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e-Society

and

Mobile Learning

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Proceedings

Edited by
Piet Kommers
Inmaculada Arnedillo Sánchez
Pedro Isaías

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INTERNATIONAL CONFERENCES

ON

E-SOCIETY 2022

AND

MOBILE LEARNING 2022

PROCEEDINGS OF THE INTERNATIONAL CONFERENCES

on

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Edited by Piet Kommers, Inmaculada Arnedillo Sánchez and Pedro Isaías

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e-Society

FOREWORD

These proceedings contain the papers of the 20th International Conference on e-Society (ES 2022) and 18th International Conference on Mobile Learning (ML 2022), organised by the International Association for Development of the Information Society, held virtually during 12-14 March 2022. Due to the unprecedented situation caused by the COVID-19 pandemic, this year the conferences were hosted virtually.

The e-Society 2022 conference aims to address the main issues of concern within the Information Society. This conference covers both the technical as well as the non-technical aspects of the Information Society. Broad areas of interest are:

- e-Government / e-Governance
- e-Business / e-Commerce
- Technology and Society
- e-Learning
- New Media and E-Society
- e-Health
- Information Systems
- Information Management
- COVID-19 & Digital Transformation

The Mobile Learning 2022 Conference seeks to provide a forum for the presentation and discussion of mobile learning research which illustrate developments in the field. In particular, but not exclusively, we aim to explore the theme of mobile learning under the following topics:

- Learning analytics and mobile learning
- Cloud computing and mobile learning
- Pedagogical approaches, models and theories for mLearning
- mLearning in and across formal and informal settings
- Strategies and challenges for integrating mLearning in broader educational scenarios
- User Studies in mLearning
- Learner mobility and transitions afforded by mlearning
- Socio-cultural context and implications of mLearning
- Mobile social media and user generated content
- Enabling mLearning technologies, applications and uses
- Evaluation and assessment of mLearning
- Research methods, ethics and implementation of mLearning
- Innovative mLearning approaches
- Tools, technologies and platforms for mLearning
- mlearning: where to next and how?

These events received 152 submissions from more than 28 countries. Each submission has been anonymously reviewed by an average of 4 independent reviewers, to ensure the final high standard of the accepted submissions. Out of the papers submitted, 27 received blind referee ratings that signified acceptability for publication as full papers (acceptance rate of 18%), while some others were published as short and reflection papers. The best papers will be selected for publishing as extended versions in the Interactive Technology and Smart Education (ITSE) journal (ISSN: 1741-5659) and also in the IADIS International Journal on WWW/Internet (ISSN: 1645-7641).

In addition to the papers' presentations, the conference also included one keynote presentation by Professor Pedro Isaias (Information Systems & Technology Management School, The University of New South Wales, Australia) and a Special Talk by Wilson Ramon Hernandez Parraci (Ph.D. Student, Northern Illinois University, USA).

As we all know, a conference requires the effort of many individuals and this year we faced a new challenge that brought us more together. We would like to thank all members of the Program Committee for their hard work in reviewing and selecting the papers that appear in this book. We would also like to thank all the authors who have submitted their papers to this conference. We wish to thank all members of our organizing committee.

Last but not least, we hope that everybody enjoyed the presentations, and we invite all participants for next year's edition of the International Conference on e-Society and Mobile Learning.

Piet Kommers, University of Twente, The Netherlands
ES 2022 Program Chair

Inmaculada Arnedillo Sánchez, Trinity College Dublin, Ireland
ML 2022 Program Chair

Pedro Isaías, Information Systems & Technology Management School, The University of New South Wales, Australia
ES 2022 and ML 2022 Conference Chair

March 2022

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MOBILE LEARNING

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MOBILE LEARNING GAMES WITH AUGMENTED REALITY IN A PARK - SYSTEM FOR CLASSIFICATION OF QUESTIONS FOR QUIZ GAME CREATION

