

Understanding User Enjoyment with Geocaching Application

P. Ihamäki, and M. Luimula

Abstract—Game developers have identified, explored, and discussed many of the key issues that arise for players interacting in game worlds and the physical world. In User-Centered Design, the integration of knowledge of players’ work practice, preferences etc. into the design process is crucial to success. Cognitive infocommunications (CogInfoCom) investigates the link between the research areas of infocommunications and the cognitive sciences, as well as the various engineering applications which have emerged as a synergic combination of these sciences. This study is relevant to CogInfoCom because it deals with users’ cognitive capabilities while communicating through the Geocaching game within the GeoCentria application. Geocaching is a technology-supported treasure hunt activity that uses a Global Positioning System (GPS) receiver or a smartphone with a Geocaching application to find something hidden by other players (geocaching.com). The results of the study provide a deeper understanding of enjoyment in real-time gaming played in the physical world, along with an identification of the strengths and weaknesses of the GeoCentria application and user experience with the Geocaching game in a touristic context. Based on these results, we present guidelines for designing and evaluating enjoyment in adventure games.

Index Terms — Cognitive Infocommunications, Geocaching game, GeoCentria application, player experience.

I. INTRODUCTION

IN GAME design, the primary driving force is user experience. Game designers try to imagine what players will experience as they work their way through the game, and try to deliver the most exciting and compelling experience possible [1]. This is the reason why user experience was considered as a key design factor during the development of the GeoCentria application – a front-end for the recently released digital game of Geocaching.

The principal tenet of cognitive infocommunications (CogInfoCom) – which states that the “primary goal is to provide a systematic view of how cognitive processes can co-evolve with infocommunications devices, [in a way targeted] towards applications in which artificial and/or natural cognitive systems are enabled to work together” [2,3] – was also taken as a fundamental basis for the development of the

GeoCentria application.

In this paper, our goal is to investigate the qualities of GeoCentria in terms of user experience. However, the conclusions drawn from the investigation serve not only to better understand the domain of Geocaching in particular. The Geocaching game has been played in 220 different countries. There are more than 1,6 million geocaches in Europe and over 5 million geocaches worldwide [4]. Therefore, understanding player enjoyment in Geocaching is expected to provide us with insights on user experiences with pervasive technologies in general. The importance of this aspect cannot be neglected, as pervasive computing is expected to become an everyday phenomenon in the near future [5].

During the course of this research, we have developed a context-dependent Geocaching game for smartphones. The purpose of this study is to acquire early feedback about how mobile games could benefit from social interaction considerations in touristic contexts. This means using the GeoCentria application to play Geocaching as a touristic activity, and introducing new ways to find and reach tourist destinations. Given the novel concept of this game, our goal is to both understand the possibility of building a light version of augmented technologies, as well as developing a preliminary theoretical framework for pervasive social games. The device used for the game is aware of its direction and tilt by means of a digital compass, and geographical position by means of a GPS-receiver. The player has to attend to ‘geocaches’ provided at certain locations, and can obtain cues by pointing the device toward various objects along the road to make virtual objects appear on the screen. There is also the possibility of incorporating different aspects of mobility to create immersive experience.

In this paper, we aim to draw out the underlying theories behind the ‘experience’ phenomenon and the evaluation of the GeoCentria application to extend the scope of the experience game design field. We explore and analyze how users experience the Geocaching game. Based on this analysis we provide the core elements underlying the phenomena that constitute experience with the GeoCentria application. Our evaluation framework conceptualizes players’ experience with the GeoCentria application based on the meanings they construct. This conceptualization provides an account of understanding and designing for users experience in interactive systems. There is not a large body of academic research on the geocaching game. Examples using a geocaching game for new applications like GeoCentria does for tourism are non-existent in academic study.

