

# Location-based Mobile Games for a house museum. Insights from an educational design activity

*Location-based Mobile Games para una casa museo. Reflexiones sobre una actividad educativa de diseño*

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DOI:

*Polimi - Politecnico di Milano*

*Polimi - Politecnico di Milano*

Retirado de: <http://convergencias.esart.ipcb.pt>

**ABSTRACT:** The paper discusses a formal didactic activity in a higher education context, which brought to the design, development, and testing of thirteen Location-Based Mobile Games (LBMGs) for the Bagatti Valsecchi House Museum. The activity involved BSc Design students in developing and testing interactive solutions aimed at reaching out to the "under 35" community of the museum with engaging and entertaining experiences. For this purpose, the stakeholder group of the museum experts was also involved in co-designing the solutions. On the one hand, this study focuses on the beneficial approach of involving Design students in the multiple roles of designer, player/visitor, and target audience. On the other hand, it looks at those aspects that may turn LBMGs into a means for engaging and entertaining museum visitors' experiences. We focus on four LBMGs (out of thirteen) that the museum selected to be tested with their younger community, highlighting those elements that emerged as particularly relevant for enhancing visitors' engagement and motivations. In this regard, three aspects stand out as the most impacting: (i) the benefits of a design approach based on the early involvement of both experts (the museum) and the target audience (students themselves); (ii) an intelligent orchestration of narratives and game mechanics, specifically designed to leverage the fascinating museum space, and (iii) the ability of such games to stimulate social engagement.

**KEYWORDS:** Location-Based Mobile Games, Cultural Heritage, Audience Engagement, Co-design, Narratives, Game mechanics, Open Source

**RESUMEN:** El artículo analiza una actividad didáctica formal en un contexto de educación superior, que llevó al diseño, desarrollo y prueba de trece Location-Based Mobile Games (LBMGs) para la Casa Museo Bagatti Valsecchi. La actividad implicó a los estudiantes de la licenciatura de diseño en el desarrollo y prueba de soluciones interactivas destinadas a llegar a la comunidad de menores de 35 años del museo con experiencias atractivas y entretenidas. Para ello, el grupo de expertos del museo también participó en el codiseño de las soluciones. Por un lado, este estudio se centra en el beneficioso enfoque de involucrar a los estudiantes de diseño en los múltiples papeles de diseñador, jugador/visitante y

público objetivo. Por otro lado, analiza los aspectos que pueden convertir a los LBMG en un medio para atraer y entretener las experiencias de los visitantes del museo. Nos centramos en cuatro LBMG (de un total de trece) que el museo seleccionó para ser probados con su comunidad más joven, destacando aquellos elementos que surgieron como especialmente relevantes para mejorar el compromiso y las motivaciones de los visitantes. En este sentido, tres aspectos destacan como los más impactantes: (i) los beneficios de un enfoque de diseño basado en la participación temprana tanto de los expertos (el museo) como del público objetivo (los propios estudiantes); (ii) una orquestación inteligente de las narrativas y la mecánica del juego, diseñada específicamente para aprovechar el fascinante espacio del museo, y (iii) la capacidad de estos juegos para estimular el compromiso social.

**PALABRAS-CLAVE:** Location-Based Mobile Games, Patrimonio Cultural, Participación del público, Co-design, Narrativas, Mecánicas de juego, Open Source

## 1. Introduction

The paper reports on a formal education activity that created thirteen location-based mobile games (LBMGs henceforth) addressed to a younger audience. The study involved a small Milanese house museum, the Bagatti Valsecchi Museum (shortened to BaVa, [museobagattivalsecchi.org](http://museobagattivalsecchi.org)), located right in the Milan Fashion District, and BSc students in Design from the School of Design of Politecnico di Milano. The collaboration aimed to exploit the museum's narrative potential, reaching out to visitors under 35, a young and vibrant audience not fully engaged at the moment but very relevant to the museum.

The study's objective is to demonstrate how (i) the use of interactive media such as LBMGs, commonly used by that specific audience, and (ii) the direct involvement of the same target audience in the role of designers, may result in engaging and entertaining experiences for museum visitors. At the same time, it presents (iii) what we consider a virtuous practice for a design course, as the fact of actively involving students in all the phases of developing a working interactive system.

The focus is not on technological innovation but instead on how standard technology can be exploited to create visitor experiences that mix engaging narratives with catchy game mechanics, leveraging the potentials of being located.

