

Discovering the invisible city: Location-based games for learning in smart cities

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Abstract. In this paper we discuss how location-based mobile games can be designed for learning in modern technology enhanced public spaces. We start with the description of the design process and we identify the main challenges faced. We elaborate the case of the game Invisible City: Rebels vs. Spies, a game to be played in a city centre using mobile devices. Through this case we highlight the adaptation of an original party game into a mobile form, the issues we faced and the key aspects conducive to learning in a smart city. It is claimed that creating mobile city games for learning is a new challenge, as our city landscapes are augmented with an increasing number of layers of digital information in which a new generation of city games are played.

Keywords: location-based games, game-based learning, situated learning, technology enhanced places, mobile game design.

1 Introduction

Technology enhanced places, in which sensing and responsive technologies have been embedded, may support new kinds of learning. A typical example is through location-based mobile games. These games take the form of playful activities situated in urban contexts and are believed to be conducive to social, experiential and situated learning [22], that may lead to the acquisition of 21st century skills, like critical thinking, curiosity, creativity, collaboration, consideration of multiple perspectives, social awareness, responsibility and media fluency [19]. The underlying idea is that with these games the players relate knowledge with physical activities situated in the real world, in particular with places rich in historic value, like historic city centres. However these claims have yet to be thoroughly studied and verified.

In a recent survey of location-based games different kinds of games built to support learning were identified [3]: scavenger hunt games, participatory simulators, games for situated language learning and educational action games. However not all of these games were effective as learning activities. In this paper we focus on a city game called Invisible City: Rebels vs. Spies (RvS for short [21], a typical site-specific multi-player mobile game. Here we discuss aspects of the design of the game focusing a) on its learning potential and b) on its playful character through the use of existing game patterns and the role of narratives in supporting the players' experience.

The aim of the designers was to create a multi-player location-based game where mobile devices would be used as game interfaces and the city would be both the

playground and the learning objective. Thus, aiming to engage the players of the RvS game with the surroundings of the city we followed a design approach which involved the adaptation of game patterns encountered in traditional games into a location-based mode. Although RvS is a new game, it was inspired by the party game Mafia [24], which was originally designed to be played in a confined space. The transformation process from the rules of the Mafia game to a location-based mode posed two main challenges: one was the spatial expansion of the game activity and the other was the integration of contextual knowledge (i.e. city related information). Spatial expansion denotes that a game is not limited to a demarcated playground [16]. By expanding the playground, the game mechanics of Mafia had to be altered to account for a game that can be played in a space that often has extended size and where the players are not permanently in eye-contact. The second and more difficult challenge in RvS involved the seamless integration of contextual knowledge in the game, knowledge that relates to the setting where the game takes place. In the final implementation, the players receive mission descriptions that require solving riddles pertaining to identification of landmarks or to answering of questions that relate to them. Contextual knowledge is included by moving and operating in an authentic environment, which has been tagged in specific points. The tags denote locations where the player can discover a piece of cultural or historical information in its geographical context. Besides the tagged locations, the route itself could provide a structure that would link the specific locations in a coherent narrative. Finally, in RvS players have a motivation to question the other players' actions which provokes a continuous conversation between the players through which they inquire and dispute the topics to learn.

In order to tackle these issues, we analysed the traditional form of the game concept which was subsequently adapted and enriched with game patterns that are suitable for location-based mobile games. We have followed this process in designing games for museums and historical sites.

2 Background

In recent years, location-based multi-player mobile games have gained in popularity. These games are playful multi-user activities where location matters and where collaboration or competition between the players is an important trait. They are played in specific locations using networked mobile devices and result in what is considered to be the breaking of borders and the merging of digital and urban space [4, 16]. In these games learning is grounded on a new relationship with space and is related to an enriched interaction with context [20] which is supported by the following characteristics: mobility, location awareness, interaction between the players and various ways of interaction with real-world objects. These characteristics render mobile games useful for situating playful learning activities in real contexts and as such they have been used in recent years to situate play in the relevant physical environment, employing this new relationship to space to support social, experiential and situated learning [22]. The underlying idea is that with these games the players associate information with physical activities in the real world, experiencing immersion in a physical and social space, augmented with digital media. As stated in

[3], learning through location-based mobile games needs not to be an explicit goal. Games that follow a ludic tradition, instead of ones with explicitly stated pedagogical goals, are still considered suitable for learning. As reflected in Bloom's taxonomy on teaching and learning [5], the definition of learning goals can be categorized in cognitive, psychomotor, and affective learning, which is suitable for describing learning that occurs through location-based games. The playful appeal of these games and the involvement of the players can be attributed to four characteristics [11]: 1) physical experience, 2) mental challenge, 3) social experience and 4) immersion. Physical experience is akin to the player's experience when interacting with real and tangible objects in a context defined by the physical location where the game takes place. Players need to move and act in physical space, doing puzzles and problem solving tasks that drive the game forward. Requiring players to meet, socialize and combine their efforts widens the social experience, strengthens ties and contextualizes the play activity within a larger framework of social interactions. Finally, immersion in the game activity should provide players with a feeling of enjoyment. Given these characteristics of location-based games, in order to evoke learning, effort should be placed into associating, stimulating mental challenges to tangible or digital objects of historic relevance, integrating social experiences in these interactions and creating a motivating and engaging story [22]. The new affordances of modern cities [17] in which a layer of digital information has been embedded and new sensing and responsive technologies are used, further promote and facilitate such activities.

