

Searching and Content Creation in a Location-Based Treasure Hunt Game

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ABSTRACT

We were interested in designing a location-based game (LBG) to promote physical activity amongst players. We also wanted to design the game such that it could be played over an extended period of time and grow in participation. Studies of Geocaching have suggested that this might be possible by allowing actual game players to create and maintain game content. Our game, See It, explores this idea to understand its feasibility in the context of new LBGs. In See It, players use images or video clips of a location to find a hidden container; they can also hide similar content for others to find. Our study revealed that it can be difficult to create a LBG that supports a variety of player-generated content while also being focused on a specific game goal (e.g., physical activity). This suggests that using player-generated content must be done cautiously and only once the game has established a level of maturity.

Author Keywords

Location-based games, Geocaching, pervasive games

ACM Classification Keywords

H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms

Design, Experimentation, Human Factors

INTRODUCTION

Location-based games (LBGs) represent a new genre of game that takes place in the everyday locations we inhabit where the experience of playing is tied to these locations. LBGs have been designed and studied to investigate a range of research topics. This has included technological issues such as wireless connectivity [1,3,5], social issues such as trust [7], childhood education [6], city exploration [2], navigation [4], etc. Despite their success, many LBGs are designed in a way that makes them difficult to duplicate in various locations or sustain long-term participation [8]. This makes it challenging to understand the effects of

repeated or long-term participation [1,22]. One of the LBGs that *has* managed to sustain long-term growth and player engagement is Geocaching, a GPS-based treasure hunt [11,17,18]. Since its inception in 2000, Geocaching has grown to include over 4 million players worldwide [11].

The goal of our research was twofold. First, we wanted to understand how we could design a LBG to increase physical activity amongst players in order to promote more healthy lifestyles. We designed a multimedia treasure hunt called See It where players use media in the form of images or videos to find hidden physical containers called “spots” or caches. Our intention was to provide ambiguous clues to the location of the containers so that players would hunt within a large area and gain increased physical activity. Second, we wanted to investigate change in physical activity over longer periods of time (e.g., months, years) with a large number of players. For this reason, we structured See It around the idea that players could create content themselves. This element has been suggested as one of the reasons for Geocaching’s long-term growth [17].

Once created, we conducted a study of See It to investigate play in the game’s early stages and to seed the game with player-generated content. 73 participants hunted for spots and also created their own spot for others to find over the course of a week. During our analysis of this study, we found that the game had flaws in promoting increased physical activity. We also realized important challenges that exist when attempting to apply lessons from Geocaching on end-user creation to a game in its infancy. This made us reconsider some of the design lessons provided by Geocaching [17] in the context of new LBGs.

Our paper reports on the lessons that we learned about new LBG design and the challenges that exist when attempting to create a flexible and scalable pervasive game that also focuses on specific research topics, in our case, physical activity. Thus, rather than focusing on how players in our game may have successfully increased their own physical activity (or not), we instead focus on the design of the game and its ability to address the research topic we were originally targeting. As mentioned, many LBGs have been created and studied. Yet what is less reported, and often is not, are the efforts that went into a game’s creation and the challenges (if any) that arose in designing the game to address specific research topics. We feel that such

Cite As:

Neustaedter, C. and Judge, K. (2011)
Searching and Content Creation in a Location-Based Treasure Hunt Game Technical Report 2011-1116-02, Connections Lab, Simon Fraser University, Surrey, BC, Canada, November.

investigations (and reporting them) are important for they provide valuable lessons for researchers and designers who are similarly attempting to explore research through LBGs.

RELATED WORK

There are a number of books that discuss how to design games well and what elements need to be incorporated (e.g., [19,20]). However, these do not describe how to design LBGs that can grow to include large volumes of players without losing player interest. McGonigal argues for large-scale augmented-reality games, but the focus is on how games can solve world problems rather than suggestions for achieving such large-scale games [16].

Turning to academic papers, we see several strategies emerge for designing scalable LBGs. First, LBGs such as Treasure [1], EyeSpy [4], Feeding Yoshi [3], Mogi [12,13], and Blowtooth [14] incorporate virtual content in the game in order to increase the number of locations that players can play in and provide continually “fresh” content. Second, the recent proliferation of casual games like Foursquare suggests that simple games that can be played in one’s “downtime” offer a compelling model for promoting scalability [15]. Third, several researchers have suggested that LBGs can scale to large numbers of players and promote long term play by allowing users to create game content themselves [8,17,22,24]. For example, in PiNiZoRo, parents can create walking routes that their children must follow when playing [22].

Most related to our work, studies of Geocaching—arguably the most successful LBG to date—suggest lessons for scalable LBGs. Forestry studies of Geocaching have shown that scalable LBGs should be designed cautiously to understand what effects a large volume of players might have on play areas. Studies have also shown that players have a variety of motivations for participating in Geocaching [9,18], which suggests that scalable LBGs should allow players to choose their own personal goals as part of the game. Neustaedter et al. [17] studied Geocaching to understand the role of end-user creation and maintenance of game elements. They suggest several strategies for creating scalable LBGs that we describe next in detail given our attempt to employ them in our own LBG.

