RAISING STUDENTS' AWARENESS ABOUT NATURE CONSERVATION: FROM THE PARK TO THE CITY

Rita Rodrigues, Lúcia Pombo and Margarida M. Marques
Research Center on Didactics and Technology in the Education of Trainers (CIDTFF), Department of Education and Psychology (DEP), University of Aveiro, Portugal

ABSTRACT

Mobile devices, augmented reality (AR), and outdoor games can be mobilized to promote Education for Sustainable Development and, thus, to sensitize to nature conservation. The EduCITY project combines mobile learning, AR, and environmental sensors towards sustainability education and creates opportunities for citizens to contribute to their city's sustainability. This paper presents a study that articulates the previous project, the EduPARK, with the current one, the EduCITY. While EduPARK was developed within an urban park, EduCITY expanded its geographical area to the entire city. This study aims to analyze students' perceptions regarding changes in their nature conservation attitudes after exploring an urban green park in a mobile AR game-based learning activity. For this purpose, 233 basic education students (from school-year 5 to 9) played a game for environmental education, available in the EduPARK app, at the Infante D. Pedro Park (Aveiro, Portugal). Through a mixed method approach, data collection was focused on students and included two questionnaires, applied before and after the game activity; a focus group guide; and an observation grid. Results show a strengthening of positive attitudes towards nature conservation. Moreover, students mentioned that their nature conservation future intentions are focused on preserving natural resources, combating resources' waste, recycling waste, reducing pollution, and protecting fauna and flora. Students also revealed willingness and concern to teach friends and family about what they have learned with the EduPARK game. The EduCITY intends to give continuity to these practices throughout Aveiro city. This is anchored on a community-based participatory project integrating AR location games based on challenges, to be explored in the city, in formal, non-formal, and informal educational contexts, in a socio constructivism approach. This study adds to the literature on education for Sustainable Development, by revealing that it is possible to sensitize school students to nature conservation through mobile AR game-based approaches in the outdoors, which can be a first step to promote positive nature attitudes.

KEYWORDS

Outdoor Learning, Mobile Learning, Game-based Learning, Augmented Reality, Education for Sustainability, Nature Conservation Education

1. INTRODUCTION

In our modern society, the protection of nature and environment is becoming increasingly important. An essential approach to address these issues and change people's behavior is Education for Sustainable Development (ESD). Faced with the challenge of promoting the sustainable development of the planet and humanity over generations, UNESCO decided to invest in education, and its recommendations will guide international and national educational policies to educate citizens to make more informed and responsible decisions (United Nations 2015)

This study adds to research in ESD and intends to contribute to the 2030 Agenda for Sustainable Development goals (UNESCO, 2015). With that aim, an educational quiz game entitled "O Verdinho [The green game]" was developed and integrated into the EduPARK app. Among all the Sustainable Development Goals, the following were selected to be addressed by this educational guide: i) goal 3: good health and well-being; ii) goal 4: quality education; iii) goal 12: responsible consumption and production; iv) goal 13: climate action; v) goal 14: life below water and vi) goal 15: life on land (United Nations Educational Scientific and Cultural Organization, 2017).

Mobile devices, augmented reality (AR) and outdoor games can be mobilized to promote ESD and, thus, to sensitize to nature conservation. Mobile devices can create more active learning experiences, which improve student engagement and learning. Moreover, can amplify motivation, which is a vital aspect of learning, deliver information when needed, and encourage students to solve problems and satisfy their curiosity (Su & Cheng, 2015).

In addition, engagement and motivation are some of the main factors that impact student performance during a learning process (Fatih, Kumalija & Sun, 2018). Mobile AR technologies offer a suitable pedagogical tool for ESD, as they enable students to learn and reflect on their behaviors by exploring the game. Furthermore, AR technology has opened new opportunities for building more attractive and pedagogical learning settings and is regarded as a type of "next-generation" pedagogical media for promoting learning quality, especially for outdoor exploration activities (Huang, 2019).

Teaching and learning that takes place outside the classroom, especially outside the school building, has other values and qualities, such as supporting contextualized and authentic learning by the direct contact with the phenomena to teach and learn, when compared with the more traditional form of education, taking place inside the classroom (Pombo & Marques, 2019). As a pedagogical approach, outdoor learning approaches may have something to offer since they support holistic and experiential learning and enable the integration of knowledge and skills from a range of discipline areas. Outdoor and environmental education research suggests that educational experiences in outdoor settings can be significant in developing environmental sensitivity and knowledge (Paixão, Jorge & Martins 2013).