Location-based mobile games can be designed for different or multiple purposes and can have varying characteristics. It was found that among the 14 most cited location-based games [3], 11 games are played outdoors in city centres, which were characterized as spatially continuous games, i.e. can be played in any place that players gather (examples are Feeding Yoshi, UncleRoy, CitiTag, CityExplorer, Hitchers, Jindeo), while other games were designed for specific places in cities usually augmenting the place with historic information and asking the players to explore historic buildings, or public spaces, examples being: Relive the Revolution (in Lexington, Massachusetts), Riot! (in Bristol, UK), and Frequency 1550 (in Amsterdam, the Netherlands). The games of this last sub-genre are called site-specific mobile games, as they are designed for specific places and usually have some associated learning objectives. In this context, questions of particular interest are raised about how to design these games and how to achieve the learning objectives.

Many location based city games have been inspired by traditional board or party games. The transformation process however is not trivial. Especially when learning is involved engaging and motivating characteristics such as story-telling, role playing and game play strategies need to be employed. Various design support tools have been proposed that provide an orientation to designers such as playability heuristics for mobile multi-player games [14], or guidelines for designing pervasive mobile games for learning [2]. Because RvS is a transformation of a game in a traditional form rather than a new game concept, we placed special emphasis on how the structure of the game is related to the player experience and thus we employed the Mechanics Dynamics and Aesthetics (MDA for short) framework [13] to analyse the traditional party game and used this analysis as a basis to design and implement the new game, RvS. In the following sections of this paper we describe the lifecycle of design and implementation of RvS, which has been implemented as an Android-based

mobile multi-player game [21], and we present some results from the evaluation study which was conducted in the city centre of Patras, Greece, to assess our design.

3 Adaptation of a traditional party game

The inspiration for RvS was the popular party game Mafia, also known as Night in Palermo, Assassins or Werewolves. Mafia, unlike board games, has a number of characteristics that make it particularly interesting: it can be played with a large and varying number of players, it has rules that are easy to learn, it doesn't require equipment, and it is reliant on player interaction. Mafia belongs to a class of games that are based on the pattern of information asymmetry. In this pattern, a minority of the players hide the fact that they know an important piece of information, while the majority of the players try to discover the players who are informed.

The design goal was to create a multi-player location-based game that involves an engaging play activity which integrates tasks to be carried out in selected city areas, so that players explore these areas and interact not only with their co-players but also with places, monuments, buildings and other objects in the city. This goal was further analysed into specific requirements that the new mobile game has to fulfil, namely a) that the game offers situated action through which the participants' experience is associated with knowledge acquisition, b) that part of the game incorporates challenges that involve performing actions in the real world, in terms of solving puzzles by engaging with real-world objects and locations and c) that the players interact with each-other. Towards this goal, specific structural game elements of the original game had to be adapted for a location-based city game mode. The aim was to maintain or adapt most of the basic structural elements in the new game mode. In the next sections, we outline the process that was followed in designing RvS and discuss major decisions. We begin by establishing a descriptive understanding of the factors that make Mafia a compelling game and build on that to inspire a location-based game. In order to do that, we observed, participated and analysed sessions of Mafia playing using an ethnographic approach, a participatory method suitable for developing understanding of complex group behaviour [15]. A number of elements were identified, that constitute the character of the game. Subsequently we focused on three factors that affect the transformation process: spatial expansion, mobile technology and the characteristics of the site. We investigated alternative designs that would work in the new game space, and finally designed the rule set of RvS, as discussed next.

3.1 The Starting Point: Analyzing the Mafia Game

The Mafia game exists in many variations and in the following we will outline a simple form of it. The game is typically played by 9-15 players. The game is about a) convincing others b) being able to lie believably, and c) being able to figure out if other people are lying. The narrative involves a once peaceful town which has been invaded by the dark forces of corruption - the Mafia. The Mafia's sole purpose is to murder the citizens in their bed. They have free reign of the town at night, but by day

they appear to be normal citizens. One player acts as moderator and the rest take the roles of either citizens or Mafia members. The game starts by drawing cards from a shuffled deck that determines players' roles. The moderator then announces the fall of the "night", and all players have to close their eyes. Then, the Mafia people open their eyes and with silent gestures agree on which citizen to eliminate from the game. The "day" comes, all players open their eyes and the moderator asks the player who got eliminated by the Mafia to step out of the game. During the "day" time the players debate and try to find who the Mafia might be. The Mafia try to convincingly act as citizens and draw the suspicions away from them. All players can vote for a suspect and at the end of the "day" the player who receives most votes is removed from the game as a suspect Mafia. The game continues in successive phases of "day" and "night" until only Mafia or only citizens are left.