Lúcia Pombo and Margarida M. Marques
Research Centre on Didactics and Technology in the Education of Trainers (CIDTFF)
Department of Education and Psychology, University of Aveiro, 3810-193 Aveiro, Portugal

ABSTRACT

This study used Bloom's Revised Taxonomy to examine 30 questions produced for a mobile quiz game with augmented reality contents to be explored in a formal learning context, in an urban green park, in Portugal. The game was co-created by 14 in-service teachers involved in a 50h training that aimed to promote the collaborative development of open digital educational resources that foster Science, Technology, Engineering and Mathematics (STEM) learning based on game approach and supported by mobile devices in outdoor settings. This is a qualitative study, based on the questions planning documents produced by the teacher trainees, which was treated using a hybrid process of inductive and deductive content analysis. The results indicate that teachers developed questions that, in the learner point of view, fall in the lower taxonomy levels, namely Remember, Understand, Apply and Analyze. Moreover, the most frequent type of question required "Direct application" of contents already known to real situations and mobilization of information expected to have been already covered at school, in a "Consolidation" approach. The empirical results suggest that the highest levels of Bloom's Revised Taxonomy (Evaluate and Create) are only achievable, during the process of game creation, and not while playing the game. Suggestions were made regarding future research, such as to analyze the process of game co-creation by teachers familiar with this classification system, to triangulate with the current study. This work is relevant for teacher trainees and teachers to promote higher quality game-based learning in teaching practices, as well as its associated resources.

KEYWORDS

Classification of Questions, Mobile Learning, Game-Based Learning, Teacher Training, Qualitative Study

1. INTRODUCTION

The concept of Mobile Learning Games has become popular in teaching and learning contexts as they can mobilize various types of skills. The main idea is to use game mechanics, such as competition, rewards, or simply curiosity in order to captivate the learners' attention and impulse them to learn (Dondlinger, 2007). There are a lot of different types of mobile learning games. Location-based mobile learning games bring together four of the most popular and current eLearning trends: mobile learning, digital storytelling, gamification, and location-based learning (Johnson et al., 2015), to unlock educational content through storytelling, rich digital media, location-awareness, maps, augmented reality (AR), and gamification strategies (Edmonds & Smith, 2017).

Location-based is one of the most interesting kinds of mobile learning games even when explored in formal contexts, as it implies to go out of four classroom walls and go to nature spaces where users can explore. Mobility also opens the possibility of situated learning in various physical settings. It turns learning into a personal and engaging experience where surroundings are linked to educational contents. Location-based mobile learning games can shift the focus from mere identification of content to interactive discovery that enhances and extends the way students experience learning from the environment and with each other (Edmonds & Smith, 2016).

When used correctly, game features enhance the learners' experience with emotion, which has positive effects on engagement and memory (Marfisi-Schottman & George, 2014), and therefore they promote situated cognition and authentic learning in educational environments. Although the benefits of mobile learning games have been recently studied, there are few reports of teachers being involved in the creation of

learning apps as well as embedded resources. Therefore, it is crucial to investigate further to identify characteristics of situated learning environments, which led to specifying characteristics of authentic activities that teachers and instructional designers can use when designing learning experiences. For that purpose, Reeves and colleagues (2002) propose ten characteristics that provide students the opportunity to: (i) engage in problems/projects with real-world relevance; (ii) address ill-defined problems and (iii) complex tasks through sustained investigation; (iv) examine tasks from differing perspectives with the support of diverse resources, and (v) collaborate with other learners and (vi) reflect on their learning experiences. Additionally, for instructors who wish to provide authentic learning experiences, the work that students undertake should (vii) be applicable to a variety of subject areas; (viii) integrate with assessments; (ix) result in meaningful products; and (x) reflect a variety of solutions and possible competing outcomes. The authors also sought to emphasize that authentic learning in mobile education is feasible with intentional instructional strategies and appropriate educational technologies.

