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Mobile games to foster the learning of history at archaeological sites

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Abstract

This paper presents a system designed to support young students learning history at an archaeological site, by exploiting mobile technology. The approach uses game-play, since it stimulates in young students an understanding of history that would otherwise be difficult to engender, helping players to acquire historical notions and making archaeological visits more effective and exciting. A strength of the system is that, by running on the visitors own cellular phones, it requires minimal investments and small changes to the existing site exhibition.

1. Introduction

The use of computers in education has grown rapidly over the last years. In addition, hardware advances have made it possible to implement the concept of computer-based edutainment, i.e. education in the form of entertainment, where learners can arrive at their learning goal by having fun [4]. Research indicates that well-designed computer games can meet some of the psychological needs of children and motivate them to learn [6]. This suggests to take advantage of the motivating nature of electronic games by using this medium for educational purposes rather than simply for pure entertainment. Electronic games on cellular phones, more than any other interactive technology, have become a significant part of young people contemporary culture.

Our work aims at supporting young students learning history at an archaeological site. Italy is full of cultural heritage. Middle schools organize several visits to archaeological sites, and it is difficult to estimate how lasting an interest in archaeological sites and museums traditional visits can generate in students. Archaeological sites pose further difficulties since students are faced with ruins of ancient settlements that have lost their original image and whose current appearance no longer reflects their initial purpose.

In this paper, we present a mobile system that supports middle school students during the visit of archaeological sites. Our approach uses game-play, since it stimulates in young students an understanding of history that would otherwise be difficult to engender, helping players to acquire historical notions and making archaeological visits more effective and exciting. The system requires minimal investments and little change to the existing exhibition because it runs on the visitors' cellular phones.

The paper has the following organization. Section 2 describes the excursion-game implementation on a cellular phone. Section 3 briefly illustrates the system architecture. Section 4 reports our evaluation studies. Section 5 draws the conclusion.

2. Excursion-game on a mobile device

The system we are developing implements the electronic version of the excursion-game proposed by Historia Ludens to support students during a visit of archaeological sites. Historia Ludens is an association, set up by researchers in the field of Teaching History at the University of Bari, Italy. The association has developed the excursion-game as a learning technique exploited by middle school students during didactic excursions to visit historical sites [2]. Excursion-games have been designed by Historia Ludens for several archaeological sites in Southern Italy. The experience with these excursion-games has been replicated hundreds of times with different classes and teachers, who appreciated a lot how much students were stimulated by the game to know more about the site and overall how they enjoyed the visit. Among the excursion-games designed by Historia Ludens, in the rest of this paper we refer to “Una giornata di Gaio ad Egnathia” (Gaius’ Day in Egnathia), which is designed for a visit to the archaeological site of Egnathia, an ancient city in the Apulia region [1]. It is only an example, since the system is designed to be easily adopted to excursion-games that refer to the different

archaeological sites. The excursion-game is structured like a treasure hunt to be played by a class of students: it combines the excitement of both chase and solving the case with the joy of freely exploring a place and discovering its hidden secrets. This type of game is perfectly suited to the archaeological site context, with wide spaces where students can move about freely and use their intelligence and imagination to conjure up how life used to be there, by observing the site and memorizing places, names and functions.

To develop a system conforming to the usability criteria, the Learner-Centered methodology has been adopted. It prescribes involving domain experts and educational experts in the system development [5]. Thus, teachers and Historia Ludens associates contributed to the development of the digital excursion-game. We exploited the contextual inquiry technique to collect data about users' own activities [3]. We participated in an actual excursion-game performed at Egnathia by students (11-12 years old) of the middle school "Michelangelo" in Bari, Italy.

In the following, we describe the digital version of the game we have implemented. It consists of the same three main phases.

