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Designing a Pervasive Adventure Gamescape: Avoiding the Pitfalls in Creating Augmented LBGs for Playful Learning

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Abstract

This article reports on the design and evaluation of player experiences in relation to a location-based game (LBG). LBGs seek to move gamified play into the "real world" of cities, parks, and other locations. These games are played in everyday places, where game information is tied to specific locations (Magerkurth et al, 2005). This connection to real-world physicality makes the game experience multidimensional and fun for players of different ages. Yet, to be able to envision and create an urban gamescape means that a set of criteria must be met. The unique challenge of creating and orchestrating LBG experiences requires a certain sensitivity from its designers to the multiple factors that must be considered. These may include—but are not limited to—factors such as the city's infrastructure, the flows of urban traffic, the maintenance of recreational areas, and human-related factors such as cooperation with the city administration. The game introduced in this article—Sigrid-Secrets—represents an urban game adventure built upon the platform of geocaching. We approach the game with a focus on its potential learning affordances. We ask how the pitfalls in creating opportunities for learning through LBGs could be avoided, especially when designing pedagogic aims into an urban gaming experience fit for school-aged children.

Keywords: Pervasive Gamescape, Location-based Game, Educational Game**,** Geocaching, Game-based Learning

1. Introduction: Location-based play in a gamified world

Location-based experiences aim to provide the user with a richer experience that extends across a series of locations. They build on three core technologies: mobile devices, wireless networking, and location sensing (Benford, 2005). Our research focuses on the design and study of a particular pervasive and location-based game (LBG), Sigrid-Secrets.

As presented by Thomas (2006), the characteristics of a pervasive game are as follows: 1) games that can be played anywhere; 2) games that can be played at any time; 3) games in which the player's location is relevant to and/or affects the gameplay; 4) games that do not have set states; 5) games that are always on, 24 hours a day (persistent world games); 6) games that take advantage of the available technology to simulate a pervasive state; 7) games that incorporate digital and traditional media; 8) games that emphasize communal (competitive and collaborative) gameplay; 9) games that contact players; In fact, some argue that Massive Multiplayer Role-Playing games are no longer "just games"; they are a monthly service provided indefinitely to highly committed paying subscribers (Stern, 2002). This means that MMOPRPGs do not have "on/off" switches, that reason games can contact players to attract players to join the game; 10) games in which the real world is the game arena, which means that the game-world is constructed based on the real world; 11) games that emphasize the journey rather than the end outcomes; and 12) games in which the game world and the real world influence each other (Thomas, 2006,

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p. 43). The geocaching game belongs in the category of pervasive games implementing these elements of gameplay.

This article introduces the geocaching trail that is enhanced with visual artworks and playified further with a narrative structure and the implementation of mini-games of a semi-fictional nature. This article reports on the design and evaluation of the players' experiences of this urban game adventure. Our article[1] tells the story of Sigrid-Secrets, a geocaching[2] trail designed and created by the authors (as designers, content developers, and researchers), and which is situated in the cityscape of Pori, a coastal town in Western Finland. It combines the geographical location of a city park with a narrative-based structure. Sigrid-Secrets is designed to be an easily accessible, narratively engaging, and educational experience for players of all ages. The geocaching trail requires its players to move along in the central park areas of the city, visiting six photographic art works prior to the actual geocache. In this way, we have both enhanced the gaming platform of geocaching with art and have even gamified an art exhibition featuring six small artworks "hidden" within different areas of the park.

The game offers its players the short-term goal of completing the trail by walking from one hidden artwork to another until one finds the final cache. The activity requires the players to walk an approximately 1-km trail that stems from one end of the park to the other. There is no time limit to compete the trail. Instead, it is the narrative of the character of Sigrid that evolves upon arriving at each of the artworks, depicting Sigrid performing different activities such as dancing or drawing. Engaging tasks are given to the players at each artwork as they are asked to solve simple trivia questions or riddles—such as providing Sigrid's middle name. While solving these tasks does not give the players scores, they do become part of the narrative that intertwines Sigrid's story with the facts of the city. By finding the artworks one by one, the player advances on the trail to finally arrive at the actual cache—a hidden container that features the physical log in which geocachers are meant to write their entries.

The objective of this article is firstly to present the aims and designed affordances of our urban geocaching trail, enhanced with artworks, a game created for 'edutainment'—both entertainment and learning; and secondly, to offer a description of the execution of this trail and the playtests conducted with different age groups. A focus is maintained throughout on how the geocaching game relates to, and is structured based upon, its geographical location—a small cityscape. Moreover, we will concentrate on discussing the content-creation, and how it was built upon the historical and presently affirmed facts of the city, as well as discussing the creative components of the game in reference to how the content is communicated to the players through the game's design. We will then go on to suggest some guidelines regarding what to consider when designing for urban game adventures (with the potential learning goals of the players in mind) based upon our knowledge of the pitfalls we detected while conducting the playtests.