### 1.1. LBMGs in Cultural Heritage: state of the art and potentialities

The story of mobile technology in the cultural context has a long and established history dating back to the '50s (Tallon & Walker, 2008). Nevertheless, over the years, different and ever new technologies substituted the previous ones to perform the same functionality with brand new devices (Spallazzo, 2012). Despite technological advancements, the dominant visitor experience supported by digital technologies strongly relied on the audioguide paradigm. Different devices provide museums and cultural institutions patrons with passive consumption of multimedia contents to be, more or less automatically, triggered at several points of interest across the exhibition (Proctor, 2010). Alongside, games emerged as a novel, involving way to engage users with cultural contents aiming at capturing that part of cultural visitors keen to learn while having fun and personalised experience (Beale, 2011). Location-based mobile games (LBMGs), namely mobile games that leverage players' position, have been increasingly explored for achieving immersive and engaging experiences in the cultural heritage field (Malegiannaki & Daradoumis, 2017) while providing contextual information.

Seminal works on LBMGs for cultural purposes have been conducted far before the widespread diffusion of contemporary smartphones – *Environmental Detectives* (Klopfer & Squire, 2008), and *Frequency 1551* (Huizenga et al., 2009). Over the years, several research groups (e.g. Mixed Reality Lab, MIT Scheller Teacher Education Program, Waag Society), media artists (e.g. Blast Theory), and finally museums developed and tested a significant number of LBMGs. Nevertheless, most of these experiences remained in the prototype stage, and very few became commercial products daily available to visitors (Malegiannaki & Daradoumis, 2017; Spallazzo, 2012). On the contrary, video games, thus games to be played exclusively on a screen, flourished in museums worldwide, to the point that some big institutions staffed themselves specifically for their in-house development (e.g. Tate, Smithsonian, MoMA).

LBMGs have not been largely explored and offer significant room for possible experimentation. Although the key role of narrative and fictional worlds as important drivers able to motivate, grab and immerse players is well recognized, such a potential seems not yet properly exploited in LBMGs. Especially in the CH field, promising advantages may spur from merging powerful narratives with the potentialities of contextual experiences that continuously mix the physical and digital realms. The potentials of LBMGs for cultural purposes rely on their ability to foster playfulness (Sicart, 2014) and mix engaging play activities with the richness of the contingent world. This condition can trigger active engagement, motivation, and situated learning (Lave & Wenger, 1991). LBMGs can indeed embed the acquisition of knowledge in authentic environments, a potential that has also been highlighted by Klopfer (Klopfer, 2008) as essential to augment the learning experience, be it in a formal or informal context. The role of the context is even more critical for those places that preserve a rich history made of objects and people, as in the case of the Bagatti Valsecchi Museum, the venue of our experimentation.

### 1.2. The setting: Bagatti Valsecchi Museum

The Bagatti Valsecchi House Museum results from Fausto and Giuseppe Bagatti Valsecchi's creative minds, an ambitious project that took the Renaissance as a reference. Mixing authentic pieces from that period and details personally designed by the brothers, the house appears as a middle ground between the collection and the personal aspiration. Still, we must not forget that, primarily, it was a context of lived life: the Bagatti Valsecchi family inhabited the house until 1974. After that date, the house was restored to the original condition in which the creative ancestors left it and transformed into a contemporary museum. A small, precious house museum frozen in the past, and, eventually, not so effective in communicating its uniqueness. The rich amount of stories and experiences of living lives contained in the house are worthy of being unveiled.

The museum is today willing to enhance the narrative potential of the place, making evident what we can call *genius loci*, the spirit of the site. Making visitors perceive the museums' rooms as something more than a simple collection of objects on the show has been the driving force of the collaboration between the museum staff and Politecnico di Milano, from which the experience here discussed took his cue. The critical point is that the museum is nowadays particularly

attractive only for an older target group, and it is willing to engage young people with a rich schedule of initiatives. In this context, the community *Speechati*, composed of people under 35, has been created to transform the museum into a living space for culturally relevant social engagement in the evening hours.

Given these ambitious aims, we decided to address the brief by involving young designers, so the same target audience, in the design and implementation of LBMGs.

