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Óscar Mealha
Monica Divitini
Matthias Rehm *Editors*

Citizen, Territory and Technologies: Smart Learning Contexts and Practices

Proceedings of the 2nd International Conference on Smart Learning Ecosystems and Regional Development - University of Aveiro, Portugal, 22–23, June 2017

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Preface

We are proud to present the proceedings of the second International Conference on Smart Learning Ecosystems and Regional Developments (SLERD2017). Following a successful first edition in Timisoara, Romania, in 2016, the conference was organized in 2017 in Aveiro, Portugal. SLERD2017 was hosted by CIC Digital/DigiMedia Research Group at the University of Aveiro, in the period June 22–23, 2017. DigiMedia[1]—Digital Media and Interaction is an interdisciplinary research group focusing on innovation in the design of new interaction approaches for human-centered digital media applications aiming to foster interpersonal and community-oriented communication.

The conference was co-organized by the ASLERD (Association for Smart Learning Ecosystems and Regional Development[2] an international no-profit interdisciplinary, democratic, scientific-professional Association that is committed to support learning ecosystems to get smarter and play a central role to regional development and social innovation. "Smart," thus, are not simply technology-enhanced learning ecosystems but, rather, learning ecosystems that promote the multidimensional well-being of all players of learning process (i.e., students, professors, administrative personnel and technicians, territorial stakeholders, and, for the schools, parents) and that contribute to the increase of the social capital of a "region," also thanks to the mediation of the technologies. ASLERD, thus, aims at generating a concrete impact by understanding learning ecosystems and accompanying design for "smartness," fostering the development of policies and action plans, supporting technological impact well beyond prototypes and pilots, promoting networking and opportunities to discuss and debate like the SLERD yearly conference.

SLERD 2017 aimed at promoting reflection and discussion concerning R&D work, policies, case studies, entrepreneur experiences with a special focus on understanding how relevant the smart learning ecosystems (schools, campus,

[1]DigiMedia - http://digimedia.web.ua.pt/.

[2]ASLERD - https://en.wikipedia.org/wiki/ASLERD.

working places, informal learning contexts, etc.) are for regional development and social innovation and how the effectiveness of the relation of citizens and smart ecosystems can be boosted. The conference had a special interest in understanding how technology-mediated instruments can foster the citizen's engagement with learning ecosystems and territories, namely by understanding innovative human-centric design and development models/techniques, education/training practices, informal social learning, innovative citizen-driven policies, technology-mediated experiences and their impact. This set of concerns contributes to foster the social innovation sectors and ICT and economic development and deployment strategies alongside new policies for smarter proactive citizens.

Overall, we received 38 unique submissions from 19 countries, demonstrating the global interest for this research area and for SLERD2017. Out of the total submissions, after a rigorous double-blind peer-review and meta-review process, we accepted 12 full papers and 10 short papers. To complement the oral presentations of short and full papers, the SLERD2017 program also included presentations of the best ideas from the 2017 international and local student contests (not included in these proceedings). These competitions challenged local and international students to propose ideas and proofs of concept/prototypes to make learning ecosystems smarter.

The selected scientific papers aim to understand, conceive, and promote innovative human-centric design and development methods, education/training practices, informal social learning, and citizen-driven policies. The papers are organized mirroring the main conference sessions in three themes, namely (i) the elaboration on the notion of smart learning ecosystems; (ii) the investigation of the relation of smart learning ecosystems with their territory; and (iii) the identification of resources for smart learning.

SLERD 2017 contributes to foster the social innovation sectors, identifying and discussing ICT and economic development and deployment strategies alongside with new policies for smarter proactive citizens. The proceedings are relevant for both researchers and policy makers.

In summary, SLERD2017 offered an exciting program that provided an excellent overview of the state of the art in smart learning ecosystems and was an occasion for bringing research forward and creating new networks.

We are very proud of the final selection of papers, which would not have been possible without the effort and support of our excellent Conference and Program Committees, including more than 50 international researchers. We would like to thank all the ones who, in different roles, have contributed their time to organize the event with enthusiasm and commitment.

