Design Guidelines for Location-based Mobile Games for Learning

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Abstract—**Today's mobile devices, like smartphones and PDAs are often used as gaming instruments. A new genre that is rapidly proliferating is that of location based games, that use the positioning capabilities of the devices and other available locative media in the game. These new games expand in space and time and often involve large numbers of players, like in the case of location based role playing games, alternate reality games, treasure hunts, urban adventure games etc. So the social dimension of this kind of activities is particularly important. It is often that this kind of games are used for learning objectives, both in formal and informal settings. These activities may be proven important in life-long learning, as mobile devices are personal assistants and adults may be easily engaged in informal games of this nature with learning potential. Design of such applications is a complex task. In this article we present an overview of the field and then discuss the process for developing design guidelines of future generation of location-based mobile games for learning. The guidelines are outlined in the final part of the paper.**

Index Terms—**About four key words or phrases in alphabetical order, separated by commas.**

I. INTRODUCTION

RECENT years have witnessed an explosion in the number of creative new games that are facilitated by mobile devices in such a way that the game activity evolves according to players' location. The term used to describe such games is "mobile location-based games", while alternative terms are pervasive games and locative games. Their proliferation is due to the widespread use of mobile devices, like smartphones and PDAs, with advanced location sensing capabilities, for example GPS satellite positioning. These games can be compelling for young players as well as adults [12]. A typical example of such games is "urban games" or "street games" that are typically multi-player games played out on city streets and built up urban environments. Some of mobile games transcend place and time and can be played in many diverse places and extend to long periods of time (the term used in this case is pervasive games), while others are designed to be event based, i.e to be played in specific places at specific times, like during conferences, in museums and other non-traditional game venues. While most of these games have been designed for the amusement of the players, in many occasions learning may be an implicit outcome or an explicit objective of the designers. This is particularly evident in a particular genre of such games, which is alternative city guides. These are game-like activities for exploration of interesting areas of a city, often linked through a narrative. Examples of such activities are the whaiwhai city guides for Venice, Rome, Milan, Firenze in Italy[1], the unlike city guides[2] for the city of Wien, Berlin etc., the REXplorer [18] for the city of Regensburg, in Germany etc. These are mobile games designed for tourists that guide the users through the city, asking them to interact with historical buildings and other interesting monuments, whereby historical information is conveyed in a fun way to the visitors. The role of a narrative in such setting is of particular importance as it relates and supports construction of meaning and eventually learning, as discussed in [17]

The games discussed in this paper are particularly important for life long learning in informal settings, as mobile devices are personal assistants of most adults today, so they may be easily engaged in informal games of this nature with learning potential.

The design of such games is a complex process, so there is a need for guidelines and in general support to designers. This paper reports the work performed to identify guidelines that help designers in developing games able to provide an effective learning experience using mobile devices. Such guidelines complement other proposals available in the literature that, by focusing on very specific aspects of location-sensitive mobile games, do not address more general issues. The presented contribution is a first step of a wider work aimed at deepening the many features of location-based mobile games, in order to inform the designers of such challenging applications.

The increasing importance of location-based mobile games requires the definition of design strategies in order to support designers creating games that offer an engaging experience. This paper contributes to this goal by presenting a set of

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[1] www.whaiwhai.com
[2] unlike.net

guidelines that will assist designers of such applications.

The next section motivates the value of design guidelines for mobile games for learning, by referring to related work. The methodology that was followed for identifying the proposed guidelines, starting from the analysis of many design issues and categorizing the guidelines along five dimensions, is then described. The paper ends with the proposed list of guidelines, as a contribution for discussion by the research community and practitioners in the field.

II. MOTIVATION

The first mobile devices used in recent times were PDAs without connections to other devices and had no context-aware capabilities. By exploiting the latest technological developments, i.e. the miniaturization of computer devices, their increased processing power and the network capabilities, latest generation systems have emerged, supporting and changing drastically everyday activities. If we take as an example a museum visit, using this kind of mobile devices for playful activities, the traditional task execution of the visit is modified, the electronic guide becomes visitors' multimedia companion, which not only provides useful information, but aims at improving the overall visitors' experience [3, 14]. In the same domain a playful character may be added in the museum visit, by designing a mobile location-based game. Such games break from the usual static paradigm of room play, going towards a more dynamic and social experience [12].

The mobile games become learning experience when embedded in places of high information, since they create an augmented reality setting which helps people to experience better the environment. Indeed, four main characteristics contribute both to the mobile game's appeal and to the emotional attachment that players feel [8]: (i) physical experience; (ii) mental challenge; (iii) social experience; (iv) immersion. More specifically, the physical experience pertains to what it is felt when interacting with real and tangible objects as well as with virtual elements. Furthermore, players do enjoy additional mental stimuli by having to solve riddles or tasks. Regarding social experience, these games require people to meet, socialize and combine their efforts in order to be more effective while playing. Finally, the feeling of immersion in the game setting is the main entertainment factor.