## 2. Educational context and methodological approach

From 2013 to 2017, we conducted a research-through-design activity aimed at exploring the potentialities, constraints, and implications of LBMGs as communication means able to convey values and stimulate players towards meaning-making (Spallazzo & Mariani, 2018). Our study took place in a formal education setting, in the context of the School of Design, Politecnico di Milano, within the elective course “Augmented Reality and Mobile Experience”. Collecting students from the four courses of the BSc in Design (Product, Interior, Communication, and Fashion), the course aimed at providing the basics of designing mobile UX in the complex interplay of hybrid reality. Whilst the first four years focused on LBMGs addressing societal issues, in the last year of experimentation (2017) we drew our attention to exploring how such games could be used within the cultural heritage field, and museums in particular (Malegiannaki & Daradoumis, 2017). Moreover, considering the BaVa desire to reach out to a broader audience, like that of under 35, we opted for addressing the activity adopting a co-design approach, actively involving end-users and cultural heritage professionals through the different stages of the design process (Ciolfi et al., 2016; Vargo & Lusch, 2004). Therefore, starting from analysing BaVa’s needs, competencies and experiences, the course became a space where part of the audience (designers under 35) designed in constant interaction with the stakeholder (museum staff). The intent was to encourage designers to conceive LBMGs as entertaining solutions for visiting the museum based on a wise union of intriguing narratives and challenging mechanics.

The course was structured in four main consecutive steps: (1) design brief, (2) concept development, (3) prototype creation, and (4) testing with peers and end-users. The design brief (1) from Bagatti Valsecchi museum drafted the desire to disclose stories about the history of the house to the visitors, making its story and that of its past inhabitants emerge from the collection. Accordingly, students were encouraged to get acquainted with the museum and its history, while establishing a connection with its staff, as paramount experts.

Relying on the information collected by mixing interaction with the museum personnel and desk research, each design team developed an original concept (2), identifying significant aspects to be told. Such elements are on the ground of the definition of fictional worlds and narratives and game mechanics, then implemented into playable LBMGs (3).

In such a frame, we asked designers in training to reflect on what it means to learn by playing as a way for grasping knowledge on the topics covered by games (Bogost, 2007) while having fun (Koster, 2005). An approach that capitalises on their being both designers and part of the potential audience for which the game experience is intended. The LBMGs obtained were (4) tested in two different stages: first with peers, then with end-users. Developing and testing prototypes is indeed a source of knowledge with a twofold aim: verifying that the games work in terms of game mechanics and that the knowledge meant to be conveyed effectively emerges as a result of the player’s interpretation. The first step was accomplished before going public, involving students as players of at least two of the 13 working prototypes. In doing so, it started the iterative process of tests and data analysis, which led to the prototype implementation. During the playtest four LBMGs (*Next, please; The fire of eternity; The crime; Wreck this BaVa*) were selected, in accordance with the museum staff, to be played again in the museum during a public event specifically addressed to the under-35 community of the museum, *Speechati*.

### 2.1. Technical limitations and design implications

Given the above-described approach that strongly relies on working prototypes and an iterative process of tests and correction, it was mandatory to find support tools to allow students, with a design background and almost no programming skills, to achieve a working system.

In the previous editions of the course, the students used and tested mainly two tools: *ARIS* by Field Day, and the CMS of the *Mobile Learning Academy* by *7scenes*. They demonstrated to be useful and powerful tools to create LBMGs and narrative location-based experiences in an educational setting (Ceconello et al., 2015; Mariani & Spallazzo, 2016). But they also caused limits in the creativity of designers: defined game mechanics, as well as rigid templates and widgets, influenced the design possibilities. As a consequence, since 2016, we looked at trade-off solutions between ease of programming and expressive possibilities. We firstly identified *Taleblazer*, developed in the context of the MIT Teacher Education Program (Medlock-Walton, 2012), then discarded in favour of MIT *App Inventor*, upon which it is based. Born as an academic project, MIT *App Inventor* is a drag-and-drop visual programming tool for building functional mobile apps running on Android devices. Focusing on the app programming logic rather than on the coding language and its syntax empowers those who don’t have a programming background to design a working application (Pokress & Veiga, 2013).

During the projects’ development, *App Inventor* demonstrated to be valuable for supporting the different game concepts. Nevertheless, it showed some limitations. The most obvious restriction is the possibility to deploy the working app on Android OS only, a condition that prevented almost half of the students from testing the prototype on their mobile device. Furthermore, *App Inventor* does not allow perfect management of the app GUI – especially for demanding designers – and it poorly supports the interface responsiveness to a variety of devices and screen resolutions.

