# INTRIGUE AT THE MUSEUM: FACILITATING ENGAGEMENT AND LEARNING THROUGH A LOCATION-BASED MOBILE GAME

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## ABSTRACT

The use of portable devices to explore informal learning environments has recently exposed museums to a mobile learning (m-learning) scenario. In particular, location-based mobile applications that take into account not only a specific physical venue, but also the personal and social context can be valuable resources to enhance the visitor experience. Game-based applications that leverage on fun and social interaction to facilitate the meaning-making process represent a promising approach, since they favor both learning and entertainment activities. This paper presents the design and evaluation of "Intrigue at the museum", a location-based game addressed to children visiting Palazzo Madama-Museo Civico d'Arte Antica (Turin, Italy). This piece of work offers a methodological insight into the evaluation of engagement as a precursor of learning and provides evidence that a resource of this kind can contribute to a meaningful and enjoyable exploration of the museum by children.

## KEYWORDS

Mobile educational games, context-awareness, pervasive learning spaces, informal learning environments, museums

## 1. INTRODUCTION

The speedy development of mobile technologies is now providing free-choice informal learning environments such as museums with new opportunities in terms of communication, education, entertainment and social sharing of the experience. Through the use of context-aware mobile applications supporting the visit, museums can turn into pervasive learning environments, where the bridging of the objects of the real world with a virtual environment by means of mobile tools can contribute to the learning process (Laine et al. 2010). Additionally, the adoption of gamification techniques that integrate game elements in non-gaming systems to improve user engagement (Deterding et al. 2011) may represent an effective way to involve specific target audiences, fostering their attention and interest.

At this stage of research, the main barriers that still limit the potential of mobile learning are not technological but social, and concern the understanding of the contexts in which mobile resources are used (Brown 2010). As suggested by authors, in a mobile learning scenario mobility does not only refer to the technology but also to the learner (Vavoula and Sharples 2009): the learner not only interacts with the devices in specifically situated physical and social contexts, but these interactions generate new contexts that may ultimately affect the learning process. As a consequence, the evaluation of mobile experiences taking place in real settings can help better understand to what extent the use of mobile resources can affect the contexts in which learning takes place.

Among the questions that emerge in this field of research, an issue that partially remains unsolved is the obtrusiveness of the technology: accessing mobile educational resources during a museum visit can be distracting and ultimately induce visitors to focus more on the device itself rather than make them taking the most of their situational experience (Simarro Cabrera et al. 2005).

In this framework, how can context-aware systems support museum visits in a non-intrusive way? How can they help visitors meaningfully explore the museum environment without distracting them from the real exhibits and the social context of the visit? (Lonsdale et al. 2004)

If we accept a definition of learning as a socially mediated meaning making process (Vygotsky 1978), it is evident that the provision of experiences that do not isolate visitors but leverage instead on the social component is particularly important, both to enhance the learning potential of mobile tools and meet visitors' edutainment agendas. Beyond knowledge, a desired outcome of the experiences is fostering a positive attitude towards the exploration of the institution and museums in general.

Additionally, given that it is now commonly agreed that learning is facilitated by a state of flow and engagement experienced by the learner (Csikszentmihalyi and Hemanson 1995), the attempt of effectively providing educational leisure experiences that leverage on visitors' attitudes towards learning for fun has become relatively common (Packer 2006) and the role that mobile technologies may play in this process is worth-investigating, especially if we consider the opportunities offered by pervasive gaming.

Coherently with this framework, this paper describes and critically analyzes "Intrigue at the museum", a game-based mobile application designed for children aged 7-13 visiting Palazzo Madama-Museo Civico d'Arte Antica, an ancient art museum located in Turin (Italy). The paper is organized as follows: section 2 revises the relevant previous works; section 3 presents the structure of the system and the solutions that were developed; section 4 discusses to what extent a location-based application of this kind can represent an obstacle or an opportunity for the fostering of learning in a museum venue. Finally, section 5 identifies lessons learnt and future areas of research.

