Travel through the oceans: augmented reality to enhance learning in early childhood education

Vitor Ribeiro[1], Vânia Sousa [2]

[1] Minho University/ESEPF, Lab2PT BRAGA, Portugal
[2] ESEPF,CIPAF, Oporto, Portugal
d5803@geografia.uminho.pt, filipa_vania.sousa@hotmail.com

Abstract. Early education plays an important role in the education system and students success in a digital society. Kindergarten pedagogy innovation by integrating technology is recognized as lacking research, however an area which needs to be improved. In this context, augmented reality showed an unprecedented growth, particularly in what regards society and marketing purposes, being recognized as having great potential this decade in the educational innovation area. This ongoing research-based methodology aims to understand both students and educator's perceptions, abilities and difficulties in using augmented reality. The Case study reports to a Portuguese kindergarten with a class of five-year old students (N=24). The project was designed to enhance children's knowledge about the ocean species´ characteristics (habitat, length/ size, food). A world map was produced and augmented reality was added to improve their motivation in the learning process and to acquire research skills. Furthermore, the study provides evidence of AR capabilities to promote interactive and collaborative work.

Keywords: Kindergarten, Augmented reality, Early education, Geography, Research Project

1   Introduction

According to ODCE, PISA study students that attend preschool had higher scores than those that did not [1]. The efforts that governments are making to introduce new pedagogical experiences using ICT can be acknowledged. ICT is currently being recognized as an important engine for teaching and learning process proving to have positive effects on children's learning and development [2]. Society is being shaped by digital tools and schools should not ignore this fact [3, 4]. Students that are not able to move inside today's complex digital world can be excluded from society and schools should provide tools to develop students' skills to navigate in society's requirements.

In the meantime, pre-school practitioners and school teachers tend not to leave their comfort zones, perpetuating the traditional ways of working, particularly in preschool [5, 6]. Increased access to computers, tablets, mobile devices with both faster and greater capacities of internet connection are not increasing the use technology in the classroom, particularly in early childhood education [7]. Further when used a more meaningful and student-centered is required to jump from traditional methods and not

use technology as some "benign addiction" [6]. Moreover, this "digital natives" generation [8, 9] constantly uses technology in their everyday life, particularly with the WEB 2.0 increase in tools. Hence, the focus should be oriented towards the "verbs of learning", such as understanding, communicating, presenting, persuading rather than, to simply focus on the tools given that they are ever changing and growing rapidly [10].

As [10, 11] encouraged that "pedagogical efforts should emphasize how, not what, technology should be used in order to achieve meaningful learning outcomes". The authors claim that for the concept of authenticity based on [12] ideas where technology should enable users to do real work and "facilitate authentic student learning" [10].

Some barriers have been identified as the main stream for not use more intensively ICT [7]. Until the turnover of the century mainly external teacher barriers was prevailing and was related with resources, training and support. In the meantime, several efforts have been done and nowadays are recognized teacher/educator internal barriers such as believes, attitudes, knowledge or skills to use technology.

Recently identified was the 21st century's knowledge and skills in educators' preparation need in order to better prepare students for the complex world. The main learning skills pointed out were Critical Thinking and Problem Solving, Communication, Collaboration and Creativity and Innovation, in which Information, Media and ICT literacy play an important role [13]. Augmented Reality can be used as a tool to achieve those goals. Augmented Reality is recognized as

> "one of the most interesting emergent technologies for education, being a powerful and motivating tool which can involve several of the student´s senses by means of the proper and correct combination of sound, sight and touch. Application of AR technology in education is only just beginning to be explored, especially using it with preschoolers" [14].

This research is based on an ongoing project that started in September 2016, and aims to finish in July 2017. It envisages to answer the following research questions:

- How does using AR motivates children in the learning process?
- How can AR promote creativity in early childhood education?
- How impaired (autism) students perceive AR activities?
- How AR engage students with different knowledge levels?

The aims of this research is to contribute to the knowledge of AR, as an advanced ICT and its benefits on students and educators engagement and motivation. It is a pioneer study in Portugal and will contribute to international knowledge on the area also. This first paper focuses on the preliminary results analysis.

2   Augmented reality and Education

AR has emerged in 1990 [15] and research in education context is in an early stage [16]. In education, active learning strategies are being affirmed as prideful in the way that they engage students in their own learning, including for example, group work or promoting the use of ICT. Also acknowledged is that young learners want to know, to

explore, to ask, to do and they are active and curious; learners [17]. Youngsters need to use technology to reinforce their skills; skills that are required for the 21st century's challenges and also for them to be able to use and let loose their imagination. [18] states that the "child learns through making his or her physical connections with the world…" and "the combination of intrinsic motivation and self-belief enables children to engage actively as learners … with new skills and ideas"[17].

