Malegiannaki, I. and Daradoumis, T. (2017). Analyzing the educational design, use and effect of spatial games for cultural heritage: a Literature Review. *Computers & Education*, 108 (May 2017), 1-10. ISSN: 0360-1315. Elsevier, doi: 10.1016/j.compedu.2017.01.007.

Analyzing the educational design, use and effect of spatial games for cultural heritage: a Literature Review

ABSTRACT

Integrating game-based approaches with learning constitutes a prevailing trend in education and training, applied in several domains, one of which is cultural heritage. The present paper attempts a literature review of such approaches developed in the cultural domain. It analyzes 34 games which intend to enable a physical or virtual interaction with a cultural place and its objects. The article focuses, first, on the game genres and game plots used to cope with cultural content and then it investigates the contexts of use in which games for culture are applied and the social relationships they create. Finally, given the need for a better understanding of games effectiveness for learning and training, we examine the reported outcomes of the reviewed games.

Keywords
Teaching/learning strategies, Interactive learning environments, Literature review, Spatial games for cultural heritage

1 Introduction

During the last decades, there is an increasing tendency for integrating game-based approaches with learning, a trend that is supported by educational theories like experiential learning, active learning and situated learning (Ortiz, Bowers, & Cannon-Bowers, 2015). The terms *edutainment* (Okan, 2011), *playful learning* (Resnick, 2004), *gamification* (De Sousa Borges, Durelli, Reis, & Isotani, 2014), *game-based learning* (Whitton, 2011) and *serious games* (Backlund & Hendrix, 2013; Connolly, E. A. Boyle, Macarthur, Hainey, & J.M. Boyle, 2012) refer to such blended approaches that are usually technology mediated.

Cultural heritage is one of the application areas of game-based approaches to learning. Games for cultural heritage differ from other games for education, because they additionally intend to preserve, reproduce and allow the appreciation of cultural content (Laamarti, Eid, & Saddik, 2014), which can be intangible or tangible (Mortara, Catalano, Bellotti, Fiucci, Houry-Panchetti, & Petridis, 2014a).

These two aspects of cultural heritage are more or less interdependent. Tangible cultural content, which encapsulates intangible elements (Papathanassiou-Zuhrt, 2015), has a fragmentary character and needs to be contextualized in interpretive contexts, in order to be meaningful. Besides the traditional way via books, documentaries and guided tours, or the more recent trend of interactive storytelling in a cultural place (e.g. Lombardo & Damiano, 2012), this can be achieved through games, which can provide an entertaining, experiential and interactive relationship with cultural heritage.

The present study focuses on digital games that intend to engage the user actively with content relative to cultural sites (archaeological/historical sites and museums). It aims to present the state-of-the-art of game-based approaches with a dominant tangible dimension, designed to be used in formal, non-formal or informal learning settings. More

specifically, a first aim of the study is to examine the different ways in which games for cultural sites engage the users with the cultural content. Then, we examine the contexts in which they are used and their potential to create social relationships. Finally, we focus on the reported outcomes of the reviewed games.

Consequently, the following 5 research questions are formulated for the needs of our study:

RQ1: In which different ways do spatial games for cultural heritage handle cultural content?

RQ2: Which different kinds of interactions with cultural content do spatial games for cultural heritage enable?

RQ3: In which contexts are spatial games for cultural heritage used?

RQ4: Do spatial games for cultural heritage enable social relationships?

RQ5: Which outcomes are reported for spatial games for cultural heritage?

The structure of the paper is as follows. Section 2 refers to the materials and methods used, including the procedure followed in order to trace similar literature reviews, the search terms and the criteria used for the literature research, and the method of analysis. In Section 3, the presentation of results is organized according to the above mentioned research questions. In Section 4, an overall interpretation of results is attempted and in Section 5, conclusions of the main findings are presented. An overview of the paper is illustrated in a PRISMA checklist (Moher, Liberati, Tetzlaff, Altman, & The PRISMA Group, 2009), provided as supplementary material.

2 Material and Methods

2.1 Originality of the literature review

A first phase of our research was devoted to identify whether a similar literature review was available. Databases including Scopus, SpringerLink, ScienceDirect and GoogleScholar were searched using the search terms (review OR “state of the art”) AND “cultural heritage” AND game. Through this search, two literature reviews focusing on games for cultural heritage were traced. The first has been conducted by Anderson, McLoughlin, Liarokapis, Peters, Petridis, and de Freitas (2010), and presents case studies integrating computer games technologies with pedagogical methodologies. A more recent literature review has been carried out by Mortara et al. (2014a), focusing on games objectives, genres, contexts of use, virtual environments and interaction modalities.

