Exploring the role of mobile game-based apps towards a smart learning city environment – the innovation of EduCITY

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Abstract

Purpose – This paper provides a general review related to a wider project, aimed at developing a mobile game-based app on Education for Sustainable Development within a smart learning city environment. It aims to address guidelines for a new action-oriented transformative pedagogy that is essential for the development of key competencies for sustainable development based on literature review and on the exploration of a previously created mobile game-based app – the EduPARK app.

Design/methodology/approach – This work gives continuity to the developed work, through a qualitative interpretive methodology of case study. Its main objective is to analyze the opinion of Higher Education students, who have experienced the EduPARK app, in what concerns the impact of the educational strategy into: (1) learning value, (2) authentic learning, (3) lifelong learning, and (4) conservation and sustainable habits. Data collection instruments involve students' reflections triangulated to a questionnaire.

Findings – The study finds that the potential for promoting conservation and sustainable habits is widely recognized by app users, although they mention that this aspect can be further explored. This legitimates the relevance of the new mission – EduCITY, which focuses on enhancing sustainability key skills of citizens who participate in extension game-based activities on strategic paths in the city.

Originality/value – This paper comprises a set of guidelines and best practices for educational stakeholders and decision makers in order to enhance a wider integration of this outdoor mobile innovative approach in education, promoting smart and sustainable attitudes of citizens within the cities.

Keywords Education for sustainability, Smart cities, Educational games, Augmented reality, Mobile application

Paper type Research paper

Introduction

Societies across the globe are facing new challenges arising from the pace of technological progress and globalization (Rieckmann, 2018), which include growing complexity, uncertainty and degrading ecosystem services upon which societies and their cities depend. Most cities environmental footprints are quite alarming and can threaten the natural resources required for sustainable lifestyles for all (Girardet, 2017).

Education for Sustainable Development should have a central role to empower learners to take informed decisions and responsible actions for environmental integrity (Konrad *et al.*, 2020) through engaging citizens who are not only users but also producers, consumers and

The EduPARK project is financed by FEDER—Fundo Europeu de Desenvolvimento Regional funds through the COMPETE 2020—Operational Programme for Competitiveness and Internationalisation (POCI), and by Portuguese funds through FCT—Fundação para a Ciência e a Tecnologia within the framework of the project POCI-01-0145-FEDER-016542. The EduCITY project is financed by Portuguese funds through FCT—Fundação para a Ciência e a Tecnologia within the framework of the project PTDC/CED-EDG/0197/2021.

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"owners" of their city. Sustainable cities and communities, according to the 2030 Agenda, are a relevant society goal that directs us to efficient urban planning and management to deal with challenges brought about by intense urbanization, such as traffic congestion, waste management and pollution. To address these challenges, citizens must be empowered to both reflect on their actions and to act in complex situations in a sustainable manner (Rieckmann, 2018), so opportunities to develop key competences in sustainability must be promoted (Wiek *et al.*, 2011).

In addition, the educative purpose of mobile devices (Huang *et al.*, 2017; Pombo *et al.*, 2019; Aznar-Díaz *et al.*, 2021) and their use in game-based learning approaches have been documented as effective (Huang *et al.*, 2017; Beça *et al.*, 2018). The competition created by games may increase people's engagement in challenging learning situations and improve their overall sense of enjoyment (Beça *et al.*, 2018). Future developments in this area involve how to create better learning skills, supported by the users' experience *in situ* and their performance while playing pervasive and challenging games (Floricel, 2020; Zhonggen, 2019).

The proposed approach, when combined with emerging augmented reality (AR) technologies, act as an immersive interface (Sousa Santos *et al.*, 2015) that enables participants to interact with digital information embedded in the physical environment. This supports situated learning (Laine, 2018; Akçayır and Akçayır, 2017), as learning moves to outdoor settings, such as Smart Cities. This concept is closely related to using smart technology to improve city life, turning it inclusive, safe, resilient and sustainable.