The gameplay that emerges from the simple set-up of Mafia can be very engaging. Salen and Zimmerman [18] offer a valuable analysis of Mafia as an example of emergent social play, where the interplay of trust, deception, observation and performance leads to an engaging experience. The game is based on asymmetry between public and private information, through which deep social involvement of the players is provoked. The citizens have very little information on which to base their decisions and the Mafia's success depends on how well they can pretend to be citizens.

A way to identify the structural elements that influence the player's experience is to analyse it using the Mechanics, Dynamics & Aesthetics (MDA) framework [13]. Although MDA is a widely known framework, relatively few examples of its practical application exist. Because it establishes a relationship between game rules and player experience, we found it valuable for analyzing the original Mafia game. The MDA framework formalizes games in three components: Mechanics, which specify the rules and concepts of the game, dynamics, which describe the run-time behaviour of the mechanics and aesthetics, which describe the (desired) emotional responses evoked by the game dynamics. These three components are analogous to game rules, game session and game fun from the player's point of view or alternatively code, process and requirements from a system perspective. The players experience only the aesthetics component directly and can infer the dynamics gradually and through experience. The designer's ultimate target is the aesthetics component, but he/she only has direct influence on the game mechanics. Next we present how we used MDA to analyze Mafia in these three components.

Aesthetics

In Mafia, no factual way exists of assuring the allegiance of a fellow player, so everyone may plausibly claim to be a citizen. During the game the citizens are faced with a kind of prisoner's dilemma, which provokes rich emotional engagement of the players – the aesthetics component of MDA. Any decision a citizen makes is ambivalent, and creates tension. The Mafia also experience tension. They know that they are observed and must remain in hiding and avoid over-acting because it will draw suspicion. Continuous bluffing and second-guessing one's decisions results in a rich emotional experience. During both night and day, every player is potentially subject to ostracization which creates a feeling of anticipation. The game is experienced as a mix of challenges to overcome, performances to deliver and

spectacles to observe, and finally social interactions that are regulated by the game's rules.

Dynamics

The dynamics that give rise to such emotions stem from the fact that the citizens suspect everyone of being a Mafia but at the same time they need to trust at least some of the players and cooperate with them in order to win against the Mafia, hence the dilemma. During the “day” there are debates where the players engage in deception and bluffing and where the Mafia members try to manipulate the citizens into ostracising a fellow citizen, who in turn observe the behaviours of the other players and try to guess bluffs. All players are also spectators and through comments they provide trajectories for competition or narratives that are external to the game, for example by referencing past experiences. The players who are eliminated from the game do not stop participating but step out of the game, observing how the game unfolds (Salen & Zimmerman, 2003). Since the eliminated players are no longer obliged to follow the day/night phases, they discover who the Mafia members are and the game gains new meaning for them as a performance: they can now spectate and interpret the actions and behaviours of the players through the lens of the newly acquired information.

Mechanics

The core mechanics that give rise to a rich and dynamic Mafia game are information asymmetry, physical proximity and ostracization. The different identities come to play through the succession of the “day” and “night” phases. There are debates during the “day” phases. The game is played in a confined space such as a room, where everybody can observe and expects to be observed. These mechanics lead to a game that relies heavily on observation. The space as such does not play any role; the game can be played in principle anywhere as long as all players have visual and aural contact, be it in a room, a hall, a train compartment etc.

Mafia is notable for using such a small number of mechanics. There is no reliance on tools, besides the initial mechanism for assigning roles. Also the narrative component is rudimentary and serves as the context that gives meaning to the rules, primarily as a way for naming the two factions, explaining their motivations and facilitating the succession between the two phases of “day” and “night”. The players are supported through role-playing and identities that impose restrictions on their possible actions.

3.2 Design Process

The aim of the design process of RvS is to employ the core elements of Mafia and to create an engaging playful experience that will involve players into exploring a new layer of knowledge about the city. Although the use of Mafia's game mechanics and their expansion with technology to be used outdoors is central, the conscious goal is to create a new game. Part of the challenge is to tie the game to a specific location and implement it so that it incorporates content that is specific to a site, i.e. the selection

of the physical space and the specific places and artefacts of interest in it and the identification of the learning goals. Furthermore, unlike video games, the location-based game is to be played in an uncontrolled environment, the pre-existing city, which subsists on its own. We put special attention on the design of the game, while the implementation of the game in a specific location will be briefly discussed through a case study, next.

