Enriching Location-Based Games with Navigational Game Activities

Stephanie Githa Nadarajah, Benjamin Nicholas Overgaard, Peder Walz Pedersen, Camilla Gisela Hansen Schnatterbeck, and Matthias Rehm(✉)

Department of Architecture, Design, and Media Technology, Aalborg University, Aalborg, Denmark
matthias@create.aau.dk

Abstract. Mobile location-based games are experiences that entertain its players by requiring interactions mainly at points of interest (POIs). Navigation between POIs often involve the use of either a physical or digital map, not taking advantage of the opportunity available to engage users in activities between POIs. The present paper examines, how riddle solving as a navigational method affects enjoyability, flow, and spatial presence.

1 Introduction

It is our conviction that the city can become the key element in creating smart learning environments that transcend traditional institutionalized learning by bringing learning back to where it originally belonged: everywhere. Our vision of smart city learning is to create a public space for learning experiences that transcend into all areas of life while at the same time establishing traditional institutions (like schools, libraries, museums, etc.) as hubs for information gathering and collaborative interactions. The city itself, becomes an enchanted place allowing for discovering hidden knowledge in a playful manner. The StreetArt project is based on previous work that realizes an exploration game that is supported by a virtual tour guide in the form of a monster and situated in a museum context [16]. As the application is targeting younger children between 6–10, the playful back story for the guide is that it has eaten some of the artworks and – as we all know – "you become what you eat". This is taken literally here, where the monster's body is textured by the artworks it has eaten and the task is now to find these artworks. Scaling up the museum experience to the city level revealed a big challenge – travel time between points of interest. In standard location-based games (LBG) this is lost time because interactions only happen at POIs. In this project we aim at integrating travel between POIs with the enfolding narrative of the LBG.

2 Background

Based on [1], LBGs are defined as *game experiences* that connect the *physical space with the virtual space* and make use of an underlying *narrative* element.

A.L. Brooks and E. Brooks (Eds.): ArtsIT/DLI 2016, LNICST 196, pp. 89–96, 2017.
DOI: 10.1007/978-3-319-55834-9_10

Location-based games (LBGs) utilize points of interest (POIs) in their gameplay, which requires navigating between POIs, when the games take place in cities. This opens opportunities for gaining additional knowledge about the surroundings during navigation. This potential has not been fully utilized yet. Several LBGs have used maps with GPS technology in a city context, in order to guide their participants to POIs [2,3,5,6,10,14,19]. To the best of our knowledge, none of these have integrated game activities, such as those that are found at the POIs into the navigation.

In [4], players navigate freely in a restricted area. However, the design of the game may only be appropriate in a bounded areas 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. In a similar study about a walking tour in the Venice, the narrative space incorporated the navigation, but kept a linear narrative structure [8]. 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 in [4,8], the user is encouraged to explore the physical space, but only on an individual basis. A LBG for tourists is presented in [7] that utilizes a sightseeing navigation system to promote enjoyability and awareness of the physical surroundings. Augmented reality (AR) is used to display descriptive information and upon arrival at the POI, users have to seek out a character in the surroundings. The concept does makes use of a map for leading the users to the area requiring AR for navigating. No evaluation has been done and therefore the outcome is unknown. Other LBGs have looked into using AR combined with physical props for navigation. Maplens displays location information on a physical map using augmented reality [12]. In a comparative study, flow, presence and intrinsic motivation have been compared to DigiMap, a map with incorporated accessibility to read about locations. MapLens scored significantly lower on most dimensions but its potential was revealed in terms of social interaction, since it encouraged collaborative behaviour.

Wayfinding using landmarks is a navigational method in which objects or structures are used as points of reference. This is typically used for route directions [15]. 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* [17]. 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. Wayfinding using landmarks opens up for integrating game activities between POIs 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. To the best of our knowledge, no LBGs have used landmarks for navigation between POIs so far.

3 Lost on Earth

Lost on Earth scales the museum-based Monsters Eat Art [16] to a city level. Monsters Eat Art is an interactive exploration game, where children find specific artworks based on certain details given. When children find the specific artwork, they get feedback from the monster. Furthermore, Monsters Eat Art has a narrative where a monster eats artworks. The children now have to find all artworks that the monster has eaten. When the children show an artwork to the monster, it gives feedback and when it is one of the artworks they have to find, the monster conveys information in a humorous way.