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The empirical findings raise five design guidelines of designing mobile pervasive adventure games in touristic contexts. The first is providing a *tracking system*, which motivates users to extend the adventure game into social interaction experiences. The second is the use of *social media tools* networks for competing with others. Social media tools integrate various aspects inherent in daily life. The third is the use of *mixed reality experience components*, using both real and virtual environments, to serve different game functions. For example, players can be shown those players who are near their current location. The fourth is the use of an *education experience tool*: geocaching game caches can promote the learning of new subjects (for example math, biology, geography etc.) and can stimulate new ideas to create caches with other players. Finally, the fifth guideline is the use of a *narrative experience tool* that could support people in experiencing new adventures on holidays, for example by using the geocaching game to tell mystery stories related to a given place. Tourist destinations involve entire narratives based on places and stories, and it is beneficial to the user experience if users are allowed to create new content relevant to specific locations.

II. THE GEOCENTRIA APPLICATION

The GeoCentria application was developed at CENTRIA Research and Development, Ylivieska. The application is currently available for Symbian^3 and Android devices. In this field experiment, we used the Symbian^3 version, which was developed using the Qt software development environment.

The application consists of three different main screens: the map window, the digital compass, and the menu window. The main functionalities can be found in the map window. Here, users can select geocaches, are able to define routes, and can directly toggle between map view and compass view. Following the selection of a geocache, orienteering can be done using the digital compass, which shows the direction and the distance to the cache.

The user currently has three different map alternatives: Nokia Maps, Google Maps, and Finnish Topographic Map. These maps can be used only in online mode. In CENTRIA's earlier field experiments, we have also used local 2D (and 3D) maps based on our own map engines [6] [7]. The user is able to add caches in various ways. The GeoCentria application supports the LOC file format used by geocaching.com. Caches, along with background information can be downloaded from <http://geocaching.com> as simplified LOC files in real-time (Figure 1). The current version does not support GPX file exchange, which is a light-weight XML data format for the interchange of GPS data (waypoints, routes, and tracks) between applications and Web services on the Internet [8].

The license-free approach of GeoCentria guarantees that the application can be used globally without any limitations. Therefore, the application has an integrated website feature for browsing more detailed information of selected caches. Basic management tools are also available for downloaded and stored caches. The GeoCentria application includes some features of social media services, for example Twitter and Flickr services,

making it well-suited to the merging between the cognitive sciences and infocommunications [2, 26, 28]. Access to QR tag information is available through the ZXing library, which is an open-source, multi-format 1D/2D barcode image processing library implemented in Java, with ports to other languages [9]. If a QR code is read, its content is analyzed for URL links, cache information, and other textual information. Based on the results, the application can be used to open various websites and dialogs. QR codes can also be used in the physical user interface in the application. For example, if a QR tag contains a hint about a cache nearby, the application will show a dialog box asking whether the user is interested in the hint or not.



Fig 1. First picture is GeoCentria map compass user interface and second picture is GeoCentria digital user interface.

III. RELATED RESEARCH

In the area of human-computer interaction (HCI) and CogInfoCom research, we find a number of different approaches to understanding player experience, but relatively few that specifically address user enjoyment [10]. Baranyi and Csapo have identified several aspects of HCI and multimodal interactions to be considered in CogInfoCom applications [11]. They summarize these aspects as negative effects of reduced resolution, (which means that in the case of reduced resolution it is better to use different modalities than the ones that are normally used for a given task); multi-sensory integration (which means that different sensory channels are not independent of each other, as contradicting information from various senses can cause confusion); cross-effects between sensory modalities (which means that it is *“possible for one sensory modality to yield realistic sensations normally perceived through another modality, while another sensory modality gives no contribution to realistic sensations, but significantly increases the user’s sense of telepresence”*); and finally sensory dominance (which means that is important to design the various sensory modalities related to one another in terms of their relative importance to human cognition) [11].

