AUGMENTED REALITY AS A TOOL IN COMPULSORY SECONDARY EDUCATION

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Abstract

This paper outlines the guidelines to fulfill an educational experience in the classroom of secondary education using new technologies, in particular, using augmented reality as a tool for visualization of concepts. For this, some of currently existing leading applications that use 3D images to improve communication in the classroom are shown. These applications were used to improve the visualization of determined geometric figures and to involve students in the management of new technologies in subjects of Technology and Plastic and Visual Education, describing the functioning and advantages of using this type of applications at a school level and showing the level of acceptance in students who worked with these methodologies.

Keywords: Augmented Reality, Educational Innovation, Compulsory Secondary Education (CSE), Information and Communication Technologies (ICTs).

1 INTRODUCTION

This research is in line with the development and use of Information and Communication Technologies (ICTs) in the classroom within the framework of educational innovation, with this being understood to be those tools that foster the dissemination of information in the classroom and its communication through the use of a digital device. There are different methodologies for the application of the ICTs in the classroom; all of them are based on the creation of multimedia texts that pretend to make the explained subject more attractive. Therefore, the explications of many concepts and work patterns could be simplified applying 3D tools, compared with 2D multimedia models and current print media. It is in this context where augmented reality arises as a resource to fill these gaps.

The paper offers an educational experience carried out in the educational center Salesianos Carabanchel with students of the first stages of Compulsory Secondary Education (CSE), applying some of currently existing tools of augmented reality. These tools were used to improve the visualization of determined geometric figures and to involve students in the management of new computer skills that currently are leading techniques in education.

1.1 Augmented reality in education

The neuroscience and other disciplines within psychology have provided new insight into the process of learning of human beings, what allows discovering key factors that have to be taken into consideration while studying the processes of teaching-learning [1]. The higher or the lower success of these processes does not depend on the higher provision of information by the communicator. The key is that transmitted information has to be significant, fostering in such a way the development of autonomy and integration of ICTs in the classroom. Nowadays, no one denies that learning is an inherent process of human person capable to interpret the surrounding world [2].

Augmented reality can be defined as the technology that allows incorporating virtual experiences (text, audio, video, multimedia resources, etc.) through a real world object [3]. Thus, it is a tool that allows extending information available in the classroom through virtual recourses using an electronic device (mobile phone, Tablet, laptop, etc.) with a camera and software able to process and interpret information through activators of augmented reality.

This technology improves not only the level of interactivity of the studied in the classroom texts extending the perspectives of the student, but also fosters the creativity and increase the quality of the online classes obtaining more practical learning through the manipulation of virtual objects [4]. In this
way, tedious language that can appear in some subjects can be avoided awakening the interest and motivation of the students. Although it is true that the application of this type of tools has given good results in primary education, an appropriate organization of the contents can extend its application to other educational stages. On the other side, this working methodology allows increasing and encouraging of collaborative work.

It is important to note that augmentation does not mean only increasing of visual capabilities destined to gather more information about the surrounding world [5]. Besides the possibility to visualize a 3D object over a real object, it is also possible to create involving effects improving auditory perception and quality of sound or any other related to the rest of the human senses [6]. Performing gradual classification of this type of application, four levels are distinguished:

- Applications that use hyperlinks that connect physical world through 2D codes with other contents, in a way there is no 3D record. Moreover, visualized content does not follow activators movements.
- Applications of augmented reality that use markers (black and white quadrangular images with schematic drawings), that are usually used in 2D patterns recognition, however 3D cases also exist.
- Applications of augmented reality using no markers, in this case different elements of physical world can be used as activators: for example, images, objects, persons, or localization and orientation of the user.
- Augmented vision using high-technology devices that offer completely contextualized experience with capacity of total and personal immersion.

The applications of augmented reality can be compared using the following criteria shown in Fig. 1.