Spatial Expansion

The most radical modification of the original game is that of designing for physical experience: the spatial expansion of the game. In a city the game is spread out, the players cannot observe each other and the narrative structure of the game does not hold any more, since it is fragmented in different locations. Also an implication of the spatial expansion is that the players who are ostracised cannot observe how the game unfolds and the performance/spectacle element of the original game cannot apply as a mechanism that engages ostracised players. In the original game it is acceptable to be eliminated and to continue participating as a spectator and in fact this is an essential element of the game. In the case of a city game this is not feasible as the players who get expelled one by one cannot observe the unfolding of the remaining game. The performance and ostracism elements cannot work in an open location because the game takes place over a larger area.

This problem of players simply waiting for the round or the game to end was addressed in other adaptations of the Mafia game. In Train Mafia [6], an earlier attempt of transferring the game out of the room, the ostracized players participate in a new game, but this just postpones the problem. A more effective solution was introduced in Resistance [25], a board-game variation of Mafia. In Resistance, scoring was introduced as a replacement for ostracism. Instead of expelling players, either faction gained a “base” in each round. Resistance is a card game and is also played in a confined space, and while scoring helps to avoid ostracism, the game mechanics still maintain a strong performance element: In each round of Resistance, only a subgroup of players participate while the others observe and wait for the round to end.

In RvS we addressed this issue by introducing the concept of critical and non critical missions and scoring rules. The factions in RvS are the “rebels” and the “spies”, the uninformed majority and the informed minority respectively. In each round all players have to complete an individual mission in a part of the city. Some missions are critical and others non critical. In each round, all critical missions must be completed successfully for the rebels to win the round (e.g. the riddles corresponding to all critical missions must be answered correctly). If at least one critical mission fails, then the spies win the round. The non critical missions have no impact on the round's outcome. However, a player is unaware of whether her current mission is critical or not. The number of critical missions in each round is equal to the number of spies (the informed minority). All missions are assigned by an elected leader for that round, who has to gain the trust of most players. A skilful spy could become leader and assign critical missions to fellow spies. If the leader is a rebel, she is able to make a judgement on the identities of the other players, based on the previous round's result and on knowledge of the critical missions. If the elected leader is a spy, then she does not need that extra information as she belongs to the group of informed minority. In this case, the leader has the chance to determine the outcome of

the next round by deciding if the spies can afford to lose a round but protect their identity, or to risk being detected by winning a round, i.e. failing a critical mission. There are numerous strategies one can build in his or her attempt to deceive or win the trust of the other players, a factor that maintains the intriguing dynamics of the original Mafia game. In short, the concepts that aid the spatial expansion include critical and non critical missions, round leaders who assign the missions, leader elections in each round and individual decisions whether to carry out or sabotage a mission.

Situated Play- Integration of Contextual Knowledge

In terms of learning outcome, the ultimate goal of RvS is to relate learning with the physical experience of playing in an urban setting. This goal was implemented in the game through player puzzles about interesting buildings and landmarks aiming to bring into play the historical layer of a city quarter. Physical involvement creates engagement and invigorates the learners in a way that is not possible with passive observation. This approach was the basis of similar games, such as Frequency 1550 [12]. In RvS, the challenges are individual missions carried out by each player in every round. The missions require the player to a) locate a site in the city, b) find his/her way to the specific site, c) find the answer to a riddle which can be accessed using a QR tag attached to a monument, or which concerns a physical landmark such as an inscription, d) use his/her mobile to suggest an answer to the riddle according to his/her role on the game. The player sees the correct answer of the riddle in the screen if she is within a short distance from the mission location (usually 10m). The player may thus consciously decide to fail the mission by intentionally giving a wrong answer. This pattern of playing activity is similar to scavenger hunt games, contextualized in the narrative and structure of RvS. As a consequence, the game cannot be played in a suburban or rural setting, unless the setting is rich in cues that can be used in the game as mission content.

