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INTERNET OF PLAY - TESTING AUGMENTED PLAYFUL LEARNING THROUGH THE FLIPPED CLASSROOM APPROACH

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Synopsis:
This study explores the relation between learning experiences of preschool children and an Augmented Reality application used in connection to a geocaching trail. We have created a game-based learning environment based on the treasure hunt of the geocaching game that utilizes Augmented Reality (AR) technology. By using this game-based learning environment and the Flipped Classroom approach as a conceptual framework in understanding the emerging role of augmented learning experiences in the preschool context, we have conducted play-tests with preschool-aged children. Our aim is to understand which kind of elements the Internet of Play, as in an augmented game-based learning environment contextualized on a geocaching trail affords, in terms of enjoyment, motivation and opportunities for playful learning.

Picture: Pirita Ihamäki & Katriina Heljakka

Internet of Play – Testing Augmented Playful Learning Through the Flipped Classroom Approach

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Abstract
This study explores the relation between playful learning experiences of preschool children and an Augmented Reality application used in connection to a geocaching trail, Sigrid-Secrets. We have created a game-based learning environment based on the treasure hunt of the geocaching game that utilizes Augmented Reality (AR) technology. Augmented Reality game-based learning (ARGBL) is quickly gaining momentum in the education sector worldwide as it has the potential to enable new forms of outdoor learning and transform the learning experience (Fotaris, et al., 2017). Our aim is to determine the experiences of preschool children regarding playful augmented learning, through the use of the Augmented Reality-enhanced Sigrid-Secrets mobile application on a geocaching trail. One of the goals is to explore which educational needs, such as collaborative learning, does new technology like Augmented Reality cater to when preschool children learn in environments outside of the classroom. This study was conducted with 20 preschool children, who participated in our Sigrid-Secrets geocaching trail play-test with their four teachers. After the play-tests, the children were asked how they would teach their peers about what they learned during the play-tests. The results show that the suggested Augmented Reality game-based learning environment may help preschoolers to engage, explore, explain, and elaborate understandings of their own environment and, for example, the history of their hometown, when using the Flipped Classroom approach.

Key words: Augmented Reality, Flipped Classroom, Game-based learning, Internet of Play, Sigrid-Secrets geocaching trail

1. Introduction

Advanced information and communication technologies provide great potential for creating new learning environments, like Augmented Reality enhanced game-based environments supporting playful and mobile learning. This study explores the relation between preschool

children and the Augmented Reality game-based environment experienced through the Sigrid-Secrets geocaching[1] trail, which is based in an outdoor public environment—a city park.

According to some studies, the learning process becomes more authentic and educationally entertaining with the help of modern advanced technologies (Shadiev, Hwang & Huang, 2017). Learners experience authentic learning situations with educationally playful features, both in the classroom and outside of school like in our case the park environment, when using advanced technologies. As a result, learning becomes more attractive, effective and meaningful (Kiernan & Aizawa, 2004; Kramsch, 1993). In addition to the development of Augmented Reality (AR) technology, there have been significant changes in many fields, with new trends observed in education in particular. The most significant difference this development has caused is related to students' learning models in schools. As learning approaches are traditionally teacher-centered, they prevent the new trends and approaches being incorporated in education. As the main source of changes in learning approaches in education, the technology is now being used in education due to its simplicity and the availability of materials during the learning (Akdemir et al., 2015, Uzunboylu & Karagozulu, 2017). For example, as illustrated in this case study, materials are available when preschoolers need them outside of the traditional environment of the classroom. Education supported by new technology also presents opportunities for both formal and informal learning, which means that students have the possibility to learn new things even on their own, in their own everyday environment, by using mobile applications, which provide educational, location-based material designed for particular environments.