In Lost on Earth, the players assist the monster character (see Fig. 1 – left) in reaching a specific goal, using streetart found in the city as POIs. The narrative is built around the monster being stranded on Earth. It needs to find fuel for its spaceship to fly home. However, the monster is also looking for its friends, who are also stranded on Earth.

Due to the importance of choice in interactive narratives and games, players have to choose for each route (see Fig. 1 – right) whether the monster should look for fuel or friends, which will affect the outcome of the game. These choices are made at the street art paintings. Ideally, different routes should be used for

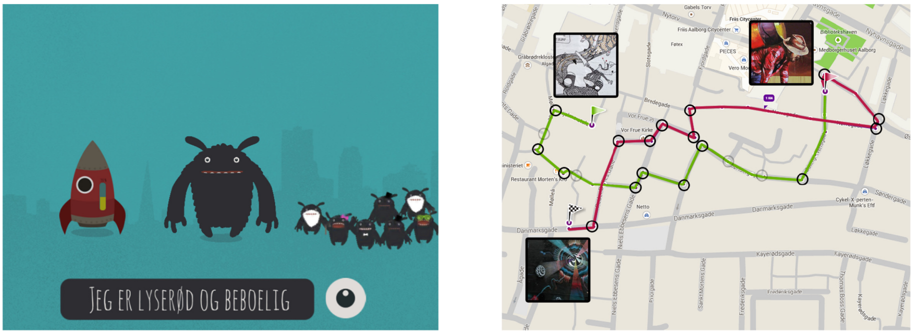

Fig. 1. Left: Riddle-based navigation showing the monster character with points in the form of fuels and friends. Right: The route between the three street art paintings during the experiment.

Fig. 2. Child in charge of the iPad (left) and parent assisting the child (right)

different choices, however to minimize the amount of bias in the experiment, the illusion of choice is given, as the choice will only influence the outcome of the game, not the route to be taken. To incorporate pedagogic elements, information about the painting itself is given through a dialogue with the monster. Additionally, players unlock access to an info screen about the particular painting. This was included, in order to incorporate the element of saving information about places visited, mentioned previously by Gentes et al. [9] and Peitzl et al. [13], giving the user a sense of progression and feedback (Fig. 2).

Players use riddle solving based on *I Spy* [18] for navigating between POIs. When players start their first riddle, a tutorial introduces how the system works. To incorporate a feedback system, players are given points as they answer correctly on the control questions for the riddles. These points are dependant on the choice made at the previous POI, so for instance in the case that players have chosen to look for fuel, fuel points will be given to the players and vice versa. Whether the monster will get home or have any friends in the end of the game, will rely on these choices. For the purpose of the experiment, a 2D map has been implemented. The map has the primary objective of resembling maps used in other LBGs. It shows the user's position on a 2D digital map provided by Google Maps. As seen in the LBG *Team Exploration*, incorporating limitations in the game such as time, can cause the focus of the game to be more on the hunt itself and not the exploration that takes place in the physical space. For this reason, the limitations used in Lost on Earth are primarily found in the act of navigating itself, where using riddles to navigate is a cumbersome, but also enjoyable way of navigating, as it makes use of the physical space.

4 Experiment

The experiment took place over two weekends in central Aalborg, Denmark. Participants used an iPad 2 3G + WiFi running the Lost on Earth application, which was developed using the Unity3D game engine. 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 was guided by the following hypothesis:

H1: Riddle solving as navigational method is more enjoyable than map navigation (due to game elements).
H2: Riddle solving as navigational method results in a higher feeling of flow than map navigation (due to game challenges).
H3: Riddle solving as navigational method creates a larger sense of spatial presence than map navigation (due to increased interaction with physical surroundings).

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.

Participants. Ten families of 2–6 persons participated. As the narrative of the game is targeting children, it was a requirement that the families had at least one child in the age range 9–11 years old. 17 children participated with ages ranging between 7 and 13 (mean = 10.1, SD = 1.6), 9 females and 8 males. 14 adults participated with ages ranging between 36 and 62 (mean = 42.3, SD = 6.4), 4 females and 10 males. All participants lived in Aalborg or nearby, and were familiar with the city as well as with using tablets or mobile devices.

Materials and Procedure. Three street arts, A, B and C, were a part of the experience (see Fig. 1 – right). 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 the same amount of turns, respectively 8 and 7 turns. For each session, 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 years old the iPad, but they were not forced to handle it the whole session.