2. Design goals for Sigrid-Secrets

"Player engagement and immersion in games is essentially performative and participatory and occurs as a direct result of active involvement, attention and interaction" (Carrigy et al, 2010, p. 93). Sigrid-Secrets was originally launched as one part of an outdoor urban and interactive art exhibition, called Kätketty Taide (or "Hidden Art," in English), located in the city parks of Pori, Finland, in May 2016. The idea of the exhibition was to hide artworks in unobvious locations such as in and under the trees, stones, and permanent structures of the park—park benches, electric cabinets, etc.

We understand our game as a casual gaming experience that affords many forms of interaction. According to Kultima (2009), to design a casual game experience is to design an experience in a wider experiential context. Kultima stipulates four design values related to casual games according to the author's acceptance of the contents: acceptability, accessibility, simplicity, and flexibility. The first of our design goals was actually the simplest and most easily executed, both from the designer's and the players' perspectives; to use the platform of the internationally known and popular geocaching game, and to enhance it with six artworks telling the story of Little Sigrid—a contemporary doll dressed and accessorized to look like a historical character from the end of the 1800s, but depicted in scenarios that are known to the children and adults of the 21st century. The audience for this game would primarily be those with an interest in, and with previous experiences of, geocaching. The prerequisite for playing this game is to have access to the Geocaching.com app on one's smartphone.

2.1. Designing for casual play through pervasive learning games

What we had in mind for Sigrid-Secrets was to design an acceptable and accessible (and in this way casual) yet rewarding game adventure for players of differing ages, with different dimensions of gameplay. In our case, "casual" follows, in part, Kultima's suggestion that our game must be acceptable, accessible, simple, and flexible. Furthermore, we aimed at a pervasive gamescape that suits to serve different learning goals, both pervasive and playful.

Learning is not just for the classroom but for the world outside the classroom's doors: Pervasive learning is a social process that connects learners to communities and devices, people and situations, so that learners can construct relevant and meaningful learning experiences in locations and during times that they find meaningful and relevant. This also means players are given autonomy in terms of their learning experiences; they take control and direct their own learning processes. Players have power over their own learning and have the ability to perform actions and step in as they deem necessary. The players understand that there are many variations and possibilities and also that their learning feedback comes from a variety of sources (Thomas, 2006).

2.1.1. Acceptability

We strived for acceptability, especially in terms of the game being accepted as a tool for learning. For instance, the acceptability of our game withholds possible instrumental dimensions when the game is considered as a tool for learning, supporting light mental or physical exercises, or facilitating social interactions. These potential dimensions of the game adventure have been scrutinized in the earlier phases of our research (see e.g. Ihamäki & Heljakka, 2017; Heljakka & Ihamäki, 2018) and we will continue to develop our work regarding the opportunities for learning within the game in this article.

2.1.2. Accessibility

Our goal of achieving accessibility within the game meant that Sigrid-Secrets would have to be easily cognitively accessible: We connected the narrative of Little Sigrid with facts from the history of Pori by exploring the collections of the Satakunta Museum; then we gave the character a semi-fictional personality (her name is based on a real person who lived in the region in the 1800s) and designed her fictional narrative partly based on this information. In this way, the story of the game became relatable to local people as it had a direct connection to the city where the LBG was located. Other points regarding the accessibility of the game include the concise information given in the adoption phase: The Geocaching.com website dedicated to Sigrid-Secrets informs the players of the "backstory" of the central character[3].

2.1.3. Simplicity

Another design goal for our game was to keep it simple, considering both its acceptability and accessibility. Simplicity as a design guideline partly overlaps with the other design goals. However, it also refers in our case to the simplicity of the user interface of the mobile device, typically a smartphone, which through the use of the Geocaching app, unlocks the coordinates needed in order to find out the exact locations of the artworks along the geocaching trail[4]. Pervasive learning games can also be seen as simplistic from the perspective of locationality, because learning occurs in locations and at times that are meaningful and relevant to the learner (Thomas, 2006).

2.1.4. Flexibility

An additional design goal for our game was to keep it flexible, to maintain the fact that the game could be casually approached—for example, by searching only for a few of the artworks one day and then returning to the game adventure on a later occasion. In Kultima's (2009) definition, flexibility means that the game supports spatial, temporal, and social pervasiveness. We, as the designers of Sigrid-Secrets and from the perspective of Kultima, also aimed at an experience that would allow other parallel activities such as strolling in the park and admiring the city with its various structures. Pervasive learning offers constructed, meaningful, and relevant learning situations to which the players can relate. Because learners are internalizing concepts

within their own personal environments, they can better understand the implications of what they are learning and can construct ways to relate this knowledge to their own lives (Thomas, 2006).

Furthermore, we aimed at a leisurely game experience, which follows, on the one hand, a non-competitive vision of walking in the park and, at the same time, involves seeking the "secrets" that the hidden photographic artworks entail.

2.2. Augmenting the Game Experience

The second dimension and design goal (at the time of writing; this is still a work-in-progress feature) of our game was to implement an additional layer to the geocaching process: An application that brings the toy photographs (or, photoplay) "alive" by activating supplementary features such as infusing augmented reality (AR) animations with the photographs that allows the players to play mini-games—which include solving riddles and answering trivia questions. The third and final dimension of our game was ultimately to implement an AR feature that would present the player with further content in relation to the Sigrid character.

