Challenges in Designing a Scalable Location-Based Game using Player-Generated Content

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Abstract. We were interested in designing a location-based game (LBG) that it could be self-sustaining, 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.

Keywords: Location-based games, Geocaching, pervasive games

1 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 [1-7]. 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]. Geocaching, a GPS-based treasure hunt, is one LBG that has managed to sustain long-term growth and player engagement [9,11,17,18]. Since its inception in 2000, Geocaching has grown to include over 4 million players worldwide with over 1.5 million geocaches hidden and available to find [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 how we could, at the same time, design our location-based game to be 'scalable' such that it could support a large amount of players (e.g., hundreds or thousands), maintain players' interests in the game for long periods of time, and essentially be self-sustaining. This would, in the

future, allow us to explore longer-term changes in physical activity amongst players. For this reason, we structured See It around the idea that players could create game content themselves. This element has been suggested as one of the reasons for Geocaching's large volume of game content, long-term growth, and continued player engagement [17].

In essence, what we wanted to do as part of See It's research was understand if and how we could replicate Geocaching's success in scalability with a game focused on specific goals. Simply put, we wanted to know if Geocaching's large-scale growth was perhaps 'one-off,' or if, as researchers have suggested [17], one might be able to incorporate player-generated content in a manner similar to Geocaching in order to create a game that scales more broadly. Within this context, we wanted to learn how player-generated content had to be structured such that players would do a good job of creating it and, as game administrators, what we needed to do to scaffold or support the act of content creation.

Once See It was created and pilot tested, we conducted a study to investigate play in the game's early stages and to seed the game with player-generated content. In total, 73 participants hunted for spots and also created their own spot as part of the game. During our analysis, we realized that important challenges exist when leveraging player-generated content for a game in its infancy. To foreshadow, our study found that it can be difficult to rely on player-generated content early on in a game's creation because players may not understand how to design content well and it may or may not match the underlying goals of the game. We also found it was difficult to review player-generated content to check on its quality without a larger community of players available to help (as is the case with mature games like Geocaching). This suggests that player-generated content should be used cautiously within a new LBG and is best suited for situations where the game has evolved to a sufficient level of maturity, both in terms of the amount of content that is available and the degree to which players are actively involved in the game.

Our paper reports on these challenges and lessons in the context of new LBG design. Thus, rather than focusing on how players in our game may have successfully increased their own physical activity (or not), we instead focus this paper on the design of the game and its ability to be scalable by directly allowing players to create game content. 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. We feel that such investigations (and reporting them) are important for they provide valuable lessons for researchers and designers who are similarly attempting to explore research through LBGs.

First, we explore related work on designing scalable LBGs and focus, in particular, on Geocaching. Second, we describe See It and our design rationale. Third, we describe our study and results, focusing on challenges with player-generated content. Fourth, we discuss our results and the lessons learned for creating new LBGs.

2 Related Work

Our related work is partitioned into two sections. First, we explore existing research on creating scalable LBGs. Second, we look closely at the mechanisms employed in Geocaching that have helped the game grow dramatically over the last decade.

2.1 Designing Scalable Location-Based Games

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] all incorporate virtual content in the game in order to increase the number of locations that players can play in and provide continually 'fresh' content. For example, in Blowtooth, finding bystanders with a mobile device emitting a Bluetooth signal creates a 'player' [14]. In Feeding Yoshi, open wireless access points automatically become game elements [3]. Such games have shown that even with simple automated content, players enjoy the competitive nature of the games [1,3,4]. Yet we don't see studies of longer-term play (e.g., months to a year) to understand if players are compelled to continue playing the games and if the content is rich enough to support such motivations.

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]. Such casual games have shown they can successfully scale to large numbers of players. However, the richness of the experiences they offer appears to be less than other non-casual location-based games (e.g., Uncle Roy All Around You [7], Geocaching). For example, studies of Fourquare have shown that while some players are motivated to use Foursquare because of its game-like properties, game play is not entirely compelling and some simply play in order to have 'something to do' when bored [15]. Game elements (e.g., badges) also become less of a motivation for playing over time [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]. Similarly, Capra et al. [8] suggest "campaign strategies" where players upload multimedia from their own personal devices in conjunction with events organized by local organizations. The idea of using players to create game content is also the strategy employed by Geocaching and we elaborate on it in detail next, given our attempt to replicate it.

