems research [13].

Although influential, research on player acceptance towards HCGs is still in its infancy. The limited work available has shown that the perception of enjoyment in terms of leisure and control is positively associated with the intention to play HCGs [6]. However, enjoyment as a state of positive emotional experience is an elusive and vague term related to perceptions such as pleasure, fun, immersion and flow [7]. It is unclear what constitutes game enjoyment [8]. This study thus extends previous work by examining the factors related to game enjoyment in HCGs and their effect on player acceptance. This can lead to a better understanding of HCGs and provide guidance for effective integration of game elements into computation tasks.

2.1 Aesthetic Experience

Game aesthetics is one of the various terms adopted to characterize the experience of gameplay [7]. One of the more specific definitions of game aesthetics comes from the MDA framework which describes three interconnected layers in games: Mechanics-Dynamics-Aesthetics. This framework explains how the different mechanics of a

game are needed so that a player's experiences can be formed during his/her real-time interactions (dynamics) with the game. Aesthetics describes designed emotional responses evoked through gameplay [10], and includes but is not limited to happiness, anxiety and relaxation [7]. Importantly, the MDA model proposes a taxonomy of game aesthetics, which includes eight categories: sensation, fantasy, narrative, challenge, fellowship, discovery, expression, and submission. This taxonomy goes beyond obscure items such as "fun" and "game enjoyment" and provides designers and researchers with a concrete means to analyze the game experience [10].

Previous studies have confirmed the assumption that the aesthetics taxonomy of the MDA framework can be applied to describe the emotional responses of a game and act as guidance for game design [e.g. 11, 14]. Here, [11] utilized the MDA model to create a general framework for educational game design and evaluation. In the context of HCGs, [14] measured perceived aesthetic experience in a HCG based on the MDA taxonomy. Results indicated that the taxonomy could characterize aesthetic game experiences in different HCGs [14]. However, that study did not test the effect of perceived aesthetic experience on player acceptance of HCGs. We deem that the taxonomy of aesthetic experiences can be applied to describe a player's emotional responses, and that a player's perceived aesthetic experience may have a positive effect on acceptance of HCGs. Thus, we propose the following hypothesis:

H1: Perceived aesthetic experience has a positive effect on acceptance of HCGs.

2.2 Usability and Information Quality

Usability concerns the mechanics layer of a game. Besides aesthetics, a successful game should provide players with immediate feedback, natural mapping of controls, error prevention, and ease of learning [15]. Failure to address usability issues may lead to a negative effect on the overall quality of the game and diminish a player's preference for it. Research has shown that usability in HCGs was important for players' sustained usage [5]. Thus we propose the following hypothesis:

H2: Perceived usability has a positive effect on acceptance of HCGs.

Next, information quality has always been considered as a vital factor for user acceptance of an information system [16]. Individuals may be motivated to use a HCG because it provides useful information or helps in collecting quality information [2]. Previous research indicated that perceived quality of computation outputs was positively related with the intention to play HCGs [6, 17]. Hence, we propose that:

H3: Perceived information quality has a positive effect on acceptance of HCGs.

Perceived enjoyment plays a more important role in predicting user behavior than technical factors in hedonic information systems [18]. Since HCGs are entertainment-oriented, users could be motivated by benefits from interaction with the system [19]. Research has also found that seeking for leisure was a more prominent factor than perceived ease of use in HCGs [5]. We thus expect that perceived aesthetic experience is a more dominant predictor of player acceptance than perceived usability and information quality in HCGs, and propose:

H4: For HCGs, perceived aesthetic experience plays a more important role in predicting acceptance than perceived usability and perceived information quality.