Our study, besides including articles published after the existing reviews, focuses on the narrower area of spatial games for culture highlighting issues of design, use and effectiveness. On that account, the paper focuses on the way different game genres and game plots handle tangible cultural content with a spatial dimension. The dimension of space in this kind of content encourages exploration, a motivating element for learning involvement. In addition, the historical dimension of cultural content, in other words the dimension of time, can encourage a narration, a sequence of events recounted, organized around intentional states and somehow violating canonical scripts (Bruner, 1991). Hence, we tried to trace the way the exploration of a cultural place is promoted by the gameplay and detect the cases where a narrative enables it. Narrative structures have also been analyzed by Avouris and Yiannoutsou (2012) in their literature review of 15 mobile

location-based games with content relative to various scientific fields.

Furthermore, in our study we focused on the games context of use, the social relationships they enable and the outcomes reported. All these elements are crucial factors to be considered in order to analyze the design, use and effect of spatial games for cultural heritage.

2.2 Literature selection

In 2016, a literature research was carried out in order to create a scientific papers database relevant to the research questions formed. The time period covered was 2000 to 2016, because we wanted to obtain an overview of the most recent trends in this field.

For this literature selection, Scopus was selected as the database source. Based on the formed research questions, a series of keywords were recognized and search terms used were TITLE(game OR "game based learning" OR "gamification" OR "playful learning" OR edutainment OR "serious game") AND ALL(museum OR "cultural heritage" OR culture) AND KEY(archaeology OR history). The subject areas set were Arts and Humanities, Social Sciences, Computer Science and Psychology.

This search resulted in 122 papers from which 9 were selected as relevant to our research. This list was enriched with papers found through references included in the initially selected papers and in the two existing literature reviews (Anderson et al., 2010; Mortara et al., 2014a) on the topic.

The above described procedure led to the creation of a database of 41 scientific papers fulfilling the criteria set and corresponding to 34 games for culture to be reviewed. The flow of information through the different phases of the review is presented in a PRISMA flow diagram (Moher et al., 2009)(see fig.1).

2.3 Selection criteria

The present study reviews journal or conference papers and book chapters, written in English language, referring to spatial games that enable a physical or virtual interaction with a cultural place. Thus, we excluded papers reporting on games with a solely historical or intangible cultural content. The research focused on case studies mentioning issues of design, use and effectiveness of games for culture. Papers focusing on technological aspects or reporting on non digital games were excluded, same as papers referring to games not yet implemented or designed by school students.

2.4 Data analysis

The scientific papers included in this study were coded following the Research Questions set at the beginning of our research (see Appendix A for an overview relating all the categories).

A first categorization was performed according to games genre, which is directly connected to research questions RQ1 and RQ2. Following the third research question RQ3, games were categorized according to their context of use. RQ4 underlined the need to categorize games in relation to the number of players and the relationships created during playing. Finally, following RQ5, a categorization was performed according to the outcomes reported after systematic evaluation or even simple observations during gameplay.