This paper presents a study that articulates the previous project, the EduPARK, with the current one, the EduCITY. The initial project, EduPARK, developed an app that promotes an interdisciplinary, active, and contextualized learning experience through innovative teaching strategies that combine mobile learning, game-based learning, and AR, and integrates geocaching principles in an outdoor environment. Its educational laboratory was an urban green park, the Infante D. Pedro Park, in Aveiro (Portugal), where students and teachers from nearly all educational levels, and the broad public as well, could play educational treasure hunt games that prompted them to follow a path through several points of interest. The EduCITY project emerged from the need to expand the EduPARK to the city, so EduCITY combines mobile learning, AR, and environmental sensors towards sustainability education and creates opportunities for citizens to contribute to their city sustainability.

The next topic in this work describes the study's methodological options, which include the description of the EduPARK activity. Data collection, analysis procedures, and tools are also presented in this section. Follows the results presentation and discussion section, based on the results obtained through a student questionnaire (before and after the activity), a focus group, and an observation grid. Finally, some conclusions are put forward.

2. MATERIALS AND METHODS

This paper reports a mixed methods study that aims to analyze students' perceptions regarding changes in their nature conservation attitudes after exploring an urban green park in a mobile AR game-based learning activity. To answer the research question "How do the strategies used by EduPARK, with the exploration of "O Verdinho [The green game]", promote students' awareness about nature conservation?", the research team organized 13 activities for students to play the game. These activities involved 233 students (from school-year 5 to 9), from formal (involving schools) or non-formal (involving study and leisure centers) educational contexts. In each activity, students were organized in groups of 2-5 elements, according to the availability of adults to accompany the students in the park. Each group played the game for an average of one hour using a smartphone of the project, to reduce technological problems and concerns. The quiz game was previously downloaded to the mobile devices and no internet connection was required to play *in situ*. The game was developed under the first author's Ph.D. work (Rodrigues, Pombo & Neto, 2020).

This section comprises two subsections: i) a description of the EduPARK activity with "O Verdinho [The green game]"; and ii) data collection and analysis approaches and tools.

2.1 The Activity with "O Verdinho [The Green Game]"

The EduPARK activity was organized in various steps. At the beginning of the activity, all students were briefly informed about the research project and asked to fill in a pre-game questionnaire. All students who participated in the game were authorized by their parents. The game was developed for students of the 2nd and 3rd Cycle of Basic Education in formal and non-formal educational contexts.

In the activity, students played the quiz game "O Verdinho [The green game]" integrated into the EduPARK app (Figure 1) to be played at the Infante D. Pedro Park. The game includes 30 multiple choice questions about Science, Maths, Physical Education, and Citizenship Education. This quiz game was enriched with AR and other multimedia resources, such as videos and images, to promote student learning. Considering the influence that multimedia resources have on student learning, it was considered pertinent to include these resources in the game to assess the impact of their use in outdoor teaching and learning environments.

Figure 1. Students at the Infante D. Pedro Park playing "O Verdinho [The green game]" integrated into the EduPARK app

With this game we intend to influence positively the behavior of students towards nature conservation, focusing on the following topics: a) Waste (reduce, reuse, and recycle), b) Lake and biodiversity, c) Water and Energy, and d) Pollution. All these topics are related to an area of the park.

Students follows a path in the park through fifteen points of interest. In each one, students are prompt to answer one or several questions that require analyzing multimedia resources or their surroundings. For each question it was necessary to develop: i) question introduction and audio narration; ii) image, video, or audio (multimedia resources); iii) the question formulation; iv) four answer options (1 correct option and 3 incorrect options); v) feedback for correct and incorrect answers with audio narration; vi) multimedia resources for the feedback; vii) accumulated points (in correct answers) or points removed (in incorrect answers); viii) associate AR marker; and ix) instructions to find the AR marker (Figure 2).

After answering all the questions about the four topics, the users are challenged to find a virtual treasure in the park. Hence, geocaching principles are explored to enhance the gameplay experience for the users of the EduPARK app, by finding hidden virtual treasures to promote curiosity, a powerful intrinsic motivator (Pombo & Marques 2019).