From the beginning of this century several case studies, in several countries have been implemented in order to understand the contributions of Augmented Reality (AR) for educational purposes. Studies tend to analyze parents influence, students' motivation and learning outcomes, knowledge and creativity, along with the degree of satisfaction (Table 1).

Table 1. AR studies in the 21st century

Year	Authors	Country
2002	Kritzenberger, H., Winkler, T., & Herczeg, M. Winkler and Herczeg	German
2003	McKenzie, J., & Darnell,	New Zealand
2007	Dünser, A., & Hornecker, E.	New Zealand
2007	Chen, Su, Lee, & Wu,	Taiwan
2008	Lee, H., Lee, J.	Korea
2010	Hsieh, M. C., Lin, H. C. K.	Taiwan
2013	Ángela Di Serio, María Blanca Ibáñez, Carlos Delgado	Spain
2013	Cascales et al.,	Spain
2013	Tomi and Rambli	Malasya
2015	Rabia M. Yilmaz	Turkey
2015	Yujia Huang, Hui Li & Ricci Fong	China
2016	Yilmaz, R. M.	Turkey

There is a difference between Virtual Reality and Augmented Reality, since the later adds artificial information into the real world while in the first, the user is completely immersed [19]. AR creates a bridge between the real and the virtual world using an application at a real time. It allows one to include live time of 3D objects, texts and sounds, on real images and video. Some authors suggest that AR should be defined broadly [20], where "AR could provide users with technology-mediated immersive experiences in which real and virtual worlds are blended" [21]. AR deals with real environments but augment them [22].

The use of AR in education is still at an early stage but results already point out important learning effects. Some of them related with, handling the information in a new and interactive way, with search skills, spatial knowledge and thinking, improving

skills for the information-age, increasing student´s motivation, improving accurate knowledge, manipulating virtual environments or enhancing psychomotor skills[20].

Besides the recent attention of educational benefits´researchers, AR is being referred to as an emergent technology for the near future [20]. The author recognizes the connection between different innovative technologies, such as mobile devices, laptops and immersion technologies, that AR permits but highlights the need to better understand the educational value of AR.

Due to its promising input, research in different contexts such as marketing or tourism opportunities is also growing. Nevertheless there is a lack of research on educational environments and more empirical studies and evidences of the effects of AR on teaching and learning, particularly regarding preschoolers, needs to be carried out [1, 20, 23].

3   Case study and methods

This paper is based on an ongoing master research that started in September 2016. This exploratory research is based on an empirical study implemented in a Kindergarten located in an Oporto metropolitan region of Portugal. There are 24 participants, they being 5 year children, of which 13 are boys and 11are girls. Special attention will be paid to the outcome of 2 children with autism, who generally manifest less interest and participation. The institution adopts the project´s methodology. The Ocean Project was chosen for this year and the AR research was undertaken to answer these same projects. Blippar builder application was used to develop the augmented reality and ArcMap was used to create the world map, using the oceans basemap.

The convenience sampling method was used. Instruments will be from a qualitative research, questionnaire, observation form and photographs. The project was implemented in successive and integrated phases according to the student's preferences:

Phase 1

- Students were challenged to choose one ocean species that they wanted to know more about;
- A matrix of chosen species was produced and a voting process was implemented to obtain the final 12 species (Figure 1);
- Phase 2
- Students were challenged to do research at home with parents about one specie;
- Students were challenged to draw the specie (Figure 1);
- Each week a new species was introduced by the teacher;
- Phase 3
- Teamwork was promoted by the recording of an audio file with the storytelling about one of the species by each pair of students;
- Finally, the Augmented Reality application was used.

