Effects of Riddle Solving as a Navigational Method on a Location-Based Game Experience

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ABSTRACT
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INTRODUCTION
Mobile technologies are increasingly being used to create experiences in the context of museums and cities. Families and children in particular are an ideal target audience in this context, due to the rising trend of families owning mobile devices [27]. Previous studies concerning engaging children and families have looked into game experiences inspired by treasure hunts, where the players search for written or visual clues in order to find specific items in a museum exhibit [14] [17]. Jensen investigated, how children can be motivated to engage in a joyful museum experience, by interacting with an agent and taking pictures of art works on a tablet device [14]. This experience was inspired by a paper version of a treasure hunt, similar to the one investigated by Larsen & Svabo. They investigated a treasure hunt in pamphlets, where children were dependent on their parents reading out the questions, interpreting the answers and writing them down, making it a family-activity rather than a child-activity [17]. We address these experiences and refer to them as *mobile location-based games* (LBGs). Upscaling such experiences at museums to the city context, we did not find any studies on LBGs targeted families. Common to LBGs are that they place in a *physical space* (e.g. require going to a specific physical location), require some interaction by the player in the *virtual space* (e.g. solving puzzles, interacting with an avatar or following a map), resulting in an interplay between the physical and virtual space [2]. This interplay between physical and virtual space also applies to experiences in museums or cities. Players navigate between points of interests (POIs), A and B, in the physical space and a mobile device is used as either (1) aid to get from A to B (e.g. using a digital map to navigate from one exhibit or cultural heritage to another) or (2) for some activity at the POIs (e.g. getting information, interacting with an artefact or taking pictures). From previous research, we found that a common tendency for LBGs is that the user simply uses either a digital or physical map for navigating between A and B. Since the purpose of LBGs is to create enjoyable experiences by creating an interplay between the physical and the virtual world, we hypothesize that a navigational method with LBG activities in the navigation instead of a map can increase enjoyment of the experience. In order to evaluate the effects of such navigational method, we designed and implemented a location-based game, *Lost on Earth*, aimed at families. The game was based on the previously mentioned museum experience by Jensen [14], targeting 9-11 years old children. In *Lost on Earth*, families navigate between POIs using riddle solving. We compared this with a 2D map. In the following paper, we describe the design end evaluation of this game.

BACKGROUND
Avouris & Yiannoutsou reviewed fifteen LBGs and categorized them as either games designed for player enjoyment (ludic), education (pedagogic) or a combination of both (hybrid) [2]. Most of the LBGs at museums, where e.g. children interact with museums exhibits fell under the hybrid category. The authors found that LBGs take place in a *physical space* (e.g. going to a specific physical location) and require some interaction by the player in the *virtual space* (e.g. doing riddles/puzzles, interacting with an avatar or following a map). This results in an interplay between the physical and virtual space, creating what is known as the game space/narrative space [2]. They also found that narrative was an underlying element in all LBGs [2]. From this, we propose that LBGs are *game experiences* that connect the *physical space with the virtual space* and make use of an underlying *narrative* element.

This paper focuses on the integration of the terms mentioned above into the navigation between POIs in LBGs. Therefore, the following sections will provide a more detailed definition of these terms followed by an analysis of how navigation is used within hybrid LBGs that take place in cities.

Activities in Location-based Games

In order to describe the game activities of LBGs, it is first important to look into what constitutes a game. There are a range of different definitions of games, however McGonigal proposes four defining traits of games which fit the scope of this project[19]. Games must have a *goal*, *rules*, *a feedback system*, and *voluntary participation*. The goal of the game is the specific outcome which players aim to achieve and what gives players a sense of purpose. The rules set limitations or remove obvious ways of getting to the goal and push players to be creative and use strategic thinking. An example of these fundamental traits can be seen in the game Scrabble. In this game, the goal is to spell out long words with lettered tiles, while the rules are that players only have seven letters to work with at a time and they must be based on words that other players already have created. The feedback system informs players about their progress in achieving their goal e.g. through points, levels, a score, or a progress bar. This gives a promise to the player that the goal can be achieved and thereby provides motivation to keep playing. Voluntary participation requires that all players accept the goal, rules, and feedback. This establishes a common ground for the players to play together, and the freedom to enter or leave the game ensures that stressful or challenging work is experienced as a safe and pleasurable activity. McGonigal further uses the following definition from Bernard Suits to define games: *'Playing a game is the voluntary attempt to overcome unnecessary obstacles'*[19]. In relation to the traits previously mentioned, this definition primarily focuses on the goal, rules, and voluntary participation of a game.