2.2 Lessons from Geocaching on Supporting Player-Generated Content

Studies of Geocaching have suggested several strategies for supporting player-generated content as part of a LBG:

Support Lightweight Content Creation. In Geocaching, players can create new game content (geocaches) in a fast and lightweight fashion and this can even be done from the onset of player participation [17,18]. This means that players are tied to the game more strongly because they become responsible for part of it [17]. We see similar aspects of lightweight game creation by players in other LBGs. For example, in EyeSpy, players tag locations with a text label or image captured on a mobile device [4]. These tags then become elements for other players to verify. As mentioned, lightweight creation is also present in PiNiZoRo [22].

Support Elaborate Content Creation. 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]. Such 'elaborate creations' are at the core of many existing LBGs. For example, in Uncle Roy All Around You, players are led through an elaborately orchestrated environment full of planted objects, people, and riddles [7]. In Savannah, children learned about animals by viewing a mobile device that carefully mapped content to real world locations in a field [6,8]. Yet in these cases, administrators or orchestrators of the games created the elaborate content, not players. In fact, beyond Geocaching, we don't know of any LBGs that leave elaborate creations in the hands of end users, given the (likely) difficult task of creating them. Despite this, it would seem likely that if players were able to create elaborate content in LBGs, like in Geocaching, such content would be highly rewarding for players to interact with.

Help Players Understand the Game. As geocachers play the game of Geocaching, they learn how to find geocaches and what makes for a good geocache [17]. This knowledge, in turn, helps them understand how to hide geocaches well [17]. Thus, Geocaching contains a set of 'customs' that players learn over time as they play and these help support player-content creation [17]. In all LBGs, players are likely to understand the norms of game play after they have played several times. In particular, this was found in studies of Can You See Me Now? [5] and Treasure [1]. What is not clear though is how much play or how much training is needed in order for players to understand how to create content well. As mentioned, Geocaching permits players to create content very early on in their play, but the game website suggests that players wait until they develop a degree of experience before hiding a geocache [11,17]. The amount of experience is never specified.

Permit Players to Monitor and Report on Content. In Geocaching, players report on and monitor the geocaches of others by recording their geocaching activities in online logs [17]. They also sometimes actively maintain others' geocaches by fixing or repairing them [17]. Together this allows the players themselves, in addition to the

game administrators, to 'police' the game and ensure content is available and of a good quality. In LBGs that support player creation of game content, the monitoring and verification of content is sometimes even a game element itself, which further suggests its benefits. For example, in PiNiZoRo, as players walk the routes created by others, they are verifying the route created [22]. In EyeSpy, one of the main aspects of the game is to verify the locations tagged by other players [4].

Taken together, we can see that existing location-based games, including Geocaching and others, have shown a variety of strategies for incorporating player-generated content. Next we describe our game, See It, which similarly tries to incorporate player-generated content as a core game element in order to promote long-term play and engagement.

3   The Design of See It

See It is a location-based treasure hunt game that we designed in order to explore physical activity and scalable location-based games. 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 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
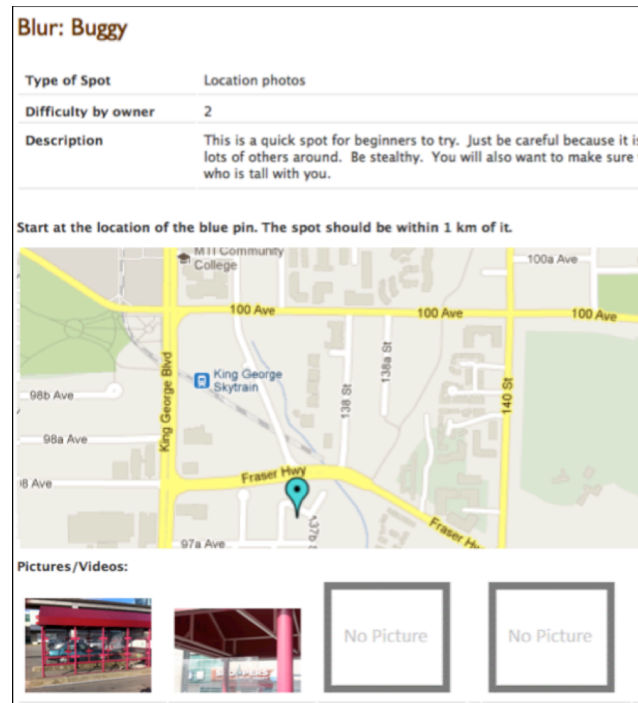
Fig. 1. The See It interface showing a spot description, start location, and images clues.

