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Location-Based Games Enhancing Education: Design and Implementation Lessons Learnt

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Location-Based Games Enhancing Education: Design and Implementation Lessons Learnt

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Abstract

Location-based games supported by a mobile technology seem to be promising tool for facilitating situated learning and enhancing cognitive and sensory engagement. The objectives of this paper are to provide a deep insight into process of development and implementation of educational location-based game, and to bring recommendations for such games' designers and educators. We created "Veltrusy: Treasure Island" the game providing an adventure educational experience in the location of chateau park Veltrusy. The Android application is freely available for its visitors but primarily it is intended for young children and parents. The story leads them throughout 10 locations in the park and presents cultural and natural heritage through logic riddles and activities demanding users' interaction with the environment. The educational aim was to provide an understanding of the local specific biotops (protected by NATURA 2000). The paper presents remarks from the process of creation the educational location-based experience and brings the results from its implementation and critical evaluation with two groups of teachers; one group (N=7) of elementary school teachers and second group (N=10) of environmental educators. They tested the final version of the game individually or in pairs, the participant observers recorded all their activities and comments into structured forms. The findings from this study highlight number of practical reflections and recommendations important for successful educational design as well the interaction design. Besides other findings, motivation and situated learning can be enhanced by an interactive story supported by discovery of material cues in location. From the technical point of view, the design need to count with not only one but a group of players and provide them by engaging collaborative activities. Furthermore the on-screen and off-screen activities need to be batched in order to provide an efficient situated learning experience while the off-screen activities should outweigh the on-screen ones.

Key Words: Location-based game; mobile technologies; education; interaction design.

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Introduction

The ubiquitous technologies offer new challenges to educational institutions as well they change the students' learning habits so the need to consider them in school curricula is rapidly growing (Facer et al. 2003, Holloway & Valentine 2003, Ito et al., 2010). Moreover mobile technologies allow us to move away from school desks and computer screens that might have several positive consequences; so-called exergames (video games that require physical activity to play) stimulate youngsters to increase their physical activity levels (Boulos & Young, 2013), coupling familiar places with the unfamiliar from digital resources promote reflection and new ways of learning and offer transformative experiences (Galarneau, 2005, Sharples et al. 2002, Price et al. 2003), and through direct interaction with natural environment stimulate situated learning and knowledge transfer (Gee, 2003, Squire, 2006). GPS enabled mobile technologies allow its users to interact simultaneously with both the physical world and with digital information (Facer, 2004) therefore it enhances a multimedia learning process.

Location-based games supported by a mobile technology connect ludic experience with physical environment and create new frames for entertainment and learning. As Richardson (2010) stated, single player games, multiplayer games and alternate reality games each activate different kinds of vectors of movement and rest, sociability and individuality. This paper describes the process of development, implementation and evaluation of mobile platform for educational location-based game *Veltrusy: Treasure Island*. Learning motivation of its users is drawn by playful tasks and strong game story that in Norman's view (1993) have the uncanny ability to encapsulate, into one compact package, information, knowledge, context, and emotion.

Location Based Game "Veltrusy: Treasure Island"