Hybrid LBGs are designed both with the purpose of player enjoyment, by using elements from ludic LBGs, as well as educating them about e.g. cultural heritage, by using elements from pedagogic LBGs[2]. In the following, these different types of LBGs will be elaborated on, however due to the scope of this project, less emphasis will be put on purely pedagogic games.

Although the focus of ludic LBGs is enjoyment, learning is often an implicit element, since players might develop skills such as exploration and orientation e.g. by navigating a city. This is especially seen in treasure hunts, where players typically move to certain physical locations and use the physical space at the location for some interaction in the virtual space. Gentes et al. describe treasure hunts as experiences that encourage people to pay attention to details in the city and read the cityscape by looking for clues. An example of this can be seen in the LBG *Team Exploration*, where players work together to compare pictures in the virtual space to real physical locations in Paris in order to figure out which areas of a map the pictures were taken at[11]. The goal of the game is to reach the final location, which is shown on a map, once all pictures have been located. The limitation is that it must be done within a certain amount of time, however in the evaluation of the game, players mentioned that this limitation turned the experience more into a race, which made it difficult for players to enjoy the city instead. Gentes et al. describe this as a tension that exists in treasure hunts between the attention players allocate to the discovery of a place and the hunt itself[11]. Furthermore, the evaluation showed that players wish they had some proof that they had been at certain locations, e.g. by being able to save a picture of the location in order to make the visit more meaningful. As these pictures would act as proof for progression, this indicates that the ability to save information about the places visited is a fitting way of incorporating feedback systems into treasure hunts. Treasure hunts also typically allow players to collect virtual objects at certain physical locations[2], such as in *Insectopia*, where the players collect virtual insects, which represent points and act as both the goal of the game as well as an indication of progression and feedback system[21].

Pedagogic games explicitly have the purpose of educating the player through informal learning[2]. Informal learning is learning that typically does not take place in classrooms, is not highly structured, and where the control of learning rests in the hands of the learner[18]. Incidental learning is informal learning that occurs when people are not conscious of it, e.g. as a result of completing a specific task[18]. According to Avouris & Yiannoutsou, these games typically have a strong narrative and use role playing by making players enact certain roles to comprehend complex scenarios[2]. In these games, it is assessed that it is particularly important that the physical and virtual have a strong interplay to support learning.

Hybrid LBGs are typically used at cultural heritage sites such as museums[2]. They tend to act as guides for exhibits and aim to make them more interesting. The game activities frequently incorporate a narrative, as described in detail in the next section, through role play combined with activities such as answering questions that are related to the cultural artefact in the physical space. *CityTreasure* is an example of a hybrid treasure hunt LBG where learning is supported through riddles at points of interest (POIs)[6]. In this game, students on a field trip visit cultural heritage sites in the city Lugano and answer riddles in the virtual space related to the POIs in the physical space. The students play in groups and are guided to the POIs through locations on a map, and as they reach the locations, they are given three riddles related to the POI. When the riddles are answered, the students will be given a new location on the map to walk to as well as feedback in the form of points if the answer was correct. The goal of the game is to gather the most points, which is driven by competition between the different groups of students playing. Furthermore, Botturia et al. reported that the game fostered collaboration within the groups to solve riddles[6]. In opposition to Team Exploration, there is no time limit in CityTreasure and by rewarding players' observations of the city through points, exploration is encouraged. Although this game does not focus on role play and narrative as the majority of pedagogic and hybrid games, it still manages to incorporate knowledge of the physical space while keeping players engaged according to the evaluation of the game[6].