The younger generations are generally considered as "digital natives" (Prensky, 2001), who spend the majority of their time playing games on screens—their smart phones, tablets or computers on a daily basis. There has been a rapid increase in game playing frequency, as children and young people exhibit an increasing interest in games, with the improved access and portability of their smartphones and similar devices (Efe, 2014). Hence, in many studies, it has been demonstrated that using games in education can be highly beneficial for learners (Prensky, 2001, Mitchell & Savill-Smith, 2004, de Freitas & Oliver, 2006, Schmitt et al., 2018). For this reason, instead of the repetitive nature of traditional learning media, there is now a tendency to integrate the new technology like Augmented Reality into education by placing the students in more entertaining, effective and creative situations. Among these methods, the *Flipped Classroom approach* and *gamified learning* experiences are perceived as complementary. Gamification has been popular for some time, and it is difficult to pinpoint when gamification first started. However, some state 1912 as gamification's first mass-market appearance. As Lyod describes, in 1912 the American Cracker Jack popcorn brand began to include a free prize in every bag. While this is not gamification in its modern sense, the use of fun and a prize that could be collected may have inadvertently presented gamification's birth. Another well-known use of gamification emerged for education in the form of the scout movement in 1910. Their utilization of ranks as well as badges for achievements in various activities has engaged children since its introduction. (Lyod, 2014)

Again, the Flipped Classroom approach supported by a game based-learning environment is different from the traditional classroom in terms of its objectives, which include creating a competitive environment where students are entertained, and their interest and motivation levels are elevated. (Özer et al., 2018) The Flipped Classroom teaching method encourages

[1] 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 that is called geocache (Geocaching.com).

the students to use mobile applications, which base on situated lessons (for example, outdoor learning) and the learning happens in a real time situation in places such as in the environment of a park.

Although numerous studies on the effects of gamification in education and the Flipped Classroom teaching technique exist in previous literature, there have been no studies that have analyzed these approaches as combined. To fill this gap in educational literature, the authors present a study on how playing a location-based game—geocaching— can be combined with the Flipped Classroom approach: In the case study presented in the paper at hand, preschoolers shared their playful learning experiences of game-related collaborative problem solving in association with the augmented geocaching game with a group of peers and were then asked, how they would teach other preschoolers about their experience.

In this regard, the aim of this study is to determine the experiences of preschool children and their teachers in connection with an Augmented Reality-enhanced game-based learning environment when walking along the Sigrid-Secrets geocaching trail during an outdoor learning session. We begin by providing an overview of the mobile Augmented Reality game-based learning environment using it in collaborative play for the Flipped Classroom approach, where children create new knowledge by collaborative learning and by teaching their peers.

In the following section of the paper we explore the digital game-based learning environment to understand of the context of game-based learning. Then, our interest turns to collaborative play and the Flipped Classroom concept in a preschool learning environment, mainly from the viewpoint of outdoor learning and using a mobile Augmented Reality game-based learning environment. After, we explore the context of the Internet of Play using connected artworks on the Sigrid-Secrets geocaching trail. Lastly, we conclude our theoretical part with exploring Augmented Reality game-based learning used in combination with the Flipped Classroom approach. In the third section of the paper, we explore the methodological viewpoints. In the fourth section we describe the results of our study. We conclude the paper with a discussion of the lessons and implications of Augmented Reality game-based learning.

2. Mobile Augmented Reality game-based learning

Digital game-based learning

Digital game-based learning (DGBL) refers to the learning approach that incorporates educational content or learning design into digital games, like in this case study, the geocaching game. It involves activities that could engage learners in simple tasks or complex problem-solving skills (Deubel, 2006). “During the game-based learning process preschool children learn how to overcome challenges and compete with classmates while solving well-designed simulation problems, as process which can increase preschool children learning motivation, and in turn improve their learning achievement” (Prensky, 2001). Owing to rapid advancements in and popularity of mobile and wireless communication technologies, digital game-based learning has moved into the mobile era (Ciampa, 2014), and in this way ‘e-learning’ has become ‘m-learning’. At the same time, along with the development of mobile technology, many games can be played on mobile phones and tablets, and can used coordinates such as GPS (Global Positioning System) and QR codes (Chang and Lin, 2012; Riconscent, 2013; Ihamäki, 2015; Heljakka & Ihamäki, 2018a; Heljakka & Ihamäki, 2018b; Ihamäki & Heljakka, 2017).

For example, Huizenga et al. (2009) have used a mobile game in the classroom, helping high school students to gain knowledge of the history of the city of Amsterdam in the Middle Ages. This makes an example of the advancements in digital technology and the popularity of the Internet, integrating them into game-based teaching, which has attracted attention (Hwang et al., 2012, Hwang et al., 2016; Hwang et al., 2013).

