Gamifying Intelligent Environments

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ABSTRACT

Recently digital designers have begun to integrate game elements and mechanics into non-game applications, systems, and services, to better engage end-users. This notion is named as the "gamification". In this paper, we discuss the idea of applying the gamification concept in designing intelligent environments to improve the overall user engagement. We present two case studies to better understand the effectiveness of gamifying intelligent systems: a mobile crowdsourcing application that works as image based social search across languages, called *UbiAsk*, and a persuasive application for motivating users to reduce CO_2 emissions named *EcoIsland*. We argue that the game-based incentive methods only work with a careful design: designers should be aware that the main functionalities of the system have much greater impact than the additional gamified components, and the desired game-like user behavior requires comprehensive game-like experience that is supported by not only a "game structure" but also a "game-look" surface.

Categories and Subject Descriptors: H.5.m [Information interfaces and presentation (e.g., HCI)]: Miscellaneous

General Terms: Design

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1. INTRODUCTION

The nature of intelligent environments has transformed with the impact of Web 2.0 and social media over the past years. The conceptualization of the user has changed from being a cog in an organizational machine to a partner in system interaction and an ultimate consumer, and more recently to a content creator and a task performer. The shift in paradigm has been tremendous. Within this shift, a strong new focus is the *user engagement* through the system, which defines the phenomena of being captivated and motivated: not just about how a single interaction unfolds, but also about how and why people develop a relationship with a platform or service across multiple interactions.

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More recently, in the field of online marketing, digital designers and social marketing practitioners have begun to adopt ideas from game design, to incentivize desirable user behavior. This approach went by the term of *Gmification* [16] most recently, which refers to incorporating the game play elements into the non-gaming applications, systems, and services, to drive user engagement. These non-game systems are "gamified" by adding game mechanics on top of their main functionalities. The ultimate goal of gamification is to incentivize a non-game system user to have the so-called *game-like* behavior: focus on the task at hand, multitasking under pressure, work overtime without discontented attitude, always keep retrying when fails, etc.

We explore the feasibility and the performance of applying gamification concept in designing human centered intelligent environments and applications in order to strengthen active participation. In this paper we present two case studies: a mobile crowdsourcing application work as image based social search across languages called *UbiAsk*, and a persuasive application for motivating users to reduce CO_2 emissions named *EcoIsland*. In Section 2, two mainstream participation incentives are introduced. In Section 3, the notion of Gamification is discussed in detail. In Section 4, we show two case studies of systems with build-in gamification motivation mechanism: UbiAsk and EcoIsland. Later, in Section 5, we conclude the paper with implications gained from the case studies.

2. USER INCENTIVES: BACKGROUND

Over the past two decades, intelligent systems and interface studies have emphasized the need to shift from usability to understand and design for more engaging experiences. It is a significant challenge for researchers and practitioners to find ways to engage and direct the participants' attention to useful purposes. Previous studies in social and computer science have identified a list of approaches to motivate engagement [4, 7]. In this section, we review two mainstream approaches in human-computer interaction studies to incentivise activate participation: the social psychology motivations and the economic incentives.

2.1 Social psychology motivations

Social psychological, such as social facilitation effect or social loafing, is another widely harnessed non-monetary in-

centive mechanism to promote increased contributions to on-line systems. Social facilitation effect [15] refers to the tendency of people perform better on *simple tasks* while under someone else's watching, rather than while they are alone or when they are working alongside other people. On the other hand, the social loafing effect [10] is the phenomenon of people making less effort to achieve a goal when they work in a group than when they work alone, since they feel their contributions do not count, are not evaluated or valued. This is seen as one of the main reasons that a group is less productive than the combined performance of members working alone.

Ways of taking the advantage of the positive social facilitation and avoiding the negative social loafing for online data collection systems, were suggested in [3]: individuals' efforts should be prominently displayed, individuals should know that their work can easily be evaluated by others, and the unique value of each individual's contribution should be emphasized. Cheshire, C. et al. [5] conducted a series of quantitative field experiments to examine the effects of social psychological incentives and their results demonstrated that social psychological incentives, like historical reminders of past behavior or ranking of contributions, can significantly increase repeat contributions. The measurement applied in the experiments was the average number of contributions per contribution session of a given individual. In addition, web browser cookie was used to identify users in order to account for multiple sessions by the same user.

