A Location-Based Serious Game to Learn About the Culture

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1. Introduction

According to Malone and Lepper [7], the widespread use of video games, especially among young people, makes them an ideal medium for educational purposes. Moreover, the growing diffusion of mobile technology and videogames, along with the availability of mobile broadband connections, offers a unique opportunity to develop innovative methods of learning [10]. Therefore it is not a coincidence that many research studies and papers in educational journals that address the issue of mobile game learning, have been steadily increasing in recent years.

Mobile devices provide people with technology that enables them to participate in a process of lifelong learning and is available wherever they choose to use it [6]. Young people also benefit from the use of mobile potentialities. In childhood, games play a crucial role in cognitive and emotional development [3]; in fact they enhance the ability to concentrate, memorize, focus attention, develop relational and emotional schemas. As a consequence, many researchers are focusing on the use of mobile devices as a console for serious games (games for educational purposes) [8]; thanks to the utilization of (i) cameras and high definition displays, (ii) GPS, (iii) image recognition programs, (iv) innovative graphic chips, (v) connections to the Internet, they can create highly immersive and pedagogically effective game experiences. The use of serious games both at school and in work training is now a reality [2].

According to Zyda [9], although educational contents are a basic component of serious games, they have to be secondary to the entertainment factor; that is to say, a serious game which is not fun to play would be useless, regardless of its pedagogical content or value. Therefore there is a need for game developers and educational designers to work together to develop engaging and motivating serious games.

Ben Sawyer and Peter Smith [4] propose a classification among different types of serious games. In this work we focus on geolocation games, also called pervasive or location-based games. Location-based serious games use GPS information in order to provide educational contents correlated to the user's position. In [1], the authors promote a taxonomy of location-based games; they can be divided into 3 main categories:
- Mobile games: games that exploit the proximity information of two or more users;
- Location aware games: games that exploit information about the user's localization and his distance from some Points Of Interest;
- Spatially aware games: location aware games with a massive use of graphics. In this kind of game, developers create a virtual representation of the real world with reproductions of buildings, monuments, and landscapes.

The aim of this paper is to introduce O'Munaciedd, a location-based serious game designed for children which has a dual purpose: (i) on the one hand to stimulate the cognitive development of children through activities that will lead them to practise and improve their concentration, memorization and problem solving abilities, (ii) on the other hand to provide information about the artistic and cultural heritage of the city of Matera. In this paper, we will describe the game design, outlining the tools and the game development and then we will draw some conclusions and present future work.

2. Game design concept

O'Munaciedd is an imaginary character who features in traditional folk stories from Basilicata. He looks like a child wearing a long robe and a funny hat, but in fact he is really a goblin. In the stories O'Munaciedd is playful and mischievous and he loves to play jokes on people, but if you manage to steal his hat he will make a wish come true. The object of this game is to find Munaciedd and grab his hat. This task will not be easy because Munaciedd is smart and hides to avoid being found. A child playing the game has to visit the historical sites in the city of Matera, following the tracks and treasures left by Munaciedd in order to earn the coveted reward.

O'Munaciedd is not like other tourist location-based games which have already been developed, such as [5]; it was specifically designed for children and combines having fun with learning to create a stimulating and attractive pedagogical learning path. The game principle behind O'Munaciedd is similar to a traditional treasure hunt; children use handsets as a travel guide and game console. Thanks to real-time position localization, children are guided along a tourist route through the streets of the old city looking for clues. They will go in search of hidden treasures Munaciedd and, at the same time, they will learn about the culture and improve their knowledge and ability by playing fun games and observing the artistic heritage and the landscape of the city of Matera.

O'Munaciedd is a game consisting of a set of mini-games. Each mini-game was studied with a specifically pedagogical aim in mind. We have developed 11 mini-games to improve students knowledge about Matera as well as to stimulate the following children's skills:(i) memorization, (ii) problem solving, (iii) eye-hand coordination and mini-game contents education.

