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# MICROGAMES FOR A COMPELLING INTERACTION WITH THE CULTURAL HERITAGE

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## Abstract (EN)

Mobile learning technologies can provide an important added-value to cultural tourism by supporting visitors in their direct field-experience. Our experience in the VeGame experiments has shown that augmenting mobile learning with game elements is effective, in particular to motivate users and to engage them - both as individual and as social groups – in challenging cultural tasks. In this paper we discuss three main kinds of game categories (observation games, reflection games and arcade games), that we consider important to support an active and engaging experience on the player-visitor's part. We also propose some microgames that instantiate such categories, illustrating the kind of activities they support and the specific skills they stimulate.

**Keywords:** Human-Computer Interaction, eLearning principles and applications, mobile gaming, multimedia, user tests, user-centered design, PDAs

## Zusammenfassung (DE)

Mobile Lerntechnologien können zu einer erheblichen Wertsteigerung im Kulturtourismus beitragen, indem sie die Besucher in ihrem Erleben unterstützen. Unsere Experimente mit *VeGame* haben gezeigt, dass mit Spielelementen angereichertes mobiles Lernen effektiv ist, insbesondere wenn es darum geht Anwender zu motivieren und sie dazu zu bewegen sich sowohl als Individuen als auch in der Gruppe mit anspruchsvollen kulturellen Anwendungen auseinanderzusetzen. In diesem Vortrag widmen wir uns drei Hauptarten von Spielen (Beobachtungsspielen, Reflexionsspielen und Arkadespielen), die wir zur Unterstützung einer für die Besucher / Nutzer aktiven und einnehmenden Erfahrung als wichtig erachten. Wir schlagen außerdem einige Mikrospiele vor, die solche Kategorien realisieren und erläutern die Art der Aktivitäten, die sie unterstützen, sowie die spezifischen Fähigkeiten, die sie fördern.

**Schlüsselwörter :** Mensch - Computer Interaktion, Prinzipien und Anwendungen des eLearning, mobiles Spielen, Multimedia, Nutzertests, Nutzerzentriertes Design, PDAs.

## Résumé (FR)

Les dispositifs technologiques mobiles d'apprentissage peuvent offrir une valeur ajoutée importante au tourisme culturel, en assistant les visiteurs dans leur expérience du patrimoine.

Notre expérimentation VeGame a prouvé qu'enrichir la découverte avec des éléments ludiques est efficace, en particulier pour motiver les utilisateurs et pour susciter leur engagement - comme individu ou en tant que groupes sociaux - dans des activités culturelles stimulantes et ambitieuses. Dans cet article nous discutons trois genres principaux — jeux d'observation, jeux de réflexion et jeux d'arcade — que nous considérons importants pour favoriser un engagement actif de la part du joueur-visiteur. Nous proposons également quelques exemples de "microjeux" appartenant à ces catégories, illustrant le genre d'activités qu'ils accompagnent et les compétences spécifiques qu'ils stimulent.

**Mots clés:** Interaction d'Humain-Ordinateur, principes et applications eLearning, jeu mobile, multimédia, essais d'utilisateur, conception utilisateur-centrée, PDAs

## I. Introduction

Mobile learning technologies can provide an important added-value to cultural tourism by supporting visitors in their direct field experience.

Recent studies have shown that ability to provide engaging experiences is a key factor to the success of education and entertainment (edutainment) products (Pine & Gilmore, 1999). Given their ability to gracefully integrate computing power in the physical world, pervasive computing technologies are well suited to enhance experience of the surrounding environment (Abowd, Mynatt and Rodden, 2002). Analyzing the "A Walk in the Wired Woods" experimental art installation, Hull et al. (2002) argue that wearable computing applications can create convincing and compelling experiences.

We explored such issues, designing multimedia mobile guides on palmtop computers for tourists (Bellotti, Berta, De Gloria and Margarone, 2002). We have researched further this field, exploring how mobile gaming can help tourists enhance their experience of art and history, favoring a pleasant and challenging interaction with documents, people and artifacts in a real urban context. We defined this concept as educational territorial gaming (Bellotti, Berta, De Gloria, Ferretti and Margarone, 2003). This approach is innovative since it exploits the challenge and appeal of games in order to implement a mobile learning service that supports the user in understanding the elements of urban heritage.