Flintham et al. [2003] explored the impact of GPS inaccuracy in order to investigate location as a key component of the content and context of information, the strategies employed by

participants to use these sources of context to achieve successful collaboration, and ways in which interface and game designers can respond to these issues and support these strategies. The study explored a game called *Can You see Me Now*, the main objective of which was to engage and excite the online players by giving them a sense of the runners' experience of the city, and of how their online actions could affect events on the streets. Players shared an online map, and players' positions were determined using GPS [12]. Brunberg and Juhlin (2003) present *The Backseat Gaming* prototype, which is a context dependent mobile game. They discuss what roadside objects could be used to create an understandable and fun mobile game, with reference to emerging game research as well as theories in highway design [13]. Sweetser and Johnson's [2004] study represents important initial exploratory research that supplements the existing literature by focusing on the player's perspective and exploring which issues and context have the greatest impact on player enjoyment [14]. Benford et al. [2005] studied a collaborative location-based game in which groups of 'lions' hunt together on a virtual Savannah that is overlaid on an open playing field. The study developed and investigated a collaborative location-based educational game called *Savannah*, in which children learn about the ecology of the African Savannah, especially about lion behavior [15].

Reimann and Paelke (2005) describe how mobile gaming has started to expand into the domain of physical movement through players taking gaming into the real world. They present the prototype of a mobile mixed-reality game that adapts the game presentation and content to the user's context [16]. Muessing and Price (2007) present EarthCaching, a form of geocaching where the player finds a site of geological interest [17]. O'Hara (2008) presents geocaching game practices and motivations that can be built around a location-based activity field, and shows the importance of looking beyond the simple in situ consumption of a 'treasure hunt'. [18] Neufeld et al. (2008) describe an autonomous Robot System designed to solve the challenging task of geocaching. Robot geocaching requires addressing three key issues: map building, navigation and local search [19]. Gram-Hansen (2009) argues in his study that the computing technologies involved, such as websites, desktop applications, GPS units and mobile software, constitute a persuasive environment along with the physical artifacts central to geocaching [20]. Hooper, Rettberg (2011) present the methodology and results of a study delving into experiences with a GPS-based scavenger hunt, geocaching, and a geo-social network, Gowalla. Their study focuses on users creating new content by sharing treasure hunt video experiences, which extend social capital and values of geocaching community [21].

IV. METHODS

Whether developing a geocaching game solely for entertainment, or with other motives such as social experience or cultural experience and feedback, designing an enjoyable experience remains one of the most important aspects. In the evolving area of Geocaching game development, a relatively

new genre known as 'Pervasive Gaming' has recently emerged. Pervasive games aim to blur the lines between the virtual world of the game and the real world of the player in order to bring a more immersive and entertaining game experience [22].

There were a total of 17 participants (8 female and 9 male), all of whom knew how to use mobile phone and map applications. Since a regular session of the Geocaching game usually takes up to one and a half hours (if no time restrictions are given), we decided to test users in a predefined mid-game position. This position gave some advantage to the users and was designed with the intention of walking with users (normally with 3-user groups) and seeking three different geocaches in Ylivieska, Finland.

Users first needed to fill out the geocaching application software preliminary survey. After filling out the preliminary survey, users underwent the main test of finding three geocaches around Ylivieska Centria campus area. After the user test, participants filled out an evaluation. Our participants' age distribution was between 17 to 57 years. Participants came from 6 different countries: 1 from Estonia, 4 from Finland, 3 from Holland, 2 from Japan, 4 from Poland and 3 from Russia. All participants had either a bachelor's degree or master's degree, or were university students. Participants gave their backgrounds in the use of sport and technology based on the statements in Table 1.

V. ADVENTURE GAME ENJOYMENT AND CO-CREATION EXPERIENCES AS THE BASIS FOR VALUE CREATION

The study was focused on understanding and designing user experience with (or through) interactive systems. Depending on the context and the domain of a system, goals of player experience may vary from supporting user entertainment (pleasure, enjoyment, satisfaction, trust, etc.) through personal growth (challenges, education, etc.) to social interaction (personal connections, emotion, etc.). Player experience design is a field that focuses as much on the experiential aspects (emotions, feelings, values, meanings, etc.) related to the system as on the technical, user experience and usability-related aspects [25]. Depending on the complexity required for a system to obtain information to gauge these aspects (e.g., through sensing or inference), it is said that the system can have various levels of cognitive capabilities. [2,26]