2.2 Economic incentives

Economic incentives are the real money or any other commodity that the users consider valuable. They are probably the most straightforward way to motivate participants. B. Frei [9] reported a simple comparison study between paid and free crowdsourcing. The results show that in most of the application domains the paid crowdsourcing can produce better completion rate and processing time than the free crowdsourcing. However, once with money being involved, quality control becomes a major issue due to the anonymous and distributed nature of crowdworkers. Although the quantity of work performed by participants can be increased, the quality cannot, since crowdworkers may tend to cheat the system in order to increase their overall rate of pay. Another drawback with economic incentives is that they can destroy pre-existing intrinsic motivations in a process known as "crowding out" [6], so they are better used when other motivations are not likely to exist.

Amazon Mechanical Turk is one of the most popular online crowdourcing marketplaces. Job providers advertise small tasks ("Human Intelligence Tasks", or HITs) on the website, and give small money as rewards for each task. Generally crowdworkers complete the tasks directly on the Mechanical Turk web site. Another example that uses economic motivation is *CrowdFlower* [1]. Contrary to Mechanical Turk, CrowdFlower involves virtual money in their rewards system. Traditionally online game (e.g., Farmville [2]) players can earn in-game currency by taking part in surveys or by clicking adverts, now they have a chance to complete CrowFlower tasks via a system called Virtual Pay.

3. GAMIFICATION

The idea of taking entertaining and engaging elements from computer games and using them to incentivise participation in other contexts is increasingly studied in a variety of fields. In education, the approach is known as "serious games" [17] and in human computing it is sometimes called "games with a purpose" [13]. Most recently, digital marketing and social media practitioners have adopted this approach under the term "gamification" [16]. The concept of gamification is to integrate game mechanics and game thinking into non-game applications. The main game mechanics used to gamify a system include point system, rewards, leaderborad, levels, epic meaning, and so forth. The idea is to create a so-called *gamification loop* (see Figure 1) in the non-game system: the iteration starts with a clear goal or challenge with specific winning condition. Every time the user achieves a small goal, some rewards are given accordingly, which is normally supported by the point system (score, virtual currency, experience point, etc). Based on the point system and achievements history, a leaderboard (global or partially) and badges are provided to players for motivating competitiveness, which eventually results in change of the players' virtual status in their social network or the system.

Figure 1: The Gamification Loop

Recently there is a gamification movement in both web and traditional industries towards gamifying their existing products. Several real world examples appear, such as: collecting badges in location based service Foursquare[1], leveling up in My Starbucks Rewards[2], Earning Points in My Coke Rewards[3], and travel leaderboards in Tripit[4].

Compared to economic incentives, gamification is a non-monetary incentive that requires light cost when operating, has less malicious users, and gives better quality of results. There is an overlap between social incentive and game-based incentive, such as the usage of leaderboradrs to increase competiveness or utilization of the effect of self-expression to motivate users to perform task. However, in general the design

[1]http://www.foursquare.com
[2]https://www.starbucks.com/card/rewards
[3]http://www.mycokerewards.com/
[4]http://tripit.com

and implementation of gamification powered system require heavier work, but also have a greater impact with regards to the ability to incentivize and influence people.

4. CASE STUDY

In this section we show two case studies: a mobile crowdsourcing application designed for image based social search across languages, called UbiAsk, and a persuasive application for motivating users to reduce CO_2 emissions named EcoIsland.

4.1 UbiAsk

UbiAsk is a mobile crowdsourcing platform [11], in which the ubiquitous users in the cloud can rapidly create, deliver, perform microtasks and share the results via different social media such as Twitter and Facebook. The application domain we targeted is image-based mobile social search. This refers to a camera phone application that attempts to solve the problems of translating text written in an unfamiliar script or explain the meaning of symbols or signs. This kind of a system is particularly useful for travelers and short-term residents in a foreign country. Conventional digital pocket translators or mobile translation applications are useless if the user is unable to input the text they see in the first place (e.g., Japanese for Western people). Traditionally, image-based mobile search uses Optical Character Recognition (OCR) algorithms to extract text out from an image. However, image recognition and text recognition are still very difficult tasks for computers. Even the state-of-the-art in this field, such as Word Lens[5] or Google Googles[6], demonstrates very limited performance in real-world situations (e.g., complex background, dark environment, blurred photos, irregular fonts, sizes or formats, etc.), especially for complex scripts like Japanese or Chinese. UbiAsk, on the other hand, is a human-powered system, thus can perform image / text recognition tasks in dramatically higher quality. In addition, human workers can provide situational advice and instruction to the mobile requesters in unfamiliar environments alone with literal translation of text.