Cities transformation into smart ones directly contributes to goal 11 – Sustainable Cities and Communities of the 2030 Agenda for Sustainable Development (2030 Agenda). Smart Cities should be open to all citizens and enable access to information, facilitating their participation, collaboration and transparency at all levels (Gianni *et al.*, 2016; Carlos and Santos, 2018). Studies in Smart Cities as a context for learning (Smart Education) are framed in goal 4 – Quality Education of the 2030 Agenda and can be used to promote new learning ecosystems, integrating technologies, enhancing the multidimensional well-being of all learning players and raising public understanding of science (Mealha *et al.*, 2017).

Smart Education shows the potential of adopting mobile technologies to generate and collect data for situated games in the city (Gianni and Divitini, 2015; Sung, 2015). Games act as motivators and enablers of sustainability-oriented citizen action (Floricel, 2020). Smart Urban Parks (Sung, 2015) are based on mobile learning frameworks in green parks, i.e. on anytime/anywhere personalized learning, fostering situated, personal and collaborative learning (Wishart, 2018; Chee *et al.*, 2017). They are particularly important concerning conservation and sustainable attitudes, since the ability to understand ecosystems is enhanced by experiences in real environments, influencing attitudes about nature (Nyberg and Sanders, 2014), which is framed in 2030 Agenda's goal 15 – Life on Land. Outdoor collaborative learning activities using AR are an approach scarcely found in educational research, so little is known about its potential to support lifelong learning contributing to the sustainability of cities.

Stemming from the success of the previous project EduPARK, the need to span its goals and impact is evident. EduPARK is a FEDER (European Regional Development Fund funds)- and FCT-(Foundation for Science and Technology) funded project, whose quality was recognized abroad, as it was the winner of the Team Award for Innovation in Teaching and Learning attributed by the European Consortium of Innovative Universities (Pombo and Marques, 2019). From here emerges EduCITY that opens the park boundaries to the city, and to other cities, seeking to strengthen the university network with community partners, such as schools, municipalities and enterprises. This network fosters knowledge further and creates opportunities for everyone to contribute to the cities' sustainability, meaning that other cities will be inspired by and replicate the ideas and solutions emerging from this project.

The big idea is to enhance sustainable cities through the creation of a disruptive smart learning environment, sustained by a mobile app with AR games with educational location-aware games, following a specific path, which integrates digital educational resources, such as simulations based on data from environmental sensors, 3D animations, informative spots, among others. These games are co-created and comprise enjoyable and interdisciplinary challenges to be explored by any citizen while touring the city.

This paper presents a general review related to the previous EduPARK results, and it aims at finding a set of guidelines and best practices helpful to enhance a wider integration of this outdoor mobile innovative approach in education, promoting smart and sustainable attitudes of citizens within the cities.

First, the research methodology is presented, which includes the case study "The EduPARK app", followed by the description of study participants and data collection and analysis. Then, results are presented and discussed, and finally, some guidelines for a new action-oriented transformative pedagogy are put forward in the Findings section, as the main contribution of this study.

Research methodology

This research gives continuity to the already developed work, through a qualitative interpretive methodology (Amado, 2014) of case study (Yin, 2014) using a cohort of Basic Education Higher Education students, by addressing the research question: "What is the educational value of the EduPARK strategy, involving a mobile game-based learning with AR app, for exploration in outdoor settings, according to the students, who will befuture teachers?" Thus, the main objective is to analyze the opinion of Basic Education undergraduate students, who have experienced the EduPARK activities, in what concerns the impact of the educational strategy into (1) learning value, (2) authentic learning, (3) lifelong learning, and (4) conservation and sustainable habits. To reach this aim first the case study and participants are described, for contextualization, followed by the data collection and analysis approach.