III. RELATED WORK

Proposals of game design guidelines are available in the literature. We briefly report here some of them, which complement those identified in our work. The design guidelines proposed in [6] focus on how a game can be adapted to the social environment in which it is played, while those proposed in [7] are related to the challenges of using several devices at the same time in cross-media games. In [10], a user study was conducted aiming at producing guidelines from 700 comments made by six participants; the authors derived seven guidelines that primarily cover the design implications in relation to the asynchronous nature of the considered game. Wetzel et al. produced twelve guidelines by using an approach that is partially similar to ours, i.e. by analysing three different games with the goal to identify what is needed to create good mobile location-sensitive games and what causes them to fail [16]; the twelve guidelines focus on the inclusion of 3D features in such games and very marginally consider more general game design aspects. Thus, we felt the need of further guidelines that address a more holistic view of the mobile educational games and complement what is already available in the literature.

IV. METHODOLOGY FOR IDENTIFYING THE GUIDELINES

The guidelines proposed in this paper are derived by following a systematic methodology, defined as "case study methodology" in [11]. A team of three researchers, experienced in the design of educational pervasive games but with different backgrounds, started their work by investigating three specific mobile games by analyzing published papers. Their initial goal was to identify as many issues as possible related to the design of such games. The researchers' knowledge of the design process allowed them to reflect on their own experience, recount important details, highlight different understandings of the design practice, participate in in-depth discussions, and elaborate on issues and concerns. The following subsections describe the activities carried out by the team.

A. Papers analysis

Each one of the three researchers involved in this phase of research, was assigned the same set of six papers to analyse independently. The papers reported the design and the evaluation of three mobile location-based games: *Explore!* A game for visitors of an archaeological site in southern Italy [2, 5], *MuseumScrabble* a game for a cultural historical museum in Greece [13, 15] and *Frequency 1550* a mobile game that takes place in the city of Amsterdam [9, 1]. All three games have the goal of supporting informal learning and utilise a different range of multimedia features, technologies and interaction techniques, in three different settings. Each researcher identified and reported a long list of game issues and then worked independently to clarify them and to eliminate redundancies. A total of 317 issues were reported by the three researchers.

B. Defining game issues

The researchers met to analyze the initial list of 317 items from which a final list was produced, containing 94 issues related to the design of mobile location based games with learning objectives. The process included identifying similar issues, merging related or duplicate issues, and refining of the

produced list. The overall goal was to identify issues in the final list, which could be addressed by a same guideline. For instance, some of the 94 final issues were: "Competition as a means to increase motivation", "Competition by hampering the other teams", "Competition for limited resources", "Competition for limited resources to induce collaboration (negotiate roles, discuss strategy)", "Competition for other team's points," "Allow competition", "Force Competition". These seven issues are covered by guidelines 3.4 and 5.3 in the final list.

C. Defining dimensions

It is useful to organise a set of guidelines along dimensions, in order to support designers in quickly realising important aspects related to design. The process of defining these dimensions included a separate phase, during which the three researchers organised all 94 issues in subsets addressing a certain dimension, and a consolidation phase where the final set of dimensions was defined by combining the results of the individual work. The resulting five dimensions are:

1. *Game General Design*, which refers to issues related to the overall game design process;

2. *Control/Flexibility*, which is a basic dimension of system usability and, with respect to the games considered in this paper, also refers to how helping players to be aware of the effects of their choices during game execution;

3. *Engagement*, which informs on how to provide an experience that captivates the players, by providing hints on how to structure the game, which tools to adopt, etc.;

4. *Educational Aspects*, which concerns effective integration of learning objectives into the game context, so that the game can have learning potential on the players;

5. *Social Aspects*, which concerns the interaction among the players, role allocation etc. (the underlying assumption is that social activity, e.g. competition, can act as a motivational factor).

D. Defining guidelines

Each of the three researchers involved was provided with a table containing the 94 game issues, organised according to the five identified dimensions. The researchers first worked individually and defined design guidelines that emerged from the issues. The guiding principle for this activity was the need to identify "a set of guidelines that could guide designers who have the task to build a mobile game of this nature, which aims at improving the learning experience of people in a specific site".

Prior to the joint refinement process, each researcher compared the set of guidelines he identified with those of the other researchers. Finally, in a discussion and negotiation phase, they consolidated their guidelines in a unique set. As a result, 40 guidelines organized in five dimensions were defined. A table reporting this first version of dimensions and guidelines was submitted to four external interactive technologies researchers with experience in the design of educational mobile games, who commented on them. Based on the feedback of these external researchers, the final list of 36 guidelines, presented in the next section, was produced.