Narrative in Location-based Games

Different disciplines (e.g. narratology, linguistics, literary studies, film studies and philosophy) define narrative with a great number of different characteristics[13]. A narrative can be defined as *'a perceived sequence of non-randomly connected events, i.e., of described states or conditions which undergo change (into some different states of conditions)'*[28]. When looking into interactive narratives, it is important to understand the concept of player choice. The quality of a game design can be characterized by looking at the relationship between the players choice and the systems response[25]. This relationship should both be supported in terms of the feedback system of the game such as receiving points, known as *discernable* relationships as well as in the larger context of the game, affecting the overall goal, where the outcome of the game should rely on players' choices, known as *integrated* relationships[25]. This can be related to interactive narratives, which offer players choices and the ability to navigate within a multi-linear branching structure of the narrative, thereby influencing the narrative[24]. Avouris & Yiannoutsou state that a narrative in the shape of an interactive course is considered a promising direction of future LBGs[2]. To understand what characterises the quality of choice and narrative in LBGs, a review of interactive narratives in LBGs is presented in the following.

Khaled et al. highlight how an interactive narrative can be used to explore both the physical space but also the virtual space. By changing location the development of the story changes. The authors observed four test subjects and found that contrasts between the story world and real world forced the reader to pay close attention to the physical setting in order to make sense of the experience[15]. Similarly, Avouris & Yiannoutsou found that LBGs emphasising on the narrative often have a strong interplay between the physical space and the virtual space[2]. Khaled et al. observed that when the users had a heightened awareness of both real world and story world, reflection on story contents occurred[15]. A qualitative study made by Blythe et al. investigated the enjoyability of an LBG called *Riot!*, which revolves around progressing a story[5]. In this game, users experience a story through sound that changes dynamically in relation to their location in a city, promoting a strong interplay between the physical and virtual spaces of the game. Results from 30 semi-structured interviews (the exact number of participants were not promoted) revealed that making blind choices caused disappointment, as users were not able to chose specific audio files to hear, since no information about the files was given. In Riot!, users are guided through the city through sound, while still maintaining a strong interplay between the physical and virtual spaces. This means that using sound as a navigational method might be a possibility for a LBG, however as the following section will reveal, it has some difficulties in the context of families.

Navigation in Location-based Games

As seen in the examples mentioned earlier, location-based games (LBGs) utilize points of interest (POIs) in their gameplay, which brings up the requirement of navigating between POIs, when the games take place in cities. This brings up opportunities to gain additional knowledge of the city, and not solely at the POIs. The potential of getting familiar with the city while walking may not be fully utilized, since LBGs often revolve around POIs rather than what is between. Previous studies revolving around the navigational aspect within LBGs is limited. Gordillo et al. made a hybrid LBG in the city for tourists[12]. The game offered three POIs which were marked on a 2D map, requiring the participant to go there in order to trigger activities provided at the location. One distance required travelling 3 km (from Güell Park to Casa Batllò), bringing the game to a pause until arrival at the point of interest. The outcome of the study is unknown, as no test was carried out. From this, we assume that the navigation mainly served as a requirement for leading the player from one POI to another and not as a part of the game activities.

Several LBGs have used 2D maps with Global Positioning System (GPS) technology (e.g. google maps) in a city related context, in order to guide their participants to POIs [8, 12, 30, 7, 3, 22, 4]. To the best of our knowledge, no 2D maps have integrated game activities such as those that are found at the POIs. Therefore, we assume that game activities such as answering questions about the physical space and gaining points either disappear or serve no purpose until the arrival to the next location. Furthermore, we have not been able to find any studies that investigate or evaluate whether navigating with a 2D map is preferable in the context of LBGs.

We have investigated the use of navigation in several LBGs, in terms of the interplay between the physical and virtual domain, use of ludic and pedagogic elements, and whether it is supported by a narrative. Some LBGs revolve around progressing a story. These types of games depend on sound, and do not depend on visuals for navigating, such as in Blyte et al. Events offered in these games are triggered based on how the player chooses to navigate, giving navigation a crucial role in the overall experience[5].

In Riot![5], players navigated freely in a restricted area. However, its design may only be appropriate in a small bounded area due to the extended freedom of exploration, and could be problematic if transferred to a wider context (e.g. an entire city) due to longer distances between POIs. Epstein and Vergani made a similar study on a walking tour in the city Venice, which likewise incorporated the narrative space into the navigation, but instead kept a more linear narrative structure [10]. A narrator in the application verbally explained where to make turns, and at the same time made comments on the physical environment. The outcome of the study did not reveal the users' experiences concerning the navigation.