Considering the above-mentioned it is vital to provide teacher training to support teachers to use educational applications, to design proper activities and games, and adapt them to their course material and specific learning situations. It is also important to involve teachers in the creation of tools that enable the development of educational games, and moreover to provide them investigation evidences that mobile learning games, compared to other types of learning materials, can allow the construction of new concepts by players in a much funnier, interactive and dynamic way (Sampaio et al., 2012), and that their use in education can contribute to an increase of students' motivation and skills development (Sindre, 2009). For example, mobility offers new possibilities for enriching games and enhancing the users' experience by taking advantage of real objects (e.g. plants, buildings, tiles) in real contexts (e.g. natural parks, archeological or geological sites) (Daniel et al., 2009). Several studies have also shown that physical excitement caused by walking, running or jumping during the game increases player engagement (Bianchi-Berthouze, 2013). When combined with quiz games, a treasure hunt game can have additional benefits. A treasure hunt is a game in which players attempt to find hidden items with a series of clues. Because this type of game pushes players to explore the environment and get familiar with it, it is very well appropriate to teach about the characteristics of real items, locations and environments.

User friendly quiz games with immediate feedback, whether the student answers correctly or incorrectly, can provide valuable information in order to improve engagement in the game, and most of all, it can provide pedagogical benefits if the feedback is constructive and motivational. Game rewards such as extra points or unlocking the next part of the story, can also help motivate the learners to physically move to the next location (Marfisi-Schottman & George, 2014) to successfully conclude the game, and with learning gains. As the process of constructing educational mobile games can be as beneficial as the act of playing, and as there is a scarcity of educational resources for educational mobile games with AR, which integrate curriculum contents, the authors developed a teacher training workshop focusing on designing learning materials and questions to integrate in a mobile app. Therefore, this paper emerges from the need to create a classification system suitable for questions integrated in AR mobile games, in an outdoor context, to provide a greater diversity and a better quality of educational resources and questioning, towards constructivist pedagogy and situated and authentic learning. For that purpose, a process articulating inductive and deductive coding was applied. The theory-driven categories were the categories of cognitive processes from the revised Bloom's Taxonomy: Remember, Understand, Apply, Analyze, Evaluate, and Create (Anderson et al., 2001). These were articulated with data-driven categories, regarding the classification of quiz questions. The idea is to develop a system for classification of questions that can be used by teachers to diversify the type of questions they create, prompting different cognitive levels and also producing challenging questions. This classification system is also useful to support the evaluation of educational resources.

The implications for practice of this study is that teachers should be encouraged to use mobile apps integrating quiz games to increase new learning or provide consolidation activities in a different environment. Teachers also should facilitate mobile learning quiz game opportunities to encourage learning outside of the classroom. The system for classification of questions should be helpful to support teachers to design and use mobile app-based quiz games, and integrate them in their classes.

2. METHODOLOGICAL OPTIONS

This work presents a qualitative study (Merriam & Tisdell, 2015) based on documents produced by teacher trainees, which were treated using a hybrid process of inductive and deductive content analysis (Bardin, 2016; Xu & Zammit, 2020). The study's main aim is to develop a system for classification of questions

integrated in mobile quiz games for outdoor contexts, based on the work developed by 14 in-service teachers under a 50h teacher training workshop. Qualitative studies are one of the most common forms of research in Education and require a flexible and data-driven research design (Hammersley, 2013). Hence, the focus is on developing rich descriptions of the phenomena under study, as contextual data are required for other researchers and practitioners to be able to relate the study findings to their own work contexts (Kivunja & Kuyini, 2017).

The research question is: How can a system for classification of questions support teachers in creating mobile learning games, adapted to their own contexts, and integrating diverse cognitive levels? Hence, to answer this question, two research objectives were defined:

1. To develop a system for classification of questions for mobile learning games;
2. To observe teachers using the system for classification of questions during the process of quiz questions creation.

