

Exploring Archaeological Parks by Playing Games on Mobile Devices

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ABSTRACT

Explore! is an m-learning system that combining e-learning and mobile computing allows middle school students to interact with learning materials in different ways while playing a game in an archaeological park. Design is based on user-centred and participatory approaches. The evaluation of Explore! through systematic field studies has shown that it is able to transform the visit to archaeological parks into a more complete and culturally rich experience. Thanks to the generality of the software infrastructure, games to be played in different parks can be easily created; to this aim, an Authoring Tool to be used by history experts and/or teachers has been developed.

Keywords

Mobile Devices, Educational Games, Archaeological Parks

ACM Classification Keywords

H.5.1 [Multimedia Information Systems]: Artificial, augmented, and virtual realities; K.3.1 [Computer Uses in Education]: Collaborative learning-Distance learning.

1. INTRODUCTION AND MOTIVATION

Italy has a rich fund of cultural heritage, with many historical sites dating back to centuries B.C. In their educational curriculum, grade and middle schools organize visits to archaeological parks and museums. Teachers report that in some cases traditional visits do not involve students as much as might be expected, because such visits tend to generate little interest in young students, especially when they are faced with the ruins of ancient settlements whose current appearance no longer reflects their initial purpose. In order to increase young people's engagement, the visit must be more interesting allowing users to come in contact with the historical site by directly interacting with the environment.

Mobile technology is opening new possibilities: the imaging and multimedia capabilities of the last generation mobile devices can transform the visit to archaeological parks into a more complete and culturally rich experience, enhancing the visitors' curiosity and letting them to be immersed in a lost reality. In the CHAT project, "Cultural Heritage fruition & e-learning applications of new Advanced (multimodal) Technologies", we have developed a software infrastructure that allows services to be accessed through thin clients such as cellular phones or PDAs and to be adaptive to the physical-virtual context of the human actor carrying the device. Explore! is an m-learning service supplied by the CHAT software infrastructure that support middle school students during

a visit to an archaeological park. It exploits a learning technique called excursion-game, whose aim is to help students to acquire historical notions while playing and to make archaeological visits more effective and exciting [1], [5].

The system presented in the paper is different from the ones available in other Italian archaeological parks. It is based on the augmented reality idea allowing users to integrate the observed environment with the information communicated by the mobile device. Our game-based approach to m-learning has similarities with those described in [11] and in [14]. The "Mystery in the Museum" PDA application aims at augmenting interaction with the museum through a mystery play that stimulates children's imagination [11]. The "Ambient Wood" system aims to encourage children to carry out scientific enquiry while exploring different habitats in a woodland [14].

Next section reports the design process of Explore!. Then the game, the system and the Authoring Tool are described. Section Evaluation provides indications about the performed field studies. Finally, conclusions are reported.

2. THE DESIGN PROCESS OF EXPLORE!

Our design team at the Interaction, Visualization and Usability (IVU) lab of the University of Bari, Italy, adopts an approach based on user-centred and participatory design [10], [16]. Domain experts, representative of end users, and end users themselves have an active role in the whole process. They are involved in the requirement analysis, which is fundamental for developers to understand the domain of interest and the user needs, skills and current working practices. They participate in the evaluation of early paper prototypes and provide feedback; they test the successive system prototypes in laboratory and then in field settings. In this sense, our approach goes beyond classical participatory design in that it stresses evaluation with end users in real field settings.

The interaction design process has involved four basic stages: 1) identifying the needs and requirements for a fulfilling user experience; 2) developing alternative designs that meet those requirements; 3) building running prototypes that can be tested with real users; 4) evaluating what is being developed throughout the process and the user experience it offers [13].

Beside human-computer interaction and software engineering experts of the IVU lab, the design team of Explore! was composed of: a) members of Historia Ludens, a cultural association in Bari, that has developed the original paper-based version of the game and used it as a learning technique for school visits to archaeological parks [5], [6]; b) experts in teaching history and

archaeologists of the Department of Ancient History of the University of Bari; c) the director and staff representatives of the Egnathia Archeological Park; d) school students and teachers of the middle school “Michelangelo” in Bari.