1. Lightweight Creation. One of the core elements of Geocaching is the fact that players can create game elements (geocaches) for other players [17,18,21]. This creation is lightweight and can even be done from the onset of player participation [17]. Thus, Neustaedter et al. suggest LBGs permit lightweight creation by players themselves [17]. We see similar aspects of lightweight creation by players in LBGs such as EyeSpy [4] and PiNiZoRo [22]. In other LBGs, such as Blowtooth [14] and Feeding Yoshi [3], lightweight content is created automatically as players move about their environment.

2. Elaborate Creations. Geocachers can also create more elaborate caches for other players to find, e.g., content with

additional attention to detail [17]. This increases enjoyment and richness in the game and ensures that players have new and interesting caches to find, thereby reducing the chance that the game will become “boring” to players [17]. Thus, Neustaedter et al. suggest LBGs permit players to also create elaborate creations as a part of game play [17]. Such elaborate creations are at the core of many existing LBGs, in particular, those designed as performance art (e.g., Uncle Roy All Around You [7]) or for educational purposes (e.g., Savannah [6,8]). However, in these cases, game designers or artists create elaborate content and not players.

3. Game Customs. Geocaching contains a set of customs that players learn over time as they play [17]. These help them understand how to look for geocaches and how to hide them [17]. The customs also evolve over time as new types of geocaches are created [17]. Thus, Neustaedter et al. suggest LBGs be designed to permit the sharing of customs through play and allow players to evolve the game incrementally [17]. In all LBGs, players are likely to understand the norms of game play after they have played the game at least once. The more they play, the better they will understand the game’s customs. In particular, this was found in studies of Can You See Me Now? [5] and Treasure [1]. Yet what is not usually seen in the related work are LBGs that evolve their customs to incorporate new types of game content, as is the case for Geocaching.

4. Monitoring Game Elements: In Geocaching, players report on and monitor the geocaches of others by recording their hunting activities in online logs [17]. They also sometimes actively maintain others’ geocaches by fixing or repairing them [17]. Thus, Neustaedter et al. suggest LBGs allow players to monitor game elements themselves and maintain them, if needed [17]. In other LBGs, it is rare to see players monitoring game elements and even rarer to see game elements fixed by players. What is more common is to see game orchestrators or actors monitoring game activities [7,8].

Neustaedter et al. suggest incorporating the above four aspects of Geocaching into a LBG’s design in order to help permit the game to grow long term and maintain its “freshness” for players [17]. Next we describe our game, See It, which directly tries to do this.

THE DESIGN OF ‘SEE IT’

In See It, players utilize media in the form of images or video clips to find a hidden physical container. Inside the container is a paper logbook that players sign when they find the “spot.” We describe basic play through an example:

Kaitlyn goes to the game website and sees a map showing the start location of “spots” in her area. She selects one called “Blur: Buggy” and views its web page, shown in Figure 1. Kaitlyn reads a short description about the spot and is given a “start location” illustrated by a blue balloon on a map. She is told that the hidden container is within 1 kilometer (0.6 miles) of this start location. Kaitlyn is also

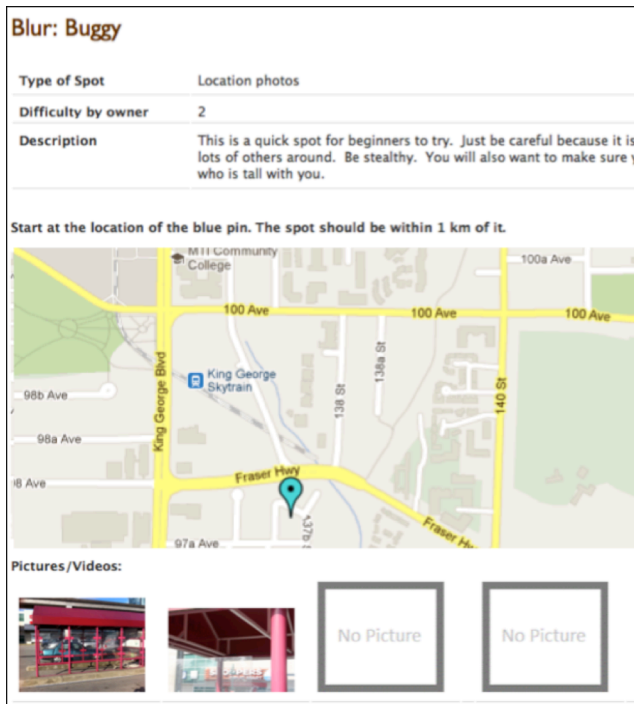


Figure 1. The See It user interface.

given two images, shown at the bottom of Figure 1. In the left image is a red shopping cart vestibule and on the right is a close-up of the interior of the vestibule with the spot container visible—a black magnetic key holder, which is a common geocache container [17,18]. Further down the page (not shown), Kaitlyn can read posts by other players who have also looked for the spot.