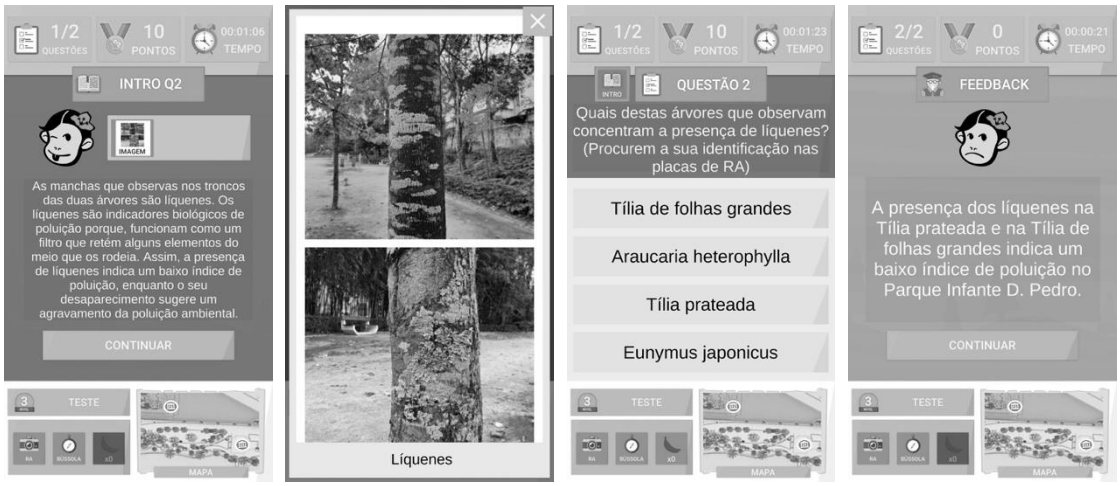

Figure 2. Game illustrative screens

After the game, the students filled in a post-game questionnaire and participated in a focus group. The activity ended with a small prizes attribution to the teams with the best performance. However, all students received a participation award.

2.2 Data Collection and Analysis

Data collection included two questionnaires, applied before and after the game activity, one focus group interview guide, and an observation grid. Data was collected anonymously and did not include any personal information or set of information allowing the identification of specific participants.

The questionnaires were similar and complement each other. The aim is to: i) Analyze students' knowledge about nature conservation and what changed at this level through the educational game, and ii) Assess the impact of the game-based activity on changing students' attitude concerning of nature conservation, as perceived by the students. For this work, only the second aim was considered. Hence, the students' answers that were analyzed were: a) the open question asking to mention three "environmentally friendly attitudes"; and b) the question with seven sentences in a Likert scale.

The purpose of the focus group was to gather students' opinions regarding the evaluation of the EduPARK game, by collecting data on different kinds of evidence, such as the game's interest, willingness to change attitudes towards nature's conservation, knowledge, and insights. The students involved were randomly chosen by the adult who accompanied each group, and it was clarified that their collaboration was voluntary. Parents authorized their participation through an informed consent statement handed before the game.

Regarding the observation grid, a checklist was created with several inferences, divided into three well-defined categories, to facilitate completion by each observer. For this article, only the category of nature conservation is considered. The grid was given to each observer before the activity, and was filled in during the game, whenever they observed a certain inference, or at the end of the activity. The observers were teachers and monitors who accompanied the groups and members of the EduPARK project.

Regarding the results of the EduPARK game app, descriptive statistics (a quantitative analysis) of the responses to the game "O Verdinho [The green game]" was carried out. Regarding the two questionnaires, all multiple-choice questions were analyzed quantitatively, except an open-ended question that was analyzed qualitatively using the WebQDA software, as well as responses to the focus group, through content analysis. The observation grid was filled in by 46 observers, particularly the researcher, the teachers/monitors who accompanied the students, and some EduPARK researchers, and it was analyzed quantitatively.

In this research, the quantitative data were analyzed through descriptive statistics and presented in the form of tables. The qualitative data were analyzed in the logic of content analysis and resorted to the categorization based on students' responses (Amado & Vieira, 2017). The questionnaire results were triangulated with the student's responses to the focus group to analyze the value of this game for the promotion of nature conservation attitudes (Coutinho, 2019).

3. RESULTS AND DISCUSSION

This section starts with the analysis of students' responses to the open questions of the questionnaires (before and after the activity). Before the activity, the nature conservation measures most mentioned by students were recycling, reducing water consumption, and preserving the atmosphere. After the activity, students mentioned again these nature conservation measures. However, they mentioned as well new measures related to the game topics, namely: recycling cooking oil, reducing microplastics, reducing food and textile waste, and preserving lichens bees, and turtles.