3 Kpoprally: The HCG Used in This Study

Annotating music videos with tags is the initial step that enables such videos to be retrieved. However, both the huge amount of music videos and the vocabulary of useful tags make this work difficult and time-consuming [4]. Besides, music videos are described by many subjective tag categories such as theme and mood, the lack of objectivity in those categories makes it difficult to train automatic annotation systems. Thus human computation has been harnessed for the collection of data spanning an excerpt of music videos [20]. *Kpoprally* (Figure 1a) is a HCG based on a guessing game genre for collecting tags of videos to facilitate their retrieval. Specifically, players contribute tags through answering questions related to K-pop (a genre of popular music originating in Korea) music videos to obtain points as well as reputation as incentives. The contributed answers are utilized to index the music videos presented in the game. We chose K-pop music videos as our computation target because of its popularity in Asian countries.

During a gaming session, a video clip will be played for 30 seconds, followed by a question about the video (see Figure 1b). The questions come in two categories. First, objective questions refer to those that have known, unambiguous answers, such as name of the artist in the video and title of the song. Next, subjective questions are those that have no fixed answers and may vary according to individual opinion such as the mood of the video or the color of the video. Points for objective questions are awarded based on accuracy. For subjective questions, points awarded equal to the percentage of other players in agreement. In this way, answers with the highest percentage of agreement can be utilized as tags for the corresponding music videos.

Kpoprally was developed based on the MDA framework. Aesthetic elements in terms of sensation, narrative, challenge, fellowship and submission were accounted for [10]. Specifically, sensation represents the extent to which players feel sensory pleasure due to the audiovisual and tactile impressions of the game. This is provided by an appealing interface design in *Kpoprally*. Narrative represents a sense of dramatics in games, operationalized as an avatar and a backstory to provide a setting and goals of the game (Figure 1c). Challenge means an appropriate level of difficulty that matches players' skills. This is achieved with questions of varying difficulty. Fellowship pertains to support for social interaction. Here, *Kpoprally* is deployed on *Facebook*, and players can invite friends and share their in-game achievements, creating a sense of community. Moreover, players can socialize with others through leaving messages in the game's message board. Submission means that games act as a tool for leisure and passing time and players may feel detached from the real world and feel an altered sense of time during gameplay [15]. *Kpoprally* engages players with attractive tasks and multiple goals, such as earning scores for the avatar and fighting for higher rankings in the leaderboard (Figure 1d). However, because *Kpoprally* is a casual game, three categories of aesthetics (fantasy, discovery, and expression) were not included as they typically are not found in such games.