Kaitlyn goes to the start location and sees it is near a mall parking lot. She walks around the parking lot while looking for the red shopping cart vestibule. She spots it and then quickly finds the hidden container. Kaitlyn signs the logbook and then records her find on the spot's web page.

As is illustrated in the example, the media—in this case, two images—provides ambiguous clues that cause a player to look around a given physical area in order to find the hidden “treasure.” Media clues could also certainly be more complex, thereby increasing the amount of searching that is required. In any case, the goal is to cause players to physically move through an environment as they hunt, in the hope that this will increase their physical activity.

Start Location and Search Radius. We chose to include a start location and search radius (1 km / 0.6 miles) so that players would have a designated search zone as opposed to having to search virtually anywhere to match the locations depicted in the media. In pilot testing, 1 km appeared to offer a reasonable search zone that wasn't too broad or narrow and it offered players some flexibility in terms of how they structured their spot (e.g., they could offer clues near or far from the start location to vary difficulty).

Player Motivation. The act of finding hidden treasure is rewarding in and of itself, and we argue that finding a physical, real world item that is concealed from the general public, as opposed to a virtual object, adds additional motivation (akin to Geocaching [17,18]). This means players must be ‘secretive’ when playing such that non-players (the general public) do not see them or the concealed item (and later steal it, etc.). This adds another element of fun and excitement. Beyond this, the See It website keeps track of the number of spots a player has found and a “leaderboard” shows the pseudonyms of players with the most finds, thus encouraging competition.

Hardware. Our goal was to support a range of hunting methods. The See It site can be accessed from any mobile device with Internet access, but works best on smartphones. Players can also access the site via a computer and print images or frames of video clips and then hunt with only paper. They could also simply hunt by memory.

Player Creation of Spots

One of the core elements to help facilitate long-term growth of See It is *player creation* of game elements. Like Geocaching, players can create spots for others to find. See It was also designed such that spot creation could be quite flexible. By flexible, we mean that it would be possible for players to create a variety of different spots in order to have a large number of different play experiences. To create a spot, players hide a container, capture media as clues for finding it, and post this information to the See It web site. Game administrators review the web pages for new spots to ensure they meet the game's rules. This involves looking at an online map to ensure the location is reasonably safe for game play and verifying that the media is suitable for public viewing (e.g., no pornography, bullying, or violence).

There are no rules as to what the physical containers can look like (as long as they contain a paper logbook). This means that spots can be easily created or one could go to great efforts to construct elaborate containers and media items describing the location. Spots do have to conform to one of several media types, which were designed to provide a degree of structure while still being flexible.

1. **Location Photo Spots** are the most basic and contain a series of one to five images that depict a location. Images are shown online at the resolution chosen by the spot creator. Kaitlyn's spot hunt illustrates this type.
2. **Eye Spy Spots** are similar to Location Photos, but all images must be captured from the viewpoint of the hidden spot as it “looks” outwards into the world.
3. **Location Video Spots** use short video clips as opposed to images to show the location of the spot.
4. **360 Spots** use video clips that rotate 360 degrees around the hidden container. This shows the container's viewpoint.
5. **Path Spots** use a series of images that progressively bring you closer to the hidden container's location.

Hardware. The creation of new spot pages is currently restricted to a computer, which renders it akin to Geocaching's creation capabilities. We wanted creation to be lightweight, but not 'quick and dirty' with little thought. For this reason, we included a short delay in the creation process. We anticipated that players would capture media of a location and then return home to create the actual spot web page where the time in between would provide opportunity for additional thought or reflection. Following from our study results, we do plan to explore mobile creation as future work, however.

Comparison to Other LBGs

See It is similar to Geocaching—in an attempt to exploit the game features that have made it grow long-term—but different in ways that were necessary in order to explore our topic of increasing physical activity in game play. First, the types of media-based caches that See It is focused on are not permitted in Geocaching; hunting is restricted to using a GPS device. Second, in Geocaching, players typically hunt within a small area because of the accuracy of most GPS devices. For example, when hunting for urban geocaches, geocachers can often drive and park very close to the designated GPS coordinates and then hunt within a small error circle of typically less than three meters [117]. These are so-called “cache n’ dashes.” [17,18] Even with geocaches hidden in parks where driving may not be an option, with a GPS device, you can quickly narrow your hunting location down to a single point. This creates a form of localized search that requires little physical exertion for hunting. Instead, the effort is trying to understand the local environment within the “error circle” and where a typical geocache container would be hidden—the effort is more mental than physical. The goal of See It was to move beyond localized hunting so players would walk about a larger physical area.