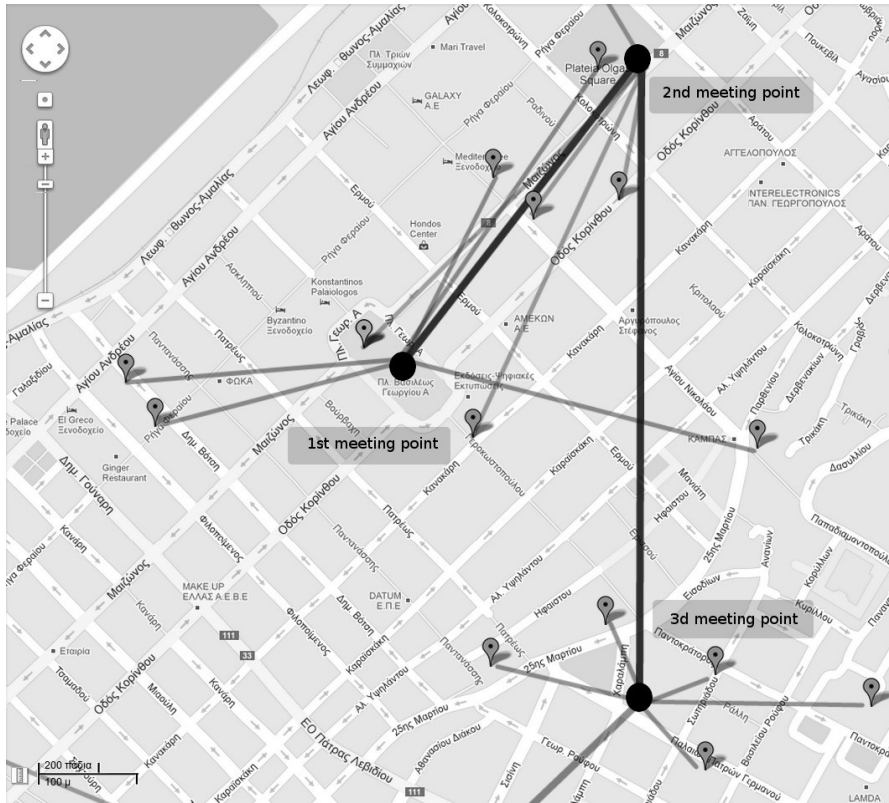


Fig. 1. The first three meeting points for the RvS game session played in Patras, Greece.

In Fig. 1 the locations of the activity of the first three missions of the game are displayed in the city centre of Patras, Greece. As it can be seen from the map, the locations of the missions and the meeting points were a few hundred meters away from each other. The puzzles had the form of questions such as “What symbol of a secret society is above the entrance of house X”, where the player had to locate the mansion that belonged to a member of a group of conspirators of the early 19th century, who had engraved the symbol of the conspiracy above the entrance of his mansion. The selection of the mission locations and of the meeting points was based on proximity. Although the city centre provides many cues for content, it proved exceedingly difficult to design the content of the missions and at the same time having an over-arching narrative that could meaningfully connect them. The missions' content drew from distant time periods (from antiquity to the 20th century) and in essence concerned facets of the city which are not widely known, but are indicative of the city's character or explain or shed light to some of the city's peculiarities or help establish a connection to the city's past. The structure of individual missions has two major drawbacks from the perspective of learning: a) the missions a player receives in each round are disconnected from one another and they do not follow a narrative path. Cohesion is exogenously imposed, by the force of the game rules and b) each player sees only a fraction of the content through the missions, a content which additionally

is different from what all the other players see. The design intention is to alleviate these drawbacks in the common meeting points, where players discuss about what they learned in their mission and justify why they did succeed. The motivation for this discussion should stem from the bluffing mechanic and the subsequent impulse to resolve ambiguities on the co-players' identities.

3.3 Rebels Vs Spies game description

In this section we present the final form of the implemented game after showing how the mechanics of the initial Mafia party game were transformed along the axes of spatial expansion and situated play/integration of contextual knowledge. In the final version of Rebels vs. Spies, the rebels are the team of the uninformed majority and the spies are the informed minority. The rebels try to successfully carry out missions but their team has been infiltrated by spies who will sabotage the missions while remaining undercover. The game is structured as alterations between meetings of the players, where they discuss and vote for a leader, and individual missions in various locations in a city centre. This cycle of: a) player gathering, b) voting for a leader, c) carrying out of missions, is repeated until the spies have been exposed or until one of the teams wins a minimum number of rounds.

At the beginning of a round the players assemble and use their hand-held devices (Android phones) to vote for a leader. The elected leader of the round has to assign missions to all the players. The players receive their missions in their devices. Some missions are critical, and if a critical mission fails, the round goes to the spies. Otherwise, if all critical missions of the round succeed, the round goes to the rebels. Only the leader knows which missions are critical. There are as many critical missions as spies. If the elected leader is actually a spy, she can assign critical missions to her fellow spies who can then try to intentionally fail the missions. After the missions have been assigned, the players move out to locations for performing the individual missions. Each player can choose to perform the mission correctly or fail it, but has no way of knowing whether the mission was critical. When a player completes the mission, the location of the next meeting is disclosed. At the end of the round all players meet at the new location and the new round begins with the voting for a new leader. In Fig. 2 some typical mobile device screenshots in various phases of the RvS game are shown.