The ideation and design work for Sigrid-Secrets was carried out in fall 2015, well before the launch of PokémonGO (2016)—Niantic's immensely pervasive and popular AR-enhanced gaming experience. To our (the game designer's) surprise, PokémonGO featured many examples of similarities to what we had already planned for our game.

Within both our game and PokemonGO, AR systems combine and align real and virtual objects within a physical environment, simultaneously running interactively and in real time (Azuma et al, 2001). AR technology has shown us different affordances that are suitable for the purpose of learning. For instance, AR enables ubiquitous, contextual, collaborative, and situated learning, which may promote the learners' sense of immersion. At the same time, AR is able to enrich physical spaces with additional information (e.g., making visible the invisible), which can bridge formal and informal learning or indeed enable learning from multiple perspectives (Dunleavy et al, 2009; Sheehy et al, 2014; Wu et al, 2013). As a consequence of technological advances, there has been a renewed interest in researching the use of AR in education (Sheehy et al, 2014; Wu et al, 2013). For example, Muñoz-Cristóbal et al (2018) have studied how to help teachers facilitate learning situations involving AR technology that has shown different affordances in terms of learning. The research for their article was conducted based on Game of Blazons and was carried out in a learning situation that was overseen by two university teachers using GLUEPS_AR and framed, over two days of outdoor activities, in a village in Spain. The results of their study highlighted that the most important thing to consider when formulating such games is to manage the learning situations and AR through other activities from the existing educational practices (Muñoz-Cristóbal et al, 2018). Ultimately, the VR and AR features[5] of Sigrid-Secrets have remained a work-in-progress project up until the present day. Consequently, the "artified" game experience is built largely on static images and the narrative is delivered to the players who registered on the Geocaching.com website.

Once the “Hidden Art” exhibition ended in August 2016, the city authorities gave us permission (the authors/reserachers/game designers) to keep the six artworks and the final cache—a hidden container—in place. This has allowed us to investigate various aspects of the game in our case studies, where we are interested in, for example, the effects of the trail on the players’ well-being (Ihamäki & Heljakka, 2017), as well as its possible educational implications (Heljakka & Ihamäki, 2018). To this day, some 336 geocachers are reported as having visited the trail (as per November 2018).

Figures 1, 2, and 3. Exhibition poster for Sigrid-Secrets as a part of the Kätketty Taide (“Hidden Art”) exhibition and the Vihervuosi 2016 event; Map depicting locations of the artworks in the parks of Pori; An example of how the artworks are displayed on existing structures such as park benches.

3. Related research: Designing pervasive learning experiences and LBGs

One could say that every instance of a played game teaches its players something. Designing for pedagogical outcomes, however, presents game designers with challenges not necessarily associated with the design of casual games. With serious games, the primary goal is often that of education. “Since 2001, when the first pervasive game, THE BEAST, demonstrated how everyday spaces could be digitally enabled to provide opportunities for play, hundreds of pervasive games have emerged that demonstrate the motivational power of ad hoc networks of connected players. Pervasive learning games take advantage of this motivational power by building on the framework provided by pervasive and ubiquitous computing and the theoretical foundations (design and practice) offered by the field of games and education” (Thomas, 2006, p. 41). Plymale (2005 cf. in Thomas, 2006) suggests that pervasive and ubiquitous learning offers, among other benefits, improved capabilities for communication, coordination, collaboration, knowledge exchange, and the removal of time and space constraints when accessing information. One way of seeing pervasive learning through games, then, is to emphasize the playfulness of this mode of learning.

Kangas (2010) sees playful learning as a key competence in terms of teaching and learning. Educational games, therefore, can be seen as being in the category of serious games, or games

with a purpose—the purpose in this case being catering for playful learning. Kangas defines the goal of playful learning as follows: It is curriculum-based learning that is enriched with play, games, and technological affordances. In our understanding, a game suitable for education and used for facilitating a playful learning process can at the same time adhere to the values of a casual game.

Playful learning and pervasive games are not only about implementing future technologies but are also about seeing the “unbounded and often overlooked opportunities for play” (McGonigal, 2003, p. 21) that surround players. It is therefore useful to also remember McGonigal’s (2003) core philosophy of pervasive games, “The best pervasive games do make you more suspicious, more inquisitive, of your everyday surroundings. A good immersive game will show you game patterns in non-game places; these patterns reveal opportunities for interaction and intervention" (McGonigal, 2003). That is why we see the geocaching game as presenting a potential platform for a pervasive learning game that is well-suited to playful learning. To be played, geocaching requires the use of digital and mobile technologies. Consequently, it represents a platform for ‘M-learning’ that enables moving learning out of the classroom and into other environments.