We made use of the contextual inquiry technique to collect data about users’ own activities [4], [8]. We participated in an actual excursion-game performed at archeological park of Egnathia, which is close to Bari, by students (11-12 years old) of the middle school “Michelangelo” in Bari. The observation provided useful information on how the game was actually performed and about the problem-solving strategies adopted by the students. Interviews and focus groups involving Historia Ludens associates, students and teachers were performed in order to capture more details on the game and on the whole experience. Interviews were also performed to the archaeologists and experts of the park in order to capture the history of the park and discuss how to model the 3D reconstructions of meaningful sites for the electronic version of the game.

Different prototypes were developed and several formative evaluations, some involving middle school students, were conducted throughout the interaction design process [2]. Wizard of Oz (WOz) simulations [9], direct observations, interviews, inspections have been employed. The evaluation sessions were performed in a university laboratory, involving small groups of students that have already once played the traditional game during a school visit to Egnathia. Based on photos of the real site posted on the walls, the students were able to recall the site they had visited, thus simulating their presence in it.

In the following sections we report the final system that has been developed and its evaluation performed in the field with middle school students.

3. THE GAME

The game implemented in Explore! is similar to a treasure hunt, played by groups of 4/5 students, who have to carry out missions to discover meaningful places in the park.

Enjoyment is important when endeavouring to achieve teaching goals, because what is enjoyably learned is less likely to be forgotten. Games are very important in children’s development [12]. Play is often a relational activity: it encourages group interaction, stimulates collaboration, helps with conflict management and is an excellent tool for individuating relational problems [15].

In this paper the game developed for the archaeological park of Egnathia, in southern Italy, is described. Each student group impersonates Gaius, a citizen of Egnathia, and receives two mobile phones, a paper map of the park, and a backpack carrying a pair of loudspeakers (Figure 1). The loudspeakers on the backpack are connected to the first phone and provide contextual sounds (that is, background noises, readings of the text displayed on the phone, warning sounds, and so on) [3].

The student group performs each mission following some indications provided on the first mobile phone running the Game Application (Figure 2).



Figure 1. A group performing the game in the Egnathia archeological park. The student on the right carries the first mobile phone with the Game Application, which provides information about the places to locate and a backpack with the loudspeakers, the next student holds the paper map, and the third student from the left holds the second mobile phone with the Hint Application displaying the Oracle

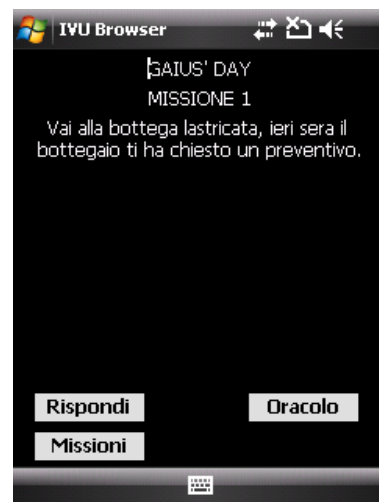


Figure 2. The second mission of the game: Gaius must go the “bottega” (screenshot taken from an HTC TyTN II running Explore!)

If players need help finding a place, they can ask the Oracle, the Hint Application software module available on the second mobile phone, which provides game hints. We implemented the Oracle as a small video game on the phone’s screen where Gaius is represented by an avatar that approaches one of six temples. Each temple contains clues about a specific place of interest (Figure 3).



Figure 3. The Oracle as displayed on the mobile phone: as Gaius approaches one of the six temples, he receives textual hints to find the associated site

After completing each mission, the group receives “Gods’ gift”, i.e. the 3D reconstruction of the place correctly identified (Figure 4). The students have the chance to interact with the 3D reconstructions on the phone and visually compare the possible ancient look with the existing remains. The proposed 3D models are scientifically correct, having been designed in collaboration with archaeologists of the Ancient History Department at the University of Bari, who are carrying out research projects on archaeological parks in Southern Italy.