Both Blythe et al. and Epstein and Vergani encourage the user to explore, but only in relation to the person handling the application due to the use of headphones. Our context deals with families, which would require sharing information. Utilizing audio without it being communicated through headphones would be problematic in terms of navigating in areas with many sounds.

Eguma et al. devised a LBG for tourists utilizing a sightseeing navigation system to promote awareness of surroundings and enjoyability[9]. The authors proposed creating a navigational

system using augmented reality (AR) to display descriptive information from air tags and upon arrival, the participants would have to seek out a character in the surroundings. The concept does however make use of a map, in terms of leading the participants to the area requiring AR for navigating. The aim of the system was letting the user become aware of the surroundings, using 'benefit of inconvenience', which is the idea of something being inconvenient to find, increasing the desire of finding it. The authors did not conduct a study, and therefore the outcome is unknown.

Utilizing AR combined with physical props has served as the navigational method in some LBGs. Morrison et al. conducted a comparative study on a technique called Maplens involving displaying location information on a physical map using augmented reality, comparing it to a 2D map with incorporated accessibility to read about locations, known as DigiMap [20]. This technique was investigated in relation to Flow, Presence and Intrinsic Motivation (IMI). The MapLens had significantly lower scores than DigiMap in most of the questions concerning Flow, Presence and IMI, but its potential was revealed in terms of social interaction since the MapLens encouraged collaborative behaviour. Morrison et al. found that MapLens did not support playing by moving, due to its demands of effort, forethought and planning. This behaviour is supported by the study made by Kuikkaniemi et al., which compared MapLens and navigating by following QR codes [16]. The authors did not find MapLens particularly useful based on observations on the participants. The authors observed that the participants rarely used MapLens, and had technical difficulties in terms of the GPS displaying their correct position. The QR codes were a fun way of navigating both indoors and outdoors, based on non-significant observations, but with no concrete examples on why. The QR codes did not promote any environmental awareness, making the interplay between the physical and virtual domain weak.

As mentioned earlier, hybrid LBGs require a strong interplay between the physical and virtual spaces, supported by game activities and a narrative with the goal of creating an enjoyable learning experience. Based on the above findings in our research, no LBGs have integrated the requirements for a hybrid LBG into the navigation between POIs without relying on sound through headphones, thereby not being suitable for groups of players. For this reason, a new navigational method that is suitable for groups of people, which in our case is families, and has the potential of integrating both the physical and virtual spaces, is needed.

Wayfinding using *landmarks* is a navigational method in which objects or structures that mark a locality are used as points of reference, and it is typically used in the communication of route directions[23]. Route directions provide procedures and descriptions that help people build mental representations of the environment they are about to traverse. When following a route, landmarks can be used for re-orientation at decision points such as road intersections and are known as *local* landmarks. Landmarks can also be used for confirming if people are on the right path, known as *route marks*. Finally, landmarks can be used for overall navigation, known as *distant* landmarks. Landmarks can be described by their *saliency*, which defines how much a landmark stands out from the surrounding objects in its environment. Different types of landmarks have different types of saliency. Sorrows and Hirtle categorize landmarks as either *visual*, *cognitive*, or *structural*[26]. The saliency of visual landmarks can be characterized by their visual contrast to surrounding objects, e.g. based on the size, shape, position or age of a landmark. For *Cognitive* landmarks, the saliency depends on the meaning of the landmark, e.g. due to the landmark being culturally or historically important. The saliency for structural landmarks depends on the accessibility of the landmark, e.g. the amount of locations a landmark is visible from.

As wayfinding using landmarks is a navigational method that uses objects in the environment, we see potential in using it in combination with game activities between POIs for LBGs due to its inclusion of objects in the physical space. This could result in a stronger interplay between the physical and virtual spaces during navigation between POIs in LBGs. Furthermore, using landmarks is based on vision instead of sound, indicating that it might be suitable for a group experience. Therefore, we see potential in using landmarks in combination with game activities as the navigational method between POIs for a LBG targeted families. As mentioned earlier, LBGs have a tendency of using 2D maps and GPS for navigation between POIs, however to the best of our knowledge, no LBGs have used landmarks for navigation between POIs. We set out to investigate the enjoyability of using landmarks in combination with game activities for navigation between POIs with the following research question:

How does landmark navigation in combination with game activities between POIs affect the enjoyability of a location-based game experience for families?