3.1. M-learning Takes Play Beyond the Classroom

In 2005, Chen and Michael predicted that “games and game technology are poised to transform the way we educate and train students at all levels” (Chen & Michael, 2005). Mobile devices enable 21st-century students to build on their knowledge anywhere and at any time. Mobile learning (or M-learning) is an educational interaction delivered through mobile technology and accessed by students from any location (Traxler, 2009). M-learning is characterized by physical mobility and its flexibility in terms of time, place, pace, and space, and by its utilization of mobile devices with an Internet connection for educational purposes (Kinash et al. 2012). According to Zimmerman and Howard, “mobile devices can situate and connect learners by supporting authentic, context-specific, immediate learning” (Zimmerman & Howard, 2013, p. 2). Consequently, learning is no longer constrained to the classroom, its integration of mobile technology enables teachers to customize student learning by creating authentic learning activities to engage students anytime and anywhere (Hess & Gunter, 2013). Several researchers refer to the ability of mobile learning to enhance collaborative learning (Barker et al, 2005; Cheon et al, 2012). Pervasive learning goes beyond the concept of the classroom. Pervasive learning is not a form of delivered instruction, instead it is a social process that happens at a time and place of the learners’ choosing. By using the real world as a playground, learning can happen, for example, in local parks (as in this case study). Pervasive learning supports spontaneous, unscripted learning from the environment—as we describe later in this article.

3.2. Questions and Challenges for Designers of Pervasive Learning Games

As demonstrated, location-based learning experiences present us with a new area of research that potentially could move and mobilize learning, bringing us outside of the traditional educational context of the classroom. Benford (2005) discusses the relevance of LBGs in education. His report concludes that location-based experiences could introduce significant benefits for education in schools, but also that a number of challenges need to be considered and assessed in the process. When designing LBGs for this purpose (for example, designing geocaches with educational implications in mind), we need to take several issues into consideration. These include technical and organizational challenges: Questions regarding technological connectivity and matters related, for example, to the privacy concerns and the "culture clashes" that could stem from using telephones in an educational context. Thus, an increasingly important factor that needs assessment is the functionality of technology. The second one addresses the user of the technology, and the third one, the content provided by this technology.

In order not to design "chocolate-covered broccoli" (as famously stated by Bruckman at the Game Developer's Conference in 1999), designers must also recognize factors that predict the effectiveness of educational games. According to a review undertaken by Linehan et al (2011), these factors may include fun, flow, engagement, feedback, goals, problem solving, game balance, pacing, interesting choices, and fantasy narratives—these are just a few examples of the many other aspects that could possibly be considered.

Furthermore, Schadenbauer (2008) lists a number of useful questions to ask that are relevant when conducting research with young people as players of a (digital) game. These are user-oriented, technology-oriented, and content-oriented questions, all relevant when considering M-learning (mobile learning): How are mobile phones used by young people? Which media are consumed by teenagers? How often do young people play games? Which kinds of games are popular? How important is social interaction in games? Do teenagers accept mobile learning games? Do the test subjects like the game and the story? Are the tasks difficult/easy? Do the aids help to solve the tasks? Does the framework support the game progress? Which technical problems can occur? Which potential improvements are possible to implement? A well-designed app presumably provides an appealing platform for the learners of the 21st century; it is useful for the designers of LBGs to consider the questions above. In the 21st century, we can see that learning can generally be described as multimodal learning, which means that learning occurs through multiple modes and that communication happens through a synchronization of these modes. Examples of modes include movement, gesture, color, animation, music, sounds, and also the possibilities of AR and virtual reality.

Linehan et al (2011) claim in their article that studies that try to point out reasons why games can be understood as valuable learning tools often do not include a review of the empirical evidence. In our study, the aim is to tackle this challenge by turning to the potential users of our

urban game adventure, with a focus on preschool and primary school-aged children. The methodologic approach used for our study will be discussed in the following section.

4. Methodology

Our research investigates how to avoid the pitfalls when designing and using an LBG such as our Sigrid-Secrets geocaching trail. This article focuses on a case study conducted with preschool and primary school-aged children. The question that guided our research was to understand how preschool and primary-aged school children respond to our pervasive game adventure during simulated geocaching tours that were guided, narrated, and gamified by ourselves, using our own mobile devices for demonstrating and documenting the tours. In the context of this article, therefore, we asked these questions:

RQ1: What are the potential learning affordances of our urban game adventure, Sigrid-Secrets?

RQ2: How could the pitfalls in creating opportunities for learning through LBGs be avoided, especially when designing pedagogic aims into an urban gaming experience fit for school-aged children?

We have studied the pervasive geocaching game using material from four sources: Our earlier research, on which this study builds, employed 1) user generated data (comments) on the Geocaching.com website. The research reported here uses 2) documentation of the playtests, 3) surveys, and 4) children's drawings. In addition, our study includes active participation and observation during the playtest sessions.

The survey method for assessing the perceptions of our game is similar to what Davis et al (2005) refer to as "playtests." To surmise, our multimethod approach allowed us to target our case study from several perspectives, which were necessary when the implementation of new types of game designs were considered. By organizing three guided tours, we play-tested both the experiential and the educational capacity of the trail. This indicates that we were interested in how the game worked for the player audience—young children with no previous experience of geocaching. Moreover, what was of interest to us was the testing of the players' responses to the second dimension of our game—the animated features, which included mini-games such as riddles and trivia.