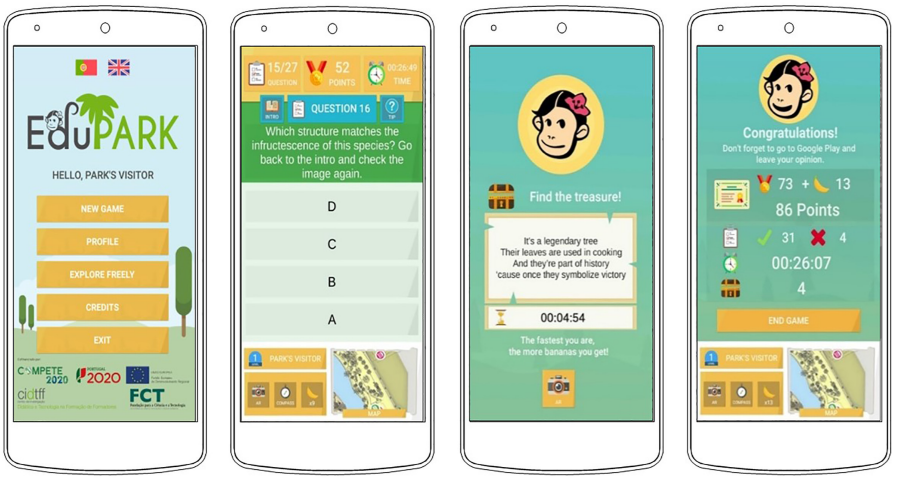
EduPARK app

EduPARK (http://edupark.web.ua.pt/) is a research and development project that integrates a multidisciplinary team from the fields of education, computer science and biology, from the University of Aveiro (Portugal), in agreement with the literature on developing educational games (Tobias *et al.*, 2014).

The project general aim is to promote innovative practices of cross-subjects learning using mobile devices, AR and games in the outdoors. The project leverages the rapid development of mobile technologies, which is allowing the integration of new and diverse functionalities in the devices to provide active and contextualized learning, as well as to encourage new teaching approaches.

The project team employed a design-based methodology, with four cycles of development, integrating users' feedback, to create and improve one of its main products, the EduPARK AR app (Pombo and Marques, 2018).

The app can be used autonomously, and at any time, using the game mode, or freely explored (see Figure 1A), promoting authentic learning so that visitors can enjoy a healthy walk while learning. The game includes several learning guides for different target groups: teachers and students from Basic to Higher Education, and also visitants and general public, in a lifelong learning perspective, as the tourist guide is also offered in English. The guides integrate multidisciplinary issues under the Portuguese National Education Curriculum and propose interdisciplinary questions (Figure 1B) articulated to educational challenges along



Source(s): Pombo (2018)

Figure 1.
EduPARK app: (A) initial screen with the language options, profile and different modes of app use; (B) multiple choice question; (C) treasure hunt challenge; (D) final screen with results

the park in a logic of treasure hunt (Figure 1C). The game enables visitors to explore and access information about the plant species living in the city park, historical references, different multimedia contents and a park's map allowing people's interaction. The goal is to accumulate points by answering correctly the questions, visualizing AR markers that help to answer questions and finding virtual caches/treasures (Figure 1D).

Participants

This study involved Higher Education students, particularly, 86 graduating students of the 2nd year of the course of Basic Education, from the Department of Education and Psychology of the University of Aveiro. These students participated in the "Nature Integrated Sciences II" curricular unit (NIS II), under the topic "Biodiversity and Conservation", in two editions: 46 students in the 2017/18 academic year and 40 in 2018/19. This is a convenience sample.

In each edition, graduating students had a preparatory lesson of two hours for a theoretical contextualization on mobile learning, game-based learning and AR (consisting on a brief definition of each of those concepts, as the students were not familiar with them), as well as a first introduction of the EduPARK project, the app features, field trip preparation and the assessment strategy. Students' previous experience with game-based and/or AR-based learning technologies was scarce.

Some students reported they had already played Pokémon Go, but no other examples were mentioned. The field trip preparation involved: (1) the clarification of rules and work to be done during the activity, (2) the definition of work groups with three elements and (3) the app installation in one Android device per group of students.

The preparatory lesson was followed by the field trip to the park, to play the EduPARK app game directed at Higher Education students. The field trip activity lasted between one hour and twenty-two minutes and one hour and fifty-five minutes.

The assessment strategy was discussed with the graduating students in the preparation lesson and included: (1) the student elaboration of three original questions that may be used in a game-based mobile learning, which were orally presented and discussed in class; (2) the filling in of an online individual questionnaire to evaluate the activity and (3) a reflection on

this teaching methodology, written in groups as autonomous work. The topic "Biodiversity and Conservation" weighted 20% of the whole curricular unit assessment.