April 2017

Monica Divitini
Óscar Mealha
Matthias Rehm

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Augmented Reality and Mobile Learning in a Smart Urban Park: Pupils' Perceptions of the EduPARK Game

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Abstract. The EduPARK game is developed under a game-based learning methodology. It is designed for outdoor learning settings by employing geocaching principles and mobile Augmented Reality technologies. The game aims to develop users' authentic and autonomous learning about diverse inter-disciplinary themes in a smart urban park. It integrates learning guides for different target groups of basic education. The purpose of this paper is to present the game prototype development, which followed a design-based research approach. The evaluation of the game involved 74 pupils from two school levels (aged 9–10 and 13–14). They explored the game and their reactions were registered. Focus groups were conducted at the end of the experience. The evaluation allowed identifying positive characteristics of the game, such as immediate feedback and collaborative dynamics. Some questions included in the learning guides were perceived as difficult to understand and also some features came out to be considered for future improvements.

Keywords: Augmented reality · Mobile learning · Smart urban park · Educational games

1 Introduction

As pupils' access to mobile devices, such as laptops, tablets, smartphones and video game consoles, increases in several contexts, the debate around mobile learning (Clarke and Svanaes 2015) and its educational potential becomes more critical. The ubiquity of mobile devices extends learning, both in formal and informal settings, and when combined with Augmented Reality (AR), it has the potential to move learning to outdoor settings.

AR is a technology that enhances life experiences by employing virtual elements in real time (Dunleavy 2014). It enables pupils to be placed at the center of ubiquitous educational contexts and to interact with digital information embedded into physical environments (Gianni and Divitini 2015). In a recent report, authors point out that AR amplifies access to and interaction with information, hence, creating new learning opportunities for broader understandings (Johnson et al. 2016). Several other studies

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(Radu 2012; Pérez-Sanagustín et al. 2014; Akçayır and Akçayır 2017) suggest that AR enhances pupils' enjoyment, motivation and interest to learn. For example, Akçayır and Akçayır (2017) highlight that this type of technology provides immediate feedback and supports autonomous learning, which can have a positive effect on pupils' motivation and increase their learning performance. Moreover, AR has been shown to be able to reduce cognitive load through the annotation of real world objects and environments as well as to increase long-term memory retention (Santos et al. 2014). However, for such affordances to occur, the multimedia material should have curricular and educational relevance (Radu 2014).

AR supported by mobile devices can move learning to outdoor settings, such as Smart Cities (SC). This concept is closely related to using *smart* technology to improve city life. Studies in SC as a context for learning (smart education) show the potential of the adoption of mobile technologies to generate and collect data for situated games in the city (Gianni and Divitini 2015), namely in the so called Smart Urban Parks (SUP). SUP are based on mobile learning, i.e. on anywhere and anytime personalized learning (Naismith et al. 2004). They foster authentic and situated learning outside the classroom (Jonassen 1994), but also personal and collaborative learning within a lifelong perspective (Naismith et al. 2004). SUP are also considered contexts that can be used to promote new modes of learning in science education, for instance concerning environmental education, since the ability to understand ecosystems is enhanced by experiences in real environments (Kamarainen et al. 2013). Moreover, they have the potential to provide learning experiences that value biodiversity (Ballantyne and Packer 2002), and attract not only pupils and teachers, but also a wide range of tourists and local visitors (Ballantyne et al. 2008), especially if associated with the use of AR and mobile technologies.

One of the emerging potentials of mobile technologies exploration in educational contexts is related with digital games (Prensky 2007). Future developments in this area involve evaluating and analyzing game usage data, providing powerful tools on how to create better learning experiences, and developing game-based learning, supported by significant data about the pupils' perception and their performance while playing (Groff et al. 2015). Additionally, the competition created by games may increase pupils' engagement in challenging learning situations and improve their overall sense of enjoyment. When game's wining conditions require working with other players, collaborative dynamics can also be promoted (Hwang et al. 2015).