## 2. GAME-BASED PERVASIVE LEARNING SPACES IN MUSEUMS

The use of context-aware mobile games matching educational and entertainment goals has been experimented in a variety of museum contexts in recent years: with regard to context-aware applications including augmented reality features, the research questions that have been usually investigated mainly concern the efficacy of these applications in terms of (i) communicating cultural content, (ii) fostering a purposeful interaction with the objects on display and (iii) encouraging the social sharing of the experience (Thian 2012; Mannion 2012; Botturi et al. 2009). If the use of dedicated mobile applications to explore museums may definitely attract visitors' attention and represent an element of curiosity in itself, a concern raised by practitioners and scholars is that this use could also actually distract users from the real objects, the physical environment and social exchange (Scanlon et al 2005; Lonsdale et al 2004), ultimately limiting the learning potential of the experience. Additional elements of discussion are the provision of challenges that balance the skills of users (Simarro Cabrera et al. 2005) and the invention of tasks and stories that are able not only to hook but also to maintain visitors' attention: these issues are particularly relevant since they may influence visitors' level of engagement and their meaning-making process.

Case-studies show that pervasive mobile games used as learning tools in cultural venues are generally enjoyed by young participants (Thian 2012; Mannion 2012; Botturi et al. 2009; Waycott et al. 2005); however, it must be noted that even though general statements about the ability of the game to engage visitors are mentioned by authors, quantitative data are not always provided, making benchmarking difficult. If the acquisition of knowledge is usually regarded as one of the most important outcomes of mobile gaming in museums, the use of mobile tools in the museum context can be beneficial for other reasons, too. For instance, children aged 6-9 interacting with a mobile game at the British Museum manifested as unintended learning outcomes stemming from the mobile activity the improvement of kinesthetic skills: children improved their coordination with regard to the scanning of tags while progressing in the game and repeating the gestures needed to activate the tags (Mannion 2012). Another important outcome that has been underlined as particularly important by authors is the facilitation of social interaction. With regard to this aspect, the analysis conducted at the Asian Civilizations Museum pointed out that a mobile game developed to convey cultural content on Chinese terracotta warriors was effective in fostering a purposeful social interaction between parents and children (Thian 2012); other examples have also stressed the potential of mobile tools in fostering peer-to-peer interaction (Waycott et al. 2005), whereas the shared use of a 7 inch tablet among a group of teenagers was found inappropriate, instead (Mannion 2012), confirming that external conditions and the social composition of groups may influence the effectiveness of the m-learning experience.

The types of activities and approaches proposed through the applications may influence the experience, too: narrative approaches aim at emotionally engaging visitors with the story that is being told (Lombardo and Damiano 2012), whereas more constructivist and task-based experiences usually encourage self-directed

exploratory behaviors. Given that both the approaches are appreciated, the selection of the method to be followed should be tailored by developers according to the goals and the learning theories at the base of the mobile experience.

## 3. INTRIGUE AT THE MUSEUM: A LOCATION-BASED MOBILE GAME FOR CHILDREN

Coherently with a mobile-learning scenario, a location-based mobile game was developed in 2012 for Palazzo Madama-Museo Civico d'Arte Antica, a UNESCO-listed historic residence located in Turin (Italy). Particularly renowned for its baroque style, the building presents architectural evidence of the history of the town from the Roman times to the present ages and it now hosts a museum with an extensive decorative art collection: due to its complex identity, it was thus decided to develop a mobile application that could help young visitors aged 7-13 to cognitively orientate themselves in the building and encourage a positive and purposeful exploratory behavior. Due to the lack of Wi-Fi connection in the museum, it was decided to implement a vision-based system: users could access multimedia content by scanning the tags deployed in the museum environment, using the camera of a 7 inch tablet borrowed at the museum entrance.

### 3.1 Goal of the Game

"Intrigue at the museum" was conceived as a mobile application aiming at facilitating engagement in young museum visitors, an audience that can easily get annoyed or even worse, frustrated, in such a context. Particularly, the application aimed at providing a solution to the lack of focused interest and to the absence of preliminary information frequently lamented in the literature (Lonsdale et al. 2004).