Through the analysis of the questionnaire responses, before the activity, a high percentage of students considered important to preserve nature (Table 1). Regarding the sentence 1 "My actions contribute to the increase of the greenhouse effect", the results do not allow taking conclusions since students' opinion are divided similarly, about 30% of answers are *neutral*, 36.5 % are *disagree* and *strongly disagree*, and 26.2% are *agree* and *strongly agree*.

The same happens in the sentence 5 "I'm not used to check the composition of my hygiene products, to see if they have microplastics in their composition", where 26.2% of students answer neutrally, 34.8% answer *agree* and *strongly agree*, and 30.9% *disagree* and *strongly disagree* with the statement.

On the other hand, students answered with more certainty, answering *agree* and *strongly agree*, to the sentence 2 "At home, I separate the waste for recycling" (71.2%), sentence 6 "I feel good when I have environmentally friendly behaviors" (83.2%), and sentence 7 "I feel capable of encouraging friends/family to conserve nature" (71.1%).

Moreover, 67% of students revealed consciousness regarding one of the biggest environmental problems today, the pollution of beaches and oceans, through their answer to the sentence 4 "When I go to the beach, I don't care about the waste I produce". In addition, 54.1% of students expressed regret when they use more energy, water, or fossil fuels than they need, while 29.2% of students responded neutrally to sentence 3.

Table 1. Students' perceptions before the activity regarding their attitudes toward nature conservation

Sentences	***Likert scale***				
	Strongly disagree	***Disagree***	***Neutral***	***Agree***	***Strongly agree***
1. My actions contribute to the increase of the greenhouse effect.	17,2%	19,3%	29,2%	15,9%	10,3%
2. At home, I separate the waste for recycling.	3,9%	5,2%	11,6%	30,9%	40,3%
3. I feel guilty when I use more resources (energy, water, fossil fuels…) than I need.	4,7%	3,9%	29,2%	28,8%	25,3%
4. When I go to the beach, I don't care about the waste I produce.	42,5%	24,5%	11,2%	9,0%	5,6%
5. I'm not used to check the composition of my hygiene products, to see if they have microplastics in their composition.	13,3%	17,6%	26,2%	24,5%	10,3%
6. I feel good when I have environmentally friendly behaviors.	0,9%	1,3%	6,0%	24,0%	59,2%
7. I feel capable of encouraging friends/family to conserve nature.	2,1%	1,3%	16,7%	36,5%	35,2%

Voided answers: 7,7%

An overall view about the answers to the questionnaire applied after the game indicates that students felt more capable and confident in answering the questions, since the percentage of neutral responses decreased when compared to the questionnaire applied before the game. This may demonstrate that students respond with more certainty after playing the game (Table 2). On the other hand, these data revealed that, after the activity, most students became more aware of the change in their attitude towards nature conservation.

Table 2. Students' perceptions after the activity regarding their attitudes toward nature conservation

Sentences	***Likert scale***				
After this activity…	***Strongly disagree***	***Disagree***	***Neutral***	***Agree***	***Strongly agree***
1. …I will contribute to the increase of the greenhouse effect.	56,2%	18,0%	7,3%	5,6%	4,7%
2. …I will separate the waste for recycling.	0,9%	1,7%	6,9%	24,9%	57,9%
3. …I will do my best not to use more resources (energy, water, fossil fuels, etc.) than I need.	3,4%	3,0%	18,9%	30,0%	36,9%
4. …I won't worry about the waste I produce on the beach.	60,5%	16,7%	4,3%	7,3%	3,0%
5. … I will start checking the composition of my hygiene products, to see if they have microplastics, which are harmful to the environment.	4,7%	3,4%	30,0%	30,9%	23,2%
6. …I feel that I should always behave in an environmentally friendly way.	0%	0%	2,6%	23,6%	66,1%
7. …I feel more able to encourage friends/family to conserve nature.	1,3%	2,1%	11,2%	33,0%	44,6%

Voided answers:7,7%

As mentioned earlier, in the pre-game questionnaire it was not possible draw conclusions regarding the students' opinions about their attitudes towards the greenhouse effect. However, in the post-game questionnaire, the students felt more able to state their opinion in sentence 1 "I will contribute to the increase of the greenhouse effect", as the answers in the *neutral* option dropped expressively (-21.9%) and there was a small number of students (10.3%) who answered *agree* or *strongly agree*. On this matter, during the focus group, only one student reflected on the increase in the greenhouse effect, saying: "*If we continue to pollute as we are now, the animals will be homeless"*.