	Never used	One time or few times	Monthly	Weekly	Daily
I have used the Sport Tracker application or similar software	13	3	0.627	1	
I have used technology (mobile phone, heart rate monitor or pedometer) in my physical training	5	7	1	1	3
I have discussed my physical exercises on different physical and online discussions forums	13	3	1		
I could use some new technology applications in my training	7	2	3		5

Table 1: Participants' use of technology for physical activities

Player experience is a broad term that can be roughly subdivided into player involvement and player enjoyment. Player involvement describes a player's focus and interest in digital play in terms of flow, immersion, and engagement. [27] Player enjoyment, as a multidimensional construct, will give a better understanding of how player experience is shaped; for example, a digital game can introduce frustration but still be experienced as a positive and challenging activity. In game development, player enjoyment could easily integrate experiences from various sensory channels through a phenomenon referred to as intermodal integration.

The pleasure experience framework proposed by Jordan (2000) includes *physical pleasures* that correspond to the visceral level, *physiological pleasures* that correspond to the behavioral level, and *ideological and social pleasures* that correspond to the reflective level. [29] McCarthy and Wright

(2004) define pleasure experience with four types of 'threads,' "including the sensual thread of experience which corresponds to the visceral level of emotion, the compositional thread of experience which corresponds to the behavioral level of emotion, the emotional thread of experience which corresponds to the reflective level of emotion, and the spatio-temporal thread of experience which is indirectly related to both the visceral level and the behavioral level. The spatial part of the spatio-temporal thread of experience is tightly related to the visceral level of emotion since the space is mostly sensed by a visual sense- i.e. the eyes". The temporal part of the spatio-temporal thread of experience is tightly related to the behavioral level since this level is induced by expectations that require the notion of time. [30]

High-quality interactions that enable individual users to co-create unique experiences with the geocaching game are the key to unlocking new sources of competitive advantage. Value will have to be jointly created by both the game itself and the users (see Table 2).

In all variations of consumer involvement, from self-checkout to participation in a staged experience, companies in general are still in charge of the overall orchestration of the experience. They focus on user experiences; while basically treating consumers/users as passive. This kind of user-centered design, where users are passive participators does not work in game development, because companies disproportionately influence the nature of the experience. The traditional view of the game companies and its product- creating users the experiences the games – has not disappeared still. [31]

Rather, what has emerged as the basis for unique value to users is their experience (which is contextual). The quality of that experience depends on the nature of the involvement the users have in co-creating experience, in our case with the geocaching community. Empirical findings present a variety of experiences, which users have shared in the usability test. Individual involvement can go beyond the treatment modality to the process of game design, users, geocaching community and GroundSpeak Forum Inc. It can vary from user to user, and depends on how each user co-creates his or her unique set of experiences. Hence, what we need to create is an experience environment within which individual users can create their own unique personalized experience. In other words, individual geocaching experience can be commoditized but co-creation experiences cannot [32]. Participants will build innovating experiences and co-create new design guidelines in pervasive adventure games in tourist context.

Table 2: The concept of co-creation in geocaching game

What co-creation is
Geocaching game co-creation is about joint creation of value by Geocaching community and users.
Allowing the geocachers to co-construct the service experiences to suit his/her context.
Joint problem definition and problem solving in Geocaching community.
Creating an experience environment in which users can have active dialogue and co-construct personalized experiences; services may be the same (e.g Geocaching Events and Cache in Trash Out Days in Globally) but users can construct different experiences.
Experience variety
Experiencing the geocaching experiences as users do in real time by through Internet
Continuous dialogue
Co-constructing personalized experiences
Innovating experience environments for new co-creation experiences.