DESIGN

In order to measure the enjoyability of a location-based game (LBG) with a game activity as the navigational method between POIs, we developed a LBG. The game takes place in Aalborg, Denmark and the points of interest (POIs) are three street art paintings[1]. The game makes players walk between the three POIs on a route with a total length of 1.8km and a distance of 0.9km between POIs (see Figure 1). Due to requirements from the method of the experiment as described in (INSERT REFERENCE TO METHOD SECTION), the particular route was chosen on the basis of it having a close to equal amount of intersections in the road between POIs as well as a close to equal distance between the POIs.

Choice of Navigational Game Activity

In the process of designing the navigational game activity using landmarks, four initial designs were created as paper prototypes and one was chosen to be used in the game on the basis of three initial tests of the designs. The tests were done using within-subjects design, meaning that each group of participants used a specific navigational game activity for each quarter of the route. The purpose of the tests was to determine which game activity the participants found most enjoyable, based on short semi-interviews conducted between

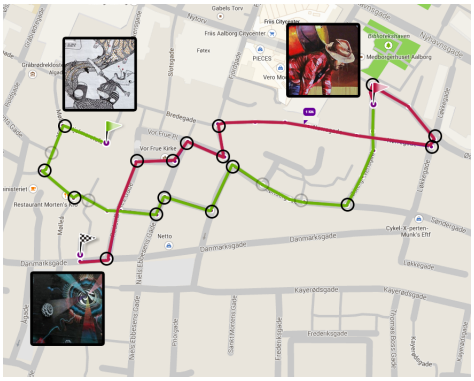

Figure 1. The route between the three street art paintings.

game activities as well as after trying all four activities. The participants of each test were a child in the age group of 8-11 years and the child's parent. We followed the participants during the activities, documenting the tests and interfering if they got lost or had other problems. As the initial designs were paper prototypes with a focus on the navigation, it must be noted that elements of LBGs such as a feedback system, a narrative, activity at POIs, and learning were not a part of the experience in these initial tests.

When designing the four navigational game activities, inspiration was taken from popular children's games, since they are familiar to most children, causing a lower learning curve for the families. Similar game activities were also found in other LBGs, giving inspiration for how they should be used in a LBG. Three navigational game activities were made as variations of matching card games such as *Concentration*[29]. In these types of games, players specify two or more cards that are alike, among a set of cards, and the goal is typically to be the player with the most matches in the end. In Team Exploration[11], players match pictures in the virtual space to landmarks in the physical space and progress in the game by specifying which pictures belong to certain areas of a map. Similarly, players are given pictures of landmarks in our three matching game activities; *Simple Matching*, *Order Matching*, and *Memory Matching*.

For all four game activities, local landmarks are used to help players choose directions at decision points, and route marks are used along streets to confirm to players that they are walking in the correct direction. In Simple Matching, players are given a set of potential landmarks, where only one of them is a true landmark in their current location. When they spot or match the landmark that is shown on the picture, they go to its position and start matching the next set of pictures. This activity proved to be the easiest of the four and most participants found it to be uninteresting due to its lack of challenge. Order Matching is very similar to Simple Matching, as the only difference is that players have to specify the order in which the presented landmarks occur from their current position. Participants found this activity to be a bit more challenging, however due to the requirement of ordering landmarks, participants sometimes walked back in the direction they came from. Through observation, it was clear that the participants collaborated more in this activity due to the increase in difficulty. In Memory Matching, the landmarks to be ordered are only presented quickly before navigating. When participants then reach the last picture in the set, they are asked to specify the order of landmarks encountered. Through observation and interviews, it was clear that participants found this activity to be the most challenging of all matching activities. This also caused participants to collaborate more, where they e.g. each would remember half of the pictures. Furthermore, participants mentioned that only being able to look at the pictures at certain points, caused them to look more around and notice the environment during navigation.

The last game activity designed was based on riddles, where similar to the game *I Spy*[29], players must spot a specific object in the vicinity based on a sentence hinting about attributes of the object. Based on I Spy and the LBG CityTreasure, where riddles are used at POIs, we designed an activity where riddles hint about the next landmark to go to. As in I Spy, the riddles describe attributes of objects through hints.