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 is accessible from any Internet-enabled mobile device, 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.

6

3.1 Player Creation of Spots

One of the core elements to help facilitate See It's scalability 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. This in turn would hopefully cause the game to grow to include large volumes of content and players.

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 plan to explore mobile creation as future work.

See It is intentionally designed to be like Geocaching in an effort to leverage what we believe are the features of Geocaching that make it a scalable game platform. We also changed certain aspects in order for us 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 to find the final location. Second, in Geocaching, players typically hunt within a small area because of the accuracy of most GPS devices. We hypothesized that this creates little

opportunity for physical activity. As such, we designed See It to try and increase the 'search zone' so players would walk about a larger physical area. Third, and perhaps most important as it relates to this paper, See It is a *new* LBG. That is, it has no players (besides our 73 study participants), administrators must ensure there is enough interesting content to seed the game, and game administrators must provide the players with an understanding of the game in order to support their creation efforts. These differences are critical for they directly allow us to explore many of the facets that have made Geocaching successful in the context of a new LBG.

4   Study Methodology

Given our game's infancy, our study focused on how game spots were found and created by newcomers to the game. First, 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. Second, we had 73 undergraduate students participate in our study by playing See It. 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 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. This introduction lasted approximately 20-30 minutes. 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]. Participants submitted a log on the See It site for each of their finds. This included a description of their activity.

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. New spots created by participants were approved *after* the study

8

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. For each spot creation, participants wrote a short description, uploaded media, and answered several questions online. For example, "Why was this location chosen?" and "What activities did you do to create the spot?" Participants also submitted additional images of their spot's container.

Data Analysis. We used open and axial 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. 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 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.

Limitations. The main caveat in our study methodology 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 player, 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.' Yet, in addition to this, participants would also have had extrinsic motivations to perform 'well' given that they were also being graded on the content they created for the game. This becomes important in our results because we saw a large number of issues related to the quality of the content that participants created, despite have the extrinsic motivation to do it well.

5   Results

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 and several people found more spots than required. Participants also each created a spot as part of their activities but only after gaining initial experience in hunting for spots. Despite this, our analysis revealed that several challenges existed directly as a result

of incorporating player-generated content into the game. 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. We outline these next.

5.1 Challenges with Reviewing and Monitoring Content

As mentioned, we reviewed the details of each spot creation using the See It site. We classified 11 of 61 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 (as mentioned). 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, though we return to this in the next section. 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).

5.2 Challenges with Creating 'Good' Content

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 and also so we could learn would effect this would have on the game. 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. Yet given that they were being graded on what they created, this is less likely. In fact, we

10

Fig 2. An image clue containing a sidewalk and some foliage that was too ambiguous.

reviewed the survey responses and content for the problematic spots after our hunting activities and found a different reason for their quality level.

We had hoped that our initial instructions and participants' hunting activities would provide players with enough knowledge for them to know how to produce quality game content. However, our analysis revealed that many participants understood how to create content 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. We discuss each of these next.

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 making them susceptible to theft. 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 hide such a container without it being visible (and susceptible to theft). What this shows as a whole is that participants did not have enough experience to understand where to properly place containers to avoid containers going missing.

Weathering. Of the nine spots we found, four contained logbooks that were soaking wet. Thus, participants did not have enough experience to 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 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.

11

Fig. 3. A spot is hidden behind a new metal corner of a bus stop bench (left) and a black spot container is hidden underneath a mailbox (right).

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. Again, we see that participants did not have enough experience, in this case, to create 'good' visual clues. For example, Figure 2 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).