The EduPARK project aims to contribute to the SUP concept by designing, implementing and evaluating the EduPARK game, supported by a mobile app, to promote learning within the urban park *Infante D. Pedro*, located in Aveiro (Portugal). This game includes several learning guides for different target groups (pupils, teachers and, possibly, tourists) and is supported by geocaching principles (hunting treasures/caches with the support of technology). The innovation of this project relies on the articulation of (i) new and easy to explore technologies; (ii) geocaching games; and (iii) multidisciplinary educational resources. The beta version of the EduPARK game was tested in the above-mentioned SUP in order to gather pupils' perceptions of the game as a means to improve it. The project methodology follows a design-based research approach and this work reports the implementation and evaluation phase (Parker 2011) of the first cycle.

In the following sections, we briefly describe the EduPARK game, the methodological options, including the data gathering and analysis processes, as well as the results and their discussion. In the final remarks section, empirical-based recommendations are proposed for the improvement of the EduPARK game and for future work.

2 Development of the EduPARK Game

The EduPARK project proposes an activity that combines AR and geocaching games in a SUP, supported by a mobile app. At the present stage, a beta version of the app was already conceived. This first version comprised an interactive AR quiz-based game to be played by teams of three or four pupils, in a friendly competition approach. Each team needs to be accompanied by one adult monitor for safety reasons and also to collect observation data. The basic structure of the app is summarized in Fig. 1.

One of the initial screens of the app prompts the players to identify their team and select a learning guide (**a** in Fig. 1): one for First Cycle pupils (aged 9–10) and another for Third Cycle ones (aged 13–14). Only learning guides for these two Cycles were included in the app, because its beta version was to be tested by a convenience sample of pupils as explained in methodological options section.

The quiz questions, as well as the predefined path in the SUP, are different depending on the selected guide. A short tutorial (**b** in Fig. 1) explains how to use the camera tool to recognize the AR markers. These unlock the access to information relevant to answer a series of questions related to each specific location. Next, the players can initiate the cycles (example in **c** in Fig. 1): (i) following instructions to find a specific AR marker; (ii) using the device to recognize the prompted marker; (iii) accessing a set of multiple-answer questions; and (iv) receiving adequate feedback to answers and scores, if answered correctly. The app also provides feedback through the constant display of accumulated scores and offers a sense of progress through the number of questions answered, locations visited and caches discovered vs. the total number of these items. The app integrated the search for and discovery of three physical caches in the SUP.

To support the players' progress, the app provides a number of tools: camera (to recognize AR markers and take pictures), backpack (to see the pictures taken), compass (to support the players' orientation in the park) and a map of the park (with the players' location as well as the next location or cache to visit). At any time, the players can access the *help menu*, accessed through the blue button available at the top of the majority of screens. This menu has a *general help* screen explaining the meaning of the symbols used in the general screen of the game (see **d** in Fig. 1), and a *help screen* for each tool of the game. Finally, the last screen (see **e** in Fig. 1) displays the overall performance of the team, with the total score, the number of correct and wrong answers and the completion time of the game.