The orchestration of the game adventure included the game administrators (in our case the authors/researchers) walking the geocaching trail with the children and leading the players (the preschool, and primary school-aged children) by reading the story of the main character of the tale— Sigrid. Moreover, the orchestration involved actively monitoring the children to ensure they stayed out of harm's way and to ensure that each one participated actively in the geocaching game (Capra et al, 2005).

The case of Sigrid's Secrets: Studying simulated geocaching tours with school-aged children

According to Mäyrä (2007), any gameplay experience is intimately linked with the immediate personal contexts of digital play, which means that we need to know the players better: how they play, what motivates their play, and/or about their aversion toward certain game forms. Again, usability research may help in identifying problems that block users from experiencing the "fun" of a game (Davis et al, 2005). In terms of games, this means a careful assessment of their playability.

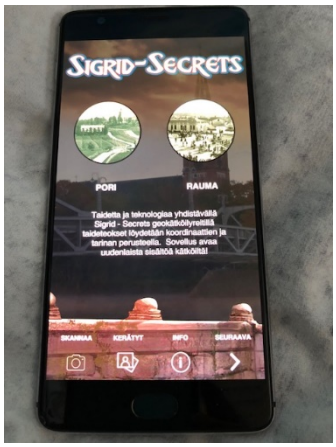
The study presented in this article centers around the evaluation of our urban game adventure and included observations of the children in action. Specifically, in the following, we will analyze the player experiences of our LBG, Sigrid-Secrets. The research reported uses documentation from the playtests, surveys, and children's drawings. In addition, our study includes the active participation and observations by the moderators during the playtest sessions. Surveys tap the players' perceptions of games and the usability tests may be employed to discover whether the experience the player has of a game matches the experience the designer intended the player to have. A combination of surveys and hands-on gameplay together form a method—the playtest that aimed to understand the players' initial experiences of the game (Davis et al, 2005). In our research, the playtests involved a simulated geocaching game of Sigrid-Secrets, which was guided, moderated, and documented by the authors. We also experimented with the additional method of asking the children who participated in the playtests to draw images of what they thought they learned by playing our game. The results of our multimethod study will be presented in the following section.

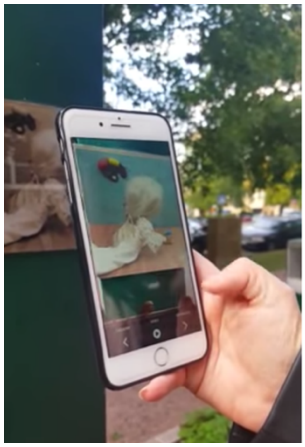
4.1 Guided Tours of the Sigrid-Secrets Geocaching Trail

The guided tours were organized over two days in October 2017. On the first day, the authors hosted the tours with the two groups that consisted of preschool children and their teachers (with n = 12 participants in the English group, n = 11 participants in the Finnish/English group, and two teachers in each group). Each guided test tour of the trail took between 45 minutes to 1 hour to complete. At the end of the tour, we asked each participant to fill in a survey and to draw a picture of what they had learned and remembered from the geocaching trail. Two children in the Swedish-speaking group (i.e. the third-graders, n = 12) were familiar with geocaching either because of having played the game elsewhere with their family, or because of them having toured the Sigrid-Secrets trail prior to our guided tour. Generally, the participating preschool children had not played geocaching before, nor had it been used by the preschool teachers either in informal or formal learning situations. However, many children reported, when asked, of having played PokémonGO in the Raatihuone Park; the starting point for the Sigrid-Secrets game experience and a hotspot for catching "Pokemonsters" since the summer of 2016.

During the tours we, as the researchers, narrated the experience by using the story of the character of Sigrid based on the text that was available on the game's website under Geocaching.com and we guided the groups by walking from artwork to artwork. As our "artified" game experience represented a work-in-progress project, not all of its designed features were available at that moment and indeed are still not available today. Each of the artworks that

represent the character of Sigrid undertaking different activities involved a mini-game such as a riddle, presented through, for example, a short animation, which in the future phases of the game's continuing development will be a part of its digital enhancement and available through an app. Consequently, these features were simulated for the groups by using mobile devices and by explaining that these features would be a part of the game in the future. In order to stimulate the children to play the mini-games, we played each animation from a tablet and asked the groups questions such as: "What is Sigrid's second name?" (The letters may be found both on the artwork and in the animation); "What do the colors in the animated film remind you of?" or "Which are the colors of the rainbow?"; "Which instrument does Sigrid play in the animation?"; "What is Sigrid doing in the animation?"; "What are they doing in this historical film?"; and "Where is this scenery from?"; or "What bird makes the kind of sound you are able to hear in the background?" Some of these questions could be solved by looking at the static image in the artwork alone, whereas some needed to be found in the animations (including sound) to be unlocked through the images by a mobile device and app (see figures 4-6).





Figures 4, 5, and 6. The Sigrid-Secrets AR-application in its current state: For a video presentation, see https://www.youtube.com/watch?v=mJZFneiVESY (Images from left to right): 4. Choosing the language; 5. Choosing the city; 6. Unleashing the AR features of the game experience.