The goal of the game was to provide children with a pleasant and rewarding experience, combining the exploration of the halls with the provision of activities that could not only foster the acquisition of knowledge about the exhibits but also generate a positive attitude towards the exploration of the venue and museums in general (Hooper-Greenhill 2007).

Apart from being an indicator of a pleasurable experience, engagement was considered as a desirable outcome since scholars of different disciplines agree that it is a catalyst for learning (Bitgood 2010), together with positive affection and the development of a state of flow (Csikszentmihalyi and Hermanson 1995) where the learner feels absorbed by the activity and manifests the will to keep up with it. More specially, "Intrigue at the museum" aimed at fostering affective engagement, which occurs when an experience is enjoyable. Considering that teenagers and children may visit museums neither with a deep background nor with a specific interest in the museum subject, the game was intended by developers as an element contributing to foster curiosity and situational interest, a state which is elicited precisely by certain aspects of a situation (Arnone 2011, Packer 2006).

### 3.2 Description of the Game Mechanics

"Intrigue at the museum" is a single player game and its plot is to find a thief in the museum among a set of virtual characters. Clues are given to the player as she solves riddles after scanning tags deployed in the building. Coherently with a constructivist approach, it was decided not to suggest a defined path to follow, but to allow children freely explore the museum environment, according to their interests and family's agenda.

Overall, the application was structured around two key-points: exploration and tasks. Location aware applications aim to contextualize learning activities by interaction with the surrounding environment (Patten et al 2006). Location is used to provide contents based on the position of the learner. The main benefit of this kind of applications is that they make the user explore the pervasive learning space, in our case a museum.

Besides exploration and contextual information, "Intrigue at the museum" pursues also the goal of making a visit at the museum enjoyable for the young visitors while preserving the educational contents of such an experience. Motivation is a strong lever and very important in learning activities that can take profit

of gamification principles and Task Based Learning, a learning method that relies upon practical activities to construct knowledge and develop skills (Bellotti et al 2011, Willis 1996).
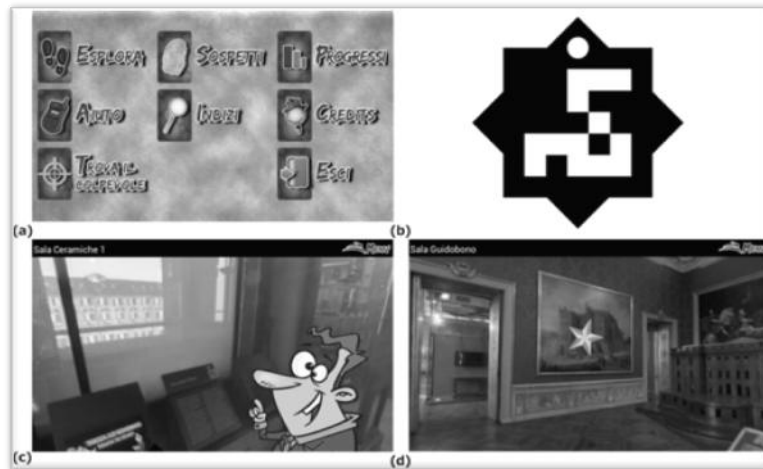


Figure 1. Game's main menu (a), marker for the location aware system (b), example of a guard of the museum (c) by touching the star, the player gets access to the mini-game (d)

The first screens of the application show the mechanics and the rules of the game. The main menu (Fig 1.a) gives access to the game statistics, the progress, the clues already collected and the list of the suspects ( Fig 2.a). This first version is only in Italian but in the future there will be also an English one. Selecting the "Explore" function (Fig. 1.a) and scanning a tag (Fig. 1.b) with the camera of the devices, a 360° view of the current room, augmented with a virtual "museum guardian" and some space clues, is presented to the player. Interacting with the character, (Fig. 1.c), the player receives information on the history of the palace or on works on display in the room. Then, the player has to solve a mini-game that is related to the knowledge she/he has gained or that involves interaction with a work of art on display in that particular zone (Fig. 1.d).