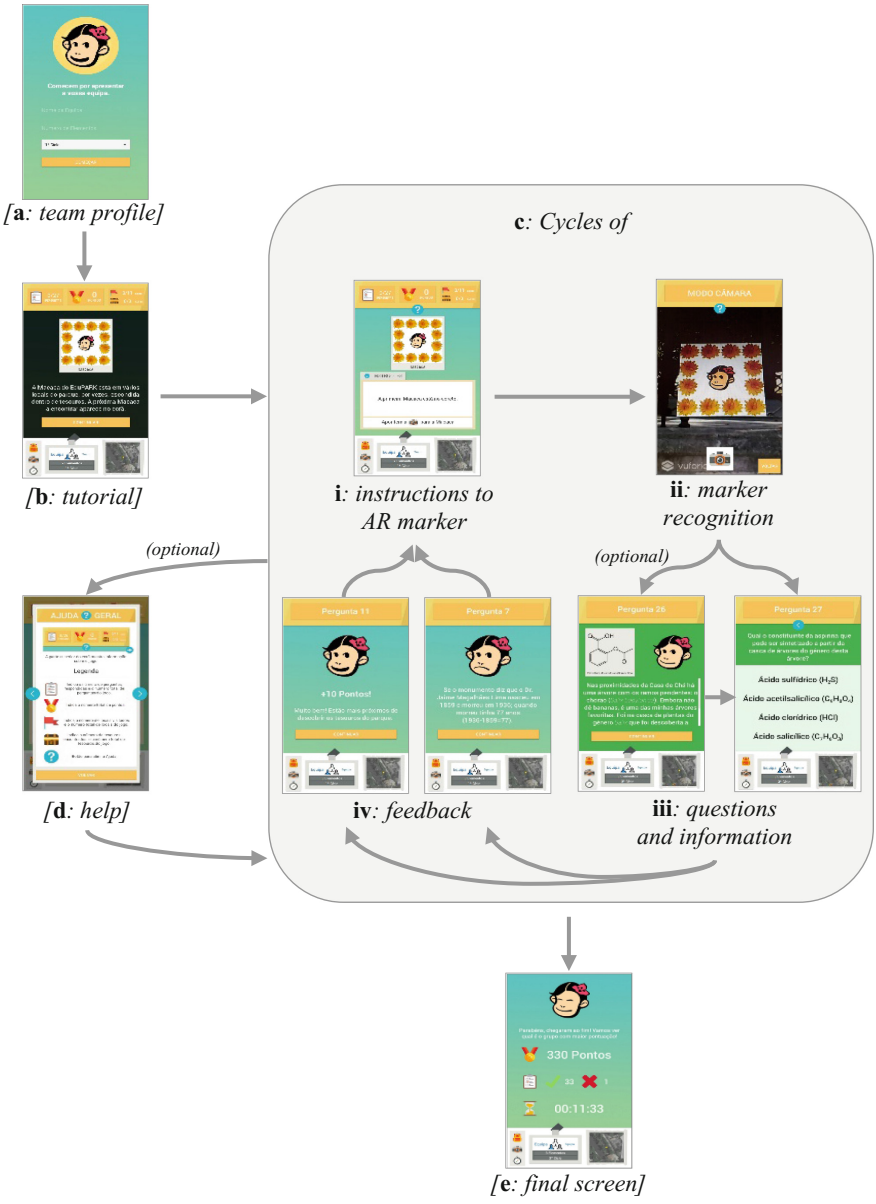

Fig. 1. Structure of the EduPARK app, illustrated by print screens of the beta version of the app, available only in Portuguese language

3 Methodological Options

As the focus of the EduPARK project is the development of a learning intervention in a real educational context, involving multiple iterations for refinement and evolution of a mobile AR game, a design-based research approach was considered suitable to achieve its objectives (Anderson and Shattuck 2012). This approach includes two or more cycles of four phases: 1. analyze the problem; 2. design and develop potential solutions; 3. implement and evaluate; and 4. reflect and report (Parker 2011). The present paper reports the results of the third phase.

The data gathering techniques selected to evaluate the game were an observation protocol and a focus group interview at the end of the activity, allowing triangulation (Amado 2014). The observation protocol was filled in by monitors and comprised two main parts: (i) a think aloud section to register pupils' behavior and perceptions; and (ii) a critical incidents section to collect information about problematic or positive events. At the end of each session, pupils were randomly distributed in two groups in order to conduct two simultaneous but independent focus groups, to facilitate the sharing of their perspectives about the EduPARK game and associated app. Focus groups have been recognized as useful tools for pilot tests in educational research, as they allow interviewees to explain their experience in depth (Williams and Katz 2001). All pupils of each focus group belonged to the same class, hence, were familiar with each other. Two focus groups had 11 pupils (Third Cycle) and four had 13 pupils (First Cycle).