4.1.1. Observations

According to our analysis, the educational affordances of Sigrid-Secrets may be grouped into the following categories: a) spatial design affordances, b) narrative design affordances, and c) interactive design affordances. Examples of these will be given in the following.

During the tours it became apparent that the children liked the idea of a "treasure hunt." Many of them enjoyed the competitive aspect of the "game within a game" they developed by themselves during our guided walk—that is, who will find the artworks first? Although this proves that children are innovative in terms of formulating their own rules for existing games, this possibility is an unintended design affordance. In geocaching, the question is not so much about how fast you find the caches, but rather, how many you find over a longer period of time[6].

1. Observation for the educational affordance of an LBG: Design features for the game that demand physical skills such as those relating to speed and dexterity

During the tour with the English preschool children, some participants asked about the number of artworks placed on the trail (altogether 6) and some were interested in how far they would need to walk during the tour. Both of these represent the game's spatial design affordances in terms of its layout. Some of the children jumped on the public artworks found in the park area (as in parkour), but which were not a part of the geocaching trail. The elements outside of the game belong to the city structures, which can be interpreted as intentional affordances of the park, but unintentional design affordances of the game.

2. Observation for the educational affordance of an LBG: Design features for the game that use the city's structures for teaching learners about measurable entities (e.g. geometry, architecture, physics, etc.)

Children in both groups paid attention to an unintended spatial design affordance at the end of the trail—a fly agaric mushroom (a poisonous mushroom). They took a relatively long time to inspect this. Based on our earlier research on geocaching (e.g. Ihamäki & Heljakka, 2017), we have come to understand that adults too become more interested in what can be found in the environment outside of the game when they are looking for caches in the name of geocaching.

3. Observation for the educational affordance of an LBG: Design features for the game that teach the learners about the city's flora and fauna (e.g. tasks related to biology)

Some of the children told us that they had been students at a local dance school that was a part of the information given in the Sigrid-Secrets story. They also enjoyed a historical short film that showed people rowing across the river Kokemäenjoki where presently there is a bridge. The possibility of interaction with the story of Sigrid-Secrets based on the previous knowledge and experiences of the local people is an intentional narrative design affordance. One of the children in the group considered the Sigrid character (a doll), as "creepy." This character also represents an intentionally designed feature of the game, or narrative design affordance, but its potential "creepiness" was not, and therefore it is classed as an unintentional design feature.

The participants in the study were enthusiastic about the short animations that were going to be made available as a part of the game (a part that has to be unlocked with an app). We simulated this for them by playing the short animations on a tablet. The participants were excited—for example, by the mini-game that asked them to find out Sigrid's second name by re-arranging the letters that floated around Sigrid within the animation. The children also liked the animation with the dancing Sigrid, which they considered to be "magical" (English group). This animation also provoked laughter with the second group (the Finnish-speaking group). The children were also enthusiastic about the sounds of the seagull featured in one of the animations where the task was to recognize the bird. This represents an interactive design affordance that from the viewpoint of the game designers was intentional and educational, as it required the employment of the cognitive skills of the players.

Our other observations made during the guided test tours are to do with the challenges and difficulties that we as the guides (and researchers) of the tour experienced during the walks. These include factors outside of the game, but that nevertheless affected the overall experience, and indeed which would impact any technologically-enhanced game that is played outdoors. These issues included: the functionality of the Wi-Fi connections; the workings of the mobile devices (i.e. running out of battery and space and the slow pace of the phone's functions, etc.); the weather conditions during gameplay; the risk of moving with groups of young children within the city center; and the maintenance of the geocaching trail, which may be affected by elements such as construction work that is being carried out in the area where the trail is located.

4.1.2. Survey

The preschool teacher in the English-speaking preschool group informed the researchers that the children had experienced filling in the survey as somewhat difficult. Again, the third-graders of the Swedish school had, according to their teacher, "filled the survey in the best way they could." Because of this, questions have been raised regarding the validity of the study.

Nevertheless, the surveys—in which we asked about the adventurous feeling of the trail, its length, about the learning that took place on the trail, and in which we also offered a chance for them to give freeform comments—were described by the children as "good" and "fun." In most cases, they graded their experience of the game's features as between 3–5 (3 = good, 4 = better than good, 5 = excellent).

4.1.3. Drawings

The children's drawings (for example, see Figure 8) of what they thought they had learned by touring the geocaching trail addressed several varying aspects. They varied from images of the trail itself, to descriptions of the park's surroundings, and even included depictions of the weather conditions. Roughly, the drawings could be divided into two categories—maps of the trail (that were based on the children's own observations, as maps of the trail were never shown to them) and those of the scenery surrounding the trail; mostly featuring trees and infrastructures within the park. Many of the children who we interviewed and videotaped, when they explained what they had drawn, mentioned the "treasures"—that is, the "secret" artworks on the trail and the actual geocache, which was located in a secret stash underneath some trees.

Figures 7 and 8. A mushroom at the end of the geocaching trail caught the children's attention; A drawing made of the geocaching trail by a 6-year-old girl. She explained the red object to be a park bench underneath which the children discovered an artwork.