Certainly other LBGs are similar to See It in that they are able to increase physical activity amongst players. For some, one could argue that physical activity is not an intentional design criterion and, rather, it becomes a byproduct of normal game play (e.g., Can You See Me Now? [5], Treasure [1]). Others, like Fitness Adventure [24] are specifically created for promoting physical activity where game designers carefully craft routes and gameplay. In comparison, See It permits *players* to create game content in an attempt to make the game scalable. The goal is that regardless of how the content is created, the game's mechanics—searching a fixed region using ambiguous visual clues—should promote physical activity.

STUDY METHODOLOGY

Given our game's infancy, our study focused on how game spots are found and created by newcomers to the game.

Participants

We had 73 undergraduate students participate in our study. All were taking the same fourth year design class and completed the study as part of a course assignment but

could decide to not have their participation included as data within the study. All participants had extensive experience with computers, mobile devices, and media. Only two participants had geocached before, though several others had heard about it. Participants did not receive additional compensation for their participation.

One caveat of our study lies in our participant selection. One could argue that some of our study findings are directly related to having students participate as part of a course assignment. This is an important critique and, as such, we directly report on potential effects from this throughout our results. Our intention for participant selection was to have a large number of non-geocachers participate such that we could reasonably approximate a community of new players to the game. Like any new players, the students will have varying degrees of commitment to the game and varying levels of engagement as a result. That is, some may really enjoy it and put in a lot of effort and others may only be partially interested and simply want to “try it out.”

Method

Prior to the study, we created five See It spots within one kilometer of our university campus. They ranged in difficulty, use of media, and spot type—one was a Location Photo Spot, one was an Eye Spy spot, two were Location Video Spots, and one was a 360 Spot. Two were located in a park next to campus and three were in mall parking lots.

Participants were introduced to See It through a verbal description along with a demonstration of how to search for a spot using the See It website. Participants were told that the game was meant to get people out of their homes and into the physical world to play games, investigate how people use images or videos to find locations, and provide people with opportunities for reflection on the environment, locations of personal significance, and the use of technology. This type of information is similar to what new players would get when reading the game's web site, or being told about the game by a friend. Participants were then given one week to complete the following activities:

1. **Spot Hunting:** *Find two spots either individually or with others and post a log for each.* Participants were given an hour and a half of class time to perform the hunting activity, but could augment this with out-of-class time. The class time was meant to encourage groups of people to hunt together, much like family members or friends may hunt for geocaches in a small group [18].

2. **Spot Creation:** *Create a spot for other players to find.* Participants were told to read the creation rules, create the physical container, capture media describing the location (either images or videos), and then hide the container. They were also told to design a container that would be fairly robust in terms of potential weathering. Again, this type of information is similar to what new players would get when reading the game's web site. Participants were not directly told that their spot should try to increase physical activity;

we had intended for the structure of the game to naturally fulfill this goal rather than having participants think carefully about how to do this. For this reason, we described the goals of the game more broadly (as previously mentioned). New spots created by participants were approved *after* the study was completed, so participants were only finding the initial spots hidden by the researchers. However, to increase participants' motivation to create 'good' spots, we told them that their creations would remain for future players to find and would also be found by the researchers.

Data Collection and Analysis

Participants submitted a log on the See It site for each of their finds. This included a description of their activity and answers to several survey questions, e.g., "How did you find the spot?" and "How long did it take?"

For each spot creation, participants wrote a short description, uploaded media, and answered several questions online. For example, "Why was this location chosen?", "Why was this type of spot chosen?", and "What activities did you do to create the spot?" Participants also submitted additional images of their spot's container. We experienced some technical difficulties with our game site during the study and only 61 of the 73 participants were successful in submitting their spot creation online. Our analysis of creations includes only these 61 spots.

We used open coding [23] to inductively analyze responses to questions about spot hunting, creation and hiding. Using the uploaded information, we also reviewed all spots' media, containers, start locations, and final locations. Thus, we did not physically go to the spot locations during this analysis stage. Overall, our analysis goals were to understand what activities occurred during both hunting and hiding and players' rationales when hiding their spot.

We also wanted to gain a deeper understanding of the game content that was created by our participants beyond what we could review online. Over the course of four weeks, one of the researchers participated in the game by hunting for 20 spots created by the participants. Spots were chosen naturalistically based on areas the researcher happened to be in; this is a typical approach for Geocaching [17,18]. The time spent hunting for each spot ranged from 15 to 90 minutes. Field notes were recorded in a private blog and affinity diagramming was used to find the main themes.

Our results are divided into two main sections. The first focuses on findings from the participants' hunting activities. The second describes findings on the spot creations.