The pupils were asked to: (i) classify (on a 1 to 5 scale, being 5 the maximum score) and justify their enjoyment of the experience, so that perceptions of their satisfaction could be understood; (ii) classify (using the same scale) and justify the easiness of the game, so that difficult features could be identified; (iii) propose suggestions to improve the game; and (iv) give their overall opinion of the experience. The interviews were audiotaped, and were moderated with flexibility, varying from 8 to 21 min, with an average time of 15 min. Observation notes and focus groups transcriptions were submitted to content analysis (Amado 2014), aiming to uncover the game positive features and the ones needing improvement. The categories emerged from the empirical data and are described in the next section.

The implementation and evaluation of the EduPARK game were conducted under the Open Week of Science and Technology of the University of Aveiro, in November 2016. The main purpose was to gather pupils' perceptions to improve the EduPARK game. This evaluation focuses on the pedadogical features of the EduPARK game. The technical evaluation of the app is described in another work (Pombo et al. in press). During the inscriptions period to the evaluation activities, two teachers of the First Cycle and one of the Third Cycle showed their strong interest in participating. Hence, the convenience sample of pupils/users of the app. Their characterization is showed below (Table 1).

At the beginning of the game, each group received a mobile device with the app, and the monitors presented the game and explained how to use the app.

The next section presents the results of the preliminary evaluation of the EduPARK game prototype and discusses them accordingly to the literature reviewed whenever

possible. The anecdotal evidence provided improvement suggestions that will be presented in Sect. 4.5.

Table 1. Characterization of the classes involved in the evaluation of the EduPARK game

Group	Cycle	N. of pupils	Average age	% of female	% of male
1	1st	26	9.0	69.2	30.8
2	1st	26	9.0	50.0	50.0
3	3rd	22	12.9	31.8	68.2

4 Results and Discussion

Data collection gathered from participants (focus groups) and from observations was both broad and specific, leading to concrete suggestions for improving the experience of using the EduPARK game in loco. Positive and negative perceptions of the EduPARK game are presented by categories, namely regarding enjoyment and level of difficulty. Content analysis also allowed identifying improvement suggestions for the development of new versions of the game.

4.1 Positive Perceptions of Enjoyment

First, pupils were asked to classify the activity using a scale, in which 1 stood for lower enjoyment and 5 for higher enjoyment. The answers revealed that in all focus groups, except one, the classification was 5. This implies that the activity was well rated by the pupils. This result is in line with studies mentioned before that point out that AR tools promote pupils enjoyment (Radu 2012; Pérez-Sanagustín et al. 2014; Akçayır and Akçayır 2017). Justifications provided by the pupils were diverse, ranging from perceptions that could imply the motivational value of the activity to the valorization of the outdoor activities. In the following paragraphs we describe pupils' justifications, illustrating them with examples.

The first subcategory is related with 'increased motivation', as illustrated by the citation: "The activity was enriching because it helped us to develop values and helped us to wish for more learning …" (G3 pupil) and "Pupils said this activity is really fun and cool" (G2, Observer H). This result is in line with the literature that reports that AR and digital games can promote motivation (Kamarainen et al. 2013; Pérez-Sanagustín et al. 2014; Dunleavy 2014; Johnson et al. 2016).

Pupils valued several aspects of the activity. Among them is the 'valorization of the social aspect of the activity' as mentioned by two pupils: "I liked it because we are socializing with our friends" (G1 pupil). Those results are similar to those of (Bacca et al. 2014) that reports socialization with peers as one of the advantages of AR technology. Another aspect was related with 'valorization of the outdoor activity': "I think we can achieve better results outside the classroom, because we are in physical and visual contact with the content we are supposed to learn" (G3 pupil). The possibility to establish connections with content was also reported by (Bacca et al. 2014) and it was

acknowledged to support situated and authentic learning (Ballantyne and Packer 2002; Naismith et al. 2004). Pupils also pointed to the 'valorization of the learning pace', as the citation shows: "… we learn quicker" (G3 pupil), and to the 'valorization of the immediate feedback' on the correct and incorrect answers included in the EduPARK game. For instance, one pupil stated: "I enjoyed it, because if we answered wrongly, the correct answer would show and we could learn more" (G2 pupil). The immediate feedback is related with increased learning performance (Kamarainen et al. 2013). This feature provides an individualized learning strategy to heterogeneous groups of pupils, giving an extra scientific explanation of the learning content activities integrated in the interactive quiz-based game. This is also one of the reported advantages of AR technologies in the literature, one that can promote autonomy (Kamarainen et al. 2013).