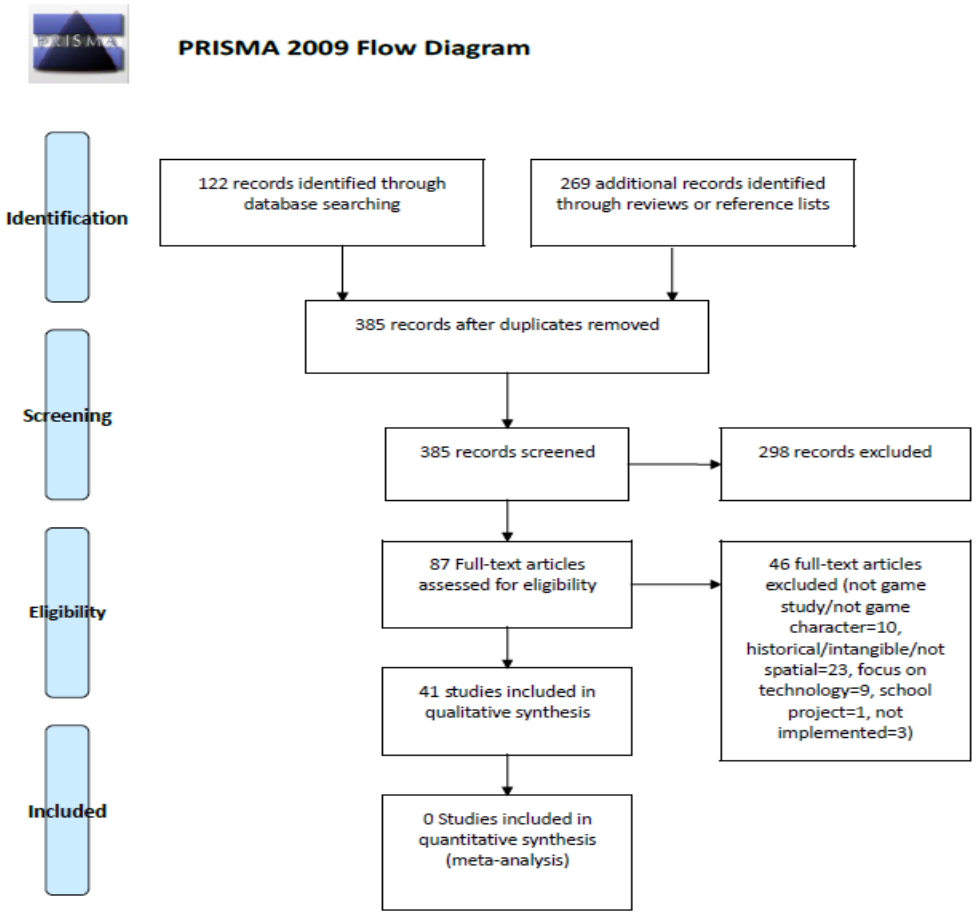

Fig.1 PRISMA flow diagram (From Moher et al., 2009).

3 Results

3.1 Game genre/game plot

The different pedagogical affordances of specific game genres are recognized by researchers (Prensky, 2005; Foster & Mishra, 2009), while the need of further research on how disciplinary knowledge connects with game-play is underlined (Foster & Mishra, 2009). On that account, we investigate RQ1 and RQ2 through categorizing the reviewed games according to their genre (see also Appendix A). Keeping in mind the difficulties of such an attempt, due to the absence of a general accepted game taxonomy (Connolly et al., 2012), and combining Herz's taxonomy, followed by the industry (Kirriemuir & McFarlane, 2004), with game genres mentioned in Mortara et al. (2014a), we classified the reviewed games in action, puzzle, trivia, role-playing, simulation and adventure games. Pure strategy games were not traced, but elements of this genre are mentioned when found in games of other genres. Finally, as explained in subsection 2.1, we additionally touch upon the use of exploration and narration, considering that their existence differentiate content handling and interactions provided, since exploration enables an overall experience of cultural elements spatially connected and narration alters

the character of the cultural elements by converting them into components of a constructed reality (Bruner, 1991).

3.1.1 Action games

This genre, based on repetitive, quick and precise actions in a digital environment, demands hand-eye coordination and is mostly suitable for achieving engagement with the subject (Mortara et al., 2014a). Among the games reviewed, 4 action mini games integrated in more complex applications were found. Specifically, in mini games of *Multi-touch rocks* (Egger, Seidl, Judmaier, Baker, Chippindale, Grubinger, et al., 2013; Seidl, Judmaier, Baker, Chippindale, Egger, Jax, et al., 2011), *Vegame* (Bellotti, Berta, De Gloria, Ferretti, & Margarone, 2003), *O'Munaciedd* (Guardia, Arrigo, & Giuseppe, 2012) and *Travel in Europe* (Bellotti, Berta, De Gloria, Primavera, & Zappi, 2008; Bellotti, Berta, De Gloria, D'ursi, & Fiore, 2012), the player interacts, through repetitive movements, with simplified digital representations of cultural objects or places. In such manner, familiarization with them and concrete knowledge acquisition are facilitated. The elements of exploration and narrative are poor in these games.

3.1.2 Puzzle games

The puzzle game genre involves mostly visuospatial tasks like observation and matching tasks, puzzles, labyrinths, but also logic puzzles (Mortara et al., 2014a). 2 (5,88%) of the games reviewed have a puzzle game character, but puzzle games are often parts of more complex adventure games (see 3.1.6). Through a procedure involving limited exploration and no narrative, the digital reconstruction of an ancient temple, in *Brauron (*Antoniou, Lepouras, Bampatzia, & Almpanoudi, 2013), or of prehistoric figures in *Multi touch rocks* (Egger et al., 2013; Seidl et al., 2011), help players understand and memorize the structure of ancient buildings or objects. Mini puzzle games like inserting missing words, coupling names with paintings*,* dragging objects to the *Rightplace* of a map etc*.,* which are included in the adventure games *Travel in Europe* (Bellotti et al., 2008, 2012) *Vegame* (Bellotti et al., 2003) and *O'Munaciedd* (Guardia et al., 2012) enable the comprehension and acquisition of factual and/or conceptual cultural knowledge.