Regarding sentence 2 "I will separate the waste for recycling", the percentage of students stating they will recycle after the activity increased from 71.2% to 82.9%. This indicates that more students were acknowledging the importance of separating waste for recycling. This sentence generated a lot of discussion in the focus group, where the students mobilized topics addressed in the game, particularly the separation of used cooking oil for recycling: *"I intend to separate waste, such as cooking oil."; "I'm going to talk to my parents about using the oil collection tank"* and *"I'm going to talk to my mother about the cooking oil, we usually pour the used oil at home."*

Part of the students (67%) *agree* or *strongly agree* whit the sentence 3 "I will do my best not to use more resources (energy, water, fossil fuels, etc.) than I need". In the focus group, the two ideas most discussed by the students were food waste and water-saving measures. Regarding food waste, the students mentioned game content: *"Buy less bread! I will never go to the bakery again to buy too much bread, just one for each person."* In addition, students valued water and expressed their willingness to save this resource: *"When I'm brushing my teeth, I used to leave the faucet running and now I'm going to start turning it off."*

The sentence 4 "I won't worry about the waste I produce on the beach", purposely written in the negative to assess students' attention when filling in the questionnaires, demonstrates that students are concerned with the waste in the beach. After the activity, more students (+ 10.2%) marked *strongly disagree* or *disagree*. In the focus group, the students demonstrated that they were concerned about the pollution of beaches and oceans and were aware of the need to adopt actions in the future to reduce it, particularly plastic pollution, as shown by the statement: *"The most worrisome thing for me is air pollution and plastic on the ground and in the sea. Poor turtles!"*.

The sentence 5 "I will start checking the composition of my hygiene products, to see if they have microplastics, which are harmful to the environment" was the one that obtained the highest percentage of students selecting the *neutral* option (30%), which is most likely associated with the student's lack of knowledge about the topic. After the activity, more students *agree* (+ 6.4%) and *strongly agree* (+ 12.9%) with

the statement. In the focus group, the students highlighted this aspect: *"with the videos and images we learned about microplastics"*.

Moreover, students' answers reflect a degree of enthusiasm for the change in nature conservation attitudes, as they revealed feeling more capable of having "environmentally friendly" behaviors. In addition, students felt more confident and able to encourage friends and family to conserve nature, as a minority marked the options *disagree* and *strongly disagree*. It should be noted that more than 9.4% of the students marked the option *strongly agree* in the post-game questionnaire. This is also evident in the responses to the focus group: "*It is important to have knowledge about everything that is going on and apply it and this activity was important for that, for us to learn and change"*.

In short, the data collected through the answers to both questionnaires (before and after the activity) showed that the students were more aware of the relevance of conserving nature and that they intend to change some of their attitudes towards the planet.

Finally, the observation grid emphasized these results. From the perspective of the observers that accompanied the students throughout the game, during this activity, students referred to nature conservation attitudes that they take daily, whilst making associations with the game contents. Moreover, students created expectations about nature conservation attitudes that they would pass on to family and friends. Observers also mentioned that AR and multimedia resources, integrated into the app, promoted motivation and nature conservation learning.

4. CONCLUSION

According to UNESCO (2015), it is essential to raise awareness and sensitize students to environmental problems, intending to raise their awareness to nature conservation. This paper summarizes the results of several activities of playing the "O Verdinho [The green game]" integrated into the EduPARK app, developed with the aim of raising awareness concerning attitudes towards nature conservation.

Firstly, this study results reveal the participant students were already well informed about some of the topics explored through the game. Nevertheless, it was also evident that, after the activity, they became more confident, aware, and sensitized to other environmental problems.

Regarding nature conservation attitudes presented by students, recycling and reducing water consumption were the two most mentioned. However, results indicate that students were more sensitized, after the activity, because they mentioned new attitudes related to the game topics, namely: recycling cooking oil, reducing microplastics, reducing food and textile waste, and preserving lichens, bees, and turtles.