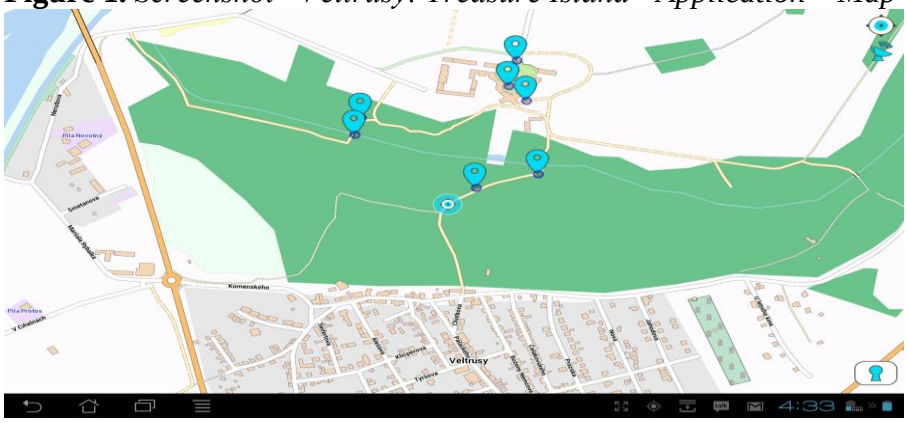
Veltrusy: Treasure Island is a location-based game designed for chateau park Veltrusy in the Czech Republic. The park invites its visitors to view many historical monuments and to discover a very specific ecosystem of this natural island created throughout several floods. The application is drawn into the story which presents key moments from history of Veltrusy and information about the local specific biotops protected by NATURA 2000. On 10 locations in park (some GPS enabled, some QR code enabled) the players get engaged into playful tasks that bring them cues leading to the hidden treasure.

Our main motivation to develop such application was to offer a new kind of guided tour in the chateau park that would be educational, joyful and offering a challenging social experience as well for families and groups of friends.

During the two-hour walk through the chateau park the players solve riddles and logic puzzles. All gaming activities are linked to the cultural and historical facts and stimulate its players to interact with the environment and discover its nature by themselves.

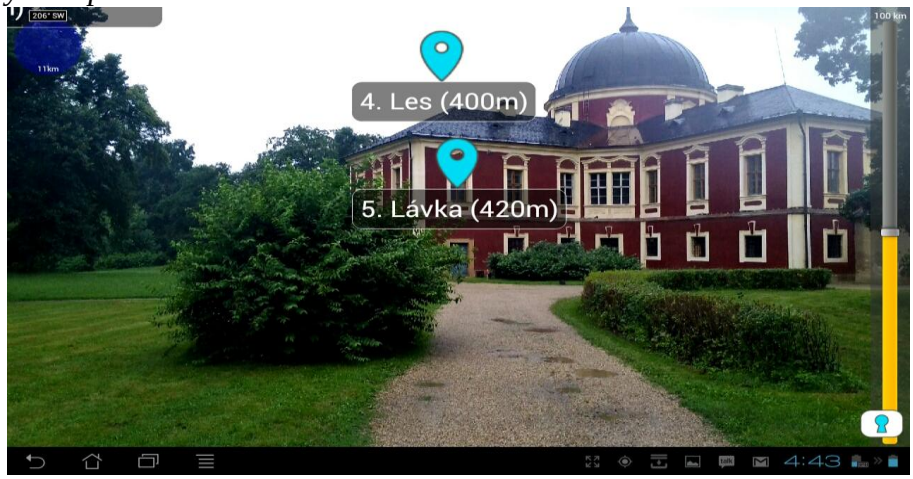
The application is freely available on Android market so each visitor can download it and start to use it directly in the area of chateau park Veltrusy. In the very beginning the players are introduced to the story and the game challenge; to deputize for Jan Rudolf Chotek, the ruler of the chateau, within the audience of Maria Theresa. The story is inspired by the real history and Maria Theresa's visit in 1754. To well represent the chateau the players need to know many details about the park and to get to know more about nature specifics that interest Maria Theresa in particular. It is known that if she will be satisfied the player might get the information about a hidden treasure in the park.
The main screen of the application shows map with seven game locations (see Figure 1), the automatic GPS system alerts the player on a specific location.