**Fig. 1. Strengths that augmented reality application should have.**

Therefore, when it is intended to fulfill a learning experience with augmented reality systems, it is necessary to follow a set of steps that allow determining whether the chosen methodology can comply with required functions [7]. Within them the following can be mentioned:

- Determine whether a necessary hardware will be available for the teachers and students during the process of learning-teaching.
- Determine previously which stages of process of augmented reality systems creation will be performed in the classroom and which stages should be prepared by the teacher. Manage the time according to these stages.
- Determine the costs of the necessary software and license type (free or proprietary).
2 METHODOLOGY

Implementation of this methodology in the classroom has to be started from the knowledge that augmented reality can be used in the process of teaching-learning without modifying traditional communication patterns, based on the transmission and reproduction of the information. Therefore, the aim is to enrich already existing contents and not to substitute them, improving educational experience through multimedia applications, making it more dynamic and enriching.

Students who are currently considered to be digital natives, pay more attention to screens and projectors than to traditional blackboard, however this does not mean that they are no longer the receptors of the information communicated by the teacher [8]. However, it is true that on the contrary they interact more with their classmates comparing to the end of the last century, converting current teacher to the guide in learning process, the aim of which is to help students to learn through discovering by themselves new experiences that impress them and awake their curiosity. The teacher is responsible to carry out the class in an entertaining way and to manage information that is given in each session so that it can be utilized to the full.

One of the most innovating ways to make students work and to involve them in the contents that are taught, is to use augmented reality as a tool in the classroom. Working with a computer and creating animated figures that are related to the subjects’ contents awake the interest and cause higher motivation, mainly at the first stages of the secondary school, where students still present strong attachment to the primary education model where all the subjects are learned in an interdisciplinary form and from the same perspective.

Table 1 shows contents corresponding to the curricular of secondary education in subjects of Plastic and Visual Education and Technology, where the use of augmented reality is possible justifying its use in the classroom [9].

<table>
<thead>
<tr>
<th>Plastic and Visual Education</th>
<th>Technology</th>
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<tbody>
<tr>
<td>1. Visual perception: the mechanism of the vision and perceptive functions (form, shape and colour). Optical illusions.</td>
<td>1. Use of information technologies as a tool for the elaboration, publication and diffusion of technical project or subject contents.</td>
</tr>
<tr>
<td>2. Differences between image and reality. Levels of iconicity of images.</td>
<td>2. Representation systems: diedric projection and perspective.</td>
</tr>
<tr>
<td>3. Identification of types of frames and shots of still image.</td>
<td>3. Use of software to simulate mechanisms that include different operators.</td>
</tr>
<tr>
<td>4. Use of computer recourses to create and obtain images and to present multimedia work.</td>
<td>4. Computer: its elements, functions and basic handling.</td>
</tr>
<tr>
<td>5. Producing visual and audiovisual messages following work planification.</td>
<td>5. Presentation tools for the diffusion of specific contents of the subject.</td>
</tr>
<tr>
<td>6. Objective representation of simple solids through their projections or diedric views.</td>
<td>6. Tools for searching, downloading and interchange of information.</td>
</tr>
<tr>
<td>8. Introduction into isometric projections of simple volumes over an isometric screen.</td>
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As it can be observed in Table 1, both subjects are compulsory in the first cycle of secondary education, and are highly related in terms of contents, being some of the topics duplicated in both courses contents. It should be noted that both subject give high importance to the use of ICTs and graphic expression, strongly related disciplines with application of augmented reality in a normal course of the classes. For this reason, it was decided to choose both subjects to fulfill enriching experience with the students of secondary educations, being true that this offer can be extrapolated to the rest of the subjects.
3 RESULTS

Once augmented reality has been chosen as a strategy to foster the use of ICTs in the classroom, the following steps shown in Fig. 2 were carried out:

Appropriate colour combinations help to develop fine motor skills, reducing pressure caused by academic activities and to develop students' creativity. For this, the application Quiver used in the subject of Plastic and Visual Education utilized augmented reality in 3D in order to give life to the pages of flat colour from the textbooks. The idea was to choose a topic of a subject corresponding to the Curricular of the first stage of CSE and make it more attractive for the students, in a way they become excited reading it. In this manner, both digital and plastic skills are developed while designing animated drawings and imparted lessons are complemented with increasing investigations capacities of the students.