Lastly, developing the games, it emerged the need of including and consequently prototyping AR experiences. Some students used systems relying on *App Inventor* but integrating AR functionality, such as *Vedils*. Others complemented the game by employing software as *HP Reveal* or *Blippar*.

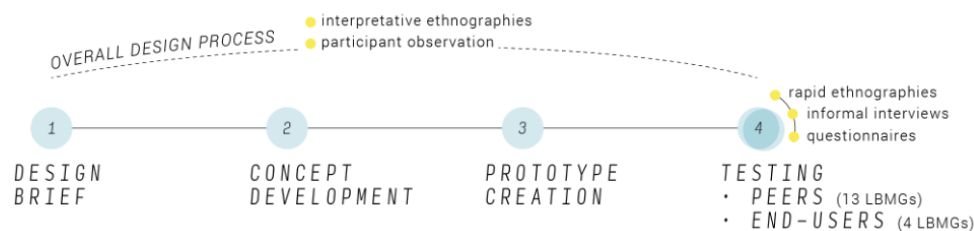
### 2.2. Assessment strategy

The experimentation involved a total of 55 students (f:38, m:17) with different design backgrounds, split into 13 groups of 4 to 5 people. Considering the objective of entertaining the museum visitors, transmitting information and knowledge in the meanwhile, our research aim was twofold:

1. Exploring **how narrative and mechanics** can be designed for developing working LBMG aimed at enhancing cultural heritage while engaging visitors in compelling and entertaining experiences (Spallazzo & Mariani, 2018);
2. Verifying **how the games developed were perceived** by the end-users.

To answer these objectives, we analysed the process of making LBMGs and the games themselves using mixed methods for collecting multiple forms of primary data and conducting triangulation with the literature (Rothbauer, 2008). The game design followed a co-design approach, capitalizing on the specific knowledge that each participant could bring in. The museum staff as contents experts, and students as in-training designers matching the age group of the end-users.

Fig. 1 – The design process and the methods applied to collect data throughout it



During the iterative design cycles, we performed three-month interpretive ethnography and participant observation to assess the overall process, looking at each LBMG as a case study. Questionnaires were employed to gauge the various interplays these games triggered, especially their ability to entertain, engage, communicate and inform. Data collected provided a deep understanding on crucial aspects: from the interaction with the museum environment and objects to the one with the stories of who inhabited it, up to the one with other visitors. In parallel, rapid ethnographies and informal interviews with players served to complement the results from questionnaires.

On a closing day, the museum hosted a playtest in which each of the 13 LBMGs designed was tested in a peer evaluation activity. The schedule was structured so that each game was played by two design teams in subsequent playtests, resulting in 26 game sessions and 104 post-experience questionnaires enquiring the game playability and their communicative effectiveness, specifically exploring players' interpretation of the games. During the playtest, four LBMGs were selected, undergoing a further iterative process of improvement in view of the aperitif evening during which they were staged for the museum under 35 community. The event gathered about 100 visitors. Nearly half of them filled our evaluation form, resulting in additional 53 questionnaires (25 for *The fire of eternity*; 12 for *The crime*; 9 for *Next, please* and 7 for *Wreck this BaVa*), and several informal interviews.

Fig. 2 – Students preparing for the playtest session in the grand salon of Bagatti Valsecchi Museum



### 3. LBMGs staging at BaVa: critical results

The educational activity resulted in 13 working LBMGs aimed at telling stories about the house and its assets. They all share a creative use of technologies already employed in the cultural heritage field, proposing a different approach. Rather than being tools for in-depth analysis or consultation, they become a way to access content pointing visitor's attention to unexpected details or presenting facts from unusual standpoints. Each original concept developed belonged to a different game genre, and making more or less extensive use of narratives explored different social configurations. We synthesise here the results achieved, taking as reference the four LBMGs chosen by the museum for the public event. In the following, we underline those elements that, according to the results of the questionnaires and insights gained in the interviews, contributed to making them engaging and pleasurable.