Data collection and analysis

This research relies on data from two sources of evidence, an individual questionnaire and a reflection group work, as a document collection.

Participating students were asked to fill in an online questionnaire individual and anonymously (goo.gl/sEQqV4) about one week after the infield session. The response rate was 100%. The questionnaire includes mainly closed questions of multi-choice, item selection and a five-point Likert scale, although it contains open questions, as well. It consists of three parts: (1) students' profile, including their use of mobile devices for learning and mobile learning advantages and disadvantages; (2) EduPARK app usability and (3) EduPARK activity educational value. Parts (1) and (2) were analyzed through descriptive statistics and content analysis and are fully presented in Pombo and Marques (2019), while part (3) is the focus of this paper.

To study the EduPARK activity educational value, document collection triangulation was made through the analysis of graduation student reflections that were confronted to the questionnaire results, supporting and reinforcing the main findings. The coding process was held by two researchers through the use of WebQDA software. The categories of analysis were previously established according to the objective of this research: (1) learning value, (2) authentic learning, (3) lifelong learning, and (4) conservation and sustainability habits.

The groups of the written reflections were the same groups that explored the app in the park. Thirty group reflections were turned over. Qualitative data analysis was completed, in the logic of content analysis and resorted to the categorization of responses based on the impact levels mentioned above with support from the literature. To decrease the risk of erroneous interpretation of the factors acknowledged by the students, in each document (group reflection) the coder coded only the existence or absence of each analysis dimension, even if the students refer to it more than once.

Data from the two sources (individual questionnaire and reflection group work) were triangulated to provide a comprehensive knowledge of the students' opinions. Data collected did not include personal data, and no individual participant can be identified through the data collected.

Results

Through the analysis of questionnaire answers, students reveal that they gave special relevance to the learning value of the app, since about 52% assigned level 5 of relevance (very relevant) and 33% assigned level 4 (relevant). With regard to authentic learning and lifelong learning, most students attributed level 4 as relevant, with 50 and 38%, respectively. Notably, 31% of students took a neutral position regarding the value of the EduPARK activity for lifelong learning. In terms of conservation and sustainability habits, levels 4 and 5 of relevance are again expressed, around 34–36%, so these graduating students consider that the EduPARK activity might be useful to promote environmental education.

Considering the students' reflections, thirty groups of students turned in their reflection about the possible impact of the EduPARK strategy on: (1) learning value, (2) authentic learning, (3) lifelong learning, and (4) conservation and sustainability habits. Table 1 summarizes the students' views, with a total of 108 individual impacts identified and an average of 15.4 per document/group reflection.

The most cited category was "Learning value", with 46 mentions in its four dimensions of analysis. Students' revealed that they give special relevance to the "content" learning

Category	Analysis dimension	Citations examples	Frequency
Learning value—ability of the EduPARK activity to promote learning (46 assertions)	*Content*—ability of the activity to support substantive knowledge learning (e.g. about the flowers of a species)	"There is acquisition of knowledge in the most diverse areas, such as Biology, Geology, History, Physics and Chemistry" R26	21 with positive assertions; one with critics
	Skills—ability of the activity to promote skills development (e.g. team work)	"While walking through the Infante D. Pedro Park, we notice species of trees and plants that were unknown for us before. After this activity, not only we now know their name, but we can also identify them in other places" R13	5 with positive assertions
	Values—ability of the activity to stimulate participants' appreciation of qualities that are important for society (e.g. conservation of the environment)	"We brought with us [from the EduPARK activity] a luggage of values, both at the personal and at the collective levels" R20	12 with positive assertions
	Not specified—ability of the activity to promote learning, without referring at which dimension(s)	"In our view this mobile app is innovative, since it uses Augmented Reality, which is an added value for learning" R3	8 with positive assertions; one with critics
Authentic learning—ability of the EduPARK activity to promote learning in a real-world context, in ways that are meaningful, useful and relevant to the participant	–	"we believe that an application like EduPARK helps children to initiate meaningful learning about biodiversity, since students have to answer questions based on what they see (. . .) the app takes students to a park where they observe their environment, reflect and learn from it" R21	23 with positive assertions
Lifelong learning—ability of the EduPARK activity to support ongoing and voluntary learning throughout participants' life	–	"is a tool that, addressing different themes, from the arts to the various sciences, contributes to lifelong learning, arousing people interest and attention to their surrounding environment, at different ages" R15	13 with positive assertions
Conservation and sustainability habits—ability of the EduPARK activity to promote in its participants routines of thinking and behaving for sustainability	–	"students realize the importance of the park's biodiversity and they can have a more real sense of what is happening around them, thus creating habits and responsibilities for the conservation and sustainability of the environment" R5	26 with positive assertions
		Total	108