3.1.3 Trivia games

Trivia games are based on questions and usually provide players with information, after their answer (Mortara et al., 2014a). Exploration and narrative are not innate in this genre.

In the papers reviewed, trivia mini games are presented as parts of more complex applications. Quizzes developed for *Travel in Europe* (Bellotti et al., 2012), *Instory* (Barbas & Correia, 2009), *Fort Ross Virtual Warehouse* (Lercari, Mortara, & Forte, 2014), *Priory Herbert Undercroft* (Doulamis, Liarokapis, Petridis, & Miaoulis, 2012), *Vegame* (Bellotti et al., 2003), *VRLerna* (Barbatsis, Economou, Papamagkana, & Loukas, 2011) enable comprehension and acquisition of verbally codified factual and/or conceptual cultural knowledge, and function as challenges to overcome, in order to proceed with the exploration.

3.1.4 Role-playing games

In this game genre, the human players assume the characteristics of some person or creature type (Kirriemuir & McFarlane, 2004), explore large-scale open environments

and interact with the numerous characters they contain (Panzoli, Qureshi, Dunwell, Petridis, De Freitas, & Rebolledo-Mendez, 2010b).

5 (14,7%) out of the 34 games reviewed can be classified in this genre. They facilitate highly experiential contact with cultural content, enabling the acquisition of procedural knowledge relative to the cultural domain. They offer the possibility to understand specific roles which existed in past societies, like that of a visitor and athlete of the ancient Olympic Games (*A Walk-Through Ancient Olympia,* Gaitatzes, Christopoulos, & Papaioannou, 2005), or that of a qualified clerk of the 19th c. Russian American Company (*Fort Ross Virtual Warehouse,* Lercari et al., 2014). Through a simple narrative, in the first case, and a complex one in the second, the player virtually explores a cultural place through the perspective of these specific roles, getting familiar with their psychological states and skills. In the role-playing and simulation game *Roma Nova* (Panzoli, Peters, Dunwell, Sanchez, Petridis, Protopsaltis, et al., 2010a; Panzoli et al., 2010b), exploration becomes highly realistic, since it is built on a virtual recreation of Rome in 340 A.D. and permits interaction with Non Player Characters in three different Levels.

Exploration is less extensive in *Red building in Tainan* (Hong, Chang, Chen, & Lin, 2013), which focuses on the transformations of the homonymous building through time. The player interacts with a movie projected on the surface of the building, by assuming the roles of a “Defender” from the WW2 bombs, a “Designer” or a “Witness” of its modern form.

Become an archaeologist (Antoniou et al., 2013), permits a different interaction with cultural heritage. The players, by digitally assuming tasks of an archaeologist, acquire knowledge about ancient objects and buildings, get familiar with the skills needed to an archaeologist and understand the laborious procedure of knowledge construction about the past.

3.1.5 Simulation games

In simulation games, the player has to succeed within some simplified recreation of a place or situation (Kirriemuir & McFarlane, 2004). 5 (14,7%) of the games reviewed have the characteristics of this genre. Similarly to role-playing games, they facilitate the acquisition of procedural knowledge, but they draw attention primarily to procedures instead of roles existing in the past. The players can live situations and imitate actions usual in past societies and cultures, like in the simulation – strategy game *Otranto in the Middle Ages* (De Paolis, Aloisio, Celentano, Oliva, & Vecchio, 2011, 2010), or in *VRLerna* (Barbatsis et al., 2011). In these games, which are mostly based on exploration than narrative, players move in the virtually restored medieval Otranto or in the Early Helladic “House of Tiles” in Lerna, respectively, interact with objects, engage themselves in activities and experience sociocultural values.

A look into more specific skills and situations of the past is achieved in the simulation and role-playing game *Hanse 1380* (de Araújo, Königschulte, & Erb, 2010; Königschulte, de Araújo, & Erb, 2010), which promotes exploration with a simple narrative and provides a virtual experience of sailing with a medieval trading boat, through the roles of a sailor and trader. In the less explorative virtual reality experience of *Feidias’ Workshop (*Gaitatzes et al., 2005), players use virtual tools and participate in the reconstruction of the colossal statue of Zeus in Olympia.