5.3 Challenges with Game Goals

Beyond the aforementioned issues with creating 'good' content, we also had challenges with content meeting both of our game's 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 a variety of game content. 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 to promote physical activity. We had thought our game's mechanics (searching within a fixed radius using ambiguous visual clues) would be able to automatically promote physical activity, regardless of the way that user's created their spots. However, we were wrong. Instead, our analysis revealed that the two goals of our game were often in conflict.

Flexible Content Creation. First, we found that the game's flexible structure for content creation did indeed allow participants to create a range of game content. 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

12

well. In many cases, they would have taken a substantial amount of time to create. For example, Figure 3 (left) 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 (right) 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 3. 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. 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.

Players also had various motivations behind the particular location they chose for their spot. The most popular 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 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.

"I placed my spot at this location because this place is very special to me. I have fond memories of <location removed> with my loved ones. So the idea of sharing this wonderful place with those in search of my spot makes me happy, as I am sure they will grow to love the place as well."

Given this diversity in the rationales for location selection and the range of spots created, it is highly likely that the spots created by participants would provide players with new challenges, experiences, or opportunities to look at one's surrounding in different ways. This would hopefully promote long-term player engagement. In this way, we felt the spots created by participants were successful because of the flexibility of the game. Thus, overall, 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 other 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. 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 and 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.

6 Discussion

We designed our LBG, See It, to increase physical activity amongst players and we did this by having them search an area for a container using ambiguous visual clues for locations. We also wanted our game to be scalable and self-sustaining over a long period of time so we designed it to utilize the same basic framework as Geocaching

where we relied on player-generated content. Yet this turned out to not be simple. Instead, our study made us realize that important challenges exist when attempting to utilize end-user creation within a game in its infancy. Our paper focuses on these challenges and we discuss each next.

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]. Players have also built up a culture that includes bragging rights for being the 'First To Find' (FTF) a geocache [17,18]. Thus, there is strong reasoning and motivation to find each and every geocache and, as part of this, check on them. New LBGs like See It do not have the luxury of being able to rely on large volumes of players to check on content and will not until they increase their player base. There is a chance that the quality of content in our study was affected by the fact that participants were students in a class, but this would not change the 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, yet virtual content may be less rewarding for players to find. 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. Yet we had anticipated a larger increase in physical activity, especially during our own hunting activities. The problem was that our game's mechanics were not designed well enough to automatically promote physical activity and players were not explicitly told their spots needed to support increased physical activity. Those who tried did not necessarily know how to do it well. Overall, we feel the main challenge at play was our attempt at designing *both* a scalable LBG and one that can fulfill specific goals (e.g., increased physical activity). The challenge is that if game designers 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. However, 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 how to create good content by playing the game and learning from what already exists in it; they learn from the existing customs and norms [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. We tried to 'bootstrap' this process by: describing the game to players before they played, seeding the game with good content, and having players find it before they created their own content. However, despite the fact that students had the extrinsic motivation of being graded on what they created, the content they created was still not of a high quality (for many participants). 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. Our study did not allow us to find out just how much experience players need before creating content, but, in general, this will likely vary on the player, the nature of the game, and the location in which it is being played. We also recognize that it may 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 will take time to develop and they will not 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. This means that a sufficient level of content must exist in the game to illustrate the game's goals, content needs to be available for a period of time such that a threshold of players can find it and learn from it, and a core group of players need to be actively participating in the game. Again, we do not have an answer as to how mature a game should be before incorporating player-generated content or how long it will take to reach a sufficient maturity level. The answer to this will certainly vary based on the specific game and its complexity and game administrators will need to carefully monitor the play of their game to know.

7 Conclusion

Our paper has presented the design and study of a location-based game called See It. Here we have explored the challenges in designing LBGs that utilize player-generated content from their inception while also attempting to fulfill specific game goals. In our case, this was increasing physical activity amongst players. Our study showed that challenges exist when relying on player-generated content within a new LBG. This stemmed from players not understanding the details of how to design content well. Moreover, within a flexible creation framework, as was the case for See It, player-generated content may or may not match the underlying goals of the game. Given these challenges, administrator review of content is critical to ensure content is of a high quality, yet such review was found to be especially challenging. Together, these findings suggest that player-generated content should be used cautiously within new LBGs and is best suited for games that have evolved to a sufficient level of maturity.

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