Research work on traditional, desktop-based computer games argues that computer games stimulate such cognitive processes as reading explicit and implicit information, deductive and inductive reasoning, problem solving, and making inferences from information displayed across a number of screens (Pillay, Brownlee & Wilss, 1999). Examining the brain's electrical activity, Kahana et al. (1999) have shown from a neuroscientific view that computer games engage spatial learning.

Since spatial reasoning and processing skills are important components in cognitive development (Natale, 2002), we are interested in analyzing how integrating a game in a physical environment can enhance interaction with the environment and support field learning.

In this sense, our work intends to contribute to the current ubicomp community's exploration of models of cognition that analyze the nature of the relationship between the internal cognitive processes and the outside world (Abowd, Mynatt and Rodden, 2002).

We have developed this research in VeGame (Venice Game, Fig. 1) – a wireless, distributed team-game played along the Venice's narrow streets to discover the art and the history of the

city.


**Fig. 1**: VeGame's initial page

We have already discussed in other companion papers the impact of VeGame on its target users and its effectiveness for knowledge acquisition (Bellotti, Berta, De Gloria, Ferretti and Margarone, 2004a; Bellotti, Berta, De Gloria, Ferretti and Margarone, 2003). In this paper we focus on the discussion of the game mechanisms and how they can support effective edutainment (i.e. education + entertainment).

## II. Ubiquitous Computing Games

In the recent years, we have noticed a growing interest among researchers for new form of gaming which applies ubiquitous computing techniques. This may make the act of playing computer games more social and tied to the context.

Sample Ubiquitous Computing prototypes games incorporate live data from the real world and process players' location and movement (Björk, Holopainen, Ljungstrand & Mandryk, 2002). The UCG research also involves games which have an educational focus. For instance, Environmental Detectives (Klopfer, Squire, Jenkins, 2002) implements scenarios - ranging from airborne particles to radioactive spills – which allow educators to investigate a wide range of environmental issues, leveraging their pedagogical and entertainment potential. In UCG, the physical game space is usually a neutral background over which the game's fiction is built (Björk, Falk, Hansson, Ljungstrand, 2001; Björk, Holopainen, Ljungstrand, Åkesson, 2002). Human Pacman (Cheok, Fong, Goh, Yang, Liu, Farzbiz, Li, 2003) is an outstanding

example of an UCG that maps the real world (objects, streets, etc.) into a fantasy 3D virtual world (i.e. the well known Pacman world). Human Pacman uses cutting the edge technology to make the players live the experience of this virtual world. Our aim is different, since we want to reinforce the link of the player with the actual reality. Inspiring to tour guides, VeGame features an in-depth linkage of the game with the territory - which is an indispensable context, rich of local information and people (Bellotti, Berta, De Gloria, Ferretti and Margarone, 2003).

## III. VeGame Targets and Principles

The main target of VeGame is to offer a pleasant and useful tourist experience in the urban context of the city of Venice. The experience relies on active exploration of the territory (streets, channels, squares, churches, palaces, etc.), its people and their activities (e.g. the famous Murano's glaziers), in order to have a better understanding and appreciation of the city's cultural heritage.
The experience is delivered through a game frame, allowing to capture and appeal a wide audience and to exploit specific educational and cognitive aspects of computer games.

The main target audiences are young adults aged 18 to 35 years. Nevertheless, the game has been designed for the general public, trying to reduce at a minimum usability barriers.
Players are grouped in teams. The suggested team size is limited to 2 players, so that every person can actively participate to the games, in particular considering the limited screen size of palmtop computers.
The game can be played by several teams simultaneously (e.g. on adequately advertised special events), or independently by tourist who want to visit Venice.
VeGame challenges players and stimulates competition by assigning points as single games, which are part of the global VeGame, are successfully completed. There is a session standings (for special events, Fig. 5a) and a hall of fame for all participants.

VeGame's pedagogical principles mostly rely on the constructivistic learning philosophies (Duffy and Jonassen, 1992), which stress the importance of constructing knowledge by situating cognitive experiences in real-world, authentic activities (Schaer and Krueger, 2000). Cognition models currently explored by ubicomp designers (Abowd, Mynatt and Rodden, 2002) - such as activity theory (Vygotsky, 1981; Fjeld et al, 2002), situated action (Suchman,

1987), and distributed cognition (Hutchins, 1995) - highlight the relevance of "knowledge in the world" versus the traditional "knowledge in the head" (Hutcins, 1995; Norman, 1990; Abowd, Mynatt and Rodden, 2002). These models emphasize the importance of social interaction and exchange with a physical environment as fundamental elements for developing the cognitive activity.