V. MOBILE LOCATION-BASED GAMES DESIGN LIST OF GUIDELINES

In this section the final set of 36 design guidelines, organized in 5 dimensions, that was produced by the process described in the previous section are presented. The broad dimensions, as already discussed, are the following: Game General Design, Control / Flexibility, Engagement, Learning Aspects, and Social Aspects

1) Game General Design

1.1 Exploit metaphors from real-life games, activities, stories

1.2 Minimize the changes to the physical places (e.g. modifications to the physical structure, installation of special equipment like projectors, big displays, etc.)

1.3 Create a multidisciplinary design team (including e.g. HCI, domain experts, site experts, educational experts)

1.4 Perform formative evaluations and pilot studies to check if tasks' difficulty is appropriate for the intended players

1.5 Consider the social conventions of the place (e.g. not loud speaking in a church)

1.6 Consider to extend the game experience beyond the game session (e.g. participating in a web community)

1.7 Consider to include activities/events that are not part of the game, but happen in the real world (e.g. the ceremony of change of the guard at noon)

1.8 Consider to include a game master (e.g. tutor, supervisor, coordinator) and her role: e.g. enforcing the rules, narrating the story

2) Control / Flexibility

2.1 Let players become familiar with the equipment and the game rules/structure (e.g. by including an introductory phase)

2.2 Facilitate game learnability (i.e. tasks, rules, constraints, etc. should be easy to understand and to learn)

2.3 Player should be free to switch between different tasks

2.4 Reflect on whether to allow players to correct their mistakes: it could be useful to force them to evaluate the consequences of their actions

2.5 Provide help or hint mechanisms to assist players

2.6 Consider to provide increasing difficulty levels (either automatic adaptation or human-generated adaptation)

2.7 Prevent rule breaking by either discouraging it (e.g. with penalties) or by incorporating cheating into the game

2.8 Make clear the game goal/s (e.g. earning points, completing tasks, being the winner, etc.)

2.9 Make clear the game ending condition/s (e.g.

maximum time, target score, end of resources, etc.)

2.10 Consider to provide alternative ways for performing a task or completing the game

2.11 Make clear the goal of each task and its effects on the overall game

2.12 Provide immediate feedback about task execution showing its impact on the overall game

3) Engagement

3.1 Consider to integrate a back-story that is at the basis of game tasks

3.2 Consider to exploit role-playing (i.e. impersonating a character) to meaningfully link tasks to the back-story (if any)

3.3 Provide contextual cues linked to specific places or events to convey additional information (e.g. sounds reproducing noises of daily activities in an ancient city)

3.4 Consider to allow players to interfere to competitors, e.g. stealing/acquiring points

3.5 Let players practice different skills by including in the game a variety of tasks, such as: perform a quest, identify/visit certain locations, shoot a picture from a specific angle, videotape a route, search for a certain object, perform a certain action/gesture, search/identify a physical mark, answer a question, collect and classifying material

3.6 Minimize the interaction with the game tools. Players' attention should be focused on the game and the environment

3.7 Tune the level of awareness of other players' activities (hide/provide/delay information, e.g. showing the score and the progress of the competitors)

3.8 Consider to include rewards in order to improve players' motivation/satisfaction (e.g. providing multimedia information as a prize for a successful task); integrate rewards tightly with the game tasks and back-story; consider when to provide the rewards to the players (during/after the game)

4) Learning Aspects

4.1 Consider to include a pre-game activity to prepare players (e.g. some lessons in classroom explaining the historical context in which the game is set)

4.2 Game should emphasize either vertical or horizontal exploration of a place/topic, i.e., deeply exploring a limited space (or few objects or a specific topic) vs. more superficially exploring a broad space (or many objects or several topics)

4.3 Tasks should require players to link areas, locations, physical objects to concepts, topics, etc.

4.4 Balance between competition and knowledge acquisition. Too much competition may have a negative impact on knowledge acquisition

4.5 Include a debriefing phase after the game to allow players to reflect on the game experience. Design it as an individual/collaborative game/activity that supports players to clarify and consolidate the game experience

5) Social Aspects

5.1 Team players (if any) should be selected based on players' social relations (e.g. friends to maximize collaboration) or according to their skills. Involve in this process a person that knows them very well (e.g. a teacher)

5.2 Assign responsibilities and tools (e.g. mobile devices, maps, etc.) among team members to induce collaboration. Consider to force, forbid or allow responsibilities exchange among team members

5.3 Consider to permit, force or neglect the competition among players/teams

VI. CONCLUSIONS

The guidelines proposed in this paper offer insights on the issues that are relevant when designing location-based mobile games with the objective of learning. These usually take place in information rich environments, like museums and cultural sites, places of historic value, natural or artistic interest. These guidelines were produced by following a systematic methodology. They aimed at assisting a designer in carrying out the design process and formalizing key design decisions. The identified guidelines are quite general and may be used for mobile location-based educational games independently of any specific domain.