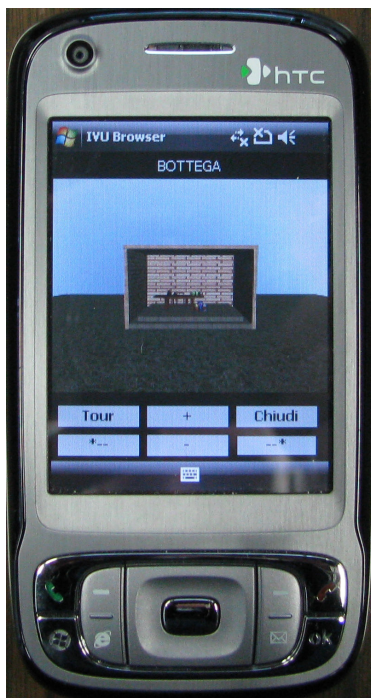


Figure 4. The 3D reconstruction of the “bottega” where wine is sold

After the game, students participate in the debriefing phase, in which the knowledge which they have implicitly learned during the game is reviewed and shared. During the debriefing phase, using the Master Application, the game master (i.e. a teacher) and students play a “collective memory game” where monuments and archaeological objects (previously observed by students as part of the game) are to be placed in the “right” place on the park map (Figure 5). The Master Application permits to show the 3D reconstructions of the historical monuments in a much higher definition than those on the cell phone.



Figure 5. Among the reflection activities proposed by the Master Application during the debriefing phase, students must place the image of the site elements (left) on the right positions on the map of the park

The Master Application can analyze the logfiles collected from the cell phones proclaiming the winning group, showing the groups’ standings. The system can replay the activities of an arbitrary group showing on the map the path they took across the archaeological park.

4. THE SYSTEM

The main novelty of Explore! is its slim architecture that aims at reducing implementation costs and architectural complexity to absolve the archaeological park from any need to invest in hardware infrastructure. Most middle school students have a cell phone, so we can assume that at least one student in each group will own one.

We designed Explore! to be as device independent and modular as possible, with a clear distinction between game content (historical information, 3D reconstructions, sounds, and so on) and game logic. The system consists of three main modules. The first one, called Game Application, relies on an XML file that describes the game content (easily authored for each archaeological park) and an XML file stating the layout and relationships among the various audiovisual elements of the user interface. The second module, Hint Application, provides the game cues, which also are represented in XML. The third module, Debriefing Application, runs on a notebook and retrieves the game’s XML log files from the memory cards on the mobile phones. The XML-based design makes the Explore! system independent from mobile platforms. Our current implementation is based on a combination of Microsoft .NET (for both Game Application and Debriefing Application) and Java 2 Micro Edition (for Hint Application).

The Game Application includes the Contextual Sounds Application, a software module that defines the user’s position and produces a virtual sound environment. This module can be

included easily in any system that needs to generate a contextual sound environment in outdoor settings. It behaves in a way that is similar to the Java Specification Request 234 DistanceAttenuationControl interface available on the Java 2 Micro Edition platform, which controls how the sound originating from a source fades as the distance from the user grows. The DistanceAttenuationControl is based on the distance gain formula; the distance is calculated using the GPS coordinates of the sound sources (coded in an XML file) and the current GPS coordinates of the mobile phone. Virtual sound sources have been placed in various locations at the Egnathia archaeological park (Figure 6). When game players walk across the park, they hear the sounds originating from the virtual sources. The perceived sound volume changes according to the distance between the player and each source.