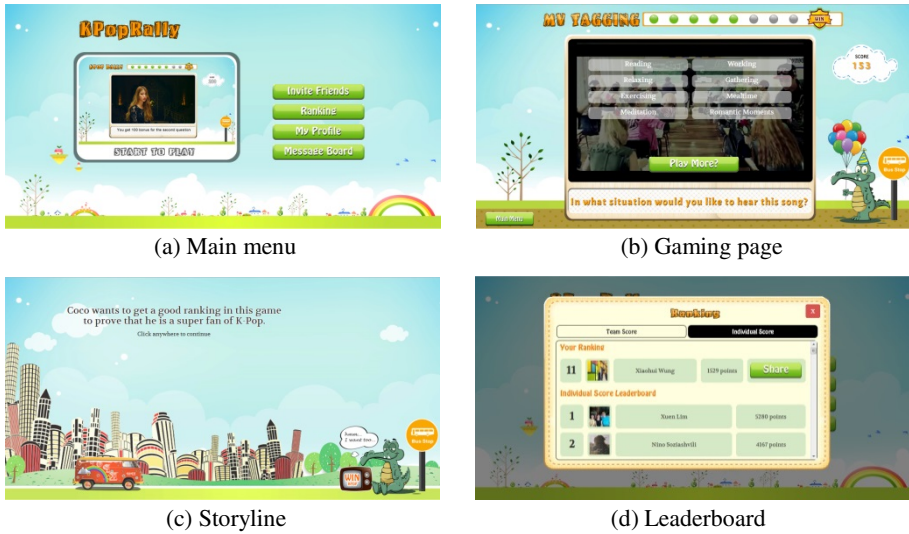


Fig. 1. Screen shots of *Kpoprally*

4 Methodology

An evaluation of *Kpoprally* was conducted to address the study's hypotheses. We recruited 122 participants from local universities, comprising undergraduate and graduate students. Fifty were male and 72 were female, with ages ranging from 19 to 41 and an average of 23 years. In addition, 82 (67.2%) participants watched music videos online on a regular basis (more than once a month). Further, 62 (50.8%) participants played casual games frequently, and the majority of the participants (more than 52.5%) played games on social networking applications such as Facebook.

The study began with a researcher providing information about HCGs and their potential for collecting useful data. Participants were also briefed on the purpose, structure and usage of *Kpoprally*. Next, each participant was handed out a card with gameplay instructions, ensuring that participants consistently experienced all elements of *Kpoprally*. The study then commenced with participants playing the game. Once concluded, participants were asked to complete a questionnaire that captured perception and acceptance of *Kpoprally*, as well as demographic data. The entire study took about 40 minutes to complete.

Three aspects were covered in the questionnaire related to the perception of *Kpoprally*. Items were adapted from previous work [e.g. 14, 21] and were all rated on a 7-point scale ranging from 1 (strongly disagree) to 7 (strongly agree).

- **Perceived Aesthetic Experience (PAE).** This was assessed with five constructs (sensation, narrative, challenge, fellowship, and submission) adopted from the MDA model. Here, 19 items were adapted from past studies related to the evaluation of game aesthetics [6, 8, 14]. Tests show good internal reliabilities with Cronbach's alpha values at .93 ($M = 4.97$, $SD = 1.13$) for sensation, .90 ($M = 3.73$,

SD = 1.27) for narrative, .64 (M = 4.34, SD = 1.04) for challenge, .77 (M = 4.08, SD = 1.39) for fellowship, and .86 (M = 3.86, SD = 1.20) for submission.

- **Perceived Usability (PU).** Four usability constructs, including feedback, control, error prevention, and learnability, were adapted from previous game evaluation studies [e.g. 15, 22]. Feedback refers to the provision of timely and appropriate messages. Control refers to the sense of mastery over the interface and intuitive operations. Error prevention means that games help players recognize and recover from errors. Finally, learnability refers to the ease and fun in learning the mechanics of the game. Here, 14 items were adapted from related studies to measure the four constructs [15, 22]. Tests show good internal reliabilities with Cronbach's alpha values at .86 (M = 5.22, SD = 1.08) for feedback, .75 (M = 4.77, SD = .87) for control, .81 (M = 4.39, SD = 1.06) for error prevention, and .69 (M = 4.77, SD = 1.01) for learnability.
- **Perceived Information Quality (PIQ).** Accuracy, completeness, relevancy are quality dimensions that frequently appear in information quality studies [16]. In the context of HCGs, accuracy refers to the correctness and reliability of the outputs. Completeness means that the outputs contributed had sufficient details. Relevancy refers to the appropriateness of the outputs in relation to the computation purpose [17]. PIQ was assessed with three constructs and 7 items from prior work [16, 17]. Tests also show good internal reliabilities with the Cronbach's alpha values at .79 (M = 5.01, SD = .93) for relevancy, .80 (M = 4.41, SD = 1.15) for completeness, and .79 (M = 4.87, SD = .92) for relevancy.

Finally, acceptance of *Kpoprally* was operationalized as attitude, intention to play, and intention to recommend. As indicated in prior work, attitude, representing the affective evaluation to a set of behaviors [12], is a strong predictor of actual usage; intention to use and intention to recommend reflects the user's satisfaction with the system and their willingness to use and recommend it to others [23]. Those three constructs were measured in the questionnaire with 10 items adapted from previous studies [2, 23]. Again, tests show good internal reliabilities with Cronbach's alpha values at .93 (M = 4.41, SD = 1.36) for attitude, .94 (M = 3.94, SD = 1.43) for intention to play, and .91 (M = 4.10, SD = 1.30) for intention to recommend.