Over the past decade, scholars have attempted to understand the application trend of game-based learning and mobile technology-supported learning in education by reviewing the literature in these areas. Regarding the use of mobile technologies in education, Klopfer and Squire (2008) examined the innovative applications of mobile technology for the purpose of education and entertainment, and discussed the instructional design and influences of the techniques. On the one hand, Hsu et al. (2012) surveyed the mobile and ubiquitous learning studies published from 2005 to 2009, and found that the amount of research in this field had significantly increased. On the other hand, several review studies of digital game-based learning have been conducted. For example, Hwang and Wu (2012) have indicated that the researchers paid close attention to students' motivation, perceptions of and attitudes toward digital games to understand the increasing trend of applying mobile technology in education. In the context of this paper, we are particularly interested in new technologies, such as AR augmentation, when employed as a part of playful learning and new educational models, such as the Flipped Classroom approach.

Collaborative Play as an area of the Flipped Classroom approach

Gadamer (1989) describes that play is "experienced subjectively as relaxation or pleasure, even though it may require considerable effort, because it "absorbs the player" and in this way frees her from the burden of initiative" (Gadamer, 1989, 105). Play requires a demarcated space to play (a playing field, explicit or implicit) and may be limited in time. Play is 'ordered' and has rules, although the rules may not be written down (Huizinga, 1950). While play may involve a task, it has no external goal as such, and is often self-renewing or repetitive (Gadamer, 1989, 103). Regarding the social forms of play, Parten (1932) identified six types of play that include: 1) unoccupied behavior, 2) onlooker, 3) solitary play, 4) parallel play, 5) associate play and 6) cooperative play (collaborative play). In this paper, our interest turns to the last mentioned form—cooperative, or, collaborative play.

Collaborative play occurs when children have a shared goal and mutually contribute to solve a problem (Ashley & Tomasello, 1998). Children's engagement in collaborative problem solving during play has been valued theoretically since play provides a pathway through which children learn to construct their own knowledge (Piaget, 1951) and develop their problem-solving skills through interacting with advanced peers (Vygotsky, 1978). This means that 'play leads development' because children strive to remain in play episodes even when they are challenged in order to remain a member of the learning group (Bodrova & Leong, 2007). This effort to remain engaged with others during play encourage a child, at times, leads to behave in more advanced ways – to stand 'a head taller' than what is typical for that child (Vygotsky, 1978, 102).

Collaborative play is the mode of use in the Sigrid-Secrets Augmented Reality geocaching trail when the game is used in the context of learning: The players use mobile devices connected to the Internet of Play in combination with outdoor learning exercises. This process not only promotes children's social interaction but also enables them to learn new skills, knowledge, and dispositions with others (Rogoff & Morelli, 1997, Rubin, Bukowski & Parker, 2006).

Children's engagement in collaborative problem solving and play reveals dynamic characteristics in everyday classroom contexts. In such settings, opportunities for the emergence of children's collaborative problem solving is fluid and often 'needs-based' in contrast to experimental contexts, in which problems and settings are managed by researchers (Dewey, 1938). As collaborative problem solving and play engage children to learn may happen at the same time, scholars are interested in the ways they can be combined. The Flipped Classroom as one of such examples is one of the most recently emerged and popular technology-infused learning model. This is a learning model in which content attainment is shifted forward to outside of class into a mobile context and then followed by teacher-facilitated concept application activities in education. Hamdan et al. (2013) present the following definition: "In the Flipped Learning model, teachers shift direct learning out of the large group learning space and move it into the individual learning space, with the help of one of several technologies" (Hamdan et al., 2013, 4). Our hypothesis is that instructor facilitation is the main causal factor of improvements in preschool children learning in the flipped model, necessitated that all other factors be tightly controlled. Thus, flipped sections were exposed to the same active-learning instructional materials (presenting the game instructions for the Sigrid-Secrets geocaching trail in the classroom) just via different platforms (and by explaining that we were using the Sigrid-Secrets Augmented Reality mobile application after we have found the physical artworks and will bring these physical artworks 'alive' by using the AR enhancement on the app). For evaluation, we used Bybee's (1993) 5-E learning cycle.