#### 3.1. The fire of eternity. Compelling narrative and AR

The first game revolves around a fictional world so captivating and well developed to become the pivot of the whole playful activity, favouring engagement and immersion. *The fire of eternity – Il fuoco dell'eternità* (Bellosi et al., 2017) tells of Fausto and Giuseppe, brothers and skilled collectors. One day they received a shady merchant who presented the two with a contract in which he promised the eternal immutability of their beloved home in exchange for its custody. After signing the agreement, the house came to life, and the souls of Fausto and Giuseppe got trapped in it, and there they still are, waiting for a brave person able to break the spell. Players who enter the museum are asked to put themselves to the test in this mission, interrogate the objects, and finally free the two trapped souls.

The story involved players in an augmented reality LBMG based on interviews with objects and mini-games. The mainstay of the game relies on its ability to create an engaging game narrative, well situated in the space, and digitally attached to the museum assets, their cultural value, and significance. *The fire of eternity* was the most played game during the public event. The questionnaires' results underline that players mostly appreciated its fictional world, defined as "compelling and thrilling, and, fortunately, not too easy". They also highlight the role of AR that "allows to plunge into the narrative", with "animations of paintings that are perfect, and create a whimsical and involving atmosphere". Players also appreciated the graphic and the ability of the game "to foster a novel visiting approach", that "allows to look at the museum from a different and stimulating standpoint".

### 3.2. The Crime. Educational and detail-oriented

Inspired by board games such as *Cluedo*, designers exploited game mechanics as interviews, mysteries and riddles that make the game engaging and the tangible and intangible heritage emerge while unfolding an intriguing story. In *The Crime – Il Misfatto* (Banfi et al., 2017), the players are given a booklet with a request for help. The ghosts of Fausto and Giuseppe Bagatti Valsecchi are invoking someone's assistance for discovering the culprit who replaced an object from their precious collection with a fake. To investigate the facts of the past, they must use a mobile device that awakens and permits them to interrogate the ghosts of the six suspects still wandering in the house. In doing so, the mobile becomes the access point to resources otherwise not visible (Spallazzo & Mariani, 2020). Some game mechanics, such as interviewing objects and ghosts, are similar to the previous game. But the focus is here on the museum assets rather than the people who inhabited it since players have to uncover the culprit by looking for discrepancies in suspects' description of the objects and understanding clues.

In *The Crime*, designers emphasised the educational dimension, focusing players' attention on often unnoticed details. Players reported that the game made them discover and remember the museum's assets and rooms. Furthermore, they considered it fun and "a new enjoyable way to experience the museum, paying attention to details".

Fig.3 – A group of students scanning a QR code to start testing the game *The Crime* (left), and students introducing players to the game *Next, please* (right)



### 3.3. Next, please. Characters and game mechanics

The game *Next, please – Avanti il prossimo* (Brambilla et al., 2017) is designed as a quiz game, based on dialogues between the players and some of the characters who lived in the house. In the game, the current heir of the family, Pier Fausto Bagatti Valsecchi, is looking for a new guardian for the house, and the players are in the role of interviewees for having the job. Each dialogue conveys notions about the habits and traditions of the time and reveals the different personalities of those who once lived in the house.

The narrative sustains game mechanics chosen to make the game fast, enjoyable, and replayable. The game concept revolved around two main aims: (i) to create vivid and plausible characters and (ii) to allow players to return to the museum several times to play a game always different. Accordingly, the designers closely cooperated with the museum staff to collect extensive documentation on the house service personnel and build the characters. They put a characters' rotation mechanism in place to favour repeated visits: every day, characters shift, creating an ever-changing experience for visitors. By mainly focusing on characters and game mechanics, designers were able to design a "dynamic and enjoyable" game, perceived as "very innovative and involving" with "very ironic characters" "changing every day".

### 3.4. Wreck this BaVa. Social engagement and fun

The game *Wreck this BaVa* (Guidi et al., 2017) is inspired by the *Wreck This Journal*, a pocket-sized diary that offers a series of tasks that test the reader's skills and creativity. It is substantially a booklet that allows visitors to experience a different and unusual visit within and outside the museum. By exploiting physical and digital interactions, this playful activity requires visitors to draw, read stories, complete a series of puzzles, and perform mobile-based actions such as activating augmented reality contents. Players are also encouraged to use social networks to share photos, images and messages, thus increasing the visibility of the museum. Finally, the interaction activities allow the journal to be expedient to make the user interact with other visitors while they are in the museum.