The simulation-strategy game *Laconia Acropolis Virtual Archaeology* (*LAVA*) (Getchell, Miller, Nicoll, Sweetman, & Allison, 2010), is different from the above mentioned, because it engages players in tasks of an archaeological excavation, aiming to train archaeology students in this procedure. The element of exploration results from the excavation process, but narrative is not a strong element in this application.

3.1.6 Adventure games

Usually, in adventure games the player has to solve several logic puzzles in order to progress in a virtual world (Kirriemuir & McFarlane, 2004). 22 (64,7%) of the reviewed games belong to this genre.

3.1.6.1 Treasure hunt type games

11 (50%) of the reviewed adventure games could be characterized as treasure hunts, in which searching for hidden information and the exploration of unknown settings create a certain degree of mystery (Garris & Ahlers, 2002). In these games, puzzle or trivia type missions draw players' attention to selected elements in a rich in cultural content virtual or real environment and motivate to a virtual or physical exploration. More specifically, a virtual exploration of a Benedictine Priory is enabled in *Priory Herbert Undercroft* (Doulamis et al., 2012), while *Shandong* (Wang, Guo, Yang, Zhao, & Meng, 2010) allows the exploration of the homonymous Chinese Province, and *Travel in Europe* (Bellotti et al., 2008, 2012) engages the player in a virtual tour in historical European cities through missions consisting of mini games (see 3.1.1, 3.1.2 and 3.1.3).

A physical exploration is enhanced in some of the reviewed treasure hunt type location-based games. *O'Munaciedd* (Guardia et al., 2012) and *Vegame* (Bellotti et al., 2003) motivate the player to visit historical points and solve mini games in Matera and Venice respectively (see 3.1.1, 3.1.2 and 3.1.3). *Explore!* (Ardito, Buono, Costabile, Lanzilotti, & Piccinno, 2009; Costabile, De Angeli, Lanzilotti, Ardito, Buono, & Pederson, 2008), using a role-playing approach and a back-story, enhances the exploration of an archaeological site. In *Rebels Vs Spies* (Sintoris, Yiannoutsou, Demetriou, & Avouris, 2013), which creates a strong mystery with a simple narrative, Rebels try to carry out missions in the city and reveal Spies who try to sabotage them. In *MuseumScrabble* (Sintoris, Stoica, Papadimitriou, Yiannoutsou, Komis, & Avouris, 2010), which does not use narrative, players explore a museum and try to connect RFID tagged exhibits to abstract concepts. Similarly, in *Inheritance* (Tselios, Papadimitriou, Raptis, Yiannoutsou, Komis, & Avouris, 2008), which uses a back-story, the participants examine RFID tagged museum exhibits, in order to trace the favorite exhibit and consequently the will of a fictitious historian. Finally, *Tidy City* (Wetzel, Blum, & Oppermann, 2012) and *H-Treasure Hunt* (Kim, An, Keum, & Woo, 2015) function as flexible tools for the creation of innumerable treasure hunt scenarios in cultural places.

In the above mentioned treasure hunt type games, factual and/or conceptual knowledge acquisition is enhanced, while missions link the selected cultural knowledge and enable deep understanding of their conceptual connections. The frequent existence of a simple narrative or a *back-story* (Avouris & Yiannoutsou, 2012) contributes towards this direction and makes the missions more attractive and meaningful.

3.1.6.2 More complex adventure games

3.1.6.2.1 Adventure games enhancing creativity

Another type of cultural adventure games (7—31,81%), detected among the reviewed games, engages players in more composite procedures, where they synthesize cultural elements in order to accomplish a complex project. Therefore, these games strongly enhance creativity following a learning by doing design. Such an approach, without the use of a narrative, can be recognized in *Janus project* (Loiseau, Lavoué, Marty, & George, 2013), in which players assume individual, collaborative and social activities that lead to the creation of a virtual notice for an archaeological site.

MuseUs (Coenen, Mostmans, & Naessens, 2013) and *Archaeologist Game* (Guazzaroni, 2012) encourage the creation of narratives by the user, during a museum visit. In the former, the user creates a personal virtual exhibition by coupling phrases presented in the virtual environment of the game with QR tagged exhibits. In the latter, participants create stories, interviews, reports or drawings inspired by the museum content.

Non linear multimedia narratives containing experts' knowledge are used as basis in the serious game for training and education *Bamiyan valley* (Spaniol, Cao, Klamma, Moreno-Ger, Fernández-Manjón, Sierra, et al., 2008). This adventure game with simulation elements, designed to raise awareness on the homonymous archaeological area of Afghanistan, engages employees in conservation tasks, like the simulated use of a GPS camera in a Buddha cave.