According to these principles, VeGame features three main learning modalities:
- Learn by doing (or playing) , inviting players to operate in the field, exploring the territory and observing attentively the documents, such as pictures, palaces, bridges, etc.
- Learn by thinking, stimulating reflection on what has been seen and told, critical reasoning and concatenation of experiences and clues.
- Learn through social interaction, inviting players - both from the same and other teams - to play together for cooperative purposes and to comment on their experience during the game. Moreover, we suggest players to interact with local citizens to answer specific questions on the local dialect and activities.

Moreover, especially according to the feedback from preliminary user and field tests, we have complemented this constructivistic approach by introducing objectivistic learning features (e.g. providing brief audio-visual historical and artistic introductions and conclusions to the single games), in order to consolidate the implicit experience with clear and explicit verbal knowledge.
Videogames are important to create interest and deliver images useful to represent meaning and content which can be recalled with ease. But it is important to complement such images with explicit verbal knowledge in order to convey an educational message easily understandable by the players.

## IV. The Game Architecture

Relying on the principles presented above we have designed a game structure which closely resembles a treasure hunt game. The participating teams are invited to go through a sequence of stages, which are points of interest distributed in the city, such as important churches, palaces and squares (e.g. Fig. 2a).


(a) (b)

**Fig. 2**: (a) The map of the urban area covered by VeGame, showing the stages and the path done until current stage, represented as a solid line. (b) The stage-menu with 5 games (in this case: HistoricalQuiz, RightPlace, VisualQuiz, Couples and VideoGame) selectable by the player.

At each stage, the player is presented with a stage-menu, which leads to the five games available at that stage (Fig. 2b). The games are instances of 13 typologies, which are briefly described in table 1. Screenshots of games are reported in Fig. 3. The table also reports the key-skills that we intend to address with each game.

We broadly divide games in three categories, according to the cognitive skills they mostly involve: observation games, reflection games, and action videogames.

- **Observation games.** These games privilege the sight as a sense to investigate and explore the surrounding environment. In general, these games tend to exploit the "knowledge in the world" in order to develop the cognition activity (Hutcins, 1995; Norman, 1990; Abowd, Mynatt and Rodden, 2002). They aim to stimulate spatial processing skills. Such skills are important in cognitive development since they allow an individual to create meaning by manipulating visual images (Natale, 2002; Pillay, Brownlee, Wilss, 1999; Gardener, 1993; Piaget, 1952).
- **Reflection games.** These games tend to favor reflection, discussion among team members, analysis of questions and possible answers considering clues available in the neighborhood and concepts learned previously during the game.
- **Arcade videogames.** These games stimulate similar skills as observation games. Their specificity lies in the animated graphics and engaging interaction, which helps to create a convincing and pleasant experience. They stimulate fantasy and evoke images and atmospheres that can be used to convey educational messages which are easily memorized by players.