2.1. The introduction phase

After children arrive at the archaeological site, the game master gives a brief introduction about place and period being studied. Then, she explains the game, the various phases and the rules. Groups of 4/5 players are formed: each group has a navigator (group leader) and impersonates a Roman family that has just arrived in Egnathia, having received a plot of land and a house. Each group is given a cellular phone, and the map of the site. During the game, the cellular phone screen visualizes each mission description to be accomplished, i.e. the description of each place that must be discovered. The map allows the players to find their way around and follow the right pathway; it also has a teaching function, because players have to mark places in the site, it fosters conceptualization and organization of the information.

2.2. The game phase

Figure 1 shows the Game Player Application start screen on the phone. A memory card hosting the game is also shown. A sound attracts players' attention while the first mission to be executed appears on the phone screen. For example, Gaius has to search for the Furnace, where Tizio, the potter, needs assistants and could employ one of Gaius' sons. The group has to explore Egnathia by collecting information about the furnace and identifying the place. An item in the Menu list allows the players to ask the *oracle* (*oraculum* in latin) for help. The oracle gives them some hints that help discovering the right place. Hints provided by the oracle support both game-play and students' learning of the underlying educational content.

Figure 1. Gaius' Day start screen.

When the group believes to have identified the mission target place, the navigator digits the place code on the cellular phone or photographs the place's visual tag, if the phone has a camera. Place codes and visual tags are distributed across the site. Another component of the group notes the place on the park map. The system acoustically signals that the current mission is concluded and that the next mission starts. It visualizes the text of the new mission and the game continues.

After completing the last mission, the group gets "God's gifts". This means that the students have the possibility to explore the 3D reconstruction of the identified places on the phone and compare their original look with the existing remains (Figure 2). The proposed 3D models have been designed in collaboration with archaeologists of the Ancient History Department at the University of Bari, who are studying archaeological parks in Southern Italy. Although cellular phones do not have high performances of 3D rendering, the quality of the visualized scenes is adequate to support the immersion experiences.

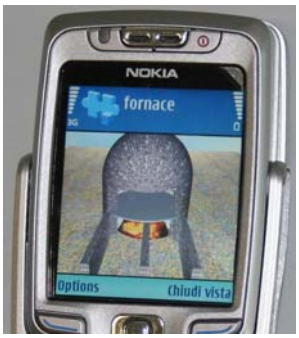

Figure 2. The 3D reconstruction of the furnace.

2.3. The debriefing phase

When the game is over, game master meets students for debriefing, to reflect upon their experience. This phase can be carried out in a lecture room in the museum or on return to the classroom. The debriefing is presented as a pleasant end to their day, and the experience they have had. In this phase, the acquired knowledge is revised and shared among students. The game master gives a complete overview of the various notions they learned during the day and encourages them to ask questions, make hypotheses and satisfy their curiosity. The debriefing phase is fundamental in didactic game-play because it fosters generalization and conceptualization of the information acquired during the game [2].

By making use of the current technology, the debriefing phase is greatly improved. During the game some information has been recorded in an XML logfile: inserted code or photographed visual tag, missions execution time, and if the oracle was invoked. The game master, using a card reader or a Bluetooth connection, collects logfiles from each group as they come in with their concluded missions. The Game Master Application, residing on the notebook of the game master, analyzes the logfiles and proclaims the winning group. The application may replay activities of an arbitrary group, based on the corresponding logfile and using higher-definition 3D reconstruction of the archaeological site than the ones on the mobile memory cards handed in by the student groups. The game master is recommended to replay the winning group's performance on a projector at the debriefing phase in front of the whole school class, as a reward to the winners but also to recapture some of the things learned throughout the visit.

3. The system infrastructure

Striving for a simple and cheap digital gaming infrastructure, we propose a design based on cellular phones, complemented with compatible memory cards containing the game software. Visitors will use their own cellular phone so that the archaeological site does not need to provide any hardware infrastructure. To reduce costs and architectural complexity, no data is transmitted from or to the cellular phone during the actual game. Instead, all data exchange is (at least at this stage in the project) taking place between the cellular phone and the memory card inside it. A notebook equipped with a large screen/projector is needed by the game master for the debriefing phase. Some information, such as the map of the archaeological site, is left on paper media.