SPOT HUNTING

Feedback from players and survey responses showed that the majority of players enjoyed playing See It. All but one player was successful in finding two spots. Seven people found three spots in total, and three people found four spots in total; thus, they went beyond what was asked of them as part of the study. The choice of which spots to find varied,

though the two most popular were the Location Photo Spot (found 54 times) and one of the Location Video Spots (found 65 times); these were the two spots closest to campus. The reported amount of time taken to hunt for each spot ranged from a minute to 45 minutes; however, it is not possible to know what other activities were included in this time (e.g., travel to location, or just hunting within the specific area of the container). This shows that participants were able to understand the basic nature of the game. Some even articulated in their responses that they were able to learn as they went, even though playtime lasted at most several hours.

Our analysis clearly showed that there were two levels of hunting activities occurring as people tried to find the hidden containers: *high-level location searching* followed by *detailed container searching*. Each of these varied in terms of their affect on physical activity.

High-Level Location Searching

First, participants hunted for the general location of the spot, as shown in the image or video clues. Here they had to travel within the search radius dictated by the starting location. As one might expect, the most common hunting strategy involved visually matching the content in the media with known locations or ones that participants could visually see from their current location.

"What tactic eventually worked was going back and forth and trying to see the difference between each object and spot out if something did not fit in the overall context."

Sometimes participants worked as a group with other participants to hunt for the spots. Group sizes typically varied between two and four people. Groups would most often view the media together and then travel as a group to the general location shown by the media; little individual searching occurred at this point.

We had intended high-level location searching to involve a large degree of physical activity as players tried to find a spot's general location. Yet familiarity with the area around campus made it easy for participants to spot the general location shown in the clues. This reduced physical activity because they could head directly to the location.

"After watching the video, I recalled the location quickly as I am very familiar with the surrounding architectures and environment. As I watch the video again the second time, I pictured the route in my head and confirmed the location with my teammates."

Thus, the start location for each spot was not the actual point from which participants would start searching. Instead, start locations were a means to understand the possible search zone (within a 1 km radius) and the actual start location was wherever the participant happened to be (e.g., the campus, the previous spot found). When landmarks shown in the media were less familiar to participants, they would walk around an area and try to find them. This occurred for one of the Location Video spots where participants had to determine which stump in the



Figure 2. A spot is hidden behind a new metal corner.

park matched the stump in the video clip. The park had between 6 and 10 stumps spread across about 100 meters.

“There were a fair few more stumps in the park than I thought there would be the first time. When I looked at the videos again, I narrowed it down to three stumps then focused on those ones. I found it after that.”

As an extreme example, one participant reported reducing physical activity dramatically when he drove to the container’s general location, three blocks from campus.

Detailed Container Searching

Once the general location was found, participants used a variety of strategies for finding the container in this more specific location, usually within an area of only several meters. Some looked at the media in more detail to see if there was a particular capture orientation, angle, or other visual indicator that would suggest more specifically where the container was hidden.

“We were looking everywhere (ie. ground, bushes, poles, under poles) to find the Cache that were seen in the video. Someone in the group took the iPhone out and we started to re-watch and compare the spot video with the location that we were at. Then, after comparing and analyzing we found it.”

Another strategy involved feeling all sides of surfaces such as fences, walls, or trees to learn if the container was present but not easily visible. Others carefully hunted around the likely container location through very careful visual inspection, sometimes looking for items or objects that stood out or were considered unusual.

“We first searched around the location and check if there was anything abnormal that’s poking out from the ground. Then we began looking for objects around eye level that did not belong.”

For those who hunted as part of a group, a common strategy was to split up once they reached the container’s specific location and each individually searched different areas.

Hunting Summary and Discussion

Together, we can see that the second more detailed hunt around the container’s specific location involves meticulous searching around a specific focal point; this aspect of hunting was very similar to Geocaching. This lends itself to little physical activity and the activity or challenge is certainly more mental in nature. On the other hand, the first act of finding the general location—high-level location searching—does have potential to increase physical activity



Figure 3. A black container is placed under a mailbox.

as players walked around looking for the location. Familiarity with an area can reduce this however. Because the participants were students and hunting for spots near their campus, which they were largely familiar with, familiarity was certainly a factor. One could argue that regular players may take longer to search for the spot’s general area then. Yet studies of Geocaching have shown that players look for caches near their home, on their way to work, or in other locations they frequent before finding caches in other non-frequented locations [18]. We would expect such behavior to carryover to See It, which would make the students’ activities more broadly generalizable.

SPOT CREATION

Participants also each created a spot as part of their activities. All spots but one met the rules of the game and some were better than others, as one might expect. In total, participants created 29 Location spots, 17 Eye Spy spots, 8 “360” spots, 6 Path spots, and 1 Location Video spot.

Spots also varied in terms of the effort that went into their creation. Similar to Neustaedter et al.’s classification of geocaches [17], we classified 16 of 61 spots as *elaborate creations* because the containers had all been designed with extra care and attention-to-detail such that they fit their hiding location well. In many cases, they would have taken a substantial amount of time to create. For example, Figure 2 shows a bench at a bus stop. The corner of the bench was previously missing the metal edging. This participant created a new metal piece for the corner, including drilling holes for screws (to appear more realistic), and hid the logbook for the spot between the metal piece and the bench.