The focus of this contribution is the first objective, as the revision of literature did not provide a classification system ready to be used by teachers. The second research objective will be pursued in future research efforts, in order to fully answer the formulated research question.

Follows the description of the context and participants in this study, as well as the data collection and analysis procedures (Section 2.2).

2.1 Teacher Training Workshop

The context of this study is a teacher training workshop, which has been described in previous studies (Marques & Pombo, 2021a; Marques & Pombo, 2021b). The training aimed to promote the collaborative development of open digital educational resources that foster Science, Technology, Engineering and Mathematics (STEM) learning based on game approach and supported by mobile and AR technologies in outdoor settings.

The educational resources were developed for the EduPARK app (http://edupark.web.ua.pt/mobile_app, accessed on 12 October 2021). It was created under the EduPARK project, funded by FEDER and FCT (2016-19) and that is still running. The EduPARK app supports exploration of AR contents developed for the Aveiro green park (Portugal) in a free mode, and in a play-the-game mode. The game supported by the app is an interdisciplinary quiz treasure hunt that integrates educational AR contents, images, audios and videos. Hence, most games available through the app foster interdisciplinary learning, one of the features of authentic activities according to Reeves (2002). The game structure is organized in the following loop (Figure 1): (i) give instructions to find a different AR marker in each location of interest (Figure 1B); each marker unlocks the access to information relevant to answering a series of questions related to that specific location; (ii) explore the AR contents, e.g., a specific botanical species with information about its origin, its flowers and leaves, and other curiosities (Figure 1C); (iii) present a multiple-choice question, with associated content - text, audio or image (Figure 1D); and (iv) give feedback to answers and award points, if the answer is correct (Figure 1E). The exploration of AR contents (B and C) is not mandatory, nor the inclusion of media files (image, audio and video) in all the questions. The game mascot is a female monkey, who lived in the park some time ago, and who guides the players and gives them formative feedback after answering; for example, when an incorrect answer is given, the mascot explains the right answer. Hence, the game structure implements several game features commended in the literature, such as prompting to physically move to different locations to find treasures or AR contents from hints, providing immediate feedback to game performance and gathering points (Marfisi-Schottman & George, 2014).

The app was developed to support social constructivism approaches to learning (Burr, 2015), where the users' construction of meaning is influenced by the interaction of the learners' prior knowledge with the new experiences, as well as by interactions with others. Thus, the project team recommends the exploration of the app in groups, to facilitate collaboration and discussion towards authentic learning experiences (Reeves et al., 2002), although it can be used individually as well.

Previous studies revealed the app has a high usability and educational value from basic to high education contexts (Pombo & Marques, 2019; Pombo & Marques, 2020; Pombo et al., 2019), which may facilitate teachers' adoption of the involved emergent technologies (mobile AR) and educational approaches (game-based learning). To promote teacher adoption of these innovative and effective approaches, a workshop accredited with 50 h (25 h in face-to-face sessions and 25 h of autonomous work) of continuous training for teachers was conducted between October 2020 and January 2021.

A B C D E

Figure 1. Selected screens of the EduPARK app and game (in Pombo & Marques, 2021)

Teacher trainees were characterized through data collected in a questionnaire. The analysis of its results was presented previously (Marques & Pombo, 2021a), so follows only the information needed to understand this study's results.

From the 16 teachers attending the workshop, 14 gave informed consent to participate in this study. The workshop's teacher cohort profile matches closely the Portuguese teacher profile according to PORDATA (https://www.pordata.pt/, accessed on 26 September 2021) in terms of: (a) gender, as 12 females and 2 males participated in the study; and (b) experience, as 12 teachers had more than 21 years of experience. Most teachers had a high degree (10 teachers), which is mandatory by Portuguese Law. The subjects taught were: (a) mathematics in the 3rd cycle of basic education (CBE) or in secondary teaching (3 teachers); (b) physics and chemistry in the 3rd CBE or in secondary teaching (6 teachers); (c) nature sciences in the 3rd CBE (1 teacher); and (d) mathematics and nature sciences in the 2nd CBE (6 teachers) (Marques & Pombo, 2021a).