Instead of looking for cultural relevance by building coherent fictional stories, *Wreck this BaVa* uses the museum assets in a bold, sometimes shameless, way, as pure triggers of playful activities. Examples are taking a selfie with the painting, or activating AR mini-game over artworks. The mainstay of this location-based activity relies on its ability to trigger playful and enjoyable activities mainly aimed at having fun with friends. Comments from players reinforce the potential of the game for social engagement. They underline that the game is "enjoyable with friends" and "facilitates social engagement". Furthermore, the game is described as "an opportunity to get around the museum far and wide" and come back for repeated visits, since "the experience invites visiting the museum several times, to test new games and augmented features". It is also noticeable the designers' will to enhance the museum's outreach, by asking players to perform fun performances and tasks across the city, raising the museum's visibility and "advertising" its activities.

Fig. 4 – Students performing one of the playful activities proposed by the game *Wreck this BaVa*



## 4. Discussion: the roles of engagement and narrative

The students were asked to imagine and design experiences in the BaVa museum telling the story of the museum and its contents while encouraging players to interact with the space, its elements and, sometimes, other visitors. Beyond each game's specific approach, the study highlights a general appreciation of the games, defined by players as captivating and fun, entertaining and unveiling unknown stories and highlighting hidden assets. We relate these achievements to three main elements: (i) the design approach based on the early involvement of both experts (the museum) and the target audience (the students themselves); (ii) a good orchestration of narratives and game mechanics, specifically designed to leverage the fascinating museum space and (iii) the ability of such games to stimulate social engagement. In the following, we discuss these three main issues.

### 4.1. Involving experts and audience in the creation process

A recurrent issue of discussion in the cultural heritage field regards the frequent gap between the audience desiderata in terms of engagement and how museums deliver their contents (Sheng & Chen, 2012). To better cope with this matter, we structured the course and its design steps favouring the constant involvement of the museum experts. An approach that encouraged proficuous discussions and positively contributed to crafting captivating game worlds where fictional or semi-fictional stories were portrayed. The activity also nurtured the definition of game mechanics able to engage visitors in challenging gameplays, keeping coherence and consistency along the way. Moreover, it produced insights that may facilitate technology design and adoption for this domain. Significant benefits in terms of understanding of needs and expectations to meet came from students themselves. Because of their age and interest in the design field, they constituted a segment of the target audience the museum aimed to reach. One specific advantage regarded students' insights into how technology could be used to make visits and explorations of the museum engaging and entertaining, being instructive in the meanwhile. Throughout the course, we noticed that this peculiar twofold role of (i) designers and (ii) expected audience largely contributed to framing the existing gap between solutions for visiting museums and games as entertaining means, properly mixing the educational aim with the entertaining one. This overlapping favoured the design of games able to answer the needs and expectations of a varied target under-35, willing to get engaged while grasping knowledge.

### 4.2. A challenging interplay: bounding narratives and locations

The LBMGs, objects of this study, were designed to sharply bridge the physical and digital dimensions, involving visitors in fascinating adventures. The aim was to obtain meaningful play experiences in terms of gaming activity rich in possibilities and choices, and meaning-making resulting from carrying out activities in the museum context while playing. Aligned with the findings from the game studies literature, the experimentation confirmed several elements served as a boundary between the physical and digital spheres. The strategy adopted was to encourage designers to operate on the museum contents, enhancing them. In particular, they were invited to leverage the value of inherent stories and objects, embedding them in charming and meaningful storyworlds. In designing culturally relevant games, fundamental was effectively bounding contextual information with evolving narratives and gameplays. From the game objects, the environment, and people's position in space, to narrative and game mechanics, every element entailed specific reasoning concerning how to significantly design their role and interaction coherently with the museum values, the fictional world, and the gameplay. Recognizing that narrative plays a pivotal role when communicating context, it became evident that mixing engagement and situated learning requires overcoming a straightforward, solution-oriented attitude favoring a more strategic approach. By making extensive use of curiosities about the Bagatti Valsecchi extended family, assets, and house personnel, designers developed unique fictional worlds.

### 4.3. Prompting social engagement

Since the design brief definition, the purpose beyond designing these LBMGs was that they should be played in the late afternoons or evenings, as an alternative, additional way to experience the house museums, without affecting the typical modalities of visiting. Furthermore, we asked designers not to substitute traditional museum technologies like apps and audio guides but rather to develop different solutions to further prompt social engagement within groups.