4.2 Negative Perceptions of Enjoyment

As described above, the majority of the pupils pointed out positive features of the activity, but they did not provide negative justifications. Nevertheless, some pupils highlighted some negative aspects of the activity related with the level of difficulty, which are presented below.

4.3 Positive Perceptions of the Level of Difficulty

Concerning the level of difficulty, the pupils' perceptions were rated between 4 and 5. Two groups did not justify their classification. The ones who did provided the following justifications.

'Connection with the curricular content' was one reason that pupils pointed out for considering the activity easy, as illustrated by the citations: "As we already knew the content, it was easier" (G1 pupil) or "Pupils stated that they already knew the information about the European holly [*Ilex aquifolium*]" (G2, Observer F). This result is in line with some authors' recommendation concerning AR activities that they should be educationally relevant for pupils (Akçayır and Akçayır 2017) and contextualized, which seems to be the case of the EduPARK game.

'Problem solving strategies' were observed by several monitors that stated, for instance, that: "[Initially] pupils needed the monitors' help, but then they became more autonomous in solving problems" (G2, Observer G).

'Instruction adequacy' was also observed by the monitors, who mentioned: "Pupils easily understood when they had to move to another location" (G3, Observer I).

4.4 Negative Perceptions of the Level of Difficulty

Pupils justified their lower rates concerning the level of difficulty of the EduPARK game referring to specific challenging aspects. One of the aspects is related to 'difficulties with the vocabulary', especially observed in the younger groups: "Pupils didn't know the meaning of 'fertilizer' and 'honoring'" (G2, Observer F) or "Pupils didn't know what plans of symmetry were" (G1, Observer E).

Concerning the 'location of the AR markers' pupils apparently had different views. Some considered them too easy to find: "I believe they should be physically better hidden [referring to the markers]" (G3 pupil); others too difficult: "The last one [marker] was really hard to find" (G3 pupil). Geocaching aspects of the game were also pointed out by the monitors. For example: "Pupils didn't understand how to use the compass" (G2, Observer F) or "Pupils didn't find the right direction" (G1, Observer E).

4.5 Improvement Suggestions

Pupils' improvement suggestions emerged during the activity (registered by the monitors) and the focus groups. They were related with three subcategories: (i) dynamic of the activity, (ii) types of questions, and (iii) interest of the activity.

Concerning the dynamic of the activity, several subcategories emerged. For example, pupils' opinions about the 'teams' constitution' were not consensual, as some of them preferred to work in smaller groups: "I think it would be better to play in teams of only two or three pupils" (G1 pupil), and others favored bigger teams, since "Maybe playing in bigger teams, because [more elements] can think better" (G3 pupil). These contrasting opinions can be related to differences between pupils' ages (9–10 and 13–14). Nevertheless, one of the pupils' concerns was related with the collaboration level within the team, which may be created in gaming situations, as claimed by Groff et al. (2015).

The youngest pupils proposed to 'extend the activity': "I think the activity should have more questions and cover more places in the park" (G1 pupil). This fact may be associated with a stronger level of enjoyment with the activity reported by the youngest pupils (who classified the activity with 5 points).

The following subcategories are related with pupils' suggestions for designing other types of questions for the game. Pupils proposed to include 'more subjects' in the learning guide, such as Portuguese, English, Astronomy, and Sports, as well as to include more 'diverse questions'. For instance, one pupil suggested a new type of question, based on visual recognition: "I would like to see questions that ask me to go to a location represented in a photo" (G1 pupil).