The workshop trainers were the authors of this study and have several years of experience as science education researchers. The workshop created opportunities for teacher trainees and researchers to collaborate in the development of high-quality open educational resources for STEM learning, accessed through the EduPARK app. The quality and relevance of the resources were supported by the integration of recommendations from the literature on effective teaching and learning methodologies, particularly when seeking to take advantage of mobile and AR potential. The produced resources (questions and associated images, audios and videos) are articulated with the National Science Curriculum and grounded in real educational contexts.

The workshop involved several activities, including group discussion and reflection on mobile learning, AR in education, and game-based learning; exploring games with the EduPARK app, as if teachers were students, in the Aveiro green park; and collaborative design and development of quiz questions and resources for a new EduPARK game, in two cycles of refinement. The created game is directed at 2nd and 3rd CBE students and it is available through the EduPARK app, in Portuguese.

The process of questions development was conducted in work groups (four groups of three teacher trainees and two groups of two). In the first cycle of game co-creation, trainees planned a first version of quiz questions, and associated resources, using a digital word document template. They were supported by the workshop trainers for ideas generation and suitability checks. A minimum of five quiz questions was asked for each group. For each question, the groups:

a) identified the curricular framing - subject(s), schoolyear, topics and aimed learning;
b) selected one point of interest in the park that offers learning opportunities under the identified curricular framing;
c) formulated one introduction to the question (optional), the question itself, up to four short answer options (indicating the correct one(s)), and differentiated feedback to the answer, whether is it correct or incorrect;
d) identified the resources to be explored under the question - previously developed AR contents, videos, audios and/or images;
e) predicted the level of difficulty for the target school level; and
f) attributed points, in case of correct answer.

Followed a presentation of the developed work (quiz questions and respective educational resources) by each work group. The presentation was followed by a big group discussion, for formative evaluation and suggestion of improvements, from other teacher trainees and trainers. The best three questions of each group were selected through a voting system where each participant anonymously selected the best question in each group and justified his/her opinion.

In the second cycle of co-creation, the evaluation and comments collected from the big group discussion were taken into consideration to improve the three most voted questions. Each group delivered an improved version of their work, to be compiled by teacher trainees into a functional and coherent game accessed through the EduPARK app. A test of the co-created game was conducted. For that, teachers explored their game in the park, using mobile devices and took notes in order to propose new improvement suggestions. A new big group discussion allowed conducting the final refinement of the game.

Finally, each group presented a final version of their planning document, with the group quiz questions and educational resources, for assessment, as part of the requirements for obtaining a continuous teacher training certificate.

2.2 Data Collection and Analysis

In this qualitative study a hybrid process of inductive and deductive content analysis (Bardin, 2016; Xu & Zammit, 2020) was used to interpret raw data: quiz questions (introduction, question formulation, answer options, associated resources and feedback) planned by six groups of teacher trainees. Four groups produced five questions, as required; one group produced six questions; and another group produced twelve questions. A document compiling the first five questions of each group was created, to keep balanced input from each group. It includes a total of 30 questions. Each question received a code similar to the following, G1.1, meaning that this was the first question of G1.

The analysis approach integrated data-driven codes with theory-driven ones based on the revised Bloom's Taxonomy (Anderson et al., 2001). In a first step, an inductive analysis was conducted, which originated a first version of question categories and their description. In this initial analysis, each question was read and the associated educational resources were analyzed, to produce tentative categories, drawing on the data and bearing in mind the aim of the study. In a second phase, the categories were revised and organized according to the revised Bloom's Taxonomy, with the different cognitive levels. The coding process for each category was manually conducted simultaneously by two researchers, who are also the authors of this paper, through a peer debriefing process.