The augmented reality solution is being produced and envisage to promote student's authenticity and their emotional reaction towards the application. An aspect considered to be fundamental in order to incorporate and to involve the students work in the final

AR and not only to use an application with augmented reality, per se as was done in previous research. To accomplish this, a world map was produced and a trigger image was chosen. The trigger image was a treasure chest to increase the student's feelings as an explorer. The images were augmented by using children´s picture and their drawing, drawn in previous classes, followed by a video of the corresponding ocean specie. Drawing were observed after clicking on a student's picture.
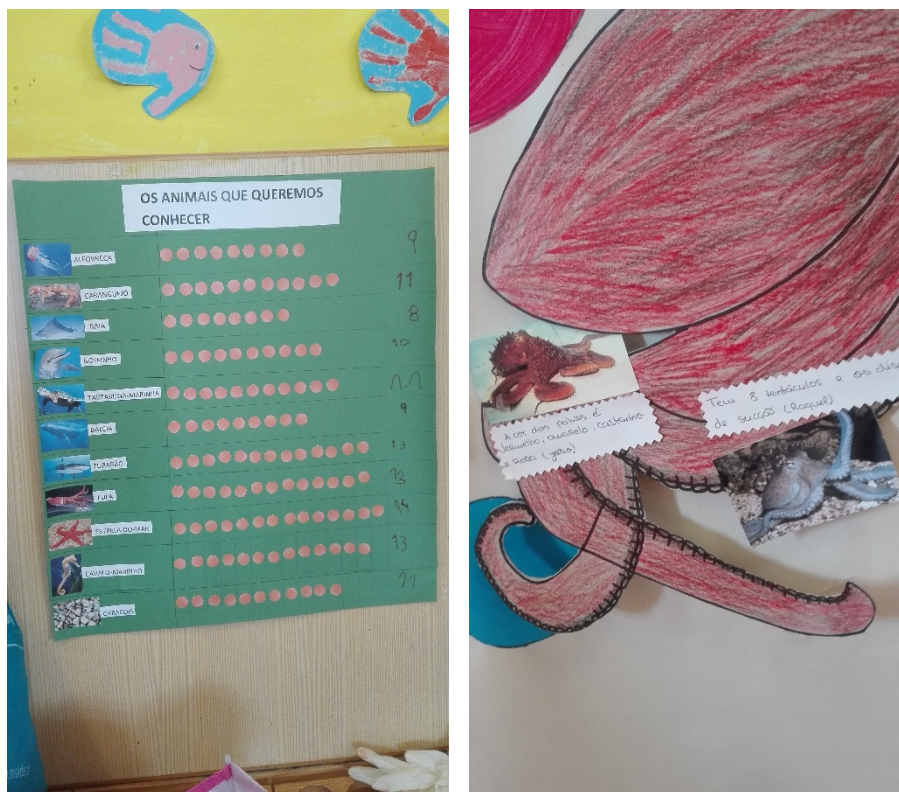

Fig. 1. - Matrix of chosen species and voting results (left) and children draw (right). Source: authors'

Methodologically, the class was split into two groups: one with the more advanced students and the other with the less. The two students with Special Education Needs were grouped into a group of students, characterized as less motivated, shy and quieter. To improve emotional engagement, the overlay image followed the following sequence: student drawing and finally a species video acquired on the internet. Ocean music was played in the background and the experience was developed by each group individually. The trigger image was a treasure chest to conjure an emotion on students that prepared them for a fully immersed adventure in discovering the ocean (Figure 2).

Fig. 2. – Oceans map and Treasure chest. Source: authors'

Researchers, recorded the whole process from the very start, reaching the place, until the end, leaving it. This will be useful to record and analyze emotions, commentaries and barriers during the use of the AR.

4   Discussion

Augmented reality is being acknowledged as an emergent and powerful technology tool and recent results have demonstrated this. At an initial stage, innovative technology immersing students in an augmented reality requires more empirical evidences are required in the educational field. This ongoing research aims to make its contribute in this field. The case study is being applied in a kindergarten with 24 children, aged five. It is expected to be useful, to be of easy usage and analyse the behaviour and attitudes of children with the manipulation of AR applications. At this stage we found that all of the students were curious about what awaited them. When they arrived in the room where the activity was implemented they explored the map and curiously looked at the treasures chest. Researcher´s have summarized the subjects learnt about Portugal's location, the ocean´s and the species studied. Finally, one experience was implemented to show the students how to hold and use the tablet to collect and explore multimedia information. Immediately students waited for their turn to experience and look for the treasure. One by one they used the application and were very enthusiastic, commenting and asking questions about the species. Most of them knew what a tablet was and easily adapted to the application. None of the students needed extra help in order to use the tablet or the AR application. Despite some blips like taking some extra time to upload, students did show nervousness, restlessness or demotivation. They shared the experience and all helped each other. At the end of the experience most of them asked to

further explore other treasures, demonstrating their taking to the app. Students that were normally very quiet or who felt uncomfortable speaking in front of groups or in the classroom change their behavior, proving to be more dynamic and participative. Frequently they expressed phrases such as, "uauu", "fantastic", "amazing", etc. All the participants found the experience very attractive and enjoyable. They also expressed that the most interesting skill was exploring and manipulating of the app; being an experience they wanted to repeat soon.