VI. RESULTS

A. Empirical Evaluation

The GeoCentria application user test sheet has six separate parts. The first part evaluates the practical benefits of using the GeoCentria application to play the geocaching game. The second part evaluates convenience aspects of the GeoCentria application. The third part evaluates the versatility of the GeoCentria application. The fourth part evaluates the manageability of the geocaching game through user skills in the GeoCentria application. The fifth part evaluates participants' emotional experiences. Finally, the sixth part includes open questions.

In the first part, we wanted to know how participants evaluate the GeoCentria application's practical benefits. We have four statements, from which the user needs to choose the best to describe their opinion. We use a five-point Likert-type scale, which is used to measure user attitude based on the following options: Strongly agree, agree, neither agree nor disagree, disagree, strongly disagree. As such, the scale purports to measure direction (agreement/disagreement) and intensity (strength) of attitude. The scale, was intended as a summated scale, which was then assumed to have interval scale properties [33]. According to Albaum [1997], with some attitude questions a person must compute an evaluative judgment, whereas, with others, such a judgment is simply retrieved. In a real sense, we can view an opinion as a verbal expression of an attitude, which means that opinions are the means we have for measuring attitudes [34].

In the *First part*, practical benefits include low cost, ease of use, adequate information for searching geocaches, software correctness and up-to-date provision of information, and the ability of users to easily obtain added information from geocaches.

The *Second part* discusses convenience aspects of the GeoCentria software, and evaluates whether the software offers users new experiences, whether the map in the software supports user actions for searching geocaches, whether the use of the software for searching geocaches feels natural, and whether searching geocaches is both challenging and interesting at the same time.

The *Third part* presents versatility statements, such as: 'the software will help to keep up physical health and inspire movement to different terrains'; 'the software will offer essential added value in the current software environment', 'the software inspires research and learning more in environments', and 'the software offers for new way to present, for example, tourist destinations'.

The *Fourth part* discusses manageability aspects, such as whether new elements could easily be added to the GeoCentria software, whether the software could easily be used together with other social media services, whether the software could offer the possibility of being viewed simultaneously by players, and whether the software could easily be used in education in learning institutions (for example, for teaching environmental studies).

The *Fifth part* presents emotional experience statements, such as 'the software offers a fun and pleasurable way to find geocaches'; 'the software offers a playful way to find geocaches'; 'the software offers an unattractive experience to find geocaches', and 'the software offers stimulation and a surprising way to find geocaches'. The results of the discussions in the previous five parts are summarized in Table 3, which provides a suggested outline of empirical findings.

Results show that that the GeoCentria application was easy to use and it was understandable for most of the users. Based on the empirical evaluation, it can be concluded that participants found that the GeoCentria application provided correct and up-to-date information in an effective and enjoyable way. Based on empirical evaluation, results indicate that participants found that searching geocaches was challenging and at the same time interesting.

Based on the empirical evaluation participants feel that they get benefits from the geocaching game, which maintains physical health and inspires them to move to different terrains. At the same time, GeoCentria inspires users to research and learn more in environments. The geocaching game offers a new way to present, for example, tourist destinations [35] [36]. In this way, the participants see that the GeoCentria application will offer new experiences in tourism business.

From the results and presented analysis, it is possible to say that new social media services could easily be added to the GeoCentria application. Participants like the idea that GeoCentria software offers the possibility of being viewed simultaneously by users. This could extend challenge experience and social experience, as using social interaction is the driving force

in gameplay, which pervasive gaming envisions. Geocaching has been used in education for example; Matherson et al. (2008) give an overview of using GPS as a teaching and learning activity. Geocaching can be an exciting tool for the social classroom, but it also requires planning [37]. Results indicate that the GeoCentria application can easily be used in education, and the motivation to learn an experience has consequence to create new information, which extend values of geocaching communities.

Results indicate that a combination of pleasurable and fun elements causes a sense of very rewarding, deep enjoyment. Additionally, an important precursor to a playful way to find geocaches is to match between the person’s skills and the challenges associated with the task, with both being at a certain level. Most flow or immersion experiences occur with activities that are goal-directed (as in this user test), bounded by rules, and require mental energy and appropriate skills. This study’s participants felt that the GeoCentria application offers them stimulation and a surprising way to find geocaches.