Augmented Reality game-based learning as a case study of the Internet of Play

Recent technological progress introduces mobile Augmented Reality (AR) learning environments, which layer virtual information on the physical environment and require learners to solve complex problems by combining collected evidence from the real world and virtual information in real time (Chiang et al., 2014; Tobar-Muñoz et al., 2017). However, although AR technologies have been around for several years, it is the recent procreation of mobile devices that has made inexpensive AR systems available to the general public (Wu et al., 2013). As an earlier study has shown, AR is currently gaining significant momentum in education (Atwood-Blaine & Huffman, 2017) with the educators hoping that the level of active engagement seen in mobile AR games such as the overwhelmingly successful Pokémon GO can potentially translate to compelling educational experiences and make learning more immersive and 'edutaining', that is, both entertaining and educational.

Azuma (1997) defines AR as a system or as visualization technique that fulfils three main criteria, which are first a combination of real and virtual worlds; second real time interaction, and third accurate 3D registration of virtual and real objects. This is commonly accepted as a real-time technology whereby a physical environment has been augmented by adding virtual information in it (Enyedy et al. 2012). However, this is different from a Virtual Environment where the use is completely immersed inside a synthetic environment. In this sense, AR supplements reality, rather than completely replacing it (Azuma, 1997), as it enriches people's senses with additional information beyond what is provided by the natural environment.

User experience includes the provision of large amount of information and additional environmental stimuli, which gives users the awareness of being inside of a visually-rich, informative environment (Squire & Jan, 2007). That is the reason, why AR technology can provide a more efficient understanding of abstract concepts, which can also lead to improved spatial and cognitive abilities (Laine et al., 2016; Joo-Nagata et al., 2017).

Augmented Reality applications are usually available through mobile devices such as smartphones and tablets, which employ cameras, GPS sensors and Internet access to embed real world environments with dynamic, context-aware, and interactive digital content (Chiang et al. 2014; Zhang et al. 2014). Consequently, the lecture-style of teaching has been experienced recently, combined with the maturity of AR technologies by creating AR in the educational environment to create practical ad highly interactive visual forms of learning, which also support the Flipped Classroom method by collaborative learning style (Hsiao et al. 2016; Huang et al, 2016). Some of the popular field of primary education that use AR in teaching are Science (Atwood-Blaine & Huffman 2017, Huang et al. 2016; Hsiao et al., 2016), Natural Sciences (Chiang et al., 2014), Physics (Enyedy et al., 2012), Astronomy (Zhang et al., 2014), Geometry (Laine et al., 2016), Social Sciences (Joo-Nagata et al., 2017) and Reading comprehension (Tobar-Muñoz et al., 2017). Additionally, early studies have suggested that content learnt through Augmented Reality technologies can benefit long-term memory, problem-solving, enthusiasm and student's collaborative learning possibilities (Huang et al., 2016; Tobar-Muñoz et al., 2017) and enhance learning satisfaction (Hsiao et al., 2016; Huang et al., 2016). However, there is still a lack of literature review studies presenting and sufficiently analyzing the educational potential and affordances of Augmented Reality in the context of early education (preschool children) and primary education. There is also lack of studies investigating the purposes of using game-based Augmented Reality applications in Early Education and Primary Education, in which it would be described how the concept of pedagogical and functional perspectives have been used. This leads to our interest in exploring education that has used game-based environments enhanced with AR features to extend the classroom into the outdoor environment and the game of geocaching.