We classified 45 of 61 spots as *lightweight creations* because the attention-to-detail in the container was less and the spots could have been more easily created and placed. They also did not blend into their environment as well. For example, Figure 3 shows a black metal container placed under a mailbox that could have been easily created. The placement is not likely to be noticed by non-players, though it certainly does not blend into the environment as well as the elaborate creation in Figure 2.

The number of elaborate vs. lightweight creations we found in our study is consistent with how often a person would generally expect to find each type in Geocaching. Yet these numbers could easily be skewed because participants were performing the study as part of a class assignment; that is,

some students may have been more motivated to create an elaborate cache in order to get a good grade, and others may simply have not cared. Regardless of the specific numbers, what is most important is that the game did in fact facilitate *both* lightweight and elaborate creations as was our goal. Thus, players could enrich the game with interesting elaborate spots if they so desired, or they could create spots more quickly and increase the number of available spots.

Our analysis also revealed that the use of media did not deviate between lightweight and elaborate creations. Aside from choosing different types of media (e.g., images vs. video), participants captured their media in a style fairly similar to the spots created by the game administrators. Thus, they understood the customs of the game in terms of media and did not deviate from them, or attempt to expand the ways in which media was used. Instead, the container's creation and placement dictated the elaborate or lightweight nature of the spot.

Our analysis also revealed a number of challenges that existed as a result of user creation in the game that we outline next. These relate to using the game to increase physical activity and also the effects of our efforts to design the game so that it would be flexible and grow over time.

Challenges with Reviewing and Monitoring Content

As mentioned, we reviewed the details of each spot creation using the See It site. We classified 11 spots as being problematic and we did not approve them. In these cases, we suspected either the spot was too visible and likely to be stolen, it was placed on personal residential property (where players are not likely to want to venture), or, in the case of one, it did not meet the rules and fell outside of a 1 km distance from its start location. The remaining 50 of the 61 spots met the rules of the game and were deemed as 'good' for others to find because they did not appear to have any of the above problems.

The online reviewing process was straightforward and relatively easy for us to do. However, while hunting for the participants' spot creations as part of our participation, we found that the quality of the spots were not as good as our review process had suggested. Of the twenty spots hunted for, the researcher found nine, couldn't find three after exhaustive searching, and declared eight missing. Thus, the quality of the spots varied considerably and at least half were either too difficult to find or no longer there.

The important point here is not that the participants created good vs. bad spots. Instead, there is an important realization in terms of administrator review of content created by players. First, such content clearly needs to be reviewed in some respect to ensure that it (likely) meets the rules of the game. However, it can be difficult to properly review game content without actually seeing the content in person. Online systems can provide some level of detail, but in practical terms this may not be enough to ensure the quality of the content. A risk then arises that player-generated

content is either non-existent or of a lesser quality. This could limit growth of a new LBG considerably as new players could be frustrated by not finding a spot or disappointed in the game's quality once they do find the spot. Similarly, the quality of spots could deteriorate longer term and it is not easy for game administrators to monitor this when physical items are placed across large geographical distances (currently a city that spans ~80 km).

Challenges with Understanding Game Norms

Geocaching allows players to create new geocaches even from the onset of their participation [17,18] and our study was structured to model this aspect. In fact, we felt this was quite important in order to help the game grow quickly. However, the creation of game elements by new players turned out to be problematic, as mentioned. It could be the case that because participants were doing the study as part of a class assignment that they simply did not want to instill enough effort to create their spots well. This is certainly possible, yet we reviewed the survey responses and content for the problematic spots after our hunting activities and found a different reason.

We had hoped that our initial instructions and participants' hunting activities would provide players with an understanding of game norms and how to produce quality game content. However, our analysis revealed that many participants understood the norms of the game on the surface, but lacked more detailed knowledge that was necessary to make quality content. That is, they understood what types of containers to use, how to hide them, how to capture media, and were motivated to do so (as evidenced in their survey responses); however, they did not always understand how to do each of these steps well. This resulted in containers being missing, weathered, or too hard to find.

Missing Containers. In the case of the eight missing containers, some were hidden in areas with large amounts of garbage on the ground and could have been misconstrued as such and thrown out. Several others were placed in plainly visible locations with a container that did not blend-in to the environment. This is despite the fact that several participants talked about purposely trying to create a container that would be small and not easy to spot or specifically camouflaged to match the area. For example:

"My container is a white diffused film-canister. I chose it because of it's seal, size and relevance to its locations context...the color of the canister looks similar to the color of the concrete in the area."

Despite the intention, an analysis of this spot's location suggests that there are few places to actually hide such a container without it being visible (and susceptible to theft).