Table 1.
Impact of the EduPARK activity, according to the graduating students

promoted by the activity, as it was mentioned 21 times, which can be illustrated with the following citation: The experience with EduPARK makes learning more fun and dynamic, avoiding the classic model that children and adults have contact with. There is acquisition of knowledge in the most diverse areas, such as biology, geology, history, physics and chemistry in an environment that is inspiring and fully linked to what is learned, which makes learning more consolidated, since direct observation is a key point (Reflection number 26). Also, quite present in students views it that the activity also promotes learning "values" (12 mentions), particularly in what concerns sustainability, as we will discuss further, and learning "skills" (with five mentions). Eight groups mentioned the activity has impacted on learning, without mentioning at each level. One group took a critical position: It is important to mention that the use of mobile devices as a learning tool does not replace any other traditional learning ways, since they are considered as an additional resource to support and enrich the teaching and learning processes, in which the student is the main constructor of knowledge (Reflection number 21).

The category "Conservation and sustainability habits" included 26 positive assertions. Graduating students acknowledged the relevance of the nature contact provided by the activity and its value for creating environmental awareness in its participants. They said, for example, "We consider that this app is highly recommended when teaching biodiversity, since, through this quiz-treasure hunt, students learn about their environment in a meaningful way" (Reflection number 21) and "this type of activities can create awareness of the need to take care of the park and its species" (Reflection number 29).

Twenty-three student reflections considered the EduPARK activity had a positive impact on "Authentic learning". As citations we can point out: "It is a new way of learning and captivating people, especially students, to put their knowledge and everything they learn in the classroom into practice" (Reflection number 3) and "we believe that an app like EduPARK helps children to initiate meaningful learning about biodiversity, since the students have to answer questions based on what they see . . . the app takes students to a park where they observe their environment, reflect and learn from it" (Reflection number 21).

The categories less relevant for these two cohorts of graduating students were "Lifelong learning" with 13 positive assertions. As a citation example, students mentioned: "we also consider that this game encourages learning throughout life, as its supporting app is available to any smartphone" (Reflection number 7). This result suggests that the graduating students acknowledge the contribution of the EduPARK project to the area of Open Education.

Through the triangulation of both data collection (questionnaire and students' reflections), it is possible to note that students reveal that they gave special relevance to the learning value of the app. This result shows that graduating students consider that this activity has a high impact on its participants' learning and, hence, contributes to a positive perception regarding the educative potential of mobile learning strategies.

Most graduating students acknowledged the activity's value for learning, but not all students recognized it in a lifelong perspective, this fraction of students fails to grasp the EduPARK activity potential for the regular citizens that might use the EduPARK app for an educational walk in the park, in their leisure time.

Finally, in terms of conservation and sustainability habits, graduating students recognize the EduPARK activity, of using a mobile app with AR to play a game and learn in a green park, is relevant for environmental education.

Findings

This study results allow to answer the research question "What is the educational value of the EduPARK strategy, involving a mobile game-based learning with AR app, for exploration in

outdoor settings, according to Higher Education students (future teachers)?" According to the graduating students, the EduPARK strategy has educational value as it:

(1) is based on mobile technologies, which they are used to learn and consider having more advantages than constraints associated;

(2) involves using an app easy to use and

(3) has a high impact on its users' authentic learning, particularly in the area of conservation and sustainability habits.