| Name | Type | Short description | Key-skills and activities |
|---|---|---|---|
| Puzzle | Observation | Reconstruct an image (e.g. a picture, a palace, etc.) whose elements have been randomly shuffled.<br>The model for reconstructing the image is not on paper: is in the reality! | Ability to identify geometrical patterns, recognize colors and associate areas. |
| RightPlace | Observation | Drag an object (e.g. a detail of a picture, the name of a city, a product) in its right position on a map (e.g. a picture, a façade, a geographic map) | Create a mental model of the environment.<br>Ability to understand a map and find correspondences between its parts. |
| Details | Observation | Find the modified/missing/added details in a picture/map/photo | Analytic analysis of a document (picture, façade of building, etc.) |
| VisualQuiz | Observation | Multiple choice questions based on images. | Analysis of images (e.g. pictures).<br>Finding correspondences between reality and other images. For instance, in the Santa Maria dei Miracoli church we present the images of 4 churches and ask what is the one that has inspired the author of Santa Maria dei Miracoli. |
| Couples | Observation | Associate an image in the first column with the corresponding image in the second column.<br>Correspondence can be due to different factors (e.g. pictures of the same painter, a detail and the containing picture, a ship and its historical period) | Finding and understanding the meaning of the images.<br>Finding clues (in the current place and among information learned during the path) to understand the possible correspondences. |
| HistoricalQuiz | Reflection | A question concerning the story of Venice. The question is generally tied with the place where it is made (e.g. the question at the arsenal concerns interpretation of a Dante's piece of the Divina Commedia where the work at the Venice's arsenal is described) | Critical reasoning and evaluation of alternatives (the HistoricalQuiz is often a multiple choice question).<br>Typically, the quiz does not rely on previous knowledge, but it stimulates reasoning on clues available in the territory and/or on concepts addressed in the introduction and/or other games. |
| GuessingGame | Reflection | Type the right answer. | Logic, imagination and inventiveness. |
| Dialect | Reflection | Multiple choice question on the meaning of Venetian dialect words | Social interaction (speaking with local people to ask for the meaning, and discussion of the possible answers within the team)<br>Reflection on the language and on the customs and traditions of the Venetian people |
| Memory | Reflection | Find the couples of equal cards on the table. Cards involve typical Venetian images such as carnival masks and sketched icons of buildings, islands, bridges, boats etc.<br>One or two players. | Memory.<br>Associate images with names and positions.<br>The game can propose images of places /artifacts not on the game path, stimulating further visit. |
| Ponte dei Sospiri | VideoGame | A prisoner launches objects from the Ponte dei Sospiri: the cat has to catch fishes and avoid shoes and bottles. | Fix the image and the function of the bridge connecting the doge's palace with the jail. |
| ShipBattle | VideoGame | Typical shoot'm up game. A | Evoke a historical event. |

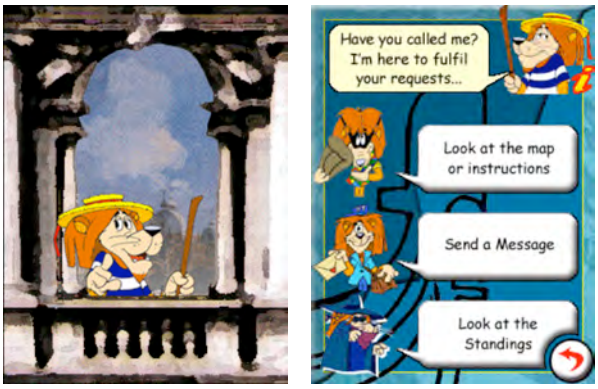
| | | | |
|---|---|---|---|
| | | Venetian galera (a military ship) fights against the Ottoman fleet in a XIV century battle in the Egean sea. | Precise historical reconstruction (in particular, the ship models). |
| Casanova | VideoGame | Two players: one is Casanova, who has to collect roses and throw them to his lover, and the lady, who has to catch them.<br>In the single player version (in case there is no team available in the neighborhood) the lady's role is played by the computer. | The game evokes the customs and the atmosphere of Venice in the XVIII century.<br>The game explicitly requires cooperation between the teams. The total score is shared. |
| Gondoliers | VideoGame | Two gondoliers (one in the single player version) have to pick up clients and bring them to their destination, which is shown as an icon on the map, with its name. Destinations are selected at random among the most important points of interest of Venice and the lagoon. | Spatial awareness of the city's and the lagoon's area.<br>Proposal of points of interest, stimulating further visit. |

**Tab. 1**: Overview of the games' typologies


**Fig. 3**: Screenshots from VeGame's games. (a) Puzzle; (b, c) RightPlace; (d, e) Details; (f, g) VisualQuiz; (h, i) Couples; (j) HistoricalQuiz; (k) Dialect; (l) GuessingGame; (m) Memory; (n) Ponte dei Sospiri; (o) ShipBattle; (p) Gondoliers; (q) Casanova.

Some games, such as dialect, visual quiz, historic quiz and couples, are multiple choice questions. This is an appealing and funny typology, since players can discuss among a small number of possible answers, and favors reasoning modes based on exclusion and evaluation of possible alternatives.
Other games – Memory, Gondolier and Casanova – can be played simultaneously by couples of teams, favoring interaction and exchange of information and experience.