In this case study, we have used the term *Internet of Play* to describe Internet-connected artworks weaved together with the geocaching game, which we see as an augmented an gamified playground to engage participants to play with others socially and collaboratively. Therefore, we have used the Sigrid-Secrets Augmented Reality application to connect the physical artworks with an Augmented Reality environment to extend the player experiences of connected physical artworks, a fictional narrative, and virtual artworks 'brought to life' alongside the geocaching gaming platform. Internet connectedness is a multidimensional conceptualization of the importance of networked technology in a person's everyday life. Connectedness suggests a relationship between a person and the Internet not captured or described adequately by traditional use measures – particularly measures based on time, such as hours of use per week (Jung et al., 2001). Internet connectedness implies dynamic and ecological relations between individuals and the Internet, which are embedded in a larger communication environment composed of multi-level relationships among individuals, institutions, organizations and various storytellers, such as artists, including all available communication through media forms (Ball-Rokeach and Readorn, 1998). We are presented with new opportunities of seeing the viewing and spectatorship of art turn to more participatory experiences through Internet of Play, from which new types of interactivity arise. Such arts are an example of the building blocks of the Internet of Things and enable novel computing applications (Kortuem et al., 2010). The Internet of Play stands as a 'playground'—a place for ritual and play vs. as a place for transmission of information (Carey, 1989). All humans engage in play, and that they will continue to do so regardless of any cultural privilege given to work, 'productive' and 'problem solving' activity, and the goals of policy initiatives, writes Carey. (1989) The Internet of Play, thus, encapsulates a global, networked platform for connected play that simultaneously happens offline and online by using mobile devices and other connected entities, such as 'smart' toys (IoToys) and networked gaming systems.

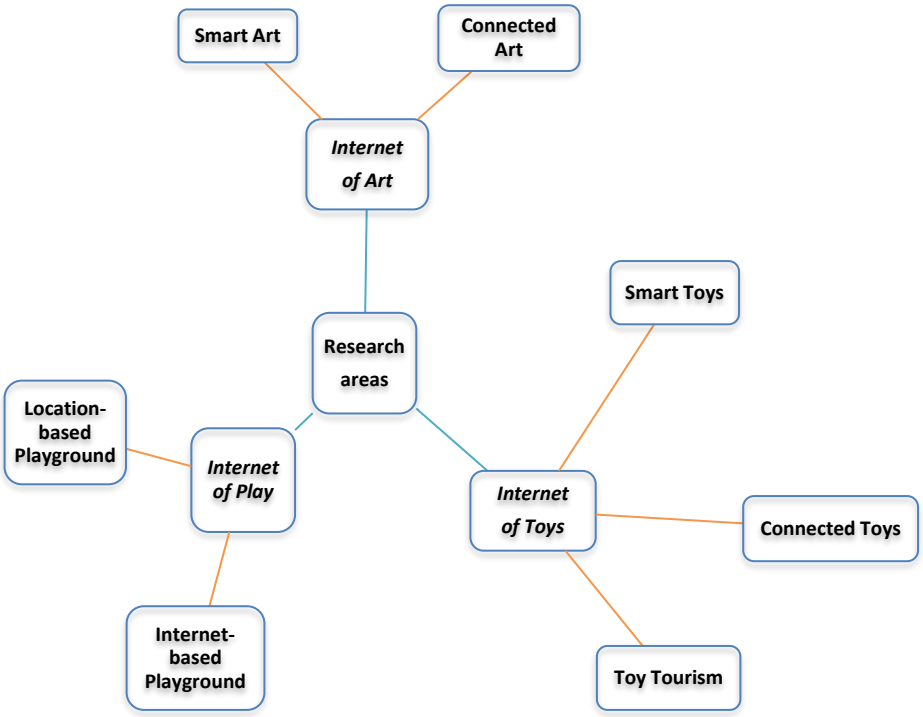

Figure 1. Ecosystem of Connected Play:
Toys (artefacts), playscapes (arenas), and art experiences.

3. Methodology

In our study, we examine the following research questions:

RQ1: How do preschool children experience the Flipped Classroom approach through the Sigrid Secrets Augmented Reality game-based environment?

RQ2: What kind of learning experiences do preschool children describe to get through the Flipped Classroom approach in the Sigrid-Secrets Augmented Reality game-based environment?

We have collected data through a multimethod qualitative approach, which is based on preschool children's group testing of the Sigrid-Secrets geocaching trail by using a mobile Augmented Reality application. We worked with n=20 preschoolers; 5-6-year old boys and girls from two groups and four teachers from a Finnish kindergarten to conduct a play-test as an 'out of the classroom' learning experience.