Specifically, each student group needs a cellular phone able to run a Java Virtual Machine (J2ME), equipped with a memory card slot and also (optionally) a digital camera. The memory card is handed out to each group at the start of the game session and contains: a) the actual game "Gaius' Day", b) game data including 3D-reconstructions of (parts of) the archaeological site, c) game-play logfile, which is continuously updated as the group visits different parts of the site and answers questions. In addition, a letter containing game instructions and missions is handed out on paper.

The game master notebook has a Bluetooth and/or memory card reader. The Game Administration Application, residing on the notebook, collects logfiles from each group as they come in with their concluded missions, and analyse the logfiles in various ways using statistics and visualisation tools. The application may replay activities of an arbitrary group, based on the corresponding logfile and using higher-definition 3D-reconstruction of the archaeological site than the ones on the mobile memory cards handed out by the student groups. The game master is recommended to replay the winning group's performance at the debriefing event on a projector in front of the whole school class, as a reward to the winners but also to recapture some of the things learned throughout the visit.

The presented infrastructure represents our first steps towards a system able to provide a rich multimodal Augmented Reality experience at archaeological sites. We are currently working on enhancing the game by providing gesture-based exploration of the 3D reconstructions [7] and/or for enabling gesture input in general; 2D location-based audio; GPS-based location information written into the logfile for use during both debriefing and gameplay.

4. Evaluation

Usability evaluation is fundamental in Learner-Centered design. We perform evaluation with various techniques during the whole development life cycle. The evaluation sessions we have performed by involving real users have been very useful. In two evaluations, the participants were four students that have already once played the traditional excursion-game during a school visit to Egnathia. The participants were divided in two groups, in which one student took the navigator role carrying the cellular phone, while the other student kept the map and the mission description. Our aim was not to evaluate the overall user experience in a real setting. That would require a more accurate study, which we plan to

perform later. Instead, the objective of these first studies were to receive students' feedback about the design and the usability of the overall prototype. For this reason, the studies have been performed in a university laboratory, where pictures of the real site were posted on the walls (Figure 3). Based on photos attached to the walls, the students were able to recall the site they had visited, thus simulating their presence in the real site.

Figure 3. The participants in the pilot study during the execution of the electronic game.

We briefly mention some results from the evaluation sessions to show how they affected the final design. For instance, given the choice between an audio-enhanced game and a silent version, the students preferred audio which created a greater engagement. This made us extend the use of audio in the next version of the game. Absence of feedback during system delays was also noted by the students and has been addressed in conjunction with a general undo mechanism. Some functionalities available during the exploration of the 3D-reconstruction were not understood by the students, thus their visual appearance has been improved. Furthermore, on request from the students, a map of the archaeological site was reproduced on the cellular phone to complement the paper-based map.

5. Conclusions

This paper has presented a mobile system designed to help middle school students to acquire historical notions during the visit of archaeological sites. The system uses a game to stimulate an understanding of history in the students that would be otherwise difficult to engender.

A great strength of this system is that it does not require any special hardware at the archaeological site (e.g. network infrastructure, totems, etc.), which administrations are often unable to afford. In fact, it takes advantage of visitors own cellular phones equipped with a memory card reader and (optionally) a camera. By being so simple and cheap, the architecture is realistically applicable to many outdoor and indoor archaeological sites. We believe that, even with this slim architecture, game-play will engage students and permit an effective and exciting visit of the archaeological sites, thus enhancing the overall students' experience. This belief has been confirmed by the preliminary pilot studies we report in this paper. Certainly, the joy and learning efficiency must be established using a more systematic on-site empirical evaluations which we in fact plan to perform during spring 2007, when schools usually perform didactic visits to archaeological sites.

We are also looking towards enhancing the game-play. In particular, assuming a camera-equipped phone, the 3D visualization of reconstructed monuments could take into account the position and rotation of the phone in relation to the visual tag, providing a "true" augmented reality experience.

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