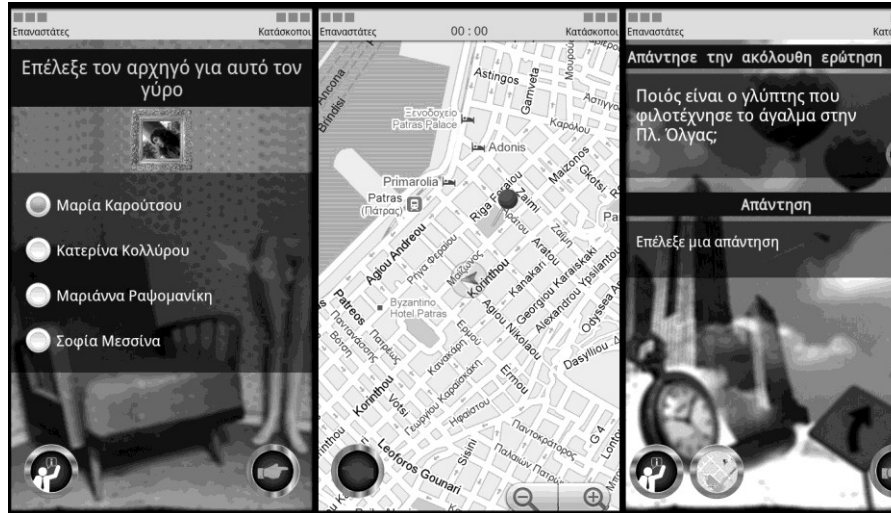


Fig. 2. RvS screenshots: (a) voting for leader, (b) mission map, (c) mission riddle.

4 Evaluation Study

Playing a location-based mobile game is imperative for understanding how it functions [23] and how the design decisions outlined previously have influenced the player experience. Rebels vs. Spies has been field-studied in the city centre of Patras, in order to evaluate the game in terms of how the modification on Mafia's mechanics have effected the aesthetics of the new game concept, while addressing how learning occurs. At the end of play, two research instruments were used: a) a questionnaire asking the view of the players on issues related to the three MDA elements and to learning and b) a focus group with emphasis on the learning experience and game mechanics.

During the design and implementation phase we were faced with two issues that influenced the learning impact and the mechanics of the game. One was related to the selection and formulation of the riddles in the missions. The other concerned the role of narrative in the game.

4.1 Study Setup

The objective of the study was twofold: a) to capture the user experience of typical players and their interaction with the city during game play activity and b) to evaluate the game design in terms of the game concept, and the specific game implementation based on the instance that was played. The number of players in the study was limited by the available devices (at the time of the study five) and by the available number of missions. There was content for 25 missions, so a game of five players could not go

beyond five rounds of play. For this reason we opted for employing a case study approach and examined a small number of players in context using data from various sources. At the time of the study, the game was at the stage of a functional prototype. While the small number of players is a constraining factor as to the extent to which the results can be interpreted, the fact that the players used a functioning prototype in a real context partly offsets this drawback. As Abowd & Mynatt note in commenting in-context evaluation, *"effective evaluation, in which users are observed interacting with the system in routine ways, requires a realistic deployment into the environment of expected use"* [1].

Five players participated, all female, aged between 26-35 yrs old. The players were of varying educational and professional backgrounds. While all the participants lived in the city, four of them did so only after adolescence and had only cursory knowledge of local history. The demographics match the requirements of a target group general enough and with a technological and local knowledge background that varies and that can approximate intended users, either playing RvS as visitors of the city centre or as occasional local players. The game started in the main square of the city and each meeting point was located in a different square of the city centre (see Fig. 1). The duration of the game was about 90 minutes, until a server failure caused the game to stop just after round three had finished and a typical walking distance was 2000m. The game took place in the early afternoon, during opening hours and streets were crowded. The data collected included a) observation notes, b) questionnaires, c) log files and d) an open-ended interview that was conducted in the form of a focus group right after the game in order to capture perceptions, concerns, impressions and user views in general. The open ended interview in the form of a focus group is a method that is considered as working well for pervasive games with short duration [23]. The focus group approach allows the emergence of a broader set of viewpoints than individual interviews. It was mentioned earlier that one of the objectives of the focus group was to describe and evaluate the learning that took place during game play. As has been noted by Stenros et al. [23], group interviews tend to fabricate narratives during the process of reflection, which is why the focus group was complemented with an individual questionnaire before the start of the focus group. It contained 51 questions that tracked several factors, which were considered to assess three aspects of the game: the game concept, the game implementation and the content for this city and the particular instance of game play. Next we offer an analysis of the transcribed data collected from the focus group and we discuss the learning implications.

4.2 Evaluation Study: Learning as Discovery of the Invisible City

Analysis of focus group data

The focus group discussion included a reflection discussion in which we asked the players to explain what they had learned. In order to further elaborate on the learning aspects of the game activity we focused our questions on what we considered the main elements of the learning activity: i.e. the riddles and the sites of the city that were involved in the game.