In the context of landmarks, the riddles describe saliency based on the visual, cognitive or structural attributes of the landmark, either in isolation or in combination. In order for players to confirm that they have found the landmark, they are also given a control question about the landmark with three possible answers. This was a solution to the problem of specifying the players' exact position through GPS, since at the time of designing the activity, it had been observed that accurate positions could not be given through GPS. Furthermore, this control question allows for the possibility of including knowledge about the landmarks in the game activity, thereby supporting pedagogic elements in the game. By being able to confirm if the player has found the landmark, it is possible to create a feedback system in the game. Upon answering the control questions, regardless of the players' answer, a picture of the correct landmark is shown to the players, so they never get lost. Through interviews, it was found that most participants preferred navigation with riddles due to them being the most fun. It was also clear that of all activities, riddles were the most challenging for the participants, mainly because people were unsure of the scale in which the landmarks could be found. This is due to the fact that participants have nothing visual to compare to in opposition to the matching activities. However, it could also be seen that this limitation contributed to the enjoyability of the activity. We also observed that this limitation caused participants to collaborate and in general communicate more during navigation. Based on these results, there were strong indications that navigation using riddles was the most enjoyable activity.

Lost on Earth

Built on Monsters Eat Art -¿ target group Have to help the monster Narrative including street arts

EXPERIMENT

To investigate the effects of riddle-solving as the navigation method in a location-based game, we conducted a comparative study between navigating by riddle-solving and navigating by a 2D map with GPS. The experiment took place over

two weekends in central Aalborg, Denmark. Participants used an iPad 2 3G + WiFi as the platform.

Hypothesis

We hypothesized that *riddles as navigational method are more enjoyable than maps.* We came up with the following null hypothesis and its alternative hypothesis.

H0: Riddles as navigational method are equal or less enjoyable than maps.

$$H0: \mu EnjoyabilityRiddle \leq \mu EnjoyabilityMap$$

H1: Riddles as navigational method are more enjoyable than maps.

$$H1: \mu EnjoyabilityRiddle > \mu EnjoyabilityMap$$

Participants

Our initial target group was originally meant to be tourists, but we chose to recruit families from Aalborg or nearby in order to gain as many participants as possible. We recruited 10 numbers of 2-6 person families through posters and flyers at schools. As the narrative of the game was targeted children, it was a requirement that the families had at least one child in the age range 9-11 year. 17 children participated with ages ranging between the age of 7 and 13 (mean = 10.1, SD = 1.6), 9 females and 8 males. 14 adults participated with ages ranging between the age of 36 and 62 (mean = 42.3, SD = 6.4), 4 females and 10 males. All participants lived in the city or nearby, and was familiar with the city Aalborg (4 went to the city daily, 5 went to the city weekly, 18 went to the city monthly, 4 went to the city yearly). All participants were familiar using tablet or mobile devices (23 used it daily, 6 used it weekly, 1 used it monthly, 1 used it yearly).

Materials and Procedure

The experiment was designed as a within-subjects design with two conditions. (1) A navigational method, where the participants navigated by solving riddles (R) and (2) A navigational method in which the participants used a digital map (M).

These two conditions were counterbalanced with the purpose of reducing the environmental effects met on the route on the results. Participants would either begin with map or riddles, and would end with the navigational method different from the one met in the beginning.

Three street arts, A, B and C, were a part of the experience. The distance from A to B was 0,9 km and the distance from B to C was 0,9 km. Each condition also had approximately same amount of turns, respectively 8 and 7 turns. Each session lasted between xx min to xx min. One facilitator and one observer would be present during the whole session. The facilitator would explain the participants in using the application before beginning the game, and further help during the game if any difficulties would arise (e.g. participants getting lost). For each experiment, one of the parents was instructed to wear a GoPro with a harness for recording video, while one of the children carried a bluetooth microphone for recording audio. All parents signed consent forms and filled out demographic questionnaires prior to the experience. We gave the child in the age range 9-11 the ipad, but they were not forced to handle it the whole session.

LBGs have previously been evaluated using both qualitative and quantitative methods including observational studies, questionnaires and interviews. Morrison et. al. used Flow(kilde), Instrinsic Movation (IMI) [6] and Presence - MEC-SPQ [12] questionnaires and successfully evaluated effects such as enjoyability, motivation and awareness of surroundings by triangulating with video recordings, logs, field notes and transcriptions of interview data. We used the same approach, based on the success of Morrison et al. investigating similar criteria as our study.