5 Results

To test the proposed hypotheses, a hierarchical regression analysis was conducted. The independent variables were the components of PU, PAE and PIQ. The dependent variables were attitude, intention to use and intention to recommend.

The multiple regression results are shown in Table 1, For attitude towards this game, 55.8% of the variance was accounted for and the model was statistically significant [$F(5, 109) = 11.54, p < .001$]. Only narrative ($\beta = .25, p < .05$) and submission ($\beta = .48, p < .001$) were significant predictors. With regards to intention to play, 54.4% of its variance was accounted by this model [$F(5, 109) = 12.49, p < .001$]. Among the antecedent variables, learnability ($\beta = .19, p < .05$), sensation ($\beta = .21, p < .05$), narrative ($\beta = .25, p < .05$), and submission ($\beta = .37, p < .01$) were significant predictors. Feedback was also a significant predictor of intention to play ($\beta = -.17,$

$p < .05$), but interestingly, the association was negative: More timely and informative feedback resulted in a smaller inclination to play. As for intention to recommend, our model was significant [$F(5, 109) = 8.44, p < .001$] and explained 50.9% of the variance. Sensation ($\beta = .20, p < .05$), narrative ($\beta = .24, p < .05$), and submission ($\beta = .31, p < .01$) were significant predictors.

Table 1. Hierarchical regression analysis with PU, PIQ, and PAE as predictors of player acceptance of HCGs, $N = 122$

Independent Variables	Dependent Variables					
	Attitude (N = 122)		Intention to play (N = 122)		Intention to recommend (N = 122)	
	β	t	B	t	β	T
First Block						
Feedback	-.02	-.26	-.17	-2.08*	-.04	-.42
Control	.06	.56	-.03	-.23	.02	.21
Error Prevention	.03	.30	.02	.22	.06	.72
Learnability	.09	.97	.19	2.12*	.17	1.80
R ² Change (%)	.25***		.23***		.26***	
Second Block						
Completeness	.09	.98	.05	.53	.05	.49
Accuracy	.05	.49	-.02	-.18	.15	1.28
Relevancy	-.08	-.74	-.04	-.36	-.19	-1.69
R ² Change (%)	.08**		.05*		.06*	
Third Block						
Sensation	.14	1.57	.21	2.32*	.20	2.20*
Narrative	.23	2.11*	.25	2.27*	.24	2.12*
Challenge	-.05	-.60	-.04	-.38	-.11	-1.12
Fellowship	-.06	-.75	-.04	-.48	-.03	-.39
Submission	.42	3.98***	.37	3.50**	.31	2.77**
R ² Change (%)	.23***		.26***		.19***	
Total R ²	.56		.54		.51	

* $p < .05$, ** $p < .01$, *** $p < .001$

We summarize our results below:

- Hypothesis 1 was partially supported. Participants who rated higher for narrative and submission elements of this game were more likely to have a positive attitude and adopted it than those who rated these elements lower. Further, participants who rated the sensory element of this game more positively were more likely to have a behavioral intention to play and recommend it.
- Hypothesis 2 was partially supported. The block of PU variables was significant in explaining player’s attitude and behavioral intention. However, only learnability was positively related to intention to play.
- Hypothesis 3 was not supported in this study. Although the PIQ block was statistically significant in influencing player acceptance of HCGs, no variables in this block were significant predictors.

- Hypothesis 4 was partially supported. Comparing the variance of player acceptance explained by PU and PAE, PAE was a stronger predictor than PU regarding intention to play *Kpoprally*, while weaker comparing to PU in predicting player's attitude and intention to recommend. In addition, PAE was stronger in explaining the variance of player acceptance than PIQ.