Indeed, one of the main features that make LBMGs engaging is their ability to favour and encourage social interaction (Spallazzo & Mariani, 2018). In the museum context, games have proved to be an essential means for promoting and inducing sociality. A condition that clearly emerged during the aperitif night. While those who attended the event with friends found activities to be performed as a group, those who showed up alone were able to join others since the games were designed to be enjoyed by several people together.

Among the others, *Wreck this BaVa* stood as particularly provocative on the sociality issue, with some activities aimed at having fun with friends, and others intended for encouraging social engagement with strangers, inside and outside the museum. Moreover, the game goes further, making players participate in activities that require sharing content on their social networks. On the one hand, the games transformed the cultural visit into an occasion for reinforcing strong social ties (Granovetter, 1983). On the other hand, they encouraged direct social engagement with strangers, both in the museum and outside the museum, and to share the experience on social networks. By doing so, they favoured the emergence of weak social ties (Granovetter, 1983) besides the strong ones, using the museum collection as a trigger.

## 5. Conclusions

The article reports a study conducted in the context of a formal education activity that resulted in thirteen location-based mobile games for a small house museum, addressed to a young and young-adult audience.

During the experimentation and observation, we noticed that the effective early engagement of stakeholders in the design process could bring significant benefits, substantially informing and driving the design activities. Especially the involvement of the museum staff as experts while having a partial but significant overlap between the intended target audience and the designers themselves provided relevant insights, understanding, and awareness. These results align with previous studies that analysed the benefits of co-design in the cultural context (Ciolfi et al., 2016; Vargo & Lusch, 2004). As a consequence, this very interplay among stakeholders impacted the overall design activities: from the concept to the testing, assessment and consequent implementation, the discussion and interaction with the end-users gave first-hand understanding that inspired fascinating game-design trajectories.

Moreover, students especially capitalised on their being at the meanwhile part of the desired target audience for which the game experience is intended and the designers of such games.

In particular, designers in training were challenged to reflect on the possibilities and implications of crafting LBMGs which are set in a precise space, of which they tell and convey values, and therefore meant to be situated in the complex spot where learning and entertainment encounter (Koster, 2005; Mariani & Spallazzo, 2016; Malegiannaki & Daradoumis, 2017). At this challenging but inspiring intersection, they were asked to design captivating LBMGs to provide knowledge on cultural heritage, enhancing and valorising the uniqueness of the Bagatti Valsecchi Museum.

The study effectively showed that a specific interactive typology of games as LBMGs, usually played by niches of users (Ceconello et al., 2015; Mariani & Spallazzo, 2016), can be opened up for meaningful purposes, as engaging established and new audiences in game-based experiences telling stories and values of cultural heritage. A crucial role is played by the rhetorics of expression that can be wisely and conscientiously embedded in games. An established knowledge on the communicative capacity of specific typology of games (Bogost, 2007) was extended to LBMGs, and hence appropriated for the scope, systematised and operationalised. Among the main results achieved, the experimentation provided us with a fundamental, better understanding of how to orchestrate narratives and mechanics for obtaining engaging and entertaining experiences for museum visitors. It emerged that when LBMGs are designed building their narratives and game mechanics as a whole, the values and fascinating spaces of the museum can be enhanced at the most. However, to reach such results and evidence-based understanding, it was strictly necessary to involve students in a complete design process. Only by going through all the phases of developing a working interactive system was it possible to have a real understanding of the range of possibilities, implications, and results of the practice. This remarks the focus on grasping knowledge on methods and approaches to design LBMGs as experiences able to engage the visitors in captivating, engaging narratives with catchy game mechanics, exploiting standard and accessible technologies within easy reach of museums, rather than advanced and expensive ones, more difficult to manage and operate.

The study further demonstrated the potential of LBMGs in prompting social engagement in a cultural milieu, involving players in activities that must be shared with friends and acquaintances, reinforcing strong social ties. At the same time, they also promoted the involvement of strangers through actions specifically designed to favour the establishment of weak social ties and direct social engagement with unknown people (Granovetter, 1983). This capability appeared clearly during the event that collected more than 100 visitors from the museum's under-35 community, involved in testing four LBMGs, playing, knowing something new about the collection and ultimately engaging socially with people not known before.

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**Reference According to APA Style, 5th edition:**

& Spallazzo, D. Mariani, I. (2021) Location-based Mobile Games for a house museum. Insights from an educational design activity. *Convergências - Revista de Investigação e Ensino das Artes*, VOL XIV (27)