5 References

1. Cascales, A., et al., *Augmented Reality for preschoolers: An experience around Natural Sciences educational contents.* 2012.

2. Lindahl, M.G. and A.-M. Folkesson, *ICT in preschool: Friend or foe? The significance of norms in a changing practice.* International Journal of Early Years Education, 2012. **20**(4): p. 422-436.

3. Azevedo, L., V. Ribeiro, and A. Osório. *Promoting a spatial perspective on primary students through geotechnologies.* in *8th International Conference on Education and New Learning Technologies.* 2016. Barcelona, SPAIN: IATED.

4. Ribeiro, V. and I.B. Monteiro. *Enhancing the teaching and learning of History and Geography throught GIS: The case of routes and battles of Peninsular war (1807-1814).* in *7th International Conference of Education, Research and Innovation.* 2014. Seville, Spain: IATED.

5. Becker, H.J. and M.M. Riel, *Teacher Professional Engagement and Constructivist-Compatible Computer Use. Teaching, Learning, and Computing: 1998 National Survey.*, in *Centre for Research on Information Technology and Organizations (CRITO).* 2000, University of California: Irvine.

6. Plowman, L. and C. Stephen, *A 'benign addition'? Research on ICT and pre-school children.* Journal of computer assisted learning, 2003. **19**(2): p. 149-164.

7. Blackwell, C.K., A.R. Lauricella, and E. Wartella, *Factors influencing digital technology use in early childhood education.* Computers & Education, 2014. **77**: p. 82-90.

8. Prensky, M., *Digital natives, digital immigrants part 1.* On the horizon, 2001. **9**(5): p. 1-6.

9. Jo, I. and S.W. Bednarz, *Evaluating Geography Textbook Questions from a Spatial Perspective: Using Concepts of Space, Tools of Representation, and Cognitive Processes to Evaluate Spatiality.* Journal of Geography, 2009. **108**(1): p. 4-13.

10. Ertmer, P.A. and A. Ottenbreit-Leftwich, *Removing obstacles to the pedagogical changes required by Jonassen's vision of authentic technology-enabled learning.* Computers & Education, 2013. **64**: p. 175-182.

11.   Ertmer, P.A. and A.T. Ottenbreit-Leftwich, *Teacher Technology Change.* Journal of Research on Technology in Education, 2010. **42**(3): p. 255-284.

12.   Jonassen, D.H., *Learning to solve problems with technology: a constructivist perspective*. 2nd ed. 2003: Prentice Hall.

13.   Greenhill, V., *21st Century Knowledge and Skills in Educator Preparation.* Partnership for 21st Century Skills, 2010.

14.   Cascales, A., D. Pérez-López, and M. Contero, *Study on Parent's Acceptance of the Augmented Reality Use for Preschool Education.* Procedia Computer Science, 2013. **25**: p. 420-427.

15.   Liberati, N., *Augmented reality and ubiquitous computing: the hidden potentialities of augmented reality.* AI & SOCIETY, 2016. **31**(1): p. 17-28.

16.   Han, J., et al., *Examining young children's perception toward augmented reality-infused dramatic play.* Educational Technology Research and Development, 2015. **63**(3): p. 455-474.

17.   Vickery, A., *Developing Active Learning in the Primary Classroom*. 2013, London: Sage.

18.   Collins, J. and D. Cook, *Understanding Learning: Influences and Outcomes*. 2001, London: SAGE Publications.

19.   Azuma, R.T., *A survey of augmented reality.* Presence: Teleoperators and virtual environments, 1997. **6**(4): p. 355-385.

20.   Wu, H.-K., et al., *Current status, opportunities and challenges of augmented reality in education.* Computers & Education, 2013. **62**: p. 41-49.

21.   Klopfer, E. and K. Squire, *Environmental Detectives—the development of an augmented reality platform for environmental simulations.* Educational Technology Research and Development, 2008. **56**(2): p. 203-228.

22.   Dunleavy, M., C. Dede, and R. Mitchell, *Affordances and limitations of immersive participatory augmented reality simulations for teaching and learning.* Journal of Science Education and Technology, 2009. **18**(1): p. 7-22.

23.   Huang, Y., H. Li, and R. Fong, *Using Augmented Reality in early art education: a case study in Hong Kong kindergarten.* Early Child Development and Care, 2016. **186**(6): p. 879-894.