Figure 1. *Screenshot "Veltrusy: Treasure Island" Application – Map*



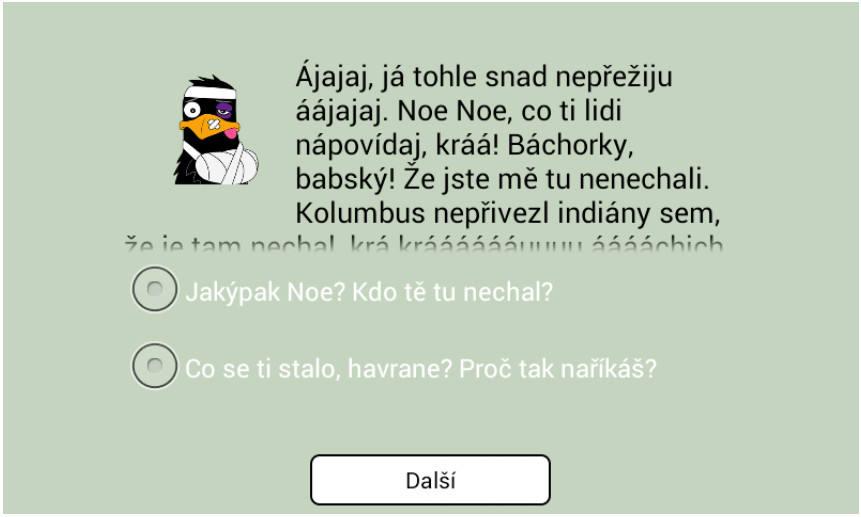
The players can navigate themselves as well with compass – the augmented reality tool adding a layer to the smartphone camera that shows direction and distance of the locations (see Figure 2).

Figure 2. *Screenshot "Veltrusy: Treasure Island" Application – Augmented Reality Compass*



At each location "is waiting" a virtual character that uncovers the game narrative through an interactive interview (see Figure 3). As well it allows the player to customize his/her path through the story and the park. At each location the player is supposed to find out more about the location or specific subject connected to the game learning goals. Virtual character assigns him/her task that can be solved only through interaction with the environment, e.g. to find a specific place and to track a QR code (leading to next interactive interview), to solve a riddle or logic puzzle through observation the specific nature elements etc.

Figure 3. *Screenshot "Veltrusy: Treasure Island" Application – Interactive Interview with a Virtual Character*



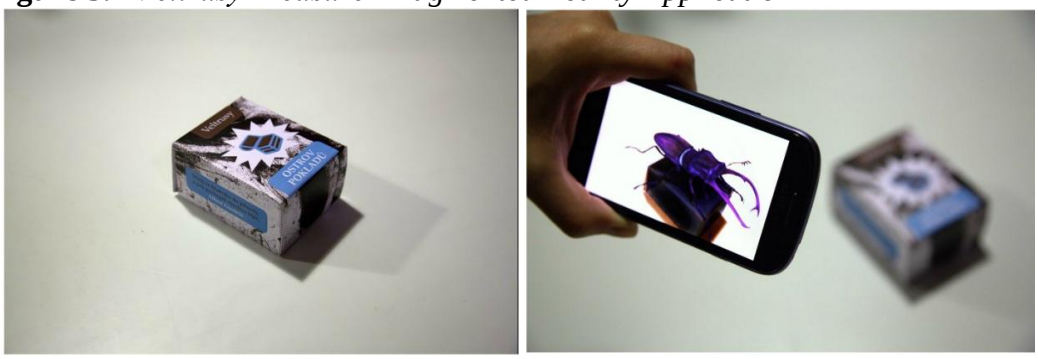
Embedded encyclopaedia provides additional texts; images and audio that help in solving the game puzzles (see Figure 4).

Figure 4. *Screenshot "Veltrusy: Treasure Island" Application – Encyclopedia*

If the player visits all the locations and solves all the game tasks, he/she gets the directions to the hidden treasure. The treasure is an old wooden coffer with

sheets of paper to create paper box in size of open hand. The pattern of the box can be tracked by an additional augmented reality application (*Veltrusy Treasure*) and shows 3D model of stag beetle, the threatened species living in area of Veltrusy chateau park (for the functionality demonstration see Figure 5).

Figure 5. *"Veltrusy Treasure" Augmented Reality Application*



Lessons Learnt: Application Design

While designing the application we came across many obstacles considering efficient learning experience in outdoor environment. The technology needs to lead its users through the learning goals and the players need to be motivated to interact with their environment to deepen the situated learning and to enhance the knowledge transfer.