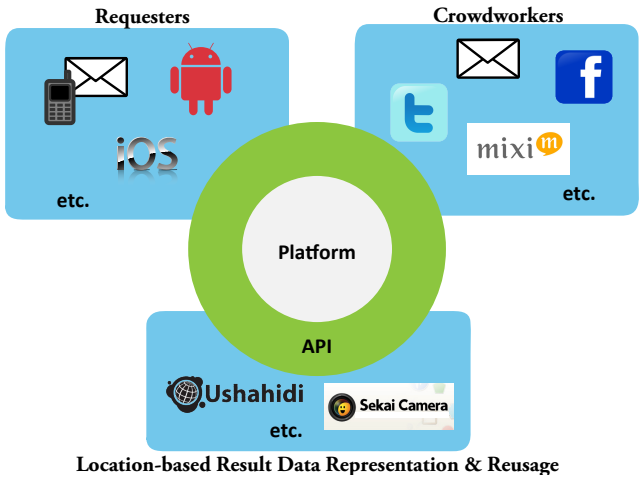

Figure 2: Platform System Architecture

[5]http://questvisual.com
[6]http://www.google.com/mobile/goggles

Figure 2 illustrates the basic system architecture. Diverse methods can be utilized by the job provider to quickly create and submit a task to the server. Proxy server pushes the task to appropriate workers via emails as well as different social media platforms such as Twitter or Facebook. We argue that the results may be not only valuable for the original requester but also beneficial to a broader public. Thereby, optionally, the location based result data can be visualized with other social mapping platforms and / or social augmented reality services. After several rounds of design iteration including formative evaluation with potential users, we implemented a prototype version of UbiAsk. Traveler can use an iPhone application or mobile email to make a new request. The request is assigned to local experts (i.e., normal local users) via email and Twitter. The result data is visualized on an Ushahidi based interactive map (see Figure 4).

A significant distinction between this platform and other mobile crowdsourcing systems (e.g., [8]) is that, it is a non-paid service. We draw on the power of ordinary people in the social networks and design gamification incentives aiming to motivate their active participation and engagement. A location based mobile game was designed and implemented, which can be seen as a kind of location based leaderboard. The main interface of the game (see Figure 5) is a Google map based real world map, which is divided into non-overlapping hexagons. The goal of the game is to conquer territories. Work user is awarded "points" from the system when (s)he is the first replier of a request. These "points" are location-based. The location of a "point" depends on where the requester submitted the question. For each hexagon on the map, players compare their "points" of this hexagon. The player with the highest number of points becomes the owner of this area, or also known as the *local expert* of this area. The local expert's profile photo and an identifying color are displayed in their hexagons on the map.

In this design, we added the important game mechanic, points system, into the application. In theory, weighting points around specific activities (i.e., fast reply) can drive users to participate in those activities, if players have been given a reason to care about the points. Hence, we further involved the location-based leaderboard to ensure the points have unique value in the system. We give ownership of the virtual space on the map as well as the special title as the rewards and the badges for the user, which are the powerful game dynamics to create player's loyalty to the system.

From the end of January 2011, we ran a six-weeks, controlled, field experiment in Japan to examine the performance of the system and the relative effectiveness of the designed incentive mechanisms [14]. The experiment involves 55 participants mainly recruited from the Internet. 36 of the participants are Japanese / English speaking ordinary local residents who act as local experts. The rest 19 participants are foreign travelers who were visiting Japan during the experiment period. They acts as requesters. In order to assess the effectiveness of the gamification incentive mechanisms, the local experts were divided into experiment groups and control group.

We finished and analyzed the user study by the end of March

Q: Why there are so many kimono grils on the street today?
LE1: They were attending the "seijin-shiki", but I dont know its eng name, sorry.
LE2: Today is the Coming-of-age day, youth are 20 years of age need to attend a very special ceremony.

Figure 3: A sample interaction with UbiAsk

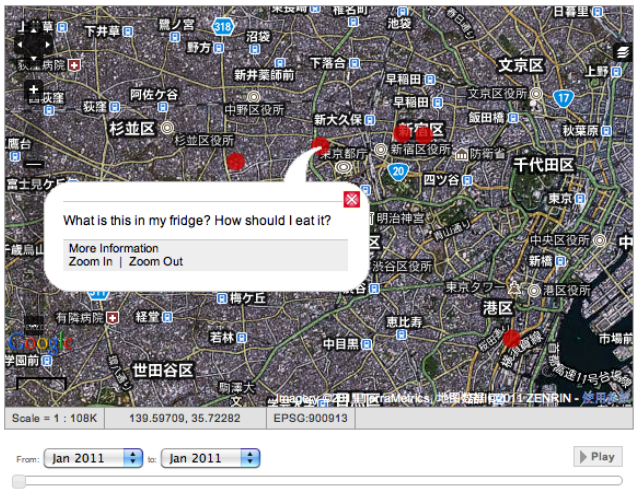

Figure 4: Interactive map for visualizing result data

2011. Our results demonstrated a reliable performance on response speed and response quantity: half of the requests were answered within 10 minutes, 75% of requests were answered within 30 minutes, and on average every request had 4.2 answers. Especially in the afternoon, evening and night, nearly 88% requests were answered in average approximately 10 minutes, with more than 4 answers per request. In terms of participation motivation, we found although the top active crowdworkers were more driven by intrinsic motivations rather than the extrinsic incentives, the effectiveness of the designed game-based incentives for the less self-motivated participants is still verified. However, based on the results we could hardly come to the conclusion that the gamification incentive has a greater impact than the social psychological incentives.

4.2 EcoIsland

Global warming caused by greenhouse gases released into the atmosphere through the activities of human is considered to

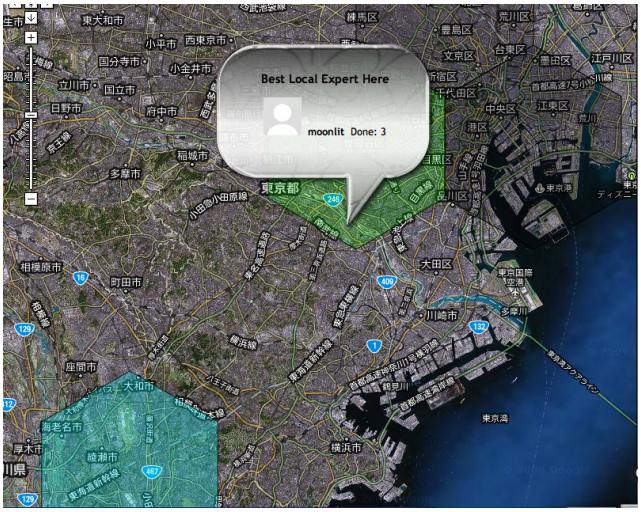

Figure 5: Main interface of the location based game

be one of the major global issues. Besides technical solutions, changes in human behavior to reduce greenhouse gas emissions is also believed to be effective effort. EcoIsland system was designed for utilizing information technologies to persuade individuals and families to change their lifestyle patterns to do more eco-friendly activities [12]. To keep users interested in the application the gamification concept was applied. The system was designed as a game-like application that ubiquitously provides feedbacks of user's normal daily activities to motivate the user to change her / his behaviors. A display installed in the living room or other noticeable place in the household presents a virtual island.

Figure 6 shows the detailed design of EcoIsland. Every family member is represented on the island by an avatar. The players (family) set their own target CO_2 emissions level (e.g., national average number minus 20%). The system monitors their approximate current emissions via self-reporting data. If the emission exceeded the pre-set level, the seawater around the island starts to rise for a certain amount of height. Users need to catch up the delay of activities to prevent the seawater rising again. A list of activities that users may take to reduce the emission is given and shown on their mobile phones and PC browsers, including: turning down the air heater by one degree, use public transportation instead of drive car, etc. After completing an activity, the participants report via their mobile phones or personal computers, and the seawater level reacts accordingly. The reported activities are shown in speech bubbles above the corresponding avatars. A lack of activity leads to the avatars to suggest desirable activities. The players can also see neighboring islands (families) and their activities in the display as well, and can list sell and buy offers for emission rights on an online marketplace. A virtual currency is introduced to the system, which can be earned through environmentally desirable activities. Participants can also use this virtual currency to buy virtual items and decorate their islands, thus successful sellers can afford to decorate their island more, while heavy emitters have to spend their allowance on emission rights.

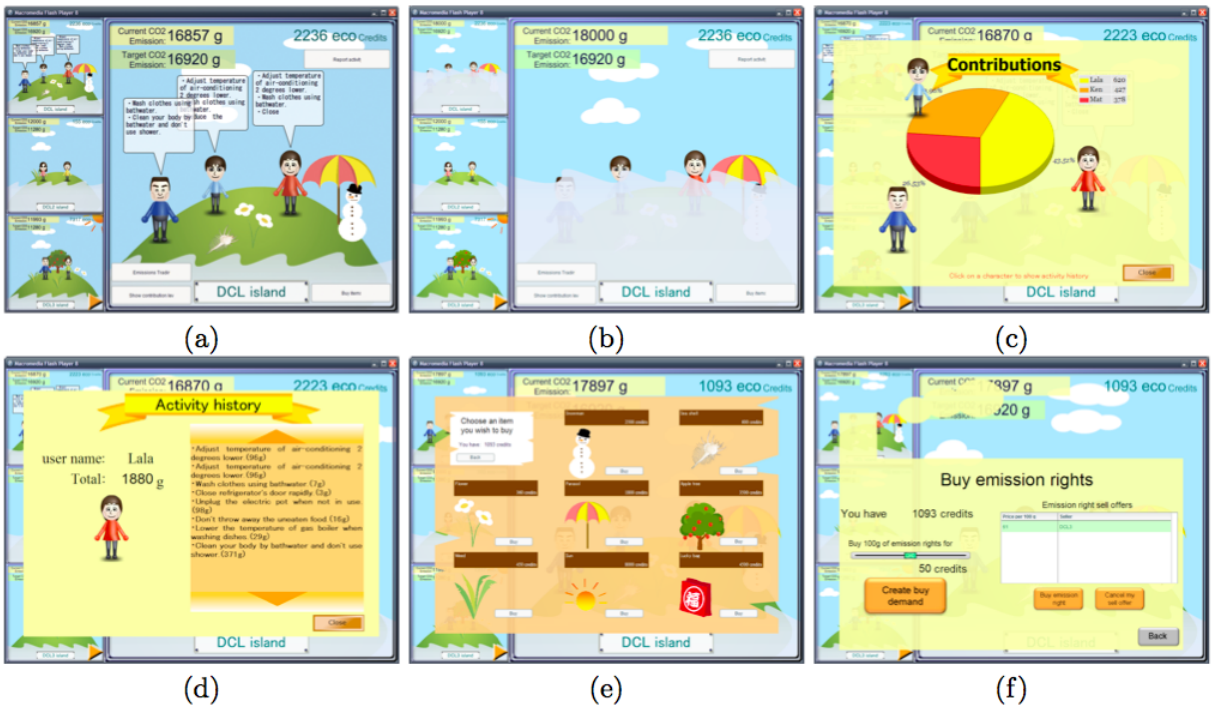

Figure 6: (a) A speech bubble appears after reporting activities. (b) Water level rises when the current CO2 level exceeds the target level. (c) Contribution of each family member shown in a pie chart. (d) Each member's activity history. (e) Buying virtual items using virtual currency. (f) Emissions trading screen.

The game mechanics in EcoIsland was centered on the virtual currency, which is a form of point system. Other important components in the gamification loop were also implemented: the game starts with a specific goal, and the rules of gameplay is clearly defined. For every achievement, the corresponding feedback is given immediately, and virtual currencies are assigned as rewards. When the targeted goal is unachieved, the EcoIsland applies the game element of Loss Aversion to keep users interested in the application, which is a game mechanic that influences user's behavior not by reward, but by not instituting punishment.

The effectiveness of EcoIsland was evaluated through user study. Six volunteer families participated, mostly acquaintance families or relatives of our laboratory members who are interested in environmental issues. In total 20 people were recruited, age from 15 to 58, 12 male and 8 female. As the system was intended to be used in a group, all families have one or two children (age 15-24), five families have both parents, and one family has a single parent (age 47-58). Participants used their own mobile phones for reporting eco-friendly activities. The experiment lasted for four weeks. In the beginning of the first week, a simple electricity usage meter called Ecowatt[7] was equipped on the participant's air heater. During the first week, participants do not use EcoIsland, and measures the energy consumption before using EcoIsland. In the second week, EcoIsland was installed and participants were asked to start to use it.

[7]http://www.enegate.co.jp

After the experiment, in the last week, we conducted a survey in the form of a questionnaire asking about the changes in the participants' attitudes. In the survey, 17 out of 20 participants said that they were more conscious of environmental ecology after the experiment than before. From the air heater electricity usage, there was no statistically significant correlation with the reported activities. While this is an alarming result, it reflects that the experiment period was short to measure the day-to-day variance in an electricity usage. The experiment was arranged from the end of December to the beginning of January, the period might also be non-optimal because it is a holiday season in Japan. In the future, EcoIsland could be linked to a HEMS (Home Energy Management System), which allows to retrieve a large variety of usage data automatically, also to make much more comprehensive evaluation possible.

5. DISCUSSION

In both study cases, the game elements and game mechanics are successfully integrated into the applications by adding point system to the basic structures. However, the evaluation results indicate the performance of gamification incentives did not reach statistical significance. We believe one major cause of this result is the relatively small number of participants and the short period of experiments, which leaded to insufficient interactions between players (i.e., the expected fierce competition did not happen) in UbiAsk case, and lack of large variety of usage data in EcoIsland case. In the following part, we discuss other important implications we have observed:

5.1 Main functionality first

Gamification is a way to improve user's engagement of a service, however, it only provides secondary support to the main system functionality. It is impossible to magically shift user's behavior via gamification when the main services of the system cannot attract user's interests at all. For example, if the users do not have an environmentally friendly mind and have no interests of saving energy at first place, they will not use EcoIsland no matter wether there is game mechanics in the system. On the other hand, gamified components likewise have less influence for those users who are already deeply interested in the core service. For instance, the most productive crowd workers in UbiAsk are driven by intrinsic motivations of giving or the effect of altruistic feelings, rather than the designed game incentives.

This could be seen as one of the key features of gamification: the goal is to add game elements into a system in order to make it a game-like application, but not really design it as an actual game. In other words, gamified systems have the game structure, but not the game surface, the essential parts of the system remain a non-gameful application. This is also one of the differences between gamification with the previous "serious game" notion, where serious game is more about adding non-entertainment purposes into a game. However, the concept of serious game failed to widely spread in the real world. One reason is the design and implementation of a "real" video game is heavy and costly with regards to both engineering and time. On the other hand, there is very few "realistic" incentives, but only quite big risks, for the game industry practitioners to develop such games with non-entertainment primary purposes.

5.2 Make it fun

Game elements like badges and leaderboard is an essential aspect but should not be the only component to create game experience. Other than adding game mechanics, building the application with an actual game-like surface is also important to prosper gamified system. Designer should build the system as a fun application to interact (play) with. We believe that the expected game-like behaviors will only arise when user is truly having a fun experience, which requires much more than simply adding basic game mechanics: well-designed avatars, content, flow, user interface and interaction model are all needful components for a successful gamification implementation.

6. CONCLUSION

How to improve user's engagement has become one of the essential challenges in designing intelligent environments. The current trend of integrating game design and game thinking into non-game applications – the so called gamification concept – suggested a new solution for better engaging with end users. In this paper, we reviewed the game-based participation motivation mechanism and compared the gamification concept with other two mainstream incentives methods: economic incentives and social incentives. We introduced two case studies, a mobile crowdsourcing application designed for image based social search across languages called UbiAsk, and a persuasive application for motivating users to reduce CO_2 emissions named EcoIsland. We discussed the experiences, the implications and the lessons we gained from applying the gamification concept in intelligence systems.

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