The empirical evidence supports the claim that geocaching is engaging to users of the GeoCentria application. Results show that users easily learn to use the GeoCentria application, for example, users often commented that “*it was quite easy to use.*” Players must be rewarded appropriately for continued play; in this study, participants felt, for example, “[*a*] *wow-experience and think to start a new hobby playing the geocaching game.*” The effort invested in a geocaching game should equal the rewards of success [38].

B. Evaluation of social aspects

The small-scale interaction among a few players (as in this study, which had groups of 3 or 4 players) in pervasive game design makes the social interaction among players a core element of gameplay. Pervasive adventure games like geocaching make use of the social factors and creativity of the players by giving them some overall goals and tools for interaction and then leaving the field open for the players [39].

Empirical findings show that participants enjoyed the social experience in geocaching game. For example, one player commented, that “*it unites people and helps them understand each other*”. Results indicate that the GeoCentria application works well with friends and general group situations. “*It shows directions so a group of friends can navigate easily. It provides helpful information on where we can find geocaches; with friends we could also discuss various options*”.

	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
Practical Benefits:					
GeoCentria application is easy to use			11,8%	58,8%	29,4%
Software offers adequate information for searching geocaches			23,5%	23,5%	52,9%
Software information was right and up-to-date			17,6%	41,2%	41,2%
Users get necessary added information by easily in the geocache itself		5,9%	17,6%	58,8%	17,6%
Convenience:					
Software offers me new experiences and even an experience		5,9%	11,8%	47,1%	35,3%
The map in software supports my actions for searching geocaches.		5,9%	11,8%	52,9%	23,5%
Using the software for searching geocaches felt natural.		5,9%	23,5%	47,1%	23,5%
Searching geocaches was challenging and at the same time interesting.			5,9%	47,1%	47,1%
Versatility:					
Software will help to keep up physical health and inspire me to move to different terrains.			29,4%	35,3%	35,3%
GeoCentria-Software will offer essentially added value for current software.		11,8%	17,6%	29,4%	41,2%
Software inspires me to research and learn more in environments.			11,8%	35,3%	52,9%
Software offers a new way to present, for example, tourist destinations.			5,9%	41,2%	52,9%
Manageability:					
New elements could easily be added to GeoCentria-software.			29,4%	35,3%	35,3%
Software could easily join other social media services.		11,8%	17,6%	29,4%	41,2%
Software could offer the possibility to be viewed simultaneously by playing users.			11,8%	29,4%	58,8%
Software could easily be used in education in learning institutions.				29,4%	70,6%
Emotional Experience					
Software offers a fun and pleasurable way to find geocaches.				52,9%	47,1%
Software offers a playful way to find geocaches.			11,8%	47,1%	41,2%
Software offers an unattractive experience to find geocaches.	58,8%	29,4%	11,8%		
Software offers stimulation and a surprising way to find geocaches.		5,9%	11,8%	47,1%	35,3%

Table 3: Geocentria user test questions



Figure 2: Users searching for geocaches

Social competition is also an important aspect of social interaction, as this study participants gain satisfaction from competing against and winning against other users. In this study, users indicated, “*GeoCaching makes possible a competitive game among a group of friends*”. We believe that the opportunities for value creation are enhanced significantly for game designers if the concept of personalized co-creation experience is embraced as a source of unique value. Personalizing the co-creation experience means fostering individualized interactions and experience outcomes.

C. Dimensions of experience

Creative experience is the freedom that players have in expressing their creativity and intentions by playing the game in the way that they want [40]. Creative experience can be understood as something active, which involves users in self-development, and users actively learn about their surroundings and apply that knowledge to develop their own skills [41]. Participants indicated that they could create and share their knowledge within the GeoCentria application.