Despite the proposed games typologies are relatively simple – they are to be understood and played with ease by the general public - and do not use advanced sensing and processing technologies, we believe that these games are good samples of ubiquitous computing games. They exploit the computer as a constant presence (Abowd and Mynatt, 2000) – which we embodied in the interface through the lion animated assistant (fig. 4) – that accompanies the user as a friendly travel-mate, favoring cognition development, and stimulating interaction with the real-world, in particular with the heritage, the other players and the local people.




(a) (b)

**Fig. 4**: The Leo animated assistant. (a) VeGame's introduction. (b) Help and inter-teams communication (messages and chat) services menu.

VeGame does not involve temporal constraints, since its purpose is to invite discovery and appreciation of the cultural heritage, not to promote a rush through the city. Thus, we do not consider time as a factor for rewarding players. The winner is not the team which completes the path first, but the one which completes all the games best, gaining the highest score. Most games reward accuracy and effectiveness. For instance, the result of the Puzzle game depends on the number of moved elements, and the Memory game rewards players able to remove all cards in the minimum number of steps. Through this simple policy we intend to promote a tour style which induces accurate analysis of the heritage in a pleasant and engaging fashion.

Action videogames are an exception, since in this case we reward efficiency - the ability to complete tasks within a limited time -, which is a fundamental factor for the information processing skills stimulated by videogames.

We also analyzed different game ideas at the beginning of the project. For instance, we evaluated the storyboard and some use cases of a role-playing game set in the Medieval Venice of Marco Polo. However, such a game would have required players to add a fictional layer over reality, which would have distracted them from the main target of interacting with the environment and the cultural heritage.

An important aspect of VeGame concerns communication among teams. Even in this regard we evaluated various game scenarios. We considered that frequent interaction between teams, may distract players and prevent them from an attentive field exploration of the field (e.g. answering to an urgent question/need from team B may disturb team A while engaged in visiting a church). Instead, we want inter-team communication to be functional to the main target of the game, which is an entertaining experience of the Venice's heritage. Thus, we moved most of the inter-team communication aspects outside the core of the game. We achieved this by implementing a chat and messaging system (Fig. 5b and 5c). These systems do not require real-time interaction: a message can be read after a while (e.g. after quitting a church) without loosing precious time/information nor making other teams wait. This kind of non-invasive inter-team communication is not strictly necessary to complete the game, but is important: teams can freely help each other, exchange opinions to improve their field experience, comment on their activity, exchange personal information, and use these communication channels with extreme freedom.
The only one exception to this model is represented by the Casanova, Gondoliers and Memory games. In this case couples of teams can engage to have a one-to-one match. This one-to-one modality relies on physical proximity (we use Bluetooth short range communication) and supports funny interaction and cooperation, with little trouble for players, since they have to physically agree before starting the game.


(a) (b) (c)

**Fig. 5**: Inter-team communication services. (a) The general standings of VeGame. (b) The chat (teams are represented by their icons). (c) Private messages between teams.

The first implementation of VeGame involved 8 stages, with 10 games per stage. Field tests revealed that the game was too long, taking about 8 hours. The current version covers 5 stages (S. Maria Formosa, Arsenale, S. Francesco della Vigna, S. Maria dei Miracoli, and S. Salvador), with 5 games each. The length of the game is 2 to 3 hours.

The contents for VeGame (audio and images) amount to 29 Mbytes, while the engine which manages multimedia contents and implements the games occupies 1.9 Mbytes.

## V. Conclusions

Extensive user testing has shown that the proposed educational territorial game is appealing and effective, in particular when attracting a demographic traditionally averse to pursuing cultural activities (Bellotti, Berta, De Gloria, Ferretti and Margarone, 2003).

In this paper we have focused on discussing three main kinds of game typologies (observation games, reflection games and arcade games), that we consider important to support an active and engaging experience on the player-visitor's part. We have also proposed some microgames that instantiate such categories, illustrating kind of activities they support and the specific skills they stimulate.

These microgames have been tested in the VeGame context but are general and can be applied in several distinct settings. The overall game architecture is modular and supports replication of the game in other cities and contexts. Moreover, the format can be easily adapted to other portable devices such as mobile phones.

For instance, the concept has been deployed for the Telecom Italia's Science Festival held in

Genoa in September 2003. In that case, we used the treasure-hunt schema and the proposed microgames typologies to support a careful and challenging approach to scientific themes and experiments (Bellotti, Berta, Ferretti, De Gloria and Margarone, 2004b).

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