We have performed a preliminary validation study by providing small groups of HCI students with the guidelines and requesting them to design a new mobile game or to evaluate their game design work that they had in progress. They reported that, thanks to the guidelines support, they trusted to have addressed important game design issues. More importantly, some students said that the guidelines helped them to make decisions on key points on which they were in doubt about. These first results are encouraging, but we are aware that the produced set of guidelines has to be validated and further refined, through more systematic studies by a wider community of designers To this objective we hope that this publication will serve.

REFERENCES

[1]. Akkerman, S., Admiraal, W., and Huizenga, J. Storification in History education: A mobile game in and about medieval Amsterdam. Computers & Education, 52, 2 (2009), 449-459.

[2]. Ardito, C., Buono, P., Costabile, M. F., Lanzilotti, R., and Piccinno A. Enabling interactive exploration of cultural heritage: an experience of designing systems for mobile devices. Knowledge Technology and Policy, 22, 1 (2009), 79-86.

[3]. Barbieri, G., Celentano, A., Orsini, R., and Pittarello, F. Understanding art exhibitions: from audioguides to multimedia companions. In Proc. DMS 2009. Knowledge Systems Institute, Skokie, IL, 250-255.

[4]. Buono, P., Di Bitonto, P., Di Tria, F., and Plantamura, V. L. Genòmena: a Knowledge-Based System for the Valorization of Intangible Cultural Heritage. In Proc. DMS 2009. Knowledge Systems Institute, Skokie, IL, 100-105.

[5]. Costabile, M.F., De Angeli, A., Lanzilotti, R., Ardito, C., Buono, P, and Pederson, T. Explore! Possibilities and challenges of mobile learning. In Proc CHI 2008. ACM (2008), 145-154.

[6]. Eriksson, D., Peitz, J., and Björk, S. Socially Adaptable Games. In Proc. DIGRA 2005. DiGRA Digital Library.

[7]. Ghellal, S., Bullerdiek, S., Lindt, I., Pankoke-Babatz, U., Adams, M., Söderlund, T., Oppermann, L. Design Guidelines for Crossmedia Game Production. Public IPerG Deliverable D8.1. http://www.pervasive-gaming.org Last accessed on July the 16th, 2010.

[8]. Hinske, S., Lampe, M., Magerkurth, C., and Röcker, C. Classifying pervasive games: on pervasive computing and mixed reality. In Concepts and Technologies for Pervasive Games - A Reader for Pervasive Gaming Research, vol. 1. Shaker Verlag, Aachen, Germany, (2007), 11-38.

[9]. Huizenga, J., Admiraal, W., Akkerman, S. and ten Dam, G. 2009. Mobile game-based learning in secondary education: engagement, motivation and learning in a mobile city game. Journal of Computer Assisted Learning, 25, 4 (2009), 332-344.

[10]. Korhonen, H., Saarenpää, H. and Paavilainen, J. Pervasive Mobile Games --- A New Mindset for Players and Developers. LNCS 5294. Springer-Verlag (2008), 21-32.

[11]. Lazar, J. Research methods in human-computer interaction. Wiley, Chichester West Sussex, U.K., 2010.

[12]. Montola, M., Stenros, J. and Waern, A. Pervasive Games: Theory and Design. Morgan Kaufmann, 2009.

[13]. Sintoris, C., Stoica, A., Papadimitriou, I., Yiannoutsou, N., Vassilis, K. and Avouris, N. MuseumScrabble: Design of a mobile game for children's interaction with a digitally augmented cultural space. International Journal of Mobile Human Computer Interaction, 2, 2 (2010).

[14]. Stock, O. and Zancanaro, M.. PEACH - Intelligent Interfaces for Museum Visits (Cognitive Technologies). Springer-Verlag (2007).

[15]. Stoica, A., Fiotakis, G., Raptis, D., Papadimitriou, I., Komis, V., and Avouris, N. Field evaluation of collaborative mobile applications. Handbook of Research on User Interface Design and Evaluation for Mobile Technology. Idea Group. 2007.

[16]. Wetzel, R., McCall, R., Braun, A.-K. and Broll, W. Guidelines for designing augmented reality games. In Proceedings of Future Play 2008. ACM (2008), 173-180.

[17]. Yiannoutsou, N, Avouris, N. (2010). Reflections on the use of location-based playful narratives for learning. In Proceedings of Mobile Learning 2010, pp. 149-156, Iadis Publ, Porto, March 2010

[18]. Ballagas R., Walz S.P., Kratz S., Fuhr C., Yu E., Tann M., Borchers J., Hovestadt J., 2007. REXplorer: A Mobile, Pervasive Spell-Casting Game for Tourists. In proceedings CHI '07, pp. 1929-1934, New York, NY, USA,. ACM Press.