Augmented Reality Applied to the Teaching of the Descriptive Geometry

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Abstract
Augmented reality (AR) allows students to visualize tridimensional shapes by turning and handing them in the palm of their hand. Taking objects "away" from the computer improves the students' perception of the three projection planes. With this new representation tool, was designed a pedagogical application. Tridimensional models were made using the Google Sketchup open license software to view these 3D models using AR. Handling the 3D models by students improves the clarity of tridimensional perception. The project also allowed for the assessment of pedagogical aspects, including the ways through which students improve their learning experience and how teachers can use these tools to build a more interactive setting where students can play an active role in the construction of their own learning environment.

Keywords: Augmented reality, Education, Geometry, architecture, ITC.

Introduction

The rise of smart phones and the ability to access the Internet has facilitated the use of applications that use the 'augmented reality' to facilitate the user location and display information about your location. There are many definitions of the source of augmented reality. Azuma defined it in 1997 as "a technology that combines real and virtual elements, which is interactive in real time and is registered in three dimensions" (Azuma, 1997). From that year began to handle this concept among researchers and developers of this technology, although in 1994 had already presