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Playing Games with Information: Investigating Perceptions of a Mobile Content Sharing Game

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ABSTRACT: *We introduce Indagator (Latin for explorer), an application which incorporates multiplayer, pervasive gaming elements into mobile content sharing. Indagator allows users to annotate real world locations with multimedia content, and concurrently, provides opportunities for play through engaging interactive game elements. A study of Indagator was conducted to obtain usability feedback, and to examine the impact of the usability of its content sharing and gaming features on participants' intention to use it. Participants used the software to complete a set of tasks and subsequently completed a questionnaire and attended an interview, both of which were to elicit their opinions on the usability of the system. Participants felt that the features in Indagator were able to support the objectives of content sharing and gaming, and that idea of gaming could be a motivator for content sharing. In terms of intention to use, usability of Indagator's gaming features emerged as significant predictors.*

Categories and Subject Descriptors: H.3.2 [Information Storage]; **Data Classification:** I.2.8 [Problem Solving, Control Methods, and Search]; **Heuristic methods:** I.7.5 [Document Capture]; **Optical character recognition**

General Terms: Data Classification, Genetic Algorithm, OCR,

Keywords: Mobile Content Sharing Game, User Evaluation, Usability, Social Computing

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1. Introduction

The rapid pace of development of mobile technologies in recent years has led to a variety of features incorporated into mobile devices. Apart from voice communication functions, mobile devices now feature a slew of capabilities including image capture, video recording, email services, Internet browsing and location positioning. With increased data-processing power, mobile devices have also become the platform on which social computing applications are

deployed. Such applications support interaction, content generation and participation among communities of users. In terms of content creation, the portability of mobile devices add a new dimension to social computing in which users can now co-create, seek and share multimedia information anytime, anywhere, and do these in new ways not possible with desktop applications [7]. Beyond ubiquitous content creation, mobile devices offer entertainment to users. From casual games, mobile games have evolved to sophisticated multiplayer, location-based ones in which players either compete and/or cooperate to achieve the games' objectives within a geographic area set in the real world [20].

The intersection of social computing, mobile content sharing, and pervasive gaming holds the potential for developing innovative, engaging applications for content sharing on mobile devices. Specifically, a central theme in this new genre of applications is that content is created and shared as a consequence of gameplay, and the gaming experience becomes an extrinsic motivator for content sharing activities. Further, many of these games are social in nature, requiring multiple players to work together to achieve the game's objectives. One example of a mobile game for data collection is the Gopher Game [4]. Gophers are agents that represent missions to be completed. As players move about their physical surroundings, they pick up gophers and help them complete their missions by supplying them with camera phone images and textual content. By doing so, content sharing among players is achieved since other users may pick up these gophers and view the images and text associated with them.

Notwithstanding their potential, research in such applications that combine mobile content sharing and gameplay is nascent, and examples are few in number [4-9]. As an emerging application genre, they have yet to attract sufficient research attention on a number of fronts, including their design and implementation, as well as user experience, perceptions and attitudes. For this reason, research is needed to understand how such applications

can effectively blend gameplay into mobile content sharing to motivate such activities, and understand how users perceive and respond to them. The objectives of the present paper are therefore three-fold. The first is to extend current research in mobile content sharing games through the design and implementation of *Indagator* (a Latin word for explorer). The second objective is to evaluate *Indagator* in a user study to determine its usability. Here, we aim to uncover strengths and weaknesses of the application in supporting mobile content sharing. Finally, given *Indagator*'s unique approach to mobile content sharing, our third objective is to ascertain aspects of the application's features that influence participants' intention to use it. In addressing these objectives, we anticipate that the findings may be used to inform the design and implementation of similar systems that blend content sharing and gaming as well.

The remaining sections of this paper are structured as follows. Section 2 presents related research in the area of content sharing and gaming. Section 3 introduces *Indagator* and highlights its key content sharing and gaming features. Section 4 describes the methodology of our study. Section 5 and 6 presents our findings and analyses while Section 7 concludes with implications of this work as well as opportunities for future research.

2. Related Work

Applications that combine content sharing and gaming elements first emerged on the Web. Perhaps one of the earlier and more successful examples is the ESP Game [27]. Here, two players are randomly paired and tasked to create keywords to images presented to them within a given time limit. Points are earned only if the two players (who are remotely located) assign the same keyword. In addition, specificity of the keywords determine the number of points obtained, and coupled with a countdown timer that ticks away the seconds on screen, these elements add excitement, challenge and hence motivation for players. While players are entertained through the game, the matching keywords or content can be used as tags for these images such that and if a sufficient number of tags are collected, they can be used improve the performance of image search engines.

This genre of games is also known as Games With A Purpose (GWAP) and may be characterized as applications that use games to solve a given problem [27]. Stated differently, such games harness humans to perform computations in an entertaining setting. In the case of the ESP Game, the problem to be solved is to label images with text, a task that existing algorithms cannot perform as well as humans. Another example is *OntoGame*, a gaming platform that offers a series of games for creating knowledge structures associated with the Semantic Web [24]. Here, games range from *OntoPronto* for creating an ontology from Wikipedia entries, to *OntoTube* for annotating YouTube videos with ontological elements. Other such games can be found at the Games With A Purpose site

(<http://www.gwap.com>).

Similar ideas that blend content sharing and gaming can also be found in mobile applications. One example is the *Gopher Game* [4]. As mentioned, gophers represent missions to be completed, and are carriers of information between players. The game is location-based and players collect gophers as they move about their physical surroundings. A player helps a gopher complete its mission by supplying it with camera phone images and textual content based on a task description. This information is submitted to a community of judges, and players earn points depending on the quality of the content submitted. Using these points, players can create new gophers and participate in other in-game activities. Through the process of helping gophers complete their missions, content sharing among players is facilitated because other users may collect these gophers and view the images and text associated with them.

Next, in *MobiMissions* [9], content sharing is accomplished through the completion of missions, which are defined by sequences of digital photographs and text annotations associated with specific locations. Players create missions for others to undertake, and search locations for available missions. To complete a mission, a player has to capture up to five photographs and add up to five text annotations. This content can then be shared with other players. The game also provides a Web site that allows players to review and rate missions as well as their respective responses. Finally, *CityExplorer* [19] extends the idea of games for labeling images (e.g. ESP Game) to the physical world. The game treats a geographic area, such as a city, as a game board which in turn is subdivided into segments or game tiles. Within each segment, players need to label as many points of interest with category names as possible. Categories are not predefined and players can develop their own. Examples can include general ones such as "food" to specific ones such as "bar" or "café". A player who creates the most number of labels in a segment wins credits for that segment at the end of the game.

3. Introducing Indagator

Indagator is an application that combines gaming elements into mobile content sharing activities. As its name suggests, the application is modeled after an exploration theme operating in two levels. First, *Indagator* provides an environment for users to create, share and seek location-based content. Second, layered upon this information environment is a game of exploration, in which players navigate their physical world to amass treasure, overcome obstacles, and interact with other players. In this section, we will first highlight the content sharing aspects of *Indagator*, followed by the gameplay features that it supports.

3.1 Content Sharing Features

At its core, *Indagator* is a mobile content-sharing

application. A map-based interface is provided for exploring and discovering content (also known as annotations) as shown in Figure 1. The map is centered on the user's current location, and annotations within the vicinity are displayed as markers. Selecting a marker will retrieve the details of its corresponding annotation (see Figure 2). Individual annotations comprise attributes such as title, tags, images, and textual information. At creation time, other implicit attributes are also captured such as contributor name, location where annotation was created, and date. As annotations are user-generated, a rating feature of one to five is also provided as a measure of information quality. Additional annotation access mechanisms include filtering by attributes such as date/time, location, and user.

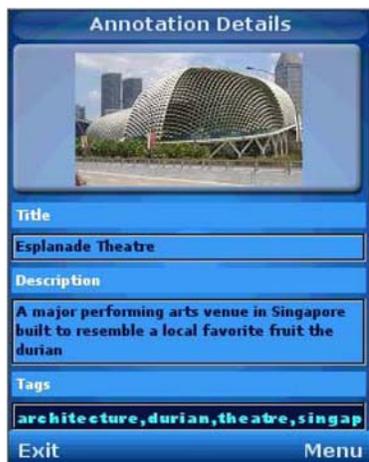


Figure 1. Annotation details



Figure 2. Map interface

3.2 Gaming Features

Layered upon Indagator's content exploration environment is a set of features that provide users the opportunity to concurrently engage with their content through play. As described earlier, Indagator gameplay is inspired by tales of explorers who navigate uncharted territory in their quest for fame, fortune and adventure. Gameplay in Indagator is deliberately designed to be simple to reduce the cognitive overhead of players who are on the go. In essence, players explore their environment to seek content

they need, or create new content to be shared with others. As part of the game, their goals are also to amass wealth by interacting with Indagator's gaming features:

Earning currency. Players earn in-game currency (called *aurum*) by enriching the environment through contributing content, rating existing content, or through successful engagement of encounters (see below). Aurum can then be spent on encounters, to acquire game objects and access other game-based features. Further, the amount of aurum comprises a player's wealth, which will determine his/her ranking on the game's leader board.

Setting encounters. When creating content, players have an option to associate an encounter with it, which will be triggered when the content is accessed. Setting encounters require various amounts of aurum depending on type and level of difficulty. Figure 3 shows an annotation with an encounter type and level of difficulty being selected. Encounters are meant to introduce the elements of entertainment and surprise into content sharing and seeking, and include:

- Mini-games – primarily casual in genre and may include puzzles, shooting, and board varieties. Games may be contextual, such as a guessing game that presents clues about a nearby attraction for players to solve, or non-contextual, in the case of a shooting game. Different games cost varying amounts of aurum.
- Traps – causes a player to lose aurum when stumbled onto. This amount is credited to the encounter setter.
- Treasure – earns a player some aurum when chanced upon. This is system generated and randomized across content.



Figure 3. Creating an annotation with an encounter

Engaging encounters. Players who access content associated with encounters may choose to engage it and earn aurum, or bypass it to continue accessing the annotation with no penalty or reward. The latter was a design decision to ensure content access takes priority over gameplay. However, players who engage an encounter

receive aurum depending on their degree of success. Figure 4 shows a contextual encounter where a player is presented with an image and asked to specify its location within a nine-grid map. Images are harvested and randomly selected from nearby content. Players who successfully specify the location will obtain aurum.

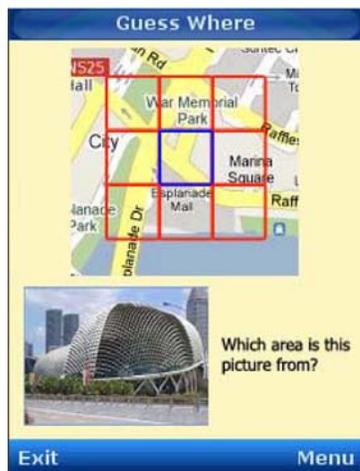


Figure 4. Engaging an encounter

Put differently, Indagator may be compared with pervasive, multiplayer games, but unlike these, there are no designated objectives. Instead, Indagator gameplay is open-ended, with the primary purpose of facilitating the exploration and creation of content as players move around in their physical environment. Thus, Indagator is more similar in genre to virtual worlds such as Second Life (<http://secondlife.com/>), with the addition of gaming elements unique to the system.

3.3 Design Decisions

The design decisions incorporated into Indagator are primarily focused on motivating users to create and share content. Thus, we have adopted the following guidelines, culled from research in a variety of domains:

- *Ease of use.* Indagator's content sharing features are an adaptation of the MobiTOP mobile annotation system. An earlier study of MobiTOP showed that participants generally rated the application favorably [15]. Specifically, participants found that the creating and viewing of annotations were relatively easy to accomplish. Further, attributes of the user interface such as the organization of features in tabs, the map navigation concept, and the consistency of design helped enhance learnability and usability of the system.
- *Entertainment as motivation.* While the popularity of social computing services such as Twitter, Flickr and YouTube suggest that people do create and share information, the motivations for doing so are mostly intrinsic to them, and may include both social (e.g. getting attention) and personal (e.g. future retrieval) reasons [1]. Indagator introduces an additional impetus for content sharing through the use of gameplay. Thus, the application shares similar ideas with GWAPs and related games on the mobile platform in using entertainment as a

motivational factor [27].

- *Gameplay control.* As discussed, although entertainment is one of Indagator's main components, content sharing, and not gaming is intended to be its primary objective. We have therefore deliberately designed the application to allow for varying levels of usage of the gaming features, thus catering to a wide spectrum of users. That is, for non-gamers, gameplay can be dislodged from content sharing activities completely if desired, while those interested in gaming could fully explore Indagator's gaming environment. Further, by exploiting the duality of the "player-as-user" and "user-as-player" dynamics [2], users lacking the propensity to share information could be motivated to do so.

- *Community support.* In Indagator, we adopt the view that content sharing implicitly supports communities of players, and this was a design decision modeled after other user-generated content environments such as blogs, wikis, and social tagging applications in which likeminded users come together to collaboratively create, share and seek information [21]. Further, competition in Indagator's gaming environment fosters a form of socializing beyond direct support and companionship reported by [6]. Specifically, gameplay may provide opportunities to interact with an audience of other players by broadcasting one's achievements and status in terms of wealth and gaming prowess.

4. Evaluating Indagator

An evaluation of Indagator was conducted with two primary goals. The first was to obtain usability feedback for the purposes of refining future versions of the application. The second goal was to examine the influence of Indagator's mobile content sharing and gaming features on participants' attitudes towards intention to use the application.

4.1 Participants

Sixty-two participants were recruited from a local university and consisted of both undergraduate and graduate students who had experience with using mobile phones. Of the 62 participants, 35 were males and 27 were females, with ages ranging from 19 to 37, and an average age of 24.6 years. Thirty-eight of the participants had a background in computer science, information technology or related disciplines, while the other 24 came from other disciplines such as arts, humanities, and business.

In addition, participants had varying backgrounds in terms of frequency of sharing content on mobile phones, playing games on mobile phones and playing games on desktop computers. Here, about 70% of participants reported they did not frequently use their mobile phones to share pictures, video, and music with others. At the same time, slightly more than 45% of the participants played games on their mobile phones frequently. The majority of the

participants (about 65%) were frequent players of games on desktop computers.

4.2 Assessing Usability

The study was conducted across 10 sessions with between four to eight participants per session. The purpose was to keep the number of participants per session low to allow for greater interaction with the Indagator software as well as with the researchers conducting the study. Each session began with an introduction to Indagator and the concept of blending gameplay with mobile content sharing. The objectives of the study were also explained. Participants were then given a demonstration of the system in which they were shown how to use its various features. Researchers ensured that there was consistency in terms of procedures and instructions across all sessions.

Next, participants used the system in an outdoor setting in which they completed a set of practice trials designed to exercise the use of Indagator's major features. Following this, participants were given a set of tasks that covered the major features of Indagator including exploring and creating annotations as well as setting and engaging encounters. During this phase of the study, researchers were on hand to answer questions and assist in using the application if requested by the participants. Each participant was provided with a Nokia N95 phone pre-loaded with Indagator and a data-enabled mobile for the study. The purpose of providing similar phones to all participants was to provide a consistent experience.

After the tasks were completed, participants returned to the lab for a structured interview to elicit participants' opinions on the usability of the system as well as how it could be improved to support the various tasks. Upon conclusion of the interviews, participants were given a questionnaire to complete. The questionnaire consisted of items that rated the usability of Indagator's content sharing and gaming features on a scale of 1 (strongly disagree) to 5 (strongly agree). Items were adapted from past studies on mobile usability and gaming [14-23], and covered six aspects:

- System navigation – understanding and accessing the various features in Indagator
- Map navigation – zooming, panning and visualizing the annotations in Indagator's map
- Annotation management – creating, viewing, editing and deleting annotation content
- Encounter usability – understanding what encounters are and how to set and engage them
- Entertainment value of encounters – whether encounters were entertaining
- Adequacy of encounter genres – whether the types of encounters were sufficient

Finally, participants were asked whether they would be willing to use Indagator to share content if the application

were made available to them.

4.3 Assessing Intention to Use

Related to assessing usability, the study also sought to quantitatively determine which aspects of Indagator's content sharing and gaming features influenced participants' intention to use the application. Here, research has unequivocally demonstrated the important role that usability plays in influencing the intention to use a particular technology [22-26]. For example, in an evaluation of a mobile collaborative learning platform for geography, [25] found that perceived ease of use of the various features by participants had a significant positive effect on intention to use the application. With respect to games, usability has also emerged as an important motivator for playing decisions. [10] studied attitudes towards mobile broadband wireless games and found that factors such as ease of use, attractiveness, and enjoyment afforded by such games were strong predictors of users' intention to play them. Similar usability-related factors were also found in a study of loyalty and continued use in online game communities by [12].

As Indagator blends both content sharing and gaming features, we contend that their respective perceived usability will affect an individual's motivation to use the application. Hence, we put forward the following hypotheses:

- H1: Perceived usability of Indagator's mobile content sharing features has a significant positive effect on intention to use the application.
- H2: Perceived usability of Indagator's gaming features has a significant positive effect on intention to use the application.

To test our hypotheses, multiple regression analysis was conducted with participants' responses to the intention to use questionnaire item as the dependent variable, and participants' responses to the six usability aspects as the independent variables.

5. Results and Analyses

Table 1 shows the 62 participants' mean ratings and the standard derivations (SD) of the six categories of questionnaire items, as well as the question on intention to use Indagator. In general, responses were favorable, with mean values above three, suggesting agreement with the six usability aspects covered in the questionnaire as well as the intention to use Indagator question. In our analysis of the quantitative responses and qualitative comments, four broad issues emerged: user interface, gaming, socializing and intention to use. The following sections discuss each of these in detail.

5.1 User Interface Issues

Indagator organises its various features in a tabbed format that includes items such as Welcome (home page where

status information is found), Annotation management (browsing and creating annotations), Gaming (game management and access to various game features), Settings (player's Indagator settings) and Help (information on using Indagator). Participants found such a navigation structure to be intuitive as they could locate and traverse to the various features easily (Aspect 1 in Table 1). For example, Participant 4 remarked that *"tabs are often used in desktop applications; hence, it is intuitive for me to use this in Indagator..."* Further, tabs also allow new features to be added without cluttering the interface or affecting the existing organization of features.

Indagator also scored relatively well in the map navigation category (Aspect 2). Participants were familiar with this form of navigation since all of them had experience with similar Web applications such as Google maps. Consequently, they felt that they could easily transfer this experience to the mobile platform. However, due to the small size of the mobile phone's screen, most of the participants noted that too many annotations would clutter the interface, making access to annotations difficult. They suggested a filter tool based on criteria including ratings, location and friends' annotations..

Finally, all participants generally agreed that the features supporting the creation and viewing of annotations (Aspect 3) were intuitive. Nonetheless, the main concern was the difficulty of typing lengthy textual content using the numeric keypad of the phone when creating an annotation. Here, recommendation mechanisms [1] could be adopted. For example, the system could recommend a list of keywords to describe an annotation based on location, nearby annotations and other contextual information. Users could then select from this list or manually enter new text depending on their needs.

5.2 Gaming Issues

Aspects 4 to 6 in Table 1 cover the concept of encounters. Generally, scores were near or above four, although certain areas of the application attracted suggestions for improvements. This was to be expected as this was the first release of Indagator, and for many participants, this was also their first time using an application that blends content sharing and gameplay.

Opinions on encounters were divided along two lines. Forty-eight participants (approximately 77%) felt that incorporating gaming into information sharing was entertaining. This view likely contributed to the scores for

Aspects 4 and 5. First, the idea of gaining aurum was a motivating factor, since it rewards players for their efforts in progressing through the Indagator environment [13]. Second, encounters could help players learn more about a particular location. For example, Participant 7 noted that an encounter is *"... an interesting idea for Indagator. In fact, if encounters are relevant to or associated with the location, users can gain extra knowledge while playing"*. However, the inclusion of encounters was controversial for 11 participants. They felt the encounters may impede those who only want to read annotations, since the encounter screen had to be dismissed before the annotation content could be accessed. Participant 17 remarked that *"encounters could be irritating when my intention is to read an annotation"*. On hindsight, our original design decision of allowing players to bypass encounters when accessing annotations proved to be a prudent one.

Results of the evaluation of encounters from the questionnaire and from participants' feedback suggest that their entertainment value and range of genres (Pinelle et al., 2008) for selection and play could be improved (Aspects 5 and 6). Due to the limited number of available encounters during the study, some participants could have felt that the motivating value of encounters for mobile content sharing was diminished. For example, Participant 12 wanted encounters to be visually attractive: *"... to me, nice graphics is the most important factor. Good animation should be considered as well. Lastly, audio/sound effects should be applied properly to make players more enthusiastic about the game"*.

Several participants wanted the ability to create their own encounters rather than selecting from a predefined list, thus extending the idea of user-generated content into game development. The rationale was that doing so would encourage a greater sense of ownership to Indagator and therefore serve as an incentive for sustained play. Participants were also interested to further explore the social dimension of encounters. In particular, they wanted to have a history of users who engaged a particular encounter for the purposes of comparison and competition. Details such as ratings and comments contributed by the community of Indagator players were cited as critical elements to make encounters more appealing.

Nevertheless, despite these shortcomings, the above average scores in Table 1 were encouraging. Even participants who did not like encounters felt that Indagator

No.	Aspect	Mean	SD
1	System Navigation	3.74	.65
2	Map navigation	3.89	.43
3	Annotation management	3.92	.43
4	Encounter usability	4.11	1.19
5	Entertainment value of encounters	3.81	1.14
6	Adequacy of encounter genres	3.97	1.21
7	Intention to use Indagator	4.03	1.11

Table 1. Responses to Indagator questionnaire

had the potential to appeal to both gamers and non-gamers. A comment from Participant 15 illustrates this: “... I prefer not to choose the game mode at this moment but I like the idea of information sharing; and if the games are multiplayer in the future, I’ll give it a try”. Thus, those inclined towards games could choose to engage encounters in Indagator while those focusing only on content sharing could bypass them and access annotations directly.

5.3 Socializing

As Indagator relies on a community of users for gameplay and content generation, the issue of socializing was a recurrent topic that emerged during the study. In particular two major themes surfaced. Firstly, participants commented that reputation was an important issue in mobile content sharing applications such as Indagator. They expressed a need for rating and commenting features for annotations, users and other user-generated content (e.g. encounters). For example, Participant 42 remarked that “ratings are helpful for me to decide if I can trust in an annotation created by a user”. In addition, there was some concern that inappropriate content may be created by players. A “Report Abuse” feature was thus recommended by some participants so that administrators could be notified. If persistently reported, an abuser’s reputation would be adversely affected. Further, administrators should also have the ability to remove such content.

A second major theme was the importance of supporting various forms of social networking among players. For example, participants wanted to share their experiences with their friends, such as useful annotations, informative authors and interesting encounters. Thus, a “Recommend” function was suggested to allow players to send their recommendations to selected friends. In addition, participants also wanted to know their friends’ current positions on the map if they were online, and also obtain notifications when their friends made updates. Finally, support for multiplayer encounters was mooted by some participants as it would foster online social ties through challenge and play. In the current version of Indagator, encounters are single-player in nature. The value of multiplayer support was highlighted by Participant 32, who explained the rationale for such encounters by reflecting on her experience with Facebook: “I think that the success of Indagator will be based on the number of

registered members and how many of them I know. For instance, I was previously not interested in Facebook as I had my own blog. However, when a large number of my friends started using Facebook and wanted to keep me updated about what they are doing, and also invited me to play different games with them, I had to explore it and now I’m a fan of Facebook”.

5.4 Intention to Use

Multiple regression analysis was conducted to examine our third objective, specifically, the influence of the usability of Indagator’s content sharing and gaming features on participants’ intention to use the application. As hypothesized, the independent variables impacted intention to use [$F(6, 55)=53.90, p<0.001$] and explained about 86% of the variance ($R^2 = .86$). Standardized beta-weights and their associated t-values are presented in Table 2. Significant predictors were all associated with Indagator’s gaming features and consisted of encounter usability ($\beta = .46, p < .01$), entertainment value of encounters ($\beta = .28, p < .01$), and adequacy of encounter genres ($\beta = .24, p < .05$).

Given these observations, we summarize our results as follows:

- Hypothesis 1 is not supported. The usability of Indagator’s mobile content sharing features, comprising system navigation, map navigation and annotation management, did not appear to influence participants’ motivation to use the application.
- Hypothesis 2 is supported. All three aspects associated with Indagator’s gaming features were found to be significant predictors. Specifically, participants who reported that encounters were usable, entertaining, and that the genres provided were sufficient, were more likely to use the application.

6. Discussion

This paper describes Indagator, a mobile content sharing game that incorporates multiplayer, pervasive gaming elements into mobile content sharing activities. Our work shares similarities with the Gopher Game [4], MobiMissions [9], GWAPs [27] and other such applications in that we aim to investigate the use of games for content sharing. Nevertheless, there are distinct

Independent Variable	β	t
Encounter usability	.46	4.13**
Entertainment value of encounters	.28	3.14**
Adequacy of encounter genres	.24	2.40*
System navigation	.01	.19
Map navigation	-.01	-.10
Annotation management	-.07	-1.27

Note: ** $p < .01$. * $p < .05$. All other p-values were greater than .05.

Table 2. Results of multiple regression analysis

differences between Indagator and existing applications that warrant the present research. The Gopher Game may be viewed as a task-based approach to content sharing in which players are given specific objectives to accomplish via gophers. On the other hand, Indagator players can independently create and share any content of interest. The Indagator environment is therefore more open-ended, requiring more complex player-player and player-system dynamics. Similarly, MobiMissions focuses primarily on generating and completing missions, which are well-defined sequences of locations and associated content. Here, Indagator offers a richer gaming environment that supports encounters, socializing features, in addition to content creation and access. In addition, current GWAPs are Web-based games and are primarily casual in genre. Indagator differs by catering to mobile users, and incorporates location-based, multiplayer gaming elements that existing GWAPs do not.

6.1 Usability, Gaming and Socializing Issues

Our study of Indagator suggests the potential of the application in terms of entertainment as well as content sharing value. This is reflected in the above average scores in Table 1 obtained from the study. In particular, participants felt that the features in Indagator were able to support the objectives of content sharing and gaming. Further, the idea of introducing encounters could positively influence participants to use the application. Our study therefore suggests that mobile content sharing is a viable activity that people will adopt as they see utility in such endeavors [11]. This is not surprising given that social computing has been embraced overwhelmingly on the Web to support community generation of content, as well as to find and recommend related content of interest. With high mobile phone ownership rates, and with phones commonly being equipped with cameras, GPS, wireless networking and other advanced features, the leap from social computing on the Web to the mobile phone is not hard to imagine. Applications such as Foursquare and Facebook are recent examples, and more of such services are expected to appear.

However, our study also illustrated that the limited affordances of the mobile phone meant that creating and viewing annotations remained a challenge to sustained usage. Specifically, textual input was a potential problem as the phone's numeric keypad limited large amounts of text to be entered. Next, slow network speeds that were occasionally encountered during the study also affected participants' perceptions of usability. In particular, being primarily reliant on map-based navigation to access annotations, participants found that there was an unacceptable lag of several seconds between pressing navigation keys and seeing the corresponding update made on the screen when the network connection was slow. The small screen of mobile phones was also a cause of concern among participants who worried about the potential clutter on the map when large numbers of annotations were contributed.

Next, participants were divided into two camps when asked

about the idea of incorporating gaming elements into mobile content sharing. One group felt that setting and engaging encounters, and earning aurum would serve as incentives for users to create, share and access annotations, while another group was concerned that these elements would impede access to content, and may even irritate users who are non-gamers [8]. However, this was not surprising as we expected that not all users of mobile content sharing applications to be gamers. Nevertheless, both camps pointed out that if gaming were to be used as a motivator for content sharing, then the quality of encounters in terms of graphic design, playability and range of genres would be crucial implementation factors.

Support for social interaction was also deemed critical in the acceptance and continued use of Indagator, and this applied to both its content sharing and gaming features. The need for a reputation system was stressed as an important feature that allowed users to rate and comment on other users. Social networking features such as recommending content, finding friends, and synchronous messaging were also highly desired. This also extended to gameplay in which participants wanted multiplayer encounters to be included in future versions of Indagator. The option to create and share new encounters was also requested as this could further foster ownership and online social relationships among Indagator players.

6.2 Intention to Use Indagator

As discussed, the user study also explored attitudes towards Indagator by investigating the influence of the usability of the application's content sharing and gaming features, as well as demographic profiles on participants' intention to use the application. The multiple regression analysis showed that all three aspects of Indagator's gaming features – usability, entertainment value and adequacy of genres were positively associated with participants' intention to use the application. This suggests the importance of creating usable, diverse, exciting and enjoyable genres of encounters to cater to a wide spectrum of players with diverse interests and preferences [10-23]. Put differently, while Indagator is fundamentally a mobile content sharing application, the layering of gaming elements introduces an added challenge of ensuring that both components (content sharing and gaming) are effectively addressed in terms of usability and playability.