The questionnaire in this study contains questions from the Short Flow State Scale Questionnaire (S-FSS 2), which measures the degree to which flow dimensions characterize the completed experience. The questionnaire also contains questions from IMI (measures enjoyability, tension, effort and perceived competence) and MEC-SPQ (measures spatial presence, allocated attention and Suspension of Disbelief). Only adults received this questionnaire due to the level of complexity, while children received a simplified questionnaire measuring enjoyability using IMI. Both questionnaires were measured on a likert scale (5-scale), going from 1 (strongly disagree) to 5 (strongly agree). The parents were instructed to help the children to fill out the questionnaire in terms of them having difficulties.

RESULTS

Observations

Parents usually waited for children to answer More communication in general when solving riddles When using map - Talk about other stuff Parents tend to take over the iPad after a little while Children could easily get distracted by things in the environment for both conditions (e.g. dogs) Not always collaboration between children, mostly between children and parents GPS was very slow at updating, caused participants to take wrong paths Some participants had a hard time understanding that you had to go to the position of the landmark first. Only very few occasions where parents used knowledge about Aalborg to answer ”Nu fr vi styr p Aalborg” Participants look more around in the environment during riddles. During map participants look more down in their iPad

Interviews

From the interview data, we found that 5 out of 22 children expressed preference towards using maps. One parent mentioned she also preferred map, saying *”It is just always fun to follow a map”*. This parent explained that they were unsure about what to do during the riddle-based navigation and could not remember what they had been told during the instructions.

Another parent mentioned that map was easy and did not make one aware of the surroundings, because the focus was on walking. In general, we found different opinions on whether the different navigational methods made people aware of the surroundings. One parent clearly stated the the children were not interested in the map at all. In line with several other test participants this parent expressed that it was fun

to notice things in the environment they usually do not notice when walking by, making it an optimal method for tourists. Opposed to that opinion, another parent expressed that she focused more on navigating than noticing things in the environment. With riddles, one parent felt that the attention was on the next location to go to, while the map made the participant more aware of the city, because there was more time to look around in the surroundings.

When asked if they would use riddles as navigational method, if they were tourists in another city, all test participants agreed and answered yes. Some thought it would be a more fun way of learning the city, finding the way and that it would make it possible to see the city in a different way. However, interview data also clearly revealed that several participants would have enjoyed it more, if the riddles were about more interesting landmarks that gave the possibility to learn more e.g. about the city. Preferably this should be done with the children in mind and a few parents proposed a system that can be adjusted depending on, whether they had any children and adjusted content according to the childrens age. Riddles as navigational method was described as *"fun if you have time for it"* by one parent. This reflected the results from the questionnaires.

The most used word to describe riddle-based navigation was "fun" (11 of 29 words). Other words included exciting, challenging, different, educational and inspiring. A number of participants thought it was fun to answer the questions after the riddles, particularly one child mentioned that it was fun to be able to answer correctly to questions. Another also expressed that it was fun to find the matching pictures in the environment.

One parent mentioned that the fun part in the riddle-based navigation was to help each other and agree on what they have seen in the environment. Several parents had a similar opinion and stated that they enjoyed collaborating and discussing the answers with the other family members. One parent said it was fun with riddles,

> "(...) because there was something to discuss. Of course you can also discuss what way to go with the map, but that just gave a different experience."

In terms of group dynamics, it was mentioned that primarily the one with the device was in control, making it a less collaborative experience. One parent mentioned that they collaborated more, when navigating using riddles and not as much with the map. In order to make it more collaborative, one of the participants suggested making the riddles more difficult, encouraging the participants to help each other. This statement supports the experience of another parent, who mentioned that they only collaborated when there was any doubt, otherwise they just followed the child, who was mostly in charge of the device. The interview data revealed a tendency to let the child control the device, which was described as following by one parent,

> "Then one find out about something and the other find out about something else. I felt I gave much of the control to Mikki (the child), because I wanted him to think it was fun."

In one family, the parent stated that it was much more fun for them both, when the child had the device, because the child was better at using the map and tablets in general.