5. Affording opportunities for playful learning through geocaching

Our assessment of the game adventure begins by comparing the design goals with the results of the playtests. The results of the first phase of our research—conducted with transgenerational users of the urban geocaching trail—illustrate that the users' experiences are multidimensional (Ihamäki & Heljakka, 2017). The general overview of the detected affordances show us that it is possible to categorize a set of different design affordances that relate to the game and are part of the environment—in our case, a park area in an urban center. These are either an intentional or an unintentional part of the geocaching trail's game-specific affordances. According to our analysis, the affordances of Sigrid-Secrets may be grouped into the following categories: a) spatial design affordances, b) narrative design affordances, and c) interactive design affordances. The intended designed affordances of an urban geocaching trail enhanced with artworks are controlled by its designers, whereas unintended design affordances emerge when users explore and interact with the game and are dependent upon the players, the changes in the environment (spatial surroundings), and the weather conditions. The tests revealed both intended and unintended design features that we describe herein as pitfalls. These are pitfalls that can be faced when school children are taken to experience an urban adventure gamescape with educational outcomes in mind. Challenges in designing for urban playscapes with educational intentions in mind include (according to our study): a) challenges in interaction within the gameplay, real-world interaction, and interaction with other players; b) challenges in the impact of the location (situational factors); and c) challenges in responses to the game's aesthetics and narrative. Based on these, we developed the following design guidelines:

General design guidelines: Suggestions for future designers of urban adventure gamescapes for learning:

- To avoid pitfalls when designing for interaction in gameplay: Design the LBG so that its goal, mechanics, and approximate length are easily understood by the players before they start to play (together) so that the players know what to expect.

- To avoid pitfalls in designing the location of the game: Design the LBG cooperatively with whoever is in charge of the location (e.g. the city officials in charge of maintaining your game's elements in the physical environment) to ensure that the game elements stay intact.
- To avoid pitfalls in designing the aesthetics and narrative of the game: Design the LBG to include approachable (in the case of young players, child-friendly) characters so that the players are not scared off by anything that could be considered "creepy."

6. Summing up the pitfalls in the park: Avoiding the unwanted outcomes of designing a LBG suited for playful learning

Two research questions guided our process. These were: 1) What are the potential learning affordances of our urban game adventure, Sigrid-Secrets? 2) How could the pitfalls in creating opportunities for learning through LBGs be avoided, especially when designing pedagogic aims into an urban gaming experience fit for school-aged children?

Regarding the important questions to ask when designing LBGs and that were stipulated by Benford (2005), the most relevant questions proved to be: How important is the social interaction in the games? Do the test subjects like the game and the story? Are the tasks difficult/easy? Do the aids help to solve the tasks? Does the framework support the game progress? Which technical problems can occur? Which potential improvements are possible?

Assessing perceptions of the game by conducting playtests with young children provided us with valuable feedback. We suggested possible educational ideas that interlinked with the affordances presented to us through our study and that stemmed from our observations. Again, a summary of the results of our case study points out how the unwanted outcomes of a designed LBG may relate to user-oriented, technology-oriented, and content-oriented issues that should be considered in design work. Our case issues (relating to interaction, location, and the aesthetics/narrative) proved to present the most prominent instances of unwanted design, which could be overcome via the implementation of an improved design process for the initial stages of development.

According to Lihehan et al (2011), the merging of the disparate goals of education and game design appears problematic: Ultimately, the design of any educational game will ensure that the game teaches in a way that has both been demonstrated as effective and is also appropriate to the medium of computer games. Therefore, game designers must work together with educational professionals when aiming to develop serious games as new teaching tools, as Lihehan et al (2005) remind us. When game-based learning is of interest to designers, it is appropriate to consider how to assess and test in order to determine that the participants can relate to the content of the game, understand the tasks provided, and make use of the game appropriately.

The findings of our study show that geocaching as a platform has the potential to be used for educational purposes of the pervasive, playful and innovative kind. Playing in the urban, outdoor environment, however, also brings possible challenges with it. In this case study, we understand geocaching as a gaming platform that, combined with the right content and educational context,

presents us with a pervasive learning experience, which relies on pervasive and ubiquitous technology. The technology commonly associated with pervasive computing includes mobile phones, smart phones, global positioning systems, and so on (i.e. anything that allows a learner to access and exchange information while on the move). The challenges that pervasive technology-based learning games can bring with them to the play experience are the challenges of using mobile and smartphones generally (their limited battery life or inconsistent network coverage). Also, we need to pay attention to social considerations such as the negative implications of how players interact with digital public spaces (users' privacy) and communications in public communities—such as the geocaching community (Thomas, 2006).

In general, when designing LBGs there needs to be awareness of the possible issues in order to avoid the pitfalls that players of different ages can face in the middle of urban environments. In our case study, these concerned the game itself (content- and technology-related challenges), the game presentation (its physical presence and the challenges of maintenance in the park's environment), the players (challenges in terms of the uncontrollable movement of young children), and seasonal constraints (weather conditions). The first three aforementioned elements can be avoided by facilitating thoughtful design, while the last issue may be avoided by organizing play sessions only at times where there are ideal weather conditions. To sum up, we have given some suggestions in the form of design guidelines for the future designers of urban (and pervasive) adventure gamescapes for learning.