Emotional experience is defined as a complex construct with physiological, affective, and cognitive dimensions, and is the core of entertainment media [42]. Positive emotional experience becomes an important reason for performing an activity: if an activity is interesting, it is motivating, and people are more likely to engage in it. The GeoCentria application motivates the use of geocaching to, for example, “*make a recreational day*”. The geocaching game was enjoyable for participants: “*I like to go search for geocaches, and explore new areas*”. The players feel in control of the actual movements and the manner in which they explore their environment [43].



Fig 3. Enjoyment framework of field work findings.

Temporal experience as experience flow starts with first time use, and its eventual success depends on its continual long-term use. Enjoyment, as realized in the flow state as experience of the activity is intrinsically rewarding, such that often the end goal is just an excuse for the process [44]. Participants experience flow and temporality of an experience; for example, one commented, “*I gained a new experience, because I never used this kind of GeoCentria application or even anything like it before*”.

Educational experience can be understood as an internal motivation to learn. Given that protecting one’s self-concept and/or self-esteem is a strong motivator to acquire new information, educational experience can be enhanced through such kind of motivation [45]. This way, subjects like math, history etc. can be taught in a playful manner. Empirical findings indicate that participants are able to learn through their experiences and co-experience in finding caches. Participants thought that the GeoCentria application is fit for “*natural science studies in schools and for children treasure hunting, including exercises*”.

Games should entice the user to linger and become immersed in the experience [46]. Immersion, engagement, and absorption are concepts that are frequently discussed and highly important in game design and research [47]. Participants become immersed in searching for the geocaches: “*Time flew by while I was collecting geocaches and information*”.

Challenge is an equally important aspect of good game design. An important precursor of flow is a match between the person’s skills and the challenges associated with an activity, with both skills and challenges exceeding a certain level [48]. Participants create new ideas, challenging the geocaching game; for example, “*people can change the position of a target*”.

just for fun to mislead other players; the interface could be changed; for example, another picture of the compass can be inserted". Using the GeoCentria application and getting information in QR -codes allow a natural way to interact in geocaching. *"The tips with QR code were easy to use and fun—also modern and innovative"*. Participants want more competition with groups: *"competition between groups of people from different countries can open new possibilities, it can be a new kind of tourism service."*

VII. DESIGN GUIDELINES

Based on the user study results presented above, we composed a set of guidelines for designing adventure game mobile applications. Design guidelines describe participants' ideas and some theoretical conclusions.

The variables listed below, it is suggested, will have an effect on the strength of the pleasurable feeling that can be evoked by each category in the framework. For example, a work may intend to create a pleasurable creative experience, but this pleasure will not be felt very strongly if the things that the participants can create are not perceived to be novel, complex or unexpected.

1. Tracking system in Adventure mobile games

Description: Adventure mobile games (like Geocaching) should support a tracking system.

Motivation: Participants saw that the geocaching game uses interface metaphors and analogies to the real world to help players understand how to navigate through the environment and interact with other users and objects [49]. Tracking systems motivate participants to extend the geocaching game into social interaction experiences especially in the context of tourism.

Example: The tracking system needs to show the past and future route taken and users could easily leave messages about geocaches by using coordinates. Users could also leave hints to other users on the road. Users want to share position information with other users and find nearby other players, maybe even players whom they are competing against.

2. Social media tool for competing with other players (social networks)

Description: The adventure mobile game should support sharing information in social media services and competing with others. Games which support visiting tourist destinations benefit from users who create places for new content.

Motivations: Participants' success encourages their desire for more social components of gaming experience. Further, participants wish to use the digital gaming platform to its full extent as an infocommunications platform capable of bringing users together [50].

Example: Social media services offer tools, which in groups have competition with other groups based on time or amount of geocaches found. Social media tools will be an easily integrated method, both in daily life and in the context of tourism.

3. Mixed Reality experience

Description: Adventure mobile games should support mixed reality components, like showing player location on the screen, showing the finding of caches, and players who are near the current location.