Questionnaires

We used the Wilcoxon Signed-Rank test, based on the nature of ordinal values and due to the sample had been exposed to two conditions (riddle solving and map).

All participants found the system using Riddles significantly more intrinsic motivating (IMI) than maps(See Table 1). Assessing IMI, we found that enjoyability and effort scored significantly higher for Riddles compared to Maps. Riddles also received a significantly higher score than Maps concerning total Flow. No significant difference was found for Presence, but Riddles was still favoured in terms of its score.

Table 1. Questionnaire items showing significant differences between Riddle navigation and map navigation

Item and Wilcoxon Signed-Rank Test	**System with higher mean**	**System with lower mean**
*Item related IMI for **all participants***		
IMI - total(**)	Riddle Mean=4.31	Map Mean=3.64
IMI - Enjoyment(**)	Riddle Mean=4.49	Map Mean=3.46
IMI - Pressure(-)	Map Mean=2.11	Riddle Mean=1.78
IMI - Effort(*)	Riddle Mean=4.30	Map Mean=3.68
IMI - Perceived Competence(-)	Riddle Mean=4.13	Map Mean=3.68
*Item related Flow only for **adults***		
Flow - total(*)	Riddle Mean=3.85	Map Mean=3.60
*Item related Presence only for **adults***		
Presence - total(-)	Riddle Mean=3.07	Map Mean=2.95

Note: (-) = $p>.05$ and (*) = $p<.05$ and (**) = $p<.01$
IMI, Flow and Presence 1-5 scale

We found significant differences when assessing individual questions from the questionnaire (See Table 2). All participants especially found the Riddle system significantly more fun and less boring compared to the map version. We observed that riddles served a potential of including multiple family members, which accommodate the fact that all participants had a enjoyable experience.

Adults found the riddles significantly more rewarding and had the feeling of the time moving faster compared to the map version. These two questions specifically assesses the dimension on having an autotellic experience and the sense of time transformation. As flow involves nine dimensions, these two were the only dimensions to reveal a significantly difference. Other dimensions of flow favoured Riddles, or was closely

tied with Maps (0.05 score difference between R and M), except for a flow question revolving on clear goals. Our questionnaire revealed that test participants found the Map system had more clear goals (R =3.31, M =3.83, p=.174). As the result is not significant, it is however observed that the Map did not require much training, and henceforth more intuitive than what we observed with the Riddle system. However, participants still favoured the Riddle system despite these difficulties.

Children thought they were significantly better navigating with Riddles, rather than using a maps. We found that children considered maps more challenging from the questionnaire which could provide an explanation on the matter, but this was not founded significant (R =2.82, M =3.33, p=.177).

We performed an multiple ordinal regression analysis on the questions from Table 2, whether age, gender, condition order or group size served as predictors for the results. In all cases, the results stayed significant, but the condition order was revealed to have a significant impact on several of the questions concerning IMI.

Due to the condition order, the selection of Riddles were different, as well as the route described on the Map. Different attractions on the route would be met differently based on the condition order, and eventually provide a different experience.

Table 2. Questionnaire items showing significant differences between Riddle navigation and map navigation

Item and Wilcoxon Signed-Rank Test	System with higher mean	System with lower mean
*Items related **all participants***		
IMI: I thought navigating was fun (**)	Riddle Mean=4.48	Map Mean=3.42
IMI: I thought navigating was boring (R) (**)	Map Mean=2.14	Riddle Mean=1.41
Flow: My attention was focused on navigating (*)	Riddle Mean=4.16	Map Mean=3.66
*Items related only **adults***		
Flow: I found the experience highly rewarding (*)	Riddle Mean=3.93	Map Mean=3.15
IMI: I enjoyed navigating a lot (*)	Riddle Mean=4.29	Map Mean=3.46
Flow: It felt like time went by quickly (*)	Riddle Mean=4.54	Map Mean=3.69
*Items related only **children***		
IMI: I thought I was pretty good at navigating (*)	Riddle Mean=4.41	Map Mean=3.73

Note: (*) = p<.05 and (**) = p<.01.
IMI and Flow 1-5 scale

We can reject our null hypothesis, stating that riddles as navigational method are more enjoyable than maps.

CONCLUSION

DISCUSSION

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