Considering the "*Dual Coding Theory*" [11], some games were designed to exploit, by means of learning and memory tasks, the role of non-verbal (visual and audio channels) and imaginative processes. Below is a brief description of the mini-games, of their pedagogical aims and the main communication channels used:

How it was and how it is: a simple game in which the player sees a set of photo views of the ancient city and has to identify the same view of modern Matera.
Music: a simple game in which the player has to pair the clips of a taranta (typical music from Matera)
Hangman: a traditional game of hangman using words associated with the culture of Matera
Simon: a simple game in which the player has to memorize and reproduce a sequence of sounds.
Where is it?: a game in which the player is asked for the location on a map of the POIs of Matera
Maze: a game in which the players have to escape from a maze
Puzzle: a classic jigsaw puzzle game in which the player has to reconstruct some pictures of Matera
Matera Invaders: classic game like space invaders
MathsQuiz: simple maths game
Memory: Classic memory Game
15 Puzzle: Classic 15 Puzzle Game

Mini-Game Name	Memorization	Problem Solving	Eye-Hand Coordination	Visual	Audio	Content
How it was, how it is				X		X
Music	X				X	X
Hangman						X
Simon	X			X	X	
Where is it?	X			X		
Maze		X	X			
Puzzle	X			X		X
Matera Invaders			X			
Math Quiz		X				X
Memory	X			X		
15-Puzzle		X	X	X		

When a child approaches a historical site (POI), a challenge from Munaciedd will automatically appear on the handset screen; the challenge has a rigid structure. Firstly, Munaciedd will provide some information about the site that the child is visiting. Secondly, Munaciedd will present a mini-game and finally he will pose a simple question or riddle that will require the child to search for a clue in the POI (real world). The clue will be used to answer a question posed by Munaciedd in the form of a quiz, a mathematical question, a linguistic question or a puzzle.
All the graphics in the mini-game have been developed to represent the site visited, in order to provide additional information that fosters informal learning.

2.1. Game development
O'Munaciedd was developed using Xcode version 3.4.1. Xcode is a development environment for creating Mac OS X / iOS apps. O'Munaciedd is compatible with iPod, iPhone and iPad, but the full functionality is reserved only for devices equipped with GPS (iPhone and iPad).
For geolocation purposes, we created an image that faithfully reproduces the ancient city map of Mater and we georeferenced it. The georeferencing was performed considering the geographical coordinates (Latitude and Longitude) of the points on the map with Cartesian coordinates (0.0) and (HeighMapPixel, WidthMapPixel). Considering how small Matera is, we were able to perform a latitude/longitude to Cartesian coordinates conversion by means of a simplified formula. Considering (TopLeftLat, TopLeftLon) as the latitude and the longitude of point (0.0) and (BottomRightLat, BottomRightLon) as the latitude and longitude of point (HeighMapPixel, WidthMapPixel) on the map using a simple proportion, as shown below, we obtained the conversion.
X = (longitudeRealtime-TopLeftLon) * WidthMapPixel / (BottomRightLon-TopLeftLon)
Y = (latitudeRealTime-topLeft) * HeightMapPixel / (BottomRightLat-TopLeftLat)
In this way we are able to track and display the player's position on the map. O'Munaciedd is hidden in the most important sites of the ancient city and whenever the child is approaching a POI he pops up with his mischievous air and challenges the child to a game that will earn or lose points.
In order to analyse the child's activity, we have deployed a data collecting system that records all the mini-game activities and the GPS position of the child at each minute of the game. At the end of the game, with the permission of the parents, the data collected can be sent to a central server, in order to create a global score

table of the users as well as to assist in further research. In particular, these data are anonymous and will be used to study learning paths correlated to the designed artistic itinerary.

O' Munaciedd is available free of charge in the Apple App Store at [12].

3. Conclusion and future work

Data analysis has shown that the game is enjoyable for children, but we still have to conduct pre-test and post-test activities to evaluate its educational value. Moreover, O'Munaciedd was developed as a single user game. Current research has demonstrated the potential of social networks in the construction of knowledge and suggests that the social aspect plays a central role in an individual's cognitive development and training. The next step in our work will be to improve O'Munaciedd as a multiplayer game that integrates cooperative and collaborative activities to exploit the educational potential of social interaction.

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