1. R: Did you learn something about the city that you didn't know before playing the game?
 2. ALL: Yes!!!
 3. A: We didn't know any of it.... it was all new.
 4. S: Yes, everything was new

 5. M: we walk every day by these sites but we had no idea of all these things about them
 [Extract 1]

Fig. 3. Discussion extract 1.

Our first observation from Extract 1 (Fig. 3) is that players were surprised that they uncovered facets of their city which they didn't know before. This element of new knowledge seems to be offering a new perspective into how players look at the sites of the city. This becomes more apparent if we consider the comment offered by player M. This comment seems to be indicating that the new knowledge she obtained makes things more interesting now, especially if we consider that walking the same route everyday make somebody indifferent of the surroundings.

1. R: So, what would you say that you learned?
 2. S: That the church of Pantocratoras was an ancient temple before.
 3. M: I was impressed with the information about the Mayor (information about an ex Mayor during the period 1949-1967)
 [Extract 2]

Fig. 4. Discussion extract 2.

The discussion in Extract 2 (Fig. 4) makes clearer what this new knowledge is about. The comment S offers in line 2 touches an important issue at least from a historical point of view: many churches are built on and with material taken from the deconstruction of ancient temples. This piece of information is not particularly interesting per se but it becomes so if we see it as a trigger that could raise other aspects of "city-learning" related to the use of material, the symbolic and sentimental meaning of buildings, the position of temples, the habits and beliefs of people etc. Another observation that comes from this extract is that learning about the city, at least the way it is perceived from the players, involves mainly gaining new information about the sites of the city. Juxtaposing S's comment with the fact that she lives within 50m of the church of Pantocratoras, we can see that it is highlighted again the effect of uncovering new information about sites that are weaved into everyday experience.

1. R: Did you have the chance to look around when you were playing?
 2. K: I knew the surroundings more or less.

 3. R: Do you think that the game would be useful for a visitor who doesn't know the city?
 4. S: It would take ages for someone who doesn't know the city to play the game because first he has to find out where the different sites are. Not easy if you don't know where you are going
 5. A: The game is not about "getting to know" the city, it is about "discovering the city". The game is not designed for a visitor who wants to learn what the characteristic sites of this city are. The questions are about discovering the invisible city- things that were hidden and not obvious when you look at the buildings for example.
 [Extract 3]

Fig. 5. Discussion extract 3.

Extract 3 (Fig. 5) reveals the dimensions that are required for learning and are embedded in the game. One dimension is related to space. Players identify as a prerequisite for the specific game to know where the different sites are (line 4) and this is the reason they think that the game might be not appropriate for visitors (note that on the device of player S the map didn't work correctly as it should be, see Fig. 2-b). The researchers' question in line 1 and "K's" response in line 2 reveal how space is integrated in the game: it is not a route that connects the different sites but a set of disconnected and separate points. It is not important to the game which route you take to accomplish your mission or to reach a meeting point or which site you visited before. It is also not important what you observe during the route. What is important is to be transferred from one site to the other. Thus space in the game is not continuous, it is rather perceived as a set of different points which, according to the players, seems to be appropriate not for visitors but for those who already know the city and can use the spatial knowledge they already have. In line 5 we see a distinction between getting to know the city and discovering the city which seems to indicate two different types of knowledge involved. Getting to know the city seems to be related to what we could call "content knowledge" i.e. the characteristic sites of a city, i.e. what you must see in a city when you visit it. Discovering the city is a different level of information that is not self-explanatory, i.e. a building cannot always tell its story to an inexperienced eye. It is rather about the city, its contents or also the space, and it can offer a new lens through which the city or its content can be seen.

Analysis of Questionnaire Data

The questionnaire contained 51 questions, in an attempt to track various aspects of the game but mainly to compare the findings with those of the focus group discussion and the observation.

In Table 1 we present the aggregate responses of the players, grouped by dimension. In terms of intention of use, the answers of the players are in accordance with their focus group statements that they found the game enjoyable and that they would like to play it again. Regarding the rules and concepts of RvS, in a total of 7 questions relating to implicit narrative concepts (such as the terms “rebels”, “spies”, “mission” or “sabotage”) or game rules, the players agreed that they understood the structure of the game and its rules. We received positive responses on a related question regarding the extent to which the players felt they could understand the state of the game and use this understanding as a basis to develop a game play strategy. The above answers regarding rules and control (items 2 and 3) need further attention for their interpretation. During the focus group discussion the players did exhibit some confusion regarding the game rules which shows that in the questionnaires they overestimated their own perception of the game rules. The use of familiar concepts (4 of 5 players had played the original Mafia game before) seems though to have contributed to the player's understanding of the rules and we wouldn't be surprised if players who have had no experience with Mafia found it more difficult to understand RvS.