Figure 2. Intrigue at the museum: the list of suspects (a), examples of observation (Puzzle) (b), reasoning (Quiz) (c) and arcade (Clean the Dirt) (d) mini-games

These mini-games are all related to the museum master-pieces as their goal is to make the user look at them under a special perspective that makes it both interesting and fun. By solving these riddles the player earns a "clue card" containing a piece of advice on who is or who is not the thief.

The mini-games were developed following the paradigm of Task Based Learning, and can be classified into three main categories:

- Observation tasks, pushing players to carefully observe the masterpieces looking for the details needed to solve the game ( Fig 2.b)
- Reasoning tasks, where initial clues, such as temporal information, factual details and so on, have to be absorbed by players in order to solve the riddles or quizzes ( Fig 2.c)
- Arcade tasks, used to provide observation stimuli entertaining the players with animated graphics and quick interaction (Fig 2.d)

By finding the thief the player earns a "detective certificate". In order to achieve this result almost all the building has to be explored for collecting the clue cards.

# 4. EVALUATION OF THE EXPERIENCE: RESULTS AND DISCUSSION

Coherently with the theoretical framework presented in the previous sections, evaluation aimed at identifying the degree of obtrusiveness of the technology and  the level of engagement, social interaction and focused exploration facilitated by the application. Additionally, the most appreciated game mechanics were investigated too, in order to guide future developments of similar games.

Research questions were addressed following a mixed-methods approach combining quantitative and qualitative research. Following the example of other authors (Brugnoli et al. 2007), the conduction of unobtrusive observations was deemed as the most appropriate method to investigate young visitors' behaviors and identify patterns of interaction with the device, the museum environment and group members. Adults accompanying children and teens having used the application were asked to answer to a questionnaire after the visit, in order to collect a set of perceptions about the level and kind of engagement manifested by young visitors when playing with the game. Moreover, questionnaires served as a trigger to start conversations about the game with adults and young visitors. The factual acquisition of new knowledge was not measured, due to the difficulty  of identifying visitors' previous knowledge and involve them in pre and post activities to register the degree of learning occurred (Falk and Dierking 2000). However, evidence of learning was qualitatively recorded paying attention  to visitors' conversations (Naismith et al 2005).

## 4.1 Unobtrusive Observations

During the evaluation, 30 young visitors playing with the game were unobtrusively observed. Individuals were randomly selected in the museum venue among children and teenagers clearly holding a museum tablet. In order to understand and code players' behavior, key-indicators of engagement were identified among contributions focusing both on educational computer games and museum learning (Bitgood 2010). Starting from visible characteristics of engagement, a list of verbal and nonverbal indicators was elaborated.

Results pointed out that 83% of young players revealed one or more signals of engagement, with the most frequent being hunting tags in the museum, walking fast, pointing at tags while saying aloud sentences such as: *"Look! There's another one (i.e. tag) over there!"*; *"Let's go and find another one!"*. A positive and purposeful interaction with the works of art on display, detected through the monitoring of behaviors, gestures and conversations, was registered for 56% of the players observed. In the 20% of the individuals a non-desirable behavior was recorded instead: children were so concentrated on the game that barely paid attention to the museum environment, suggesting that technology was highly intrusive for this sample of users. The rest 24% did not show externally detectable signals of purposeful interaction with the works of art on display instead, even though a meaningful interaction cannot be excluded. The analysis of verbal and nonverbal indicators also pointed out that interaction among young players and adult companions or peers was registered at least for 73% of the sample observed. Interaction was identified both through the detection of collaborative behaviors (i.e. adults or peers helping children to solve specific tasks; adult companions gazing at the tablet to follow their children's activities; physical proximity between children and other members of the group) and conversations such as: *"You have to match these items"*; *"We need to find this. Let's get closer, so that we can look better at the painting"*. The social sharing of the experience was particularly intense among peers: in fact, collaboration was identified in 10 of the 12 groups including more than one child/teenager; apart from behavioral patterns of collaboration similar to the ones described above, sentences such as the following represent evidence of purposeful collaboration: *"Come here, I will show you how to do it"*; *"Now it's your turn"*; *"I think that we'd better do this"; "Why don't we do this?"*. The data