The questionnaires in this study contain questions from the Short Flow State Scale Questionnaire (S-FSS 2), which measures the degree to which flow dimensions characterize the complete experience [11]. The questionnaire also contains questions from the Intrinsic Motivation Inventory (IMI), which measures enjoyability, tension, effort and perceived competence as well as from a Spatial Presence Questionnaire (MEC-SPQ) for measuring 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 measuring on a five point Likert scale, going from 1 (strongly disagree) to 5 (strongly agree).

Table 1. General results

Dimension	R	M
Intrinsic Motivation total (**)	4.31	3.64
Enjoyment (**)	4.49	3.46
Pressure	2.11	1.78
Effort (*)	4.30	3.68
Perc. Comp	4.13	3.68
Flow total (*)	3.85	3.60
Presence total	3.07	2.95

Table 2. Item specific results

Item	R	M
Intrinsic Motivation		
I thought navigating was fun (**)	4.48	3.42
I thought navigating was boring (**)	1.41	2.14
I enjoyed navigating (*)	4.29	3.46
I was pretty good at navigating (*)	4.41	3.73
Flow		
I was focused on navigating (*)	4.16	3.66
The experience highly rewarding (*)	3.93	3.15
I felt like time went by quickly (*)	4.54	3.69

Note: (*) = $p < .05$ and (**) = $p < .01$

4.1 Results

Tables 1 and 2 show the results for the Wilcoxon Signed-Rank test. Table 1 gives the general results for intrinsic motivation, flow and presence. Significant effect for intrinsic motivation esp. on the dimensions of enjoyment and effort shows that riddles were more motivating and enjoyable. 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 2 gives results for specific items from the intrinsic motivation and flow questionnaires that showed significant differences between the ratings for riddle- and map-based navigation. Riddles were significantly more fun and less boring. Adults found the riddles significantly more rewarding and had the feeling of time moving faster compared to the map version. These two questions specifically assess the dimension of having an autotelic experience and the sense of time transformation. As flow involves nine dimensions, these two were the only dimensions to reveal a significant difference. Additionally, children thought they were significantly better at navigating with riddles than maps. A multiple ordinal regression analysis was performed in order to investigate, 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 had a significant impact on several of the questions concerning enjoyability in IMI. Due to the condition order, the selection of riddles was different for each condition, as well as the route described on the map. Participants met different landmarks on the route based on the condition order, which eventually provided a different experience between conditions.

4.2 Discussion

Based on the results H1 (enjoyability) and H2 (flow) are retained while H3 (spatial presence) has to be rejected. Results from our study clearly shows that riddle solving is a more enjoyable way of navigating than a digital map. Children were challenged using the map as well as, perhaps because they are not used to any of the navigational methods. We found that children thought they were better at navigating with riddles than maps. Similarly, parents were significantly more in flow with riddle-based navigation. One of the explanations could be that parents were less challenged by using maps, as they are used to navigate with maps, while riddle-based navigation was just as novel an experience for the parents as for the children. We assume that maps were less challenging and therefore that challenge was one of the reasons why riddle-based navigation scored higher on enjoyment. Furthermore, we also found that children enjoyed answering questions and getting feedback. This supports that incorporating game activities into the navigation makes it more enjoyable for the players. We found no significant results about presence, though riddle-based navigation scored higher on making the participants aware of their surroundings. Despite not being the main focus of this study, we observed some interesting elements in terms of social interaction among participants. Even though we did not find any statistically significant results supporting that participants helped each other more during riddle-based navigation, we found in the post-interviews that riddle-based navigation has potential in motivating groups of people, making it a enjoyable group experience rather just a matter of getting from A to B. We observed that participants discussed more and that topics revolved around solving the riddles and discussing the landmarks. Though this requires a more thorough analysis of the interaction among the participants, we hypothesize that riddle-based navigation has potential in supporting learning e.g. about landmarks or developing skills in terms of exploration, particularly in a group context.

5 Conclusion

In this study, we investigated the effects of riddle solving as a navigational method in a location-based game experience for families. We compared this method with map navigation and found significant results indicating that riddle solving is more enjoyable. Though perhaps not being more intuitive, riddle-solving clearly suits the scope of location-based game experiences, as it makes use of the physical space to navigate from one POI to another, while also adding more enjoyment as well as learning possibilities to the experience.

Acknowledgements. We would like to thank Martin Lynge Jensen for support in adapting the Monsters Eat Art project and VisitAalborg for their kind collaboration.