![Fig. 2. Patterns to be taken into consideration to implement augmented reality in the classroom.](image)

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![Fig. 3. Examples of augmented reality. (a) Quiver; (b) Aumentaty Author.](image)
Moreover, free tool Aumentaty Author that is very appropriate to create geometric figures was used in the subject of Technology. This application makes it easy to visualize 3D pieces, making it possible to do traditional exercises form axonometric perspective and after that visualize the results through this application. Moreover, this application also allows exporting drawings from other programs and visualizing them through augmented reality techniques, simplifying files conversion.

As it can be observed in Fig.3, the possibilities of this type of applications are extended to any subject that is wanted to be worked through these methodologies. Moreover, all these platforms have examples of applications that make it easier to work from home when it is necessary to create a new element compatible with the application. It is true that there are a lot of other applications such as Aurasma o ARCrowd, these two applications were chosen because of their simplicity and great amount of recourses available on the web. Nevertheless, with better means and higher inversion, it is possible to use 3D vision with the use of glasses of augmented reality and paid software, being the results much more powerful and allowing the user to intervene directly over created image.

Moreover, degree of satisfaction of students was very high, repeating the experience to work with the contents of other subjects. Advantages and disadvantages of the methodology expressed by the same students are shown in Table 2.

<table>
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<th>Disadvantages</th>
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<td>Learning of a new entertaining tool.</td>
<td>Doubts about the final scope of the methodology, due to its wide possibilities.</td>
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<td>Better understanding of the concepts of geometry and software handling.</td>
<td>Difficulties, mainly at the beginning, handling the program.</td>
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<td>Fostering of teamwork.</td>
<td>Necessity of coordination with other subjects.</td>
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<tr>
<td>Improvement of the competence of learning to learn and digital skills, through information searching.</td>
<td>Use of mobile phone and other devices in the classroom and corresponding risks to be used with other aims.</td>
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<tr>
<td>Good final results.</td>
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<tr>
<td>Good and entertaining presentation.</td>
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As it is shown in Table 2, all the disadvantages that were stated by the students can be corrected with higher control in the classroom, and using some more class for learning program handling. It was indicated that as it was the first use of the methodology, there were no elaborated guides for the teacher on the use of augmented reality programs; that is why it was proposed to the students as a complementary work to elaborate an explanatory tutorial that could be used as a reference for their schoolmates of the following course. Nevertheless, advantages of the method were much more superior to disadvantages, and generally there were no complaints from students during the practice.

In terms of time management, hour of common tutoring was used in all the courses to clarify doubt during a short period of time, in this way all the topics corresponding to the practice and related to both subjects could be seen during at least some minutes. The final importance of the practice corresponded to 30% of the grade in both subjects, this made that students paid more interest while performing it and the percentage of passed increased in both subjects significantly.

4 CONCLUSIONS

Implementation of ICTs in the classroom is already a reality in the current educational context. Within this situation that the teachers have to face every day, there are determined free software tools that encourage learning and make classes more attractive. This paper presented augmented reality as a leading technology in education field, proposing an interdisciplinary practice that relates the contents of the subjects of Plastic and Visual Education and Technology, and allows fulfilling practice through cooperative work, where students can develop their digital skills and improve capacity to learn in an autonomous form through the use of initially unknown programs. The results obtained using this methodology show its efficiency measured in high level of satisfaction by the students and good
academic results obtained, that improved significantly with respect to the previous courses that used traditional methods proposed by the publishers of educational centers.

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