Technical Obstacles

Within the preparation phase we needed to consider some specifications connected to location-based gaming applications:

Data Stream

The project was started by feasibility study that revealed a non-stable cell phone signal in the area of the park which is generally common for locations away from urban areas. For this reason we decided to create the application working completely offline. This decision makes the outdoor work with mobile devices easier and more predictable but bears as well some technical restrictions and data limitations. In the first pilot testing sessions we witnessed highly negative attitudes towards downloading huge amount of data to personal cell phones, that were caused by low data stream, data restrictions of some cell phone networks, cell phone memory limitations or "just" users' aversion to download huge packages of data for an educational application. Therefore we limited the application database and more data demanding media (video and image galleries) used only in places with wi-fi connection.

GUI

Another technical obstacle was graphics that changes while viewed outside on direct sunlight. White text on darker background was appropriate.

Interaction Design

Location-based educational experience calls for specific interaction design:

On-screen vs. Off-screen Activities

The main goal of location-based educational games is to offer a valuable interaction with nature environment leading in efficient situated learning. The on-screen activities should complement the experience by guiding through points of interests, framing the game narration and offering supportive learning content. The off-screen activities should markedly outweigh the on-screen ones whereby sensory and cognitive engagement with natural environment can be enhanced.

The nature environment provides many unexpected stimulus thus the learning experience cannot be completely controlled, the players are in the position of independent learners so not the application provides learning outcomes but the individual outdoor experience itself. For this reason the tasks should be designed as open-ended challenges or stories (Klopfer, 2008) that give the players a freedom to enfold the activity with their preliminary knowledge and the outcome of the outdoor experience.

User Experience Control

Because the application was designed for independent users and wide public, we needed a system able to recognize that all outdoor tasks were filled up. We decided to use a model of interactive interview with virtual characters (see Figure 3) on locations that allowed us to control whether players know a right answer that could be find through the observation of environment and as well to deepen the immersion in the game story through direct interaction with its protagonists. Some tasks are not GPS enabled but demand a QR code hidden in the park so the players search for the codes with a help of cues from virtual characters from interviews.

Lessons Learnt: Evaluation with Educators

Learning Motivation in Location-Based Gaming

The evaluation showed that the location-based game motivates its players to engage with real environment and intellectual tasks. Generally the players were motivated by tasks involving searching in the location and revealing the game cues through logic puzzles demanding observation and investigation of material objects in location (statues, ancient placards, tree stools, etc.). The sensory engagement was the strongest motivation element that led the whole location-based learning experience. Even though some puzzles were on-screen, the players directly connected them to the real environment afterwards, e.g. they discussed what species of birds they can hear after solving an audio-visual logic puzzle of bird songs.

Strong story and discovery of material cues in location both strengthened immersion in the game. The players discussed the possible consequences of their actions and the real historical background of the game events.

Location-Based Games as Social Experience

Veltrusy: Treasure Island showed to be convenient for families and group of friends visiting the place. In our evaluation study the participants spontaneously gathered in small groups where always one person hold a mobile device, navigated and read the in-game texts.

Figure 6. *"Veltrusy Treasure" as a Social Experience*

Such a game in location with strong cultural or natural heritage was by the participants considered as a social event. Therefore the game design needs to count with not only one but a group of players and provide them by engaging collaborative and discussion activities.

Location-Based Games in Educational Programs

In the interviews after the game play the participants were asked for comments and attitudes towards it. Followings themes were considered: (1) the personal experience and evaluation of gaming experience, (2) the personal experience and evaluation of learning experience, (3) obstacles and challenges of such application for educational programs.

The participants evaluated the experience very positively; throughout whole game (approximately two hours) they felt immersed in the story and game tasks, moreover in the final interactive interview they knew most of the answers on Maria Theresa's questions, i.e. they remembered most of the educational content that they were exposed to during the game-play.