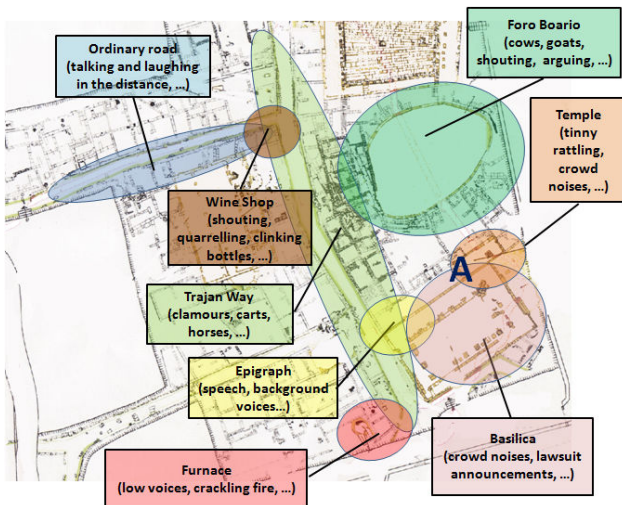


Figure 6. Sound source locations in the Egnathia archaeological park

5. THE AUTHORIZING TOOL

In order to allow end users not expert in computer programming to develop games to be played in different parks, we have designed an Authoring Tool (Figure 7). Through a wizard process that guides the user, it permits to specify all the information that Explore! needs: the character to be impersonated (Gaius in the case of Egnathia), the game challenge, the missions, the hints provided by the Oracle. Also the environmental context can be specified: places to be discovered, their photos, 3D reconstructions and GPS coordinates, contextual sounds. Some audiovisual interface elements can be personalized to be appropriate to a historical period (for example, some icons are suited for a Roman city but not for a Greek city). After the user has terminated the process of specifying the new game, all the information is automatically described by XML files and the multimedia material is stored in a folder which must be copied in the cell phone memory card.

6. EVALUATION

A systematic study was performed when the system was ready for a summative evaluation. Three classes of the middle school Michelangelo in Bari were involved for a total of 68 children (11-13 age) and 6 teachers. The visit to Egnathia was part of their didactic curriculum. Groups of students performing the game in its

traditional version (paper-based) and groups performing the game with Explore! were compared. Details about the study and its results are described in [7].



Figure 7. The Authoring Tool interface (labels are in Italian) that permits to specify information related to a specific place in the park: name, textual and audio description, photo, contextual sounds, GPS coordinates, 3D reconstruction. The user can mark the place position on the map of the park

The analysis of the great amount of data collected during the field study demonstrated that users enjoyed playing the game with Explore! and the introduction of the mobile was appreciated a lot. The very advantage of the mobile version of the game with respect to the traditional version is the overall user experience it provides. Regarding the learning, no significant differences were found between the two versions. This must not be considered a negative result, since it demonstrates that technology does not distract students. Indeed, the fact that the game, even in its original paper-based version, is a valid learning technique was already well assessed by various experiences reported by teachers and members of *Historia Ludens*, who have performed hundreds of games in the last ten years with several schools in Italy. The main reason for developing Explore! is to exploit current computer technology to enable interactive exploration of cultural heritage with the aim of engaging people and providing a more satisfactory user experience. In particular, students explicitly stated in their essays that they appreciated very much the 3D reconstructions of the historical monuments, that they visualized on the cell phone during the game and, in a more accurate definition, during the debriefing.

An interesting difference between the two versions is in the game behaviour: the sequential order imposed by Explore! affected users problem-solving strategies. Due to the screen limitation of the mobile device, the different missions to be solved during the game are proposed to the players one at a time, forcing children to solve them in sequence. During the field study, we observed that students in the paper-based condition changed the mission order, either firstly performing those missions they perceived as easier or according to a personal strategy; moreover, students could read on paper all items of the Oracle at once, possibly getting more information for identifying the mission target.

We performed a second field study with the aim of evaluating if contextual sounds would affect students' experience and learning. We have involved 51 further middle school students to compare a version of the game, which includes contextual sounds, with a mute version. Preliminary analyses of the collected data show that students appreciated the integration of sounds. This is an

important result because satisfaction is a significant component of the user experience.

7. CONCLUSIONS

This paper has presented an m-learning system that exploits a game to be played on cell phones to help middle school students to acquire historical notions during the visit of archaeological sites. The system enables interactive exploration of historical sites, not only for enhancing the user experience but also for learning purposes. Thanks to the generality of the software infrastructure, different games can be easily created: the Authoring Tool application guides also an end user not expert in computer programming in developing games to be played in different parks than Egnathia.

We adopted an approach based on user-centred and participatory design, involving domain experts, representative of end users, and end users themselves in the whole process.

The evaluation of Explore! through systematic field studies shows that the system is able to transform the visit to archaeological parks into a more complete and culturally rich experience.

8. ACKNOWLEDGEMENTS

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