References

1. Avouris, N., Yiannoutsou, N.: A review of mobile location-based games for learning across physical and virtual spaces. J. Univ. Comput. Sci. **18**(15), 2120–2142 (2012)
2. Ballagas, R., Kuntze, A., Walz, S.P.: Gaming tourism: lessons from evaluating rexplorer, a pervasive game for tourists. In: Indulska, J., Patterson, D.J., Rodden, T., Ott, M. (eds.) Pervasive 2008. LNCS, vol. 5013, pp. 244–261. Springer, Heidelberg (2008). doi:10.1007/978-3-540-79576-6_15

3. Bell, M., Reeves, S., Brown, B., Sherwood, S., MacMillan, D., Ferguson, J., Chalmers, M.: EyeSpy: supporting navigation through play. In: Proceedings Human Factors in Computing Systems, pp. 123–132. ACM (2009)
4. Blythe, M., Reid, J., Wright, P., Geelhoed, E.: Interdisciplinary criticism: analysing the experience of riot! a location-sensitive digital narrative. Behav. Inf. Technol. **25**(2), 127–139 (2006)
5. Carrigy, T., Naliuka, K., Paterson, N., Haahr, M.: Design and evaluation of player experience of a location-based mobile game. In: Proceedings of NordiCHI, pp. 92–101. ACM (2010)
6. Diamantaki, K., Dizopoulos, C., Charitos, D., Tsianos, N.: Theoretical and methodological implications of designing and implementing multiuser location-based games. Pers. Ubiquit. Comput. **15**(1), 37–49 (2011)
7. Eguma, H., Izumi, T., Nakatani, Y.: A tourist navigation system in which a historical character guides to related spots by hide-and-seek. In: Proceedings Technologies and Applications of AI, pp. 337–342 (2013)
8. Epstein, M., Vergani, S.: Mobile technologies and creative tourism: the history unwired pilot project in Venice Italy. In: Rodriguez-Abitia, G., Ania, B.I., (eds.) AMCIS, p. 178. AIS (2006)
9. Gentes, A., Guyot-Mbodji, A., Demeure, I.: Gaming on the move: urban experience as a new paradigm for mobile pervasive game design. Multimed. Syst. **16**(1), 43–55 (2010)
10. Gordillo, A., Gallego, D., Barra, E., Quemada, J.: The city as a learning gamified platform. In: IEEE Frontiers in Education Conference, pp. 372–378 (2013)
11. Moneta, G.B.: On the measurement and conceptualization of flow. In: Engeser, S. (ed.) Advances in Flow Research, pp. 23–50. Springer, Heidelberg (2012)
12. Morrison, A., Oulasvirta, A., Peltonen, P., Lemmela, S., Jacucci, G., Reitmayr, G., Näsänen, J., Juustila, A.: Like bees around the hive: a comparative study of a mobile augmented reality map. In: Proceedings of CHI, pp. 1889–1898. ACM (2009)
13. Peitz, J., Saarenpaeae, H., Bjoerk, S.: Insectopia - exploring pervasive games through technology already pervasively available. In: Proceedings of ACE, pp. 107–114 (2007)
14. Procyk, J., Neustaedter, C.: GEMS: a location-based game for supporting family storytelling. In: CHI 2013 Extended Abstracts, pp. 1083–1088. ACM (2013)
15. Raubal, M., Winter, S.: Enriching wayfinding instructions with local landmarks. In: Egenhofer, M.J., Mark, D.M. (eds.) GIScience 2002. LNCS, vol. 2478, pp. 243–259. Springer, Heidelberg (2002). doi:10.1007/3-540-45799-2_17
16. Rehm, M., Jensen, M.L.: Accessing cultural artifacts through digital companions: the effects on childrens engagement. In: Culture and Computing. IEEE Computer Society Press (2015)
17. Sorrows, M.E., Hirtle, S.C.: The nature of landmarks for real and electronic spaces. In: Freksa, C., Mark, D.M. (eds.) COSIT 1999. LNCS, vol. 1661, pp. 37–50. Springer, Heidelberg (1999). doi:10.1007/3-540-48384-5_3
18. Wise, D.: Great Big Book of Children's Games. McGraw-Hill, New York (2003)
19. Wu, B., Wang, A.I.: A pervasive game to know your city better. In: IEEE Games Innovation Conference, pp. 117–120 (2011)