Weathering. Of the nine spots we found, four contained logbooks that were soaking wet; thus, participants did not clearly understand how to avoid weathering. Again, this is despite some participants purposely saying they selected their container so that it would be waterproof or going out of their way to construct a watertight container. For



Figure 4. An image clue that is too ambiguous.

example, one participant added a plastic sheath inside of the container with a special seal to keep water out. When we found this spot, the logbook was soaked. The plastic sheath had not been adequately designed to stop water from getting in, despite significant efforts to do so.

Too Hard to Find. The three spots that could not be found were far away from their starting location (but within the limits set by the rules) and the associated media was too ambiguous to determine the correct location. Trying to match the media to locations in the area would have been impossible or taken a very long time. For example, Figure 4 shows an image clue for a Location Spot containing a sidewalk path and some foliage. The area within the spot’s search radius contains many residential buildings and side paths similar to the one in the image. Walking around to try to find the spot could certainly produce a lot of physical activity. Yet finding the correct path would be very difficult and could easily create feelings of frustration amongst players (as it did for us when trying to find it).

Challenges with Game Goals

As said, we had intended See It’s design to fulfill two goals. First, we wanted the game to be flexible so that players could create game content that reflected a variety of motivations or personal goals. This could then provide hunters with a wealth of different experiences and, hopefully, cause players to play the game longer term; this is one of the cornerstones of Geocaching [17,18]. Second, we wanted the game’s mechanics (e.g., the use of ambiguous visual clues) to automatically promote physical activity, regardless of the spot creations. However, our analysis revealed that these two goals were in conflict.

Flexible Content Creation. First, players did indeed create spots in a variety of locations based on a range of motivations. The most popular reason for location selection was an attempt to bring people to an overlooked location or provide awareness of a location.

“The reason I chose to place the cache at that spot is because people usually go to the same bus stop on certain days on a weekly basis and usually wait for the same bus at the same time. Yet as human we tend to neglect objects or places we encounter frequently, and we seldom pay close attention to their changes.”

Another popular reason for location selection was attempts to create a challenge by bringing people to an area with lots of hiding spots or with lots of people present, thereby requiring that the hunter be stealthy when finding the spot.

“Fun place to dodge bystanders and be stealth while trying to look for this container. It is an added difficulty while trying to locate the hidden container.”

We also found other lesser-reported reasons for locating spots such as pragmatic issues in trying to locate a spot close to home or near a transit station. Sometimes selected locations evoked personal memories. Overall, given the diversity in rationales, and the range of spots created (previously discussed), we felt that the game successfully supported the first goal of flexible player-generated content.

Physical Activity. Yet as we hunted for spots we recognized that the underlying goal of the game, to increase physical activity, was not necessarily being met. That is, the game’s structure was not always allowing the implicit goal of physical activity to be fulfilled in addition to the user-chosen goals described above. Spots could be anywhere within a 1 km radius, in order to promote physical activity, and we had anticipated that clues would narrow this down to a walkable hunting area. We previously described how familiarity with an area reduced physical activity and, in addition to this, we saw two other challenges arise that reduced physical activity.

First, some spots were placed too close to their start location and, upon arriving at the area, it was fairly easy to match the clues in the media with the location’s landmarks or landscape. This meant that players could park at a starting location and walk straight to the spot’s hiding location in only a few meters. These spots would equate to Geocaching’s “cache n’ dash” geocaches [17,18]. In Geocaching, these are desirable so people can easily increase their find counts, but in See It they are problematic because they reduce physical activity.

Second, and in the opposite case, it was sometimes not immediately obvious where a spot was located in relation to the starting point. Because of the 1 km search radius, it was then assumed that the spot could be found *anywhere* within this search zone (even if it was actually very close by). In this situation, we would commonly get back in our vehicle and canvas the broad search zone while driving. Thus, the activity had removed nearly all physical activity and, worse, it promoted excessive use of a vehicle.

Within the nine that we found, we saw two instances of successfully structuring spots so that they could produce physical activity. In neither case was this the intent of the participant as evidenced by their survey responses; instead, it was simply an unintended byproduct of the spot’s creation. The first instance was a spot placed by a participant along a walking path in a park. The starting location was in a parking lot adjacent to this path. The image clues showed a stump and a garbage bin off in the distance. To find the correct stump and garbage bin in the background, hunting involved traversing the walking path, often back and forth, and looking at each stump and its relation to garbage bins in the area. In this case, there was

no possibility of using a vehicle because it was a walking path. The second instance was a spot placed in a newspaper stand on the side of a busy road. The road was busy enough that it was difficult to drive up and down the road while looking for the spot. This forced one to park and walk while hunting. The street also had several newspaper bins within the search radius so hunting involved walking and inspecting to see which stands matched the image clues.

DISCUSSION AND CONCLUSIONS

We designed our LBG, See It, around two primary goals. First, we wanted it to increase physical activity amongst players and we did this through the use of ambiguous visual clues for locations. Second, in order to investigate change in physical activity over longer periods of time, we designed See It around lessons from Geocaching, which have been suggested as reasons for its long-term growth [17]. However, when studying early creation and hunting in See It, we realized important challenges exist when attempting to apply lessons from Geocaching on end-user creation to a game in its infancy. We also found that our game did not promote physical activity as we had intended.