Motivation: Participants gain motivation from mixed reality because its playing field exists in both real and virtual environments, serving different game functions. Geocaching offers the opportunity to explore a nascent area of media convergence and to understand how the naturally occurring phenomenon of self-motivated social learning and collaborative problem solving reflects the growth of 21st century skills [51,26]. In the context of tourism, mixed reality components can provide useful information relevant to the local area.

Example: Mixed reality components can show player scores as well as the location of other players. Users want to use cameras in gameplay, for example, to take pictures with virtual components ("mixed reality screenshots", for example including scores and hints) and share them with other users in social media services. In touristic venues, users can create new content by using the geocaching game.

4. Educational experience tool

Description: Adventure mobile games should support educational experience tools. Players can increase their knowledge on subjects like math, geography, and history.

Motivation: The motivation in participants is to have a learning experience that enables them to create new information for future social interactions, increasing the values of the community as a whole.

Example: Adventure mobile games could be used as an educational experience tool, which companies could use for functions like team-building days, or teachers could use in education for any subject. Treasure hunt could be a method in education and give an experience for users to learn about the environment. Creative tourists involved in creating their own experience could profit from the educational capabilities of such an adventure game. The geocaching game supports players in creating their own experience, and also creates new possibilities for sharing experiences with others.

5. Narrative experience tool for Tourism (or any other context)

Description: Adventure mobile games should support narrative experience. Narratives emerge from the interaction between objects and physical locations.

Motivation: Exciting stories motivate participants. Also, users get a description of history of the places or a mystery story based on the places, which makes them further enjoy the search for new places. Humans are always interested in adventure, that's why narrative tools support people in gaining new experiences.

Example: Adventure mobile games can offer narrative experiences around the world. Finding caches is part of the nar-

rative experience; the story sequence begins with a setting in which the narrator introduces the location and the time in which the story takes place [52]. Users hunt for a narrative experience by finding new places with new stories. Tourist destinations make narratives of places and stories through their products. Hence, players can create new content for the game.

VIII. CONCLUSIONS

The purpose of this study was to analyze how the GeoCentria application contributed to playing Geocaching, and how device, methods, and techniques support adventure geocaching games in the context of tourism. It is important to acknowledge that digital games are designed primarily for entertainment. The types of emotional experience that serve to entertain will likely support pleasurable user experiences in playing digital adventure games. Empirical findings, however, show that an equally important component in game design is social experience and co-experience. Users want to share their experiences and create new content, for example based on tourist destinations. Nowadays, social media tools and methods are important aspects of game design, which raises the need to extend and create new tools in pervasive adventure games.

Results show that players' creative experience plays an important role in game design, which gives users the opportunity to create and share, for example, location information and other users' hints and messages. Player creative experience makes users active participants, who want to develop their own game experiences. Further, creative tourists want not only to create their own experiences, but also to learn from the experience of others. Hence, sharing and having co-experiences play an important role in the design of new adventure games for tourism. Empirical findings also indicate a component of educational experience, as there is a motivation to learn through playful experiences.

Design guidelines were formulated based on users' suggestions for developing the GeoCentria application. Empirical findings support new elements, like mixed reality components, narrative experience components, educational experience, social experience (social network services), and the use of a tracking system in adventure game design.

We have found that mixed-reality components seem to be an interesting new feature in the geocaching game. Therefore, we suppose that mobile and ubiquitous computing will offer new possibilities in the future for further developing geocache concepts. For example, we believe that RFID and wireless sensor network technologies could offer new possibilities to implement mystery geocaches. Ubiquitous tourism services should enrich experiences but at the same time be invisible. For example, the use of pressure or motion detecting sensors as a part of infrastructure of mystery geocache location would provide information on user behavior in an invisible manner, and thus enrich geocaching experiences (for example, in sport geocaching). It should be noted that the use of wireless sensors

would bring possibilities to attach sensors in environments without any cables. All in all, these technologies are already available in the market and robust enough to be used in these contexts.

ACKNOWLEDGMENTS

We thank all participants on this research. We thank Markku Hartikainen for helping in the development around the GeoCentria application.

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