After the test-playing researchers have asked them questions like "what is your most memorable experience of the Sigrid-Secrets geocaching trail", "what happened when you saw the mobile device 'bring the artwork alive'", "was the Sigrid-Secrets app easy to use", "what was the funniest experience on the Sigrid-Secrets geocaching trail", "what did you learn from the Sigrid-Secrets geocaching trail", and "how would you play the Sigrid-Secrets geocaching trail with your friends?". All research material was documented by photographing and videotaping. Afterwards, we have analyzed all material by using content analysis.

We met with the children in their classroom and explained the content of the geocaching trail, where we will go during the test-playing in the park, and what we are going to do with the mobile device. Throughout the process, we documented via notes, video and photographs so that we could review children's experiences. After playing the game and looking for artworks by walking the geocaching trail (about 1 kilometer in length) we came back to the kindergarten and asked the children to tell about their most memorable experiences of the geocaching trail. At the same time, we collected data with the help of the preschool teachers, who also participated in the geocaching experience.

We have tried to understand the existing geocaching game as an urban 'artified' experience related to the Internet of Play (case Sigrid-Secrets geocaching trail) and investigated what the children and teachers considered valuable when test-playing the geocaching trail (gamespace) through the Augmented Reality mobile application (treasure hunt activities searching for physical artworks and using a mobile device to access the digitally augmented dimension of the artworks). We have categorized our method in two phases, which are 1) observing the group play-testing, and 2) collecting and documenting the feedback from children to understanding preschool children's augmented play experiences.

Phase 1: Observing the play-test

In order to gain a good understanding of the benefits and drawbacks of computational elements (digitally-mediated augmentation) in the geocaching trail, we emphasized observation prior to implementing a first version of Augmented Reality application called Sigrid-Secrets. Our group tests were carried out at the Sigrid-Secrets geocaching trail, which was created in 2016 and includes six physical artworks that can be found by using the geocaching application or the Sigrid-Secrets Augmented Reality application presented in this paper. The story behind the game gives hints on where the six art works and the geocache can be found.

By using the Sigrid-Secrets mobile application the players of the game can experience the physical artworks with their virtually augmented dimensions. Our group test focused on preschool children's experiences of and interaction with the Sigrid-Secrets application, their experiences of looking for the artworks, and their drawings and testimonials about Sigrid-Secrets geocaching trail. One of the goals in this study is to understand the preschoolers' experiences in encountering the mobile Augmented Reality game-based learning environment through the Flipped Classroom approach: What can preschool children learn from the historical narrative accompanying the game, how they become involved in collaborative play (in searching together for the artworks), and how they understand the multi-literacy required from playing with hybrid play worlds combining physical and digitally augmented (learning) environments, such as the Internet of Play.

Phase 2: Collecting and documenting feedback from the preschoolers

In the initial phase, the participating preschool children were invited to fill an evaluation form with preschool teachers and draw their memorable experiences of the Sigrid-Secrets geocaching trail. While the analysis of the drawings is work-in-progress, the results presented in the paper at hand focus on the written materials: We asked the children to evaluate their experiences of the geocaching trail, for example, by answering questions such as: "how did you like the geocaching trail", "what was the funniest thing to do on the geocaching trail", "was it easy to find artworks", "do you remember some artwork particularly well", "what do you think about the artworks", "how did you feel when you looked at the artworks through the mobile device" (iPad), "what really happened on the mobile device when you looked at the physical artworks", "what else would you like to do with the Sigrid-Secrets mobile application", and, "what you would do when using the Sigrid-Secrets mobile app together with your best friend?".