Cultural adventure games following a learning by doing design can also take advantage of more complex narratives, tightly interconnected with missions and facilitating the presentation of cultural elements together with their causal and temporal relationships. Representative of this tendency is *Frequency 1550* (Akkerman, Admiraal, & Huizenga, 2009; Huizenga, Admiraal, Akkerman, & Ten Dam, 2009), whose content is related to the medieval history of Amsterdam. Players, pursuing the attainment of civil rights, complete orientation, fantasy or symbolic tasks in the city. Likewise, the location-based *Premierløytnant Bielke* (Wake & Baggetun, 2009), additionally presenting role-playing and strategy game features, engages players with tasks related to building vessels, during the Napoleonic Wars. In order to find construction drawings, raise funds and find locations for the construction works, they explore places in the real city of Bergen.

Another game that enhances a museum exploration by combining a highly narrative structure with learning tasks and mystery is *Gossip at palace* (Rubino, Barberis, Xhembulla, & Malnati, 2015). The visitor tries to find a spy in Palazzo Madama in Torino, by exploring the rooms, taking pictures of selected exhibits, interacting with virtual characters and solving mini games.

3.1.6.2.2 Adventure games as narrative experiences

A few (4—18,18%) of the reviewed adventure games could be characterized as narrative experiences in archaeological sites. In this case, a cultural place and its components function as the scenery of a story with fictional elements. Exploration and narrative are tightly interconnected enhancing the contextualization of cultural elements in concrete scenarios and enabling deep understanding of facts and concepts. The role-based *Middle Rhine Eduventure* (Ferdinand, 2005; Ferdinand & Ritschel, 2005) and the game designed for the project *Instory* (Barbas & Correia, 2009) can be classified in this

category. In the former, the player searches for a woman who got lost in the past, after using a time machine. A combination of information collected in a first virtual episode with real world data collected in the castle of Marksburg will lead to the solution. *Instory* enhances the exploration of a palatial complex through a narrative related to hunting. Events are traced in specific points, but the route followed by the player differentiates their sequence, duration and number of episodes.

Another narrative-rich mystery game is *Mystery of Elin* (Guadalupe, Díaz, & Toftedahl, 2014). Players live the adventures of a virtual heroine while they try to discover enigmas and symbols, in the real city of Skövde. Finally, the role-based adventure game *Who Killed Hanne Holmgaard* (Paay, Kjeldskov, Christensen, Ibsen, Jensen, Nielsen, et al., 2008) purely implements this tendency. In this game, two players assume the roles of two historical detectives of Denmark, during WW2. They try to solve the mystery of a murder, investigating virtual suspects and searching for clues in Aalborg, while experiencing an interactive textual and audio storytelling.

3.2 Context of use

One of the criteria for the categorization of the reviewed games was their context of use (research question RQ3) (see also Appendix A). Regarding games designed for a formal educational setting, 4 (11,76%) of the reviewed games are found suitable for use in a school classroom and 2 (5,88%) are designed as training tools for cultural heritage professionals.

In the category of games for non-formal educational settings, 10 (29,41%) of the games can be used in public displays and 18 (52,94%) are games for cultural tourism and augmented visit, also called *mobile location-based games* (Avouris & Yiannoutsou, 2012), designed to enhance the visitors' interaction with the cultural content, while they move in a cultural site (Mortara et al., 2014a).

Finally, 5 (14,7%) of the games can be played by independent players in informal learning settings.

3.3 Number of players and social relationships

One of the criteria for the categorization of the reviewed games was the number of players involved and the type of relationships enabled during gameplay (research question RQ4) (see also Appendix B). 17 (50%) of the reviewed games present a single-player design, which, however, does not exclude the possibility of an unplanned collaborative play by small groups. The possibility of a digital interaction among individual players is provided in 3 of the games, while 1 (*Red Building in Tainan)* encourages the existence of an audience.

17 (50%) of the reviewed games have a multiplayer character. 12 (70,58%) of them are played in teams, an element that augments social interaction and strengthens the element of collaboration among the players, because members of the same team share the same goals, rewards and penalties (Zagal, Rick, & Hsi, 2006). In 7 (58,33%) of the 12 team based games, the technique of giving distinct roles to each team member is followed (Loparev & Egert, 2016), preventing the degeneration of a collaborative game into a solitaire one, when the most competent players marginalize the others (Zagal et al., 2006).

In 7 (58,33%) of the team based games, the element of intra team collaboration is combined with inter teams competition, creating tighter bonds among members of the same team and a greater engagement of the players. Finally, 1 (5,88%) of the multiplayer games, disposing the characteristics of a MMORPG, facilitates the emergence of an online community of learners who benefit from social learning.