Interestingly, none of the usability aspects of Indagator (system navigation, map navigation and annotation management) were significant predictors of participants' intention to use the application. This result however does not imply the unimportance of usability. Rather, one possible explanation is that due to the novelty of blending content sharing and gameplay, participants were more focused on Indagator's gaming features as opposed to features for creating, sharing and viewing annotations. In addition, because Indagator's content sharing features were patterned after those found on the Web (e.g. map navigation) as well as on established mobile user interface

design guidelines [15], participants may have found usability to be relatively less critical when compared to the application's gaming features.

7. Conclusion

Arising from our results, the following are some design considerations for Indagator and similar systems. First, games can serve as viable motivators for mobile content sharing applications because they can enhance players' usage experiences. Put differently, games may encourage users to spend more time with an application as the entertainment derived may reduce resistance to use the application [21]. Consequently, blending of elements of fun and challenge can help promote an application through word-of-mouth. Examples of features to incorporate include experience levels, achievement badges, and quests.

Next, because users value socializing in online environments, social networking elements cannot be overlooked. For content sharing, this would include mechanisms such as reputations (e.g. ratings and comments), filtering (e.g. most viewed, most popular, by author), as well as recommendations (e.g. collaborative filtering). For gaming, socializing features may include public scoreboards, guilds and customizable avatars. Additionally, developers can explore features that reward users when they perform a socially-oriented task, such as inviting their friends to join the game (e.g. receiving an award for having five friends using the application).

Games and content sharing though seemingly dissimilar, can be mutually reinforcing as evidenced by our findings. However, the challenge is for developers to ensure that both game design and application usability principles are adhered to since users may seamlessly switch between the two activities [7]. For gaming, it would be prudent to consult game design guidelines [13-23] even though content sharing may be the primary focus. As discussed, these guidelines should result in games that are challenging, immersive, entertaining, easy to use and learn, and offer a range of genres to cater to players with varied backgrounds and interests. Beyond good game design, application usability should not be overlooked as suggested by qualitative feedback from our study's participants. Here, issues that surfaced concerned the limited affordances of the mobile device. First, the limitations of the numeric keypad points to the need to reduce manual textual input, and introduce automated mechanisms such as recommendations during content creation. Second, the need to manage content on small screens to avoid information overload is imperative. In Indagator's case, this relates to the number of annotations that appear on the map. Here, two options are envisaged: Providing a text-based view of annotations near the current user, and clustering nearby, personally meaningful or semantically-related annotations to reduce the amount of content appearing on-screen.

Although the user study has yielded useful results, we plan to conduct more comprehensive evaluations in future

work. For example, the sample of 62 participants and their short term use of the application may prevent our results from being generalizable. However, the sample size is partially attributed to the current realities of developing mobile applications where cross-platform compatibility is difficult to achieve. Consequently, and as mentioned earlier, our evaluation approach had to consider the logistical and practical issues of lending mobile devices to large numbers of participants for long periods of time. Nevertheless, our approach is consistent with recent work on usability evaluations of mobile applications [5]. Further, the present study uncovered interesting observations that should be investigated. This includes a better understanding of the usability and game design aspects and their relationship with content sharing. For instance, since different features of a technology may afford different benefits to users, this may affect their perceptions and usage intention [18]. Thus, future research may consider examining the relationship between gaming features and the resources they provide to users in order to facilitate content sharing. In addition, personality, gender and other demographic factors that influence attitudes towards content sharing and gaming applications such as Indagator [10- 16] should also be investigated in future work. In the process of doing so, formulating effective design guidelines and evaluation heuristics for this genre of mobile applications would be another significant area of investigation. A final research-worthy area to explore is the richer integration of context-awareness into encounters. Here, beyond location, Indagator could consider a player's current context such as time, profile and his/her companions to customize a given encounter, facilitating a richer and more varied user experience. Work on Indagator is currently still ongoing and we plan to include releasing it for public use in the near future.

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