have thus pointed out that the mobile game was effective in fostering conversations and collaboration both between adults and children and couple or small groups of young participants. Even though it is not possible to state to what extent the engagement excited by the gaming experience was effective in fostering learning, evaluators took notes about players' conversations, providing evidence of the learning potential of the mobile game. For instance, a boy reported to his mother that *"All the female figures painted on the ceiling have the same expression and represent the Royal Lady"*, which is a piece of information that could be gained only through the playing experience.

## 4.2 Questionnaires

During the experiment, 81 questionnaires filled in by adults visiting the museum with the children who played the game were collected. Data referring to the sex of young players report similar percentages for boys (46%) and girls (54%). The age of participants spanned between 6 and 16 years, registering a peak for children aged 10 (Fig. 3.a).

In order to have an insight of the emotional engagement manifested by young players, adult companions were asked to define the feelings of children when playing with the game; a list of adjectives was provided, but adults had the chance to write any other adjective they felt appropriate. Results show that selected adjectives had almost exclusively a positive connotation (Fig. 3.b), indicating the effectiveness of the game in fostering a positive emotional engagement towards the experience. The fact that the gaming experience was mainly perceived as positive and effortless may indicate that "Intrigue at the museum" was effective in balancing challenges and participants' skills (Csikszentmihalyi and Hemanson 1995), suggesting that the design of the game was appropriate for the target audience. Opinions verbally expressed by children and adults when commenting on their answers underline the importance of carefully design reliable game mechanics that meet visitors' expectations: in fact, disappointment was mainly due to the presence of non-active tags and to the inability of successfully scanning tags placed in dark spots, resulting in a lack of access to new challenges. These results seem to indicate that once exposed to a mobile learning scenario, players adapt to the system (Scanlon et al 2005) and expect to explore and learn.

According to adults' opinions, the aspects of the game young visitors mostly appreciated were the solving of challenges and the tag-hunting (Fig. 3.c). A smaller percentage of participants mentioned the general aim of the game (i.e. finding the thief) as particularly valued, whereas just a minority stated that children and teens did appreciate information concerning the history of the palace and the museum collections. These results indicate that the game mechanics were effective in facilitating an enjoyable exploration of the museum as a physical context and that the design of puzzles, quiz and riddles that leveraged on players' sense of self-pursuit was an element of success, too. These results also identify areas of future improvement in the story-line and in the way cultural content is conveyed: it should be more deeply integrated in the game mechanics, in order to maximize the learning experience young visitors are unconsciously exposed to through m-learning tools (Schaller 2011).

Data collected with the questionnaires confirmed that children and teens mainly played with adult companions (46%) and - if present- peers (31%). An in-depth analysis of social interaction patterns pointed out that young visitors mostly shared with adult companions their feelings, the description of the challenges and the cultural content provided. Children and teens asked for adults' help especially for answering to quizzes (85%); other riddles were solved with a lower degree of external help (62%), instead. This suggests that quizzes concerning cultural content were felt as more challenging and it forces a reflection about how effectively communicating cultural content during the gaming experience. Since the game was developed to foster a meaningful and deep exploration of the museum context by players, the amount of time spent by participants was also registered.

On the average, people spent 107 minutes playing, being 41 minutes the minimum and 236 minutes the maximum. Considering that previous studies pointed out that the average permanence inside the museum manifested by visitors was 80 minutes, it can also be postulated that the game actively contributed in stimulating a longer permanence inside the museum.