3.4 ***Games outcomes***

The effectiveness of games as educational tools is still a challenging issue for research (Backlund & Hendrix, 2013). Knowledge acquisition and comprehension, perceptive and cognitive abilities, emotional and motivational results, motor skills and change of attitude are concluded up to now as their most common benefits for learners (Boyle, Hainey, Connolly, Gray, Earp, Ott, et al., 2016; Connolly et al., 2012).

Understanding the effectiveness of games in the cultural sector is equally indispensable. Consequently, the reviewed games are categorized according to the outcomes (RQ5) indicated through systematic evaluation or even simple observations during gameplay. Specifically, the categories of Learning, Entertainment, Social interactions, Engagement and Change of attitude towards cultural heritage are created, in order to better understand whether evaluation studies or observations focus on them and which are the outcomes reported (see also Appendix C). The aforementioned procedure concerns 23 of the 34 reviewed games, since the papers corresponding to the other 11 do not include data examined in our study.

Learning outcomes are reported for 19 (82,60%) of the 23 reviewed games. In 18 (94,73%), they are positive and mostly concern knowledge acquisition (12 games), which in 5 cases is identified as concrete or lower level, and comprehension (explicitly reported in 5 cases). 1 of the games is mentioned to promote strategic planning and another 1 the composite skills needed for an excavation. In 3 cases the learning outcomes of a game intervention is compared to a traditional teaching or guiding method; problem solving and detailed lower level knowledge acquisition (*Travel in Europe)*, learning gains mostly for upper general and preuniversity secondary education pupils (*Frequency 1550),* and visual knowledge and simple concepts but not verbal knowledge acquisition (*Vegame)* are presented as the games comparative benefits. Finally, no statistical difference was found in the 1 case comparing the digital version of a game (*Explore!)* to its paper version.

Social outcomes are mentioned for 11 (84,61%) of the 13 multiplayer games with reported outcomes. All of them are positive in respect to collaboration. In 4 cases, the element of inter teams competition is confirmed. 1 of the mini games of *VEgame* also proved to enhance players' social interaction with the locals, in Venice.

Entertaining outcomes are reported for 17 (73,91%) games. All of them are positive, indicating that the participants perceived the game experience as entertaining.

Outcomes relative to engagement during gameplay are reported for 15 (65,21%) games. In general, all of them are positive, while a few problems are indicated. In 1 case (*MuseUs*), immersion problems are reported, which is normal, though, for pervasive games. Finally, in 1 case *(Gossip at palace),* the engagement results of a game are compared to those of a digital guide and a prevalence of the former is observed.

Outcomes regarding users' attitude towards cultural heritage, after the game intervention, are reported for 7 (30,43%) games. All of them are positive. Emotional connection to a cultural site is referred in 2 cases.

4 Discussion

Through the present literature review relative to digital games with a cultural content, observations can be made with respect to the main tendencies in this domain. Regarding the research questions RQ1 and RQ2, we can firstly observe that the reviewed spatial games most frequently offer an overall interaction with cultural content, through exploration. An adventure game design is most often chosen to serve this need, offering also greater challenge, one of the basic game elements (Garris & Ahlers, 2002). Such a design either enhances players' interaction with selected information bound together in a treasure hunt or facilitates creative synthesis of cultural elements in complex projects. A few adventure games function as narrative experiences permitting interaction with cultural content contextualized in concrete stories. Fewer games emphasizing procedural knowledge acquisition were found. By using a pure role-playing or simulation game design, or elements of these genres, they facilitate a first person interaction with roles or processes of cultural interest. Games focusing on individual cultural elements and mostly enhancing factual and conceptual knowledge acquisition are rarely found standing alone; puzzle and trivia games, are often integrated in complex applications, permitting a look into details (Bellotti et al., 2008), same as action games which are, though, used more sparingly just to engage players with simplified cultural objects.

Evidently, the coexistence of more than one genre features is frequent (15 games) in the reviewed games (see also Appendix A). This approach provides diverse kinds of interaction with cultural content. It is worthwhile mentioning that, even if pure strategy games were not traced, elements of this genre exist in 3 of the games, offering deeper thinking and planning over cultural content (Gabbiadini & Greitemeyer, 2017).