From other previous studies (Pombo, 2018; Pombo and Marques, 2019; Pombo *et al.*, 2019), the EduPARK revealed a strong impact in the Educational field, not only in the local context but also in national and international context. It moved learning from traditional classrooms to natural spaces that students can physically explore, making connections with curricular contents, in the Aveiro park.

Results from other studies (Pombo and Marques, 2018, 2019) show that, according to students and teachers of different educational levels, the EduPARK app is easy to use and reached high usability and a strong educational value. The potential for promoting conservation and sustainability habits is widely recognized by app users, although they mention that this aspect can be further explored, which legitimates the relevance of the EduCITY project. From the need to enlarge EduPARK's scope, EduCITY emerges by opening the boundaries of the park to the city, and to other cities, seeking to strengthen networking with other partners (schools, municipalities and enterprises) fostering knowledge further and enabling opportunities for everyone to contribute to sustainable cities.

In fact, results show that to develop an innovative technology-enhanced practical solution that can be replicated elsewhere, some specific elements should be considered, such as the use of: (1) smart technology, such as AR; (2) outdoors instead of four-walls classroom; (3) game-based apps; (4) self-directed and authentic learning strategies; (5) inter and multidisciplinary approach, linking formal and informal learning, and (6) collaboration fostering a community-based participatory approach in a social constructivism philosophy.

This set of guidelines and best practices are described below, so they can be helpful to enhance a wider integration of this outdoor mobile innovative approach in education, promoting smart and sustainable attitudes of citizens within the cities:

(1) Smart technology

This innovative pedagogy uses real-world pervasive and familiar technology (mobile devices) for 'learning by doing' following a whole-school approach to engage communities in sustainable change, as well as to enhance healthy behavior and better life quality. The literature showed that mobiles can be associated with moving learning from the classroom to outside, for more authentic learning settings (Chee *et al.*, 2017; Herrington and Herrington, 2008; Wishart, 2018; Huang *et al.*, 2017). However, the EduPARK team considers that these technologies can play a much more prominent role in education than that. One of the new technologies that can be integrated in mobile devices is AR, as mobiles can support overlaying virtual elements onto real objects and locations, thus, augmenting the reality with additional information in compelling and meaningful ways (Akçayır and Akçayır, 2017; Laine, 2018).

For example, AR 3D models can be used to support visualization and comprehension of phenomena or concepts outdoors, in ways that are not possible with traditional books (Akçayır and Akçayır, 2017). This technology combination can effectively engage and motivate students for learning in several school levels and contexts (Akçayır and Akçayır,

2017; Pombo and Marques, 2018; Sousa Santos *et al.*, 2015). EduPARK is augmenting the Infante D. Pedro Park to support authentic and cross-subject learning. With the app, park visitors can easily access virtual information that complements and sustains the interpretation of real natural and social phenomena – the AR resources produced by the team – through a relatively inexpensive technology, the mobile device, owned by most of the Portuguese population, including young children (Mascheroni and Cuman, 2014).

(2) Outdoors

The use of challenging paths that move education outside of the classroom combines learning with healthy lifestyle habits and with enjoyable time. This combination is relevant for formal education, for instance, during lecturing time, as well as for non-formal and informal education, for example, during leisure time or holidays (Pombo, 2018). Results point out the anytime/anywhere learning, including outdoors, by the use of mobile devices; and, also the supporting of community learning, as its resources are available to the wider public in a green park usually used to walk, but now can also be used to learn. As the educational laboratory of the EduPARK is a green park in the city, these activities are particularly important in what concerns conservation and sustainable attitudes of citizens about nature, contributing to promote smart, sustainable and inclusive growth in society.

(3) Game-based apps

Game-based learning is a well-known promoter of learner motivation and engagement, as pointed by participating students and in line with the literature (Chee *et al.*, 2017; Huang *et al.*, 2017; Tobias *et al.*, 2014), particularly if the games are designed considering the desired learning objectives (Tobias *et al.*, 2014). The mechanics of game play make this approach attractive, and are used with the aim of maximizing motivation, in line with the recommendation of Tobias *et al.* (2014), promoting the enjoyment of learning curricular content, while supporting an authentic learning that lasts (Herrington and Herrington, 2008).