The educators were motivated to involve such a game into their educational programs, they appreciated having additional audio-visual material "in hand" and they considered the mobile technology as a strong motivational element for youngsters.

Some environmental educators disputed about the use of mobile technologies for environmental education as it can distract the attention to nature itself. In

environmental education the on-screen activities should be limited to minimum and always refer to the natural environment itself.

Conclusion

Location-based educational games seem to be promising tool in formal and non-formal education; our study offers outcomes of location-based educational application evaluation and some guidance for preparation of such programs.
The creation and implementation of location-based games to education is connected with several technical and interaction obstacles. Outdoor work with mobile devices is more stable and more predictable while the application works offline only with GPS system. In this case the amount of in-app data needs to be limited not to distract the users by data demanding and long download in the beginning. Another technical obstacle was graphics that changes while viewed outside on direct sunlight.

Learning motivation and situated learning may be enhanced by an interactive story supported by discovery of material cues in location. The on-screen and off-screen activities should to be batched in order to provide an efficient situated learning experience while the off-screen activities should outweigh the on-screen ones. To control the players' activities in nature environment we used interactive interviews with virtual characters, that allowed us to control whether players know a right answer that could be find through the observation of environment and as well to deepen the immersion in the game story through direct interaction with its protagonists.

The evaluation study showed that the interaction design of location-based games needs to count with not only one but a group of players and provide them by engaging collaborative and discussion activities.

The participants felt throughout whole game immersed in the story and game tasks, moreover after the game they remembered most of the educational content that they were exposed to. For educators the most important benefit was to have an additional audio-visual material in application so they can easily enrich their outdoor educational programs.

References

Boulos, M. N. K., Yang, S. P. 2013. *Exergames for health and fitness: the roles of GPS and geosocial apps*. International Journal of Health Geographics, 12 (18).

Facer K., Furlong J., Furlong R., Sutherland R. 2003. *Screen Play: Children and Computing in the Home*. Routledge Falmer, London.

Facer, K., Joiner, R., Stanton, D., Reid, J., Hull, R., Kirk, D. 2004. *Savannah: mobile gaming and learning?* Blackwell Publishing Ltd., Journal of Computer Assisted Learning 20, 399–409.

Galarneau, L. 2005. *The power of perspective: Games and simulations for transformative learning*. Presented at Games, Learning & Society Conference, Madison, WI.

Gee, J. P. 2003. *What video games have to teach us about learning and literacy*. New York: Palgrave/St. Martin's.

Holloway S. & Valentine V. 2003. *Cyberkids: children in the information age*. Routledge, London.

Ito, M., Baumer, S., Bittanti, M., Boyd, D., Cody, R., Herr-Stephenson, B., Horst, H. A., Lange, P. G., Mahendran, D., Martinez, K. Z., Pascoe, C. J., Perkel, D., Robinson, L., Sims, C., Tripp, L. 2010. *Hanging Out, Messing Around, Geeking Out. Kids Living and Learning with New Media*. Cambridge, Massachusetts: The MIT Press.

Klopfer, E. 2008. *Augmented Learning: Research and Design of Mobile Education Games*. MIT Press.

Norman, D. 1993. *Things that make us smart: Defending human attributes in the age of the machine*. Reading, MA: Addison-Wesley.

Price S., Rogers Y., Scaife M., Stanton D. 2003. *Using tangibles to promote novel forms of playful learning*. Interacting with Computers 15, 169–185.

Richardson, I. 2010. *Ludic Mobilities: The Corporealities of Mobile Gaming Mobilities* 5(4), 431–447.

Sharples M., Corlett D., Westmancott O. 2002. *The design and implementation of a mobile learning resource*. Personal and Ubiquitous Computing 6, 220–234.

Squire, K.D. 2006. *From content to context: Videogames as designed experiences*. Educational Researcher, 35(8), 19-29.