After the activity, students mentioned being concerned about reducing resources waste, recycling waste and used cooking oil, reducing pollution caused by microplastics, and protecting fauna and flora, more specifically protecting bees, as they are endangered species. Moreover, students showed that they felt more capable of conserving nature, as they revealed willingness to sensitize friends and family about what they have learned with the EduPARK game.

The EduPARK app proved to be an educational tool with great potential for Education for Sustainable Development (ESD). Innovative interdisciplinary practices, combined with curricular integrated outdoor activities supported by mobile technologies, allowed to sensitize students for nature conservation. The EduCITY intends to continue these practices throughout Aveiro city. Hence, EduCITY 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 can be inspired by it, and replicate the ideas and solutions emerging from this project.

This project is anchored on a community-based participatory approach integrating AR location games based on challenges, to be explored in the city, in formal, non-formal, and informal educational contexts, in a socio constructivism approach. In terms of future work, within the EduCITY project, it is proposed to carry out activities related to ESD with a higher number of students and teachers from different school contexts, and the general public.

This study adds to the literature on ESD, by revealing that it is possible to sensitize school students to nature conservation through mobile AR game-based approaches in the outdoors, which can be a first step to promote positive nature attitudes.

ACKNOWLEDGEMENT

This work is funded by Portuguese funds through FCT – Foundation for Science and Technology within the framework of the EduCITY project "PTDC/CED-EDG/0197/2021". The EduPARK project is funded 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 within the framework of the project POCI-01-0145-FEDER-016542.

The first author's work is funded by Portuguese Funds through FCT with a research grant (SFRH/BD/139048/2018) within the Doctoral Program in Multimedia in Education.

The third author's work is funded by Portuguese funds (state budget), through University of Aveiro, in the scope of the framework contract foreseen in the numbers 4, 5 and 6 of the article 23, of the Decree-Law 57/2016, of August 29, changed by Law 57/2017, of July 19.

REFERENCES

Amado, J. & Vieira, C 2017, 'A validação da investigação qualitativa', in João Amado (ed), Manual de investigação qualitativa em Educação , Imprensa da Universidade de Coimbra, Coimbra, pp. 359–378.

Coutinho, C 2019, Metodologia de Investigação em Ciências Sociais e Humanas: Teoria e Prática 2nd edn, Edições Almedina, Coimbra.

Fatih, Y, Kumalija, J & Sun, Y 2018, 'Mobile learning-based gamification in a history learning context', in 14h International Conference Mobile Learning 2018, Lisboa, pp. 143–147.

Huang, TC 2019, 'Seeing creativity in an augmented experiential learning environment', Universal Access in the Information Society, vol. 18, no. 2, pp. 301–313.

Paixão, F, Jorge, FR & Martins, H 2013, 'Aprender no jardim: matemática criativa com a sombra', in Encontro ensinar e aprender matemática com criatividade dos 3 aos 12 anos, Associação de Professores de Matemática, Viana do Castelo, pp. 17–29, retrieved from <http://hdl.handle.net/10400.11/2146>.

Pombo, L & Marques, M 2019, 'Educational Mobile Augmented Reality EduPARK game: Does it improve students learning?', in I Sánches, P Isaías, P Ravesteijn, & G Ongena (eds), 15th International Conference Mobile Learning 2019, Utreque, pp. 19–26.

Rodrigues, R, Pombo, L & Neto, T 2020, 'Aprender a conservar a Natureza: construção do guião educativo integrado na aplicação móvel EduPARK', in A Carvalho, F Revuelta, D Guimarães, A Moura, C Marques, I Santos, & S Cruz (eds), Atas do V Encontro sobre Jogos e Mobile Learning., Centro de Estudos Interdisciplinares do Século 20 (CEIS20); Universidade de Coimbra -Coimbra, Coimbra, pp. 502–510, retrieved November 30, 2022, from <http://hdl.handle.net/10316/89364>.

Su, CH & Cheng, CH 2015, 'A mobile gamification learning system for improving the learning motivation and achievements', Journal of Computer Assisted Learning, vol. 31, no. 3, pp. 268–286.

United Nations 2015, Transforming our world: the 2030 Agenda for Sustainable Development, retrieved October 18, 2022, from <https://www.refworld.org/docid/57b6e3e44.html>.

United Nations Educational Scientific and Cultural Organization 2017, Educação para os Objetivos de Desenvolvimento Sustentável Objetivos de aprendizagem, retrieved from <http://unesco.org/>