3. RESULTS AND DISCUSSION

This section presents and discusses the system for classification of questions (Table 1) that resulted from the analysis of the 30 questions produced by 14 in-service teachers, in groups, which were integrated in a mobile quiz game with AR contents in the EduPARK app to be played in an urban green park, in the context of a 50h training course. Overall, the results indicate that teachers developed questions that, in the learner point of view, fall in the lower levels of Bloom's Revised Taxonomy, namely Remember, Understand, Apply and Analyze.

Results reveal that the most frequent type of question produced by the teachers required "Direct application" of contents already known to real situations (10 questions) and was produced by all but one group, revealing that most teachers acknowledge the importance of this type of question. An example question is about a structure delimited by marble walls near by a statue in the park, representing a geometric figure formed by a rectangle and a semi-circle. The students are asked to select the correct option that allows them to calculate the figure's area. In the feedback a figure is presented. It explains the figure is composed of two geometric figures and how the area is calculated for each one. The result is the sum of the two figure's areas. Hence, this type of question is framed in engaging in problems/projects with real-world relevance, contributing to authentic experiences, promoting engagement and motivation to learn and better equipping learners to succeed in college, careers, and adulthood (Reeves et al., 2002). Moreover, as school content is related with real world places, objects and situations, games with this type of questions may engage students emotionally, which, according to Marfisi-Schottman and George (2014), has positive effects on engagement and memory, promoting situated cognition and authentic learning.

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Table 1. System for classification of questions for mobile learning games with AR and frequency of questions in each questions category

Bloom's Taxonomy	Questions category	Description of questions category	Frequency	Id Questions
Remember - recall facts and basic concepts	Consolidation	The question mobilizes information already covered at school.	8	G1.3, G2.4, G3.1, G3.2, G4.1, G4.4, G5.2, G6.4
Understand - explain ideas and concepts	Observation	The question requires the user to observe the surroundings.	4	G1.5, G4.3, G4.5, G5.3
Apply - use information in new situations	Direct application	The question requires mobilizing information already covered at school to use in a real and specific situation.	10	G2.2, G2.5, G3.3, G4.2, G5.1, G5.4, G6.1, G6.2, G6.3, G6.5
	Selection of information	The question requires the exploration of AR contents, videos, audios or images and selection of the information needed.	4	G1.1, G1.4, G2.1, G.5.5
Analyze - draw connections among ideas	Relation of new information	The question requires relating new information from different origins (e.g. from the question introduction and from the AR content).	4	G1.2, G2.3, G3.4, G3.5

The second most frequent type of question prompted the mobilization of information expected to have been already covered at school, in a "Consolidation" approach (8 questions) and was produced by all groups. Once more this type of question was considered relevant by in-service teachers. An example of a "Consolidation" question starts with the fact: "The mallard is a constant presence in the Park's lake. The male and female have different colors. Click on the video icon". The video shows both male and female mallard individuals and describes their main physical differences. The question is: "Physical differences (feather color, size…) between male and female are related to…" Four options are given and students are supposed to already know from previous experiences that physical differences are related to reproduction. In the feedback it is explained that these differences (e.g., the male's attractive colors) increase the chance of mating. The relevance of constructive and motivational feedback is also pointed out by Marfisi-Schottman and George (2014), who acknowledged it can provide engagement in the game, and most of all, it can boost pedagogical benefits.

In three of the other types of questions were included four questions each: i) "Observation", which requires the user to observe specific features of the surroundings to understand phenomena, and it is associated to the Understand category of the Bloom's Revised Taxonomy; ii) "Selection of information", requiring the exploration of AR contents, videos, audios or images that help to answer correctly the question, and is related to Apply in Bloom's revised Taxonomy, where it is important to select and use information in new situations; and iii) "Relation of new information", when it requires relating new information from different origins (e.g. from the question introduction and the AR content), linked to Analyze in Bloom's Revised Taxonomy, where it is needed to make connections among different ideas.