Pupils provided valuable hints to increase the interest of the activity related to the inclusion of 'different paths and sites'. For example, pupils proposed: "… we should have more locations. For instance, I think that we could focus more in the lake, since we have a very beautiful lake [in the park]" (G3 pupil); "Different paths should be implemented" (G1, Observer B). Another pupil's suggestion was related with 'preventing cheating behavior', as expressed in the following citations: "I think that the hints should be different from team to team because, when a team is behind, they can copy what the others are doing" (G1 pupil) and "Pupils think that the teams should have staggered starts during the activity" (G1, Observer D).

Finally, pupils also suggested to 'increase the competition', as revealed by these citations: "We could take a photo nearby the caches and then, the best photo would be the winner" (G2 pupil) and "One of the criterions [to win] should be the time, to increase the competition" (G3 pupil).

5 Final Remarks

The development of the EduPARK AR game follows a design-based research approach. In this work we present the implementation and evaluation phase of the first cycle. The game was experienced by pupils in a SUP, the *Infante D. Pedro* park in Aveiro (Portugal). Data gathering techniques included focus groups (with pupils) and observation (made by monitors). The authors acknowledge some limitations, such as the loss of participants' nonverbal cues (Parker 2011), as the interviews were audiotaped and not videotaped. Another aspect to consider is the fact that the pupils were interviewed in a group, which has the potential to standardize the participants' opinions (Parker 2011). However, given the available resources and setting for the conduction of the interviews, these limitations may not affect the results, taking into account that the aim of this work is to collect the players' opinions regarding the activity in loco.

Results suggest that pupils' considered the game enjoyable and easy to play. However, some negative perceptions were also pointed out. These results allowed us to propose the following design principles for educational games for SUP. The game activities should:

- increase pupils' motivation to learn (Pérez-Sanagustín et al. 2014; Dunleavy 2014; Johnson et al. 2016), by providing immediate feedback (Kamarainen et al. 2013) and promoting the socialization among peers (Bacca et al. 2014);
- value the outdoor aspects of the activity, as well as the SUP related content that promotes situated and authentic learning (Ballantyne and Packer 2002; Naismith et al. 2004);
- allow contact with nature, which seems to promote learning at a faster pace than in the classroom and may increase learning performance (Kamarainen et al. 2013);
- offer opportunities to learn local culture and history issues;
- be connected with the curricular content (Bacca et al. 2014) and employing problem solving strategies in order to develop autonomous learning;
- provide adequate instructions, by attending to eventual difficulties to interpret the game questions and using suitable vocabulary. If support is given, new vocabulary can be introduced;
- be challenging, for instance, by balancing the difficulty of the AR markers localization.

The above-mentioned design principles may contribute to create better learning experiences supported by significant data retrieved from pupils' perceptions and their performance while playing (Groff et al. 2015). Pupils' offered several relevant improvement suggestions, such as: increase the activity length, provide different paths and sites in the SUP, increase competition to promote enjoyment and learning (Prensky 2007) while enabling collaboration (Groff et al. 2015), as well as diversify the type of questions and of disciplines involved. These suggestions will be considered in future work under the EduPARK project. The results show that combining mobile technology with outdoor gaming activities allows learning to move beyond traditional classroom environments that pupils can explore and, simultaneously, make connections with curricular content. Furthermore, the EduPARK game provides collaborative, situated and authentic

learning. It also offers new challenges, opens up horizons and opportunities for Science Education. The EduPARK game already integrates some of these recommendations [dynamic of the activity, types of questions, and interest of the activity], because the EduPARK researchers recognize that the game competition is an important aspect for promoting enjoyment and learning (Prensky 2007). In line with (Kamarainen et al. 2013), it is also acknowledged that the Aveiro SUP has important educational potential to develop formal and informal learning about ecological conservation, biodiversity and city historical patrimony, which will be reinforced in future versions of the EduPARK game.

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