6 Discussion and Conclusion

We developed a HCG using the MDA framework and examined the factors that influenced player acceptance. The evaluation suggested that *Kpoprally*, our developed HCG, provided players with a positive aesthetic experience. Further, perceived aesthetic experience and perceived usability were significant predictors of attitude towards, intention to play and intention to recommend HCGs. As HCGs have increasingly attracted the attention of both researchers and practitioners, as well as have the potential to be deployed in the digital libraries context, we expect that this study will help in the development of this game genre.

Our results showed that PAE was a significant predictor of player acceptance, highlighting the importance of fostering an aesthetic experience in HCGs. Results showed that submission was a dominant factor influencing acceptance of *Kpoprally*. This demonstrates the importance of helping players ease boredom and pass time in HCGs, such as providing multiple tasks and goals to induce players to linger. Sensation and narrative also affected player acceptance, suggesting that developing HCGs with attractive interface designs and engaging storyline should be pursued. Aesthetic elements such as challenge and fellowship did not show a significant effect in this study, contrary to prior work [e.g. 15]. One plausible explanation could be that the participants could not match the difficulty level of the questions. Participants also did not have time to socialize due to the duration of the study. This suggests more explicit support for fostering a sense of challenge and fellowship in future iterations of the game. For instance, game tasks need to be properly evaluated for difficulty so that they can be better matched with players' abilities.

Second, the significance of PU suggests that usability issues can be a strong catalyst in facilitating acceptance of a HCG. Here, we found that PU was a more prominent factor in explaining players' attitude and intention to recommend HCGs compared to PAE, which is inconsistent with findings in entertainment technologies [e.g. 18]. We hypothesize that although emotional responses play a vital role in predicting acceptance of HCGs in general, usability problems may hinder this effect, as these could immediately turn potential players away. However, more investigation needs to be done to support this. The significant positive effect of learnability on intention to play HCGs suggests that interface design of HCGs should be intuitive and easy to learn. The negative effect of feedback on players' intention to play is surprising [e.g. 22]. One possible explanation could be the questions in *Kpoprally* were more difficult than players expected. More incorrect answers would lead to more negative feedback, thus frustrating players and contributing to the negative relationship. Further, the non-significant results for the other variables suggest that players pay less attention to those issues in HCGs. However, this could be due to short period of the study, and future work could focus on longer-term usage.

We found it interesting that PIQ only accounted for a small amount of variance for player acceptance, and none of the components of PIQ showed a significant influence on player acceptance of *Kpoprally*. This nonetheless does not indicate the unimportance of information quality. Rather, one possible explanation could be that collecting quality tags is a latent function of *Kpoprally*. Players of *Kpoprally* focused on gaming and did not perceive it as an information system that could generate useful information. This implies that in order to engender enjoyment from computation contribution, HCGs developers should consider making the task overt to players. For instance, applications can deploy a dashboard to indicate the amount of contributions that a player has been made.

Our findings yield the following contributions. One, we add to the understanding of the predictors of HCG acceptance. While the main objective of our HCG is collecting useful computations, interestingly, PIQ may not always be a significant contributor for its acceptance. Instead, players may be more concerned about aesthetic elements and usability issues. This suggests that developing such applications is challenging because of the need to adhere to design principles of both games and information systems [6]. Two, significant factors behind acceptance covered in our study provide guidance for developers to allocate their limited resources in HCG development. For instance, the importance of sensation, narrative and submission in influencing player acceptance underlines the need to develop HCGs with interesting backstories, high quality graphics, and to help players pass time.

There are some limitations in this study that could be addressed in future work. First, our findings were generated from one study based on a single genre of HCG in the area of video tagging. Thus, testing the findings with different game genres and computation tasks would increase the generalizability. Second, players' individual differences, such as age, gender, prior experience, and personalities could have effect on their perception of aesthetic experience in HCGs. Further, our data was collected in a single study for a short period of time. A longitudinal study involving sustained usage of our game would provide more robust data on players' perceptions.

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