An example of "Observation" question is one where it is mandatory to observe the birds in the lake to answer the number of such populations in that habitat, linking students' surroundings with curricular contents. It is worth noting that one of the features claimed in the literature as interesting in location-based mobile games, the mobility to go out of the classroom to explore nature (Edmonds & Smith, 2016), necessarily involves observation. And, notably, half of the teacher groups took advantage of the mobility allowed by mobile devices to promote situated learning, by creating observation questions, turning learning into a personal and engaging experience (idem).

Finally, “Information selection” and “Relation of new information” questions were created by half of the teacher groups. These types of questions require students to go through multimedia resources (including AR contents), as advised by Edmonds and Smith (2017). The latter type of question requires a higher cognitive level, as students not only need to select information from different media supports (Apply level in Bloom’s Revised Taxonomy), but also have to relate different information from distinct origins (Analyze level in Bloom’s Revised Taxonomy). Moreover, AR contents also scaffolds learning through the exploration of real objects in real contexts, a feature relevant in authentic learning environments (Reeves et al., 2002). This is only possible as the EduPARK game is not just a quiz game, but it has other complementary resources supporting students’ learning (Pombo & Marques, 2020).

When observing the type of questions produced by each group of teachers, we found that G6 produced questions in 2 categories, G3 and G4 produced in 3 categories, and G1, G2 and G5 produced in 4 categories. Hence, although some teachers already produced questions classified in several categories, there are teachers that still produced questions in only 2 or 3 categories. This result seems to indicate that, maybe unconsciously, some teachers intended to diversify the type of questions, which is also a concern when they create other resources, such as instruments of assessment (e.g., written tests). However, this is not true for all. The authors' expectation is that all teachers will be able to create more diversified questions at the cognitive level, through the use of this classification system.

In a final reflection, the highest levels of Bloom’s Revised Taxonomy, Evaluate and Create, seem achievable only in the process of creation of questions, and not while playing the game. For example, the Evaluate level was observable only during the process of game creation, when teachers selected the best question produced by each group and justified their opinion, through a voting system. Also, the Create level was identified during the process of question creation, which implies not just formulating a question, but also creating a feedback system and a set of other media resources that complement the question. It also implies considering the question suitability to a determined point of interest in the park, offering learning opportunities under a certain curricular framing.

4. CONCLUSION

Mobile learning games with AR in the outdoors should be spread among all learning levels, as it can mobilize various types of skills and consolidate learning in different environments. These games also contribute with positive effects on engagement and memory (Marfisi-Schottman & George, 2014), as they may promote situated cognition and authentic learning in formal and non-formal education, and also extend the way students experience learning from the environment and with each other (Edmonds & Smith, 2016). In addition, quiz games combined with treasure hunting allows the construction of new concepts by players in a much funnier, interactive and dynamic way (Sampaio et al., 2012).

This work highlights the importance of providing specialized training in supporting teachers to use mobile apps integrating quiz games, motivating them to include mobile outdoor learning in their teaching practices. More importantly, these initiatives empower teachers with the proper skills to collaboratively design and create mobile learning games. The system for classification of questions, developed in this work, is intended to increase teachers’ consciousness regarding the creation of a higher variety of questions, as well as its associated feedback and resources. This way, they can prompt different cognitive levels, according to Bloom’s Revised Taxonomy (Anderson et al, 2001), and promote higher quality game-based learning in teaching practices. For example, this system supports teachers becoming aware that questions from the categories “Direct application” and “Consolidation” are particularly suitable for integration with formal assessments in the classroom, to provide evidence of the learning gains from playing mobile quiz games with AR contents in real outdoor situations.

This study has a small number of participants, which allows a deeper analysis to uncover key aspects of the study more clearly (Merriam & Tisdell, 2015). Hence, no statistical generalization is intended. The aim was to develop a first version of a classification system to be used in future research. This should analyze the process of game co-creation by teachers in new training initiatives, where they are familiar with this system for classification of questions in the task of game creation, to triangulate with the current study.

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