Reviewing and Monitoring Game Content. Our study showed that there were challenges in reviewing and approving game content created by players. This task was more difficult and error prone than we anticipated and a large number of spots that we approved were of a lesser quality than we had hoped. Geocaching has a similar approval process to See It and would likely suffer from the same challenge. However, Geocaching gets around this problem because players actively police game content, report on it, and even help owners maintain caches [17]. This is because there are a lot of players and the logging infrastructure in Geocaching supports the activity of policing content [17]. New LBGs like See It do not have this luxury and will not until they increase their player base. There is a chance that we had fewer high quality spots because our participants were students in a class, but this would not change the main finding that it can be harder to review and monitor new content in a LBG in its infancy.

In the meantime, while LBGs are young, game administrators need to monitor player content themselves and have the ability to easily update it if needed. This is likely easier if content is virtual. However, in the case of See It, where there are also physical items spread over large play areas (e.g., an entire city), there is the additional challenge of overseeing the quality of physical content.

Physical Activity vs. Flexible Creation. Our study also showed that See It was successful in allowing flexible end-user creation of game content. Players created both lightweight and elaborate content, they used a wide variety of containers (to make spots interesting), and had varied reasons for bringing people to specific locations. See It also promoted some increased physical activity, in particular when spots required walking and players were less familiar with an area. Yet we had anticipated a larger

increase in physical activity, especially during our own hunting activities.

On the surface, it may seem that See It did not promote more physical activity because not all spots were created well by the participants. That is, they failed to design them in a way that increased physical activity. Yet participants' creations matched the instructions given to them (thus they were successful in their task) and they were not trying to increase physical activity with their creations. We purposely did not tell them more specifically about promoting physical activity because we had wanted the game's mechanics (e.g., start location, search radius, types of clues) to implicitly accomplish this goal. Yet this didn't always work.

Overall, we feel the main challenge at play was our attempt at designing *both* a scalable LBG and one that can fulfill specific research goals. The challenge is that if you want end users to create game content—and a variety of it at that—you are not guaranteed to get game content that will meet the underlying game goals. We also realize that in LBGs like See It where the game is always available and can be played at any point in time, as game administrators, we are not in control over when or how people play. For example, we cannot force players into walking to locations or going in a certain path. Driving can be an easy alternative when the situation supports it (even for us!).

Game Mechanics and Rules. There are certainly ways that we could redesign See It to better balance underlying game goals (e.g., physical activity) with attributes to help them scale (e.g., flexible end user creation). These could similarly aid game designers of other LBGs. First, game designers could carefully tweak game mechanics. For example, in See It, we could try modifying the search radius that we chose. However, the right size of search radius will vary depending on the location, the obstacles blocking one's view (e.g., buildings, trees), a player's familiarity with that location, etc. This makes it difficult to adjust 'correctly.' Designers of other LBGs may be faced with similar obstacles where there is no obvious right decision, especially when flexibility in game content is a concern.

Second, game designers could set the rules of the game to enforce its goals. For example, in See It, we could tell players that their spots *must* promote increased physical activity. Yet players may not know how to do this well and it would be difficult to review spots online to ensure that they could in fact increase physical activity. Rules could instead enforce known practices for creating spots that promote physical activity. For example, players might be required to hide a spot deep in a forested area where vehicles cannot go. Yet these changes could easily limit what players are able to create and this would certainly detract from the flexibility of the game and any attempt for it to provide a range of experiences for players. Thus, we suggest applying such rules and mechanics cautiously.

Customs and Norms. Game designers can also rely on game customs and norms to help promote game goals in LBGs that permit content creation by players. In Geocaching, players learn the norms of the game and can apply them when they make their own geocaches [17]. This helps them create good content [17]. We had intended this to happen in See It, but players did not have enough opportunity to understand game norms well and the norms of the game had also not been clearly established yet. This suggests two important implications.

First, we feel that in LBGs like See It, players should have broader experience with the game—such that they can see and understand the customs—before they are allowed to create content. They should also be exposed to content that, for the most part, achieves the game’s implicit goal. This should make it so that new game creations created by players would have a greater chance of fulfilling the game’s goal as well. It may also be helpful to simplify the creation process even more than we have done. If content is easier to create, players may be more compelled to understand the intricacies of ‘good’ content creation more quickly.

Second, it is important to realize that Geocaching is a well-established game; See It is not. This means that customs and norms will take time to develop and they will not necessarily be there from the onset of the game’s creation. For these reasons, we suggest that new LBGs should reach a sufficient level of maturity before players create content. Customs and norms need to first be established and noticeable to players.

We welcome others to continue to think about how one might design new LBGs such that they can scale to large volumes of players over longer periods of times. We hope our research complements such work.

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