Usually, the games progress is dependent on the completion of learning tasks. The element of a simple narrative (back-story) is frequently used (15 games—44,11%) in order to further engage the player with the tasks assigned. Bottom up narratives created by the users are found in 2 games (5,88%). More complex storytelling, which helps integrate cultural elements in a context of causal and temporal relationships, is rarer (8 games—23,52%) and used mostly in games for cultural tourism, but the experience of a playful interactive narration that is not built on learning tasks is even more seldom. The pervasive game *Who Killed Hanne Holmgaard* mostly represents such an approach. The above remarks seem compatible with Bopp's (2008) observation that designing educational games with complex narratives and multidimensional characters is still a challenge. Additionally, according to Akkerman et al. (2009), even if narration is suitable for history education, we know little about the value of games as a narrative learning environment.

Regarding the context of use (research question RQ3), most of the reviewed games are games for cultural tourism, implemented in mobile devices. Fewer are suitable for static use in a cultural place or independent users on line, while 11,76% of the games can be used in a school classroom and only 5,88% in a training course. The small number of games for classroom is compatible with Backlund's and Hendrix's (2013) remark about the incomplete research relatively to the use of educational games in the teaching practice. Furthermore, game-based approaches, although considered to be effective in professionals' training, because of the potential for experimentation without the risk of irreversible mistakes (Ortiz et al., 2015), do not seem to be enough exploited in the cultural sector.

As far as the social aspects of games are concerned (research question RQ4), 50% of the reviewed games can create social relationships through a multiplayer design. These games, though, are mostly games for cultural tourism (70,58%), while fewer static games

for cultural places (30%) have a multiplayer character. All the 4 reviewed games for classroom are single-player. The majority of the multiplayer games studied strongly enhances collaboration through team working, but intra team role designation and inter team competition are less utilized.

As regards research question RQ5, social outcomes (for multiplayer games) and learning outcomes are mostly reported, followed by entertainment and engagement outcomes, while attitude towards cultural heritage is less examined. Specific issues, as the potential of games to correct misconceptions, socialize lonely individuals or engage indifferent and “weak” students, do not seem to be examined. Moreover, studies evaluating the effectiveness of a game-based approach relatively to a traditional teaching method are limited (18,18%), a lack underlined also by Mortara, Catalano, Fiucci, and Derntl (2014b). Besides, a lack in evaluations of the digital version of a game comparatively to its non-digital version can be noted (1 case only registered). Finally, evaluations studying the impact of the setting (formal, non formal or informal) or the coordinator on the game outcomes were not found in our review.

5 Conclusions

This paper presents an up-to-date literature review that focuses on spatial games for culture. It constitutes a solid groundwork of conceptual aspects that have to be taken into account, while it reveals the necessity of further research directions on the topic.

The use of complex *storytelling* in spatial games for culture constitutes one of the axes that can be further exploited and evaluated. This, inherent in cultural information, element can keep players concentrated on the narrative content of the game and discourage the mechanical carrying out of learning tasks (Akkerman et al., 2009). Thus, it would be of interest to study deeper the role of spatial games for culture which are based on the enjoyment of a complex narrative, while learning emerges as a side effect.

Furthermore, in the specific field of spatial games for culture, as it happens in the general domain of educational games (Arnab, Berta, Earp, de Freitas, Popescu, Romero, et al., 2012; Backlund & Hendrix, 2013; Hanghøj & Brund, 2010), a tighter connection with teaching in formal educational settings is needed. The effect of cultural games on students’ learning performance and their interrelations, as well as the potential of these games to motivate “weak” or uninterested students can be mentioned as indicative research directions. Additionally, the effectiveness of games for culture in relation with other teaching methods needs to be deeper studied.

Moreover, effects of game-based approaches in players' attitude towards cultural heritage could be further examined. Finally, the influence of the context of use of games for culture needs further investigation, in order to comprehend better how a game intervention functions in a formal educational setting and how it is differentiated in a non-formal or informal setting.

Research work to the above mentioned issues can contribute both to the wider domain of games for learning and the narrower domain of games for cultural heritage. It can help better understand the suitability of game-based approaches for the transmission of cultural content as well as their limitations and preconditions of use that can maximize their effectiveness in formal, non-formal and informal settings.

The present review includes selected scientific papers regarding spatial games for cultural heritage. It is not based, though, on the game experience itself and this constitutes one of its limitations. Another limitation is the restricted number of games reviewed, since

commercial games, educational games not scientifically published or games tagged quite differently than the search terms used were not included. It would, therefore, be of interest to extend this study using more keywords (e.g. “play” AND “ancient places” OR “past civilizations” etc.) and more databases as sources, in order to investigate the research questions set in a larger number of games and better apprehend current trends in the field of spatial games for cultural heritage.

Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.compedu.2017.01.007.

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