	Dimension	Number of Questions	Spies	Rebels	Diff	Total	
			Avg	Avg		Avg	Stdev
1	Intention of use	8	4.50	4.83	0.33	4.70	0.56
2	Rules and background narrative	7	4.57	4.81	0.24	4.71	0.79
3	Control	4	3.50	4.58	1.08	4.15	1.31
4	Social expansion	2	1.75	1.67	0.08	1.70	0.95
5	Spatial expansion – Navigation	3	4.56	4.58	0.02	3.20	1.42
6	Deception pattern	3	1.67	2.44	0.77	2.13	1.30
7	Social interaction	2	1.50	3.00	1.50	2.40	1.43
8	Pace	7	2.86	2.76	0.10	2.80	1.16
9	Player engagement	2	1.00	2.67	1.67	2.00	1.15
10	Learning content	3	4.33	4.67	0.34	4.53	0.92
11	Mission design	3	2.00	2.67	0.67	2.40	1.40
12	User interface	5	3.70	4.00	0.30	3.88	1.20

Table 1. Answers of the post-activity questionnaire, grouped by dimension. Answers were on a scale of 1-5 (1 fully disagree, 5 fully agree). In the above results, larger values of a dimension are to be interpreted on the positive side.

More interesting are the answers regarding the social and spatial expansion of the game. The players answered that they were not aware of causing annoyance to non-playing bystanders, nor did they mind playing in a crowded city-centre. They had no problems of navigating in the city, but they did need a map occasionally. The questions regarding game pace (6 questions), navigation (3 questions) and social interaction (2 questions) highlight some problems regarding the spatial expansion of the game. Players found the game more interesting at the meeting points, where all players are gathered and on average they took a neutral position regarding game pace.

A reason for this might be the numerous opportunities a player has to be occupied with unrelated tasks while being alone (making unrelated phone calls, stopping to watch shop windows etc – behaviour that was observed), thus temporarily interrupting the game. Regarding mission content (item 10), the conclusions of the previous section are supported, since they found that the content was previously unknown, relevant and meaningful. Finally, an interesting note is that both spies didn't notice lack of engagement on behalf of the other players, while the rebels' answers are more neutral, that is, they found that the other players didn't take the game seriously enough. This more intense engagement for the players in the rebels team could stem from their lack of complete information. Similarly different perceptions between rebels and spies are visible on social interaction (item 7), which groups questions regarding cooperation.

5 Concluding Remarks

Research on mobile learning games which focus on addressing historical aspects of a city, reports visitor engagement, motivation and knowledge about objects of attention as important factors (see for example [12] and for a critical review see [26]). On the other hand there is a criticism questioning what the players seem to learn in the context of these games. In the analysis we offered earlier we see that the structure of the game and the riddles included in it involved mainly factual information (previous use of a building, information about the owner of the building etc). In this context the game becomes a vehicle for transferring new, “hidden” information to the player. In the context of games the search of this factual information might take place in an intriguing and pleasant way and might involve interesting processes such as hypothesis testing, reflection on actions etc [7]. There is no doubt that factual information is an important part of living the city experience. The discussion with the players helped us elaborate more on the different types of knowledge involved – way finding, getting to know the important sites of the city-. But in order to design games that can support learning in the city we need first to think what this learning involves. Learning in the city is first and foremost an embodied experience that involves much more than information. It involves the smell, the light, the feeling of cold or warm, sounds; the people living in it, their habits and their activities in various parts of the city, it involves taking in consideration what is called the city narrative [9], the collective imagery of the place. A possible design choice for infusing meaning and sense-making in playful location-based activities could involve more creative design activities in game play [26] where meaning making becomes an active process as it is introduced by the constructivist perspective [10] and it is further enhanced by the idea of developing a sense of ownership [8] over the created artefacts. Another solution is to create a background narrative that binds the various locations, landmarks and other physical objects to a coherent story. The design challenge then shifts to the non-trivial creation of such a story and its connection with the physical context in a meaningful way, as it was found that a strong narrative supports meaningful incorporation of contextual knowledge in the game [27].

Another aspect we need to consider when designing games for learning in the city is which part of learning and what kind of learning we expect to take place during game play. In many cases (e.g. Fig. 4), games can function as useful triggers for fruitful learning and not as direct mediators of the pursued learning. Learning design towards this direction could include user involvement in game construction. Technology can mediate these activities by a) providing access to content which will allow players' contribution of historic information b) allowing manipulation of game elements so that players can create different instances of mobile games c) generating mobile games based upon player manipulation of game elements and content d) supporting sharing, evaluating, ranking, reconstruction, enrichment and exchange of games among communities of players.

Apart from the above considerations, and with regard to the game as a *playful* activity and as a construct that is viewed through the lens of game design, it was evident that for the players the new experience was more than just the sum of the game mechanics. The city playground is a stage in constant commotion, which, together with the *city narrative*, are crucial factors that shape the players' experience but which elude the game designer's direct control.

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