(4) Self-directed and authentic learning strategies

Self-directed and authentic learning establishes relationships between curricular concepts and real-life situations and through the use of resources already existing in the park to reach curricular learning objectives in an authentic and contextualized way (Herrington and Herrington, 2008). Graduating students explicitly mentioned the EduPARK promotes meaningful learning namely about biodiversity, since the learners have to answer questions based on what they observe locally. In the EduPARK approach, students can establish connections between their environment (what they can see, observe closely and even touch) and school learning content, through discussion with their classmates.

(5) Cross-subject approach

The cross-subject learning is also an important element. Participating students acknowledged that learning within the EduPARK occurs in diverse subject areas, such as biology, geology, history, physics and chemistry. The literature reveals that mobile learning research for cross-subject learning is not frequent (Chee *et al.*, 2017) and, at a first stage, EduPARK also started to integrate only science subjects, but rapidly history issues joined the app content, as well as physical education, mathematics, visual arts and languages.

(6) Community-based participatory approach

Concerning collaborative learning linked to a community-based participatory approach, graduating students valued the EduPARK activity's ability to promote team work for

learning, as the game educational challenges can promote collaborative discussion of ideas among group members (Pombo and Marques, 2018). In fact, the project's recommendation is to play the EduPARK game in small teams, although it is perfectly playable individually. This recommendation is in line with research that suggests collaboration is more effective than competition to reach learning achievements (Laine, 2018). However, game-based learning also enhances competition among different groups, which may increase pupils' engagement in challenging learning situations and improve their overall sense of enjoyment (Laine, 2018).

Considering the above-mentioned guidelines and best practices found in literature and in the presented experience, the new smart learning city environment is being designed in order to enhance a wider integration of an outdoor mobile innovative approach in education, promoting smart and sustainable attitudes of citizens within the cities. The EduCITY project's unquestionable contribution for the knowledge progress is its innovative framework based on a grounded, participatory and user-centered approach for the development of key competencies for sustainable development, by using smart technology and moving Education to a Smart City. This is anchored on a community-based participatory project integrating AR location games based on challenges, to be explored in the city, not only by students in formal or non-formal contexts but also by citizens and tourists in informal educational contexts, in a social constructivism approach. It also involves masters and PhD students, embracing training and research.

In EduCITY, the use of this innovative pedagogy uses real-world pervasive and familiar technology (mobile devices) for "learning by doing", where the AR games allow environmental awareness in the city – a living laboratory of experimentation – as citizens are "active scientists" and agents in sustainable changes, in a citizen science logic while they're effectively improving their sustainability skills.

EduCITY's innovation lies in: (1) the use of the territory as a living experimental laboratory, moving Education to a real-life context; (2) the use of widely-used intelligent technology with AR mobile games; (3) community participation giving opportunities for all to actively contribute, in a social constructivism approach; (4) wide knowledge sharing among the university, schools and the wider community; and (5) the applicability of this approach to any city to build a digital, green and healthy future for everyone. Its mission is much more than a traditional research and development project. It is a challenging and ambitious endeavor where citizens commit to transformation and engage in it for the benefit of cities' quality of life and sustainability.

As a final note, in technology-driven societies, such as the current one, the gap between the use of mobile devices inside and outside educational institutions can lead to students' disengagement, impacting negatively on their academic success. The creation of a disruptive learning environment, leveraging from games' motivational potential and from green parks' authentic and contextualized learning opportunities, such as EduPARK, and now EduCITY, supports learning ecosystems to get smarter and more effective. The author believe that many more people might explore this strategy with effects on future teaching and learning practices.

Further studies are needed with bigger and more diverse samples to better understand the educational value of this mobile game-based app. Hence, future research should collect data with broader samples, namely other school level students, teachers of different areas, as well as the public in general, to triangulate different target public opinions. Furthermore, future work related to the development of the EduCITY smart learning city environment will allow to analyze the progress of both apps, not only in terms of usability but also in educational value, and to understand if this strategy may improve the key skills of citizens who participate in this kind of extension activities.

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