4. Results

Our results show that the play-testing preschool children were engaged and experienced connectedness in the geocaching game we have also called the "Sigrid-Secrets Adventure". With the aim of creating the illusion that the Sigrid-Secrets physical artworks are merging with a mixed reality environment in the player's surroundings, the players' view of the augmented reality animations are unleashed through the mobile device. The augmented reality effect is perceived quite realistic, as participants of the test-playing session described that artworks are exciting and some of the children even felt tension when experiencing them. The findings of the test-playing session show that by far the most engaging aspects of gameplay were connected to the geocaching game mechanics of Sigrid-Secrets. For the most part, participants found the treasure-hunting mechanic satisfying and enjoyed the process of physically moving around the environment searching for the physical artworks. The discoveries of the physical environment and finding artworks constituted playful experiences in themselves. However, the augmented dimension of the artworks enabled by the use of the mobile application, which brings artworks 'alive', brought elements of surprise with it. Overall, the participating preschoolers used the multimodal features of the Sigrid-Secrets app interface as a guide when searching for physical artworks, and they received multisensory experiences based on animated visuals and sound (Augmented Reality experiences). For example, in the first artwork of the trail, the augmented reality experience shows letters of the alphabet one by one, and those letters form the second name of the main character of the game–Sigrid. This made children collectively spell and say those letters. Together, they solved the challenge and experienced pleasure that made them connect with the Sigrid-Secrets adventure. Moreover, the results show that the physical location of the geocaching trail contributed to the overall game experience because the historical narrative (the backstory of Sigrid-Secrets) fits the context of the trail's physical location. Furthermore, we have used Bybee's (1993) 5-E learning cycle analyze the experiences communicated by the play-testing preschoolers.

The 5-E learning cycle consists of five instructional phases, which we have applied to the insights collected from our research materials interested in the AR-enhanced learning environment we here refer to as the Internet of Play. The first three phases (engage, explore and explain) are used to facilitate content attainment. The elaborate phase is the one in which preschoolers apply the concepts they have constructed through the content attainment stage that is the concept application phase (Jensen et al., 2015):

- *Engage:* The Sigrid-Secrets geocaching trail serves as an example of the Internet of Play that caters for playful learning in the way it *engages the preschool children in the material and the process of learning*. In the test-playing group, the geocaching trail presented the preschoolers with a puzzling phenomenon. In our case study, one of the researchers begun the test-playing session by introducing the Sigrid-Secrets geocaching trail for preschool children. In the classroom, the researcher explained the content of the geocaching trail by showing pictures of physical artworks, and explained that these are what the children need to search for on their adventure. The researchers guided the test-playing tour by walking the geocaching trail together with the preschoolers and their teachers. The test-playing took place in the park area, where the group looked for the six physical artworks. After each find (one of the six physical artworks), the Sigrid-Secrets Augmented Reality application was used to enliven the physical artworks. One of the participating preschoolers describes the most memorable artwork in the following way: "That was the Sigrid dancing artwork", when you look at the physical Sigrid artwork where Sigrid was making a ballet split and then looked at the artwork through the app on the mobile device, one saw Sigrid dancing and making a split at the end. The Augmented Reality experience was considered "amazing" to the children as they described that "*the artworks came alive*".

- *Explore:* The Sigrid-Secrets geocaching trail serves as an example of the Internet of Play that allows the preschool children *to explore the content and construct their own understanding* before introducing any terminology. In this case study, preschool children actively engaged with materials to discover patterns (connected artworks belonging to the Internet of Play), make their own stories and to build a conceptual understanding of the history of the place. One of the preschool teachers described the experience of one of her students in the following way: "*She is walking to kindergarten through this park every day and she has never seen one artwork before. Now she can take her mom with her on this adventure together and show her the secrets*". (Child_A1)

- *Explain:* The Sigrid-Secrets geocaching trail serves as an example of the Internet of Play where to explain means the phase at which the instructor introduces terminology that preschool children can link to their own constructions to facilitate concept building; in this case, this was accomplished through Augmented Reality video materials and provided by the researcher leading the test-playing: She read a snippet of a story about the main character Sigrid standing next to the physical artworks. One of the participants described that "*The Sigrid-Secrets geocache trail was an adventure and [the part I was] most interested in it was to searching for the geocache under the 'tree tent' together with preschool friends*". (Child_B2)

- *Elaborate:* The Sigrid-Secrets geocaching trail serves as an example of the Internet of Play, which asks the preschool children to apply their new conceptual understanding to novel situations in order to broaden the domain and strengthen the framework of these concepts. In this case study, the preschoolers were asked to solve little exercises at the six artworks collaboratively, by using what they had learned in the previous phases. The groups solved the tasks successfully together.