In order to test this hypothesis, further studies including control groups and focusing on the amount of time specifically spent by families inside the museum will be needed. However, comments provided by adult companions while answering to the questionnaires further support this hypothesis: *"We've never been in a museum for so long!"* (mother of a 9 years old girl); *"We came to the museum to visit the panoramic tower,*

*but then we've started to use the mobile game and we've explored the whole museum"* (father of a 10 years old girl). Other studies have reported a similar phenomenon (Sharples et al 2007) and have stressed the correlation between the time spent at the museum and the degree of learning occurring (Sandifer 1997).
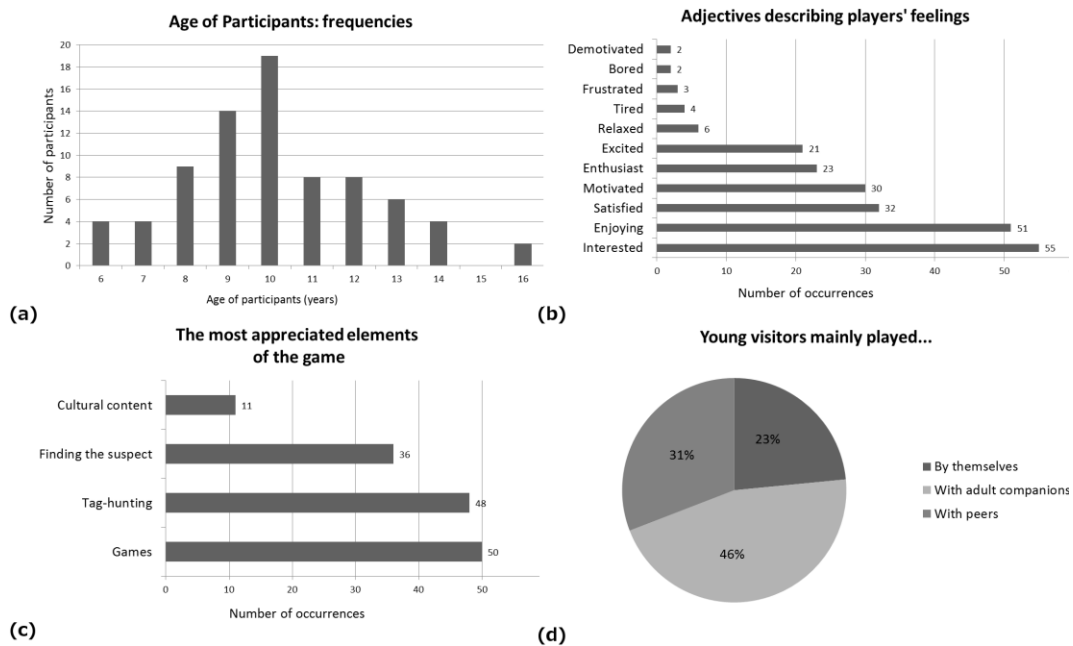


Figure 3. Questionnaires results: age of participants (a), players feelings about the game (b), game appreciation (c), social interaction (d)

While not explicitly measured by the questionnaires, the observations carried out during the evaluation show that only a fraction of the young visitors remained stuck to the device screen, while most of them clearly showed a positive attitude to the surrounding environment, manifesting curiosity and interest towards the exhibits: *"Look! How strange is this object!"*, *"These medallions look very similar, but they are all different!"*.

# 5. CONCLUSION

This paper has shown that location-based mobile games may represent a valuable m-learning resource in the museum scenario, since a careful design of the proposed activities can limit the obtrusiveness of the technology and facilitate engagement, a precursor of learning. Given these results, a future step of research will be measuring the acquisition of factual knowledge, asking children to participate to pre and post visit tests. Nevertheless, the positive feelings manifested by participants during the gaming experience and the significant amount of time spent at the museum when playing suggest that the use of the application was successful to achieve a desired learning outcome: making children want to explore the museum environment and fostering a positive attitude towards the exploration itself. In order to take into deeper consideration the mobility of the learner, future areas of development could be represented by providing connectivity to the devices, so that some elements of the gaming experience could be shared through social media platforms and translated to the everyday life of the learners. Finally, adding the game a higher degree of control from the user could represent another possible work direction, making the application even more reacting to visitors' choices and resulting in a more personalized experience.

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