Figure 9. Avoiding the pitfalls when playing urban adventure games with young learners.

7. Conclusion

In this article we have explored how the cityscape provides both a formal and an informal setting for learning when an LBG such as our Sigrid-Secrets is used for game-based learning in outdoor play. We found that the participants of the guided test tours interacted with our Sigrid-Secrets geocaching trail through three affordances, namely the affordances in relation to its spatiality and narrativity, and the reciprocal interaction between the game and the player.

As Hirsh-Pasek et al (2009) describe, both free play and playful learning should command a central role in high-quality education for preschoolers (Hirsh-Pasek et al, 2009). The tentative results demonstrate that children as young as the preschool and primary school children in our study can (by playing the game in teacher-supervised and guided situations) effectively learn about the urban infrastructure and information embedded in the game's narrative—in this case, the story of Sigrid-Secrets that links to the city's historical past and present. By turning to the participants of our case study, we were able to see how the children interacted creatively with the city park environment, how experiencing the game sparked their artistry when drawing images of the trail, how they immersed themselves in the story of Sigrid through their imagined "treasure hunt" for the artworks, how they innovated new uses of the parks structures, for example, by climbing and jumping from the park benches and concrete structures, and how they used their personal expression in explaining their meaningful memories of the trail, and what it, most prominently, taught them.

Finally, by letting the early learners show us how they interacted with our geocaching trail, we were able to see how collaborative learning may take place outside of the classroom when the game of geocaching is played in a social situation. Seeing how the children played, we were able to sense their excitement, their engagement, and even see the process of them discovering the fun of playful learning in the park, instead of the emotions that the usual school surroundings may stir in them. We propose that acceptability, accessibility, flexibility, and simplicity are useful design values to consider when designing LBGs as urban adventures in cityscapes. Furthermore, we add that game interaction, location, and the aesthetics/narrative should be carefully considered, mainly based on their acceptability and accessibility. Finally, we have suggested some guidelines that, according to our understanding, are central to designing similar multidimensional geocaching trails such as the urban Sigrid-Secrets game adventure presented in this article. Further research questions may include an analysis of the teacher's perspective. For example, what kind of content would educators see as relevant to employ in the narratives embedded into LBGs like Sigrid-Secrets? And: How would educators like to measure the outcomes of learning if such game-based learning experiences were used in the future?

Neustaedter et al (2012) have noted that what might be challenging in terms of designing "mixed-reality games" is ensuring the "scalability" of the games: In other words, perpetuating the possibility of duplicating these games in various locations, or sustaining long-term participation in them. In this research, our larger project (which is interested in LBG development and related research) now also includes the design and execution of another similar LBG adventure in the city of Rauma—a continuation and further development of the story of Sigrid. Our second urban game adventure is based some 50-km southwards from Pori in the UNESCO heritage site of Old Rauma on the West Coast of Finland. There, the story of Little Sigrid continues with new adventures, a work-in-progress app for players of different ages, and even gamer profiles outside of the geocaching community. The second phase of our research will reveal whether or not an urban game adventure is able to be continued in a second location and, perhaps, allow for the interaction between these two geographically separate, but virtually connected gamescapes. We hope to initiate a playful—entertaining and educational—dialogue, and in this way enrich the overall experience of playing with Sigrid.

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Endnotes

[1] A first version of this article was published as a work-in-progress conference paper in the Proceedings of the Play2Learn Conference. In the revised version at hand, we expand the discussion on pervasive games and present further material on the digital augmentation of our game, such as the development of the game's AR features.

[2] Geocaching is a gaming platform and a form of digital treasure-hunting, in which players use GPS devices or geocaching applications on smartphones to search for geocaches in different environments. Currently, geocaching is practiced in 185 countries and there are over 10 million registered users on the Geocaching.com service online.

[3] It is important to note, however, that although the game is physically easy to access (the photographs are permanently exhibited in the surroundings of the city parks), the digital component needed for the game—the Geocaching app—is needed at this time to communicate the idea and content of the game. Our plan is to launch an app specifically designed for *Sigrid-Secrets* (a work-in-progress project), which enables users not familiar with the game of geocaching to be able to play it as well. Some steps have already been taken in designing this app: See figures 4-6.

[4] As the game is physically based in the public sphere in the context of the city park, it is also possible that it might be accessed by a non-participating audience, or approached by curious individuals, who would start to look out for and follow the path of artworks spread across the park. It is still unlikely that a spontaneous instance of game play would ultimately lead to finding the actual geocache, as it is well hidden in a secret spot that is not visible to passers-by.

[5] The future of pervasive, or, location-based experiences brings to the foreground many interesting research topics, one of them being what AR technologies will bring to these game experiences.

[6] However, for geocachers familiar with the Geocaching game logic, there is a special goal to consider: When a geocache is launched, whoever finds that first receives the "First to Find" title, a merit within the geocaching community.

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