- *Evaluate:* The Sigrid-Secrets geocaching trail serves as an example of the Internet of Play that can take the form of both formative and/or summative assessments that test their understanding of the concept they have just learned. The participants describe that they learned more about the city where the geocaching trail is based, their hometown. For example, there is an artwork where the character Sigrid looks at the old Puuvilla cotton factory in the physical artwork. When one looks at the artwork through the Augmented Reality app the picture comes alive and there is a historical video about people crossing the river Kokemäenjoki with a boat. The participating preschool children knew straight away that there was a bridge called "Charlotta" built in this particular place afterwards, and they were surprised that there were those who used to cross the river by boat before there was a bridge.

In this study, we have asked preschool children to take part in test-playing the Sigrid-Secrets geocaching trail that we understand to represent the *Internet of Play*—a global, networked site for learning and entertainment shared through social and collaborative (game)play. We have asked the children who joined our play-test what they would teach other preschool friends about their experience of the geocaching trail. The Flipped Classroom learning examples preschool children described, are introduced in the following. For example, one of the preschoolers, a boy, explained that he learned in this play-test "*to do sport*". He says: "*I also learned, that if I find birdhouse and there is a bird I can't touch the bird."*(Child_C3) The birdhouse association comes from where the actual geocache was hidden. As was discussed with the preschoolers and teachers at the geocache place, was that it is not real birdhouse—it is a geocache, and if it is birdhouse, "don't touch the birdhouse". Other preschool children continued about what they can teach others: "*When we are walking on an adventure on the Sigrid-Secrets geocaching trail one must remember that you can't make too much noise because everyone has to hear the Sigrid-Secrets story. It is better to walk calmly, or else you can step into dog's poop*" (Child_D4). One preschool child taught others: "*that is good to keep your eyes open all the time, you will never know when you find an artwork*" (Child_E5). One of the preschool children advised the other children to "*explore and focus*" (Child_F6). One preschool child taught the others that, "*you can't open the birdhouse [geocache] by yourself*" (Child_G7). One preschooler described, that "*she learned where to find a birdhouse and it was little bit scary when those artworks came alive when we watched [the AR features] on the mobile phone*" (Child_H8). One preschool child described that she will teach others to "*playfully explore all places to find something interesting*" (Child_I9). One of the children was astonished about how Augmented Reality materials make photos come alive "*The Augmented Reality experience doll looks so real*"(Child_J10).

5. Conclusions: Implications of Augmented Reality game-based learning

As the results of our study have shown, the use of a mobile Augmented Reality game-based learning environment through the geocaching trail in early education may be an excellent way to combine situated and active learning with fun. The learning potential of mobile and location-based technologies lies in the possibility to embed learning in an authentic environment, enhance engagement (like using treasure hunting with preschool children) and foster learning (with using various exercises) outside traditional formal educational settings (by using the Flipped Classroom approach). Although this case study on Augmented Reality game-based learning constitutes an expanding research domain, claims that mobile Augmented Reality game-based learning really enhance early education still lack solid empirical evidence (de Freitas, 2006). Augmented Reality in preschool education and primary education is followed closely by location-based AR making use of sensors in mobile devices such as gyroscopes, accelerometers and GPS (Huang et al., 2016). According to our study, an Augmented Reality game-based learning environment that we here describe as the Internet of Play, holds great potential to be used in playful learning, as it can lead preschool children cognitive acceleration, increased self-management, and enhancement to their engagement in practice-based and playful learning activities.

The main advantages of Augmented Reality game-based learning experiences are, according to our findings knowledge gain, increased motivation, augmented interaction, and enhanced collaboration. With the use of AR technology, preschool children can improve their learning performance, partly due to improved positive attitudes towards the learning process and visual Augmented Reality video material that helps them to easily to understand the subject of a certain location, a certain task within that location, and to make them to engage in a learning situation. In the creation of multisensory experiences with Augmented Reality technology, for example, combining real objects (such as physical artworks placed along a geocaching trail) with virtual objects (such as augmented game content), could be an appropriate option to increase students' motivation and participation in playful learning experiences that can have a direct impact on learning outcomes. Moreover, by using the Flipped Classroom approach, students as young as children of the preschool age, can be inspired to reflect upon their own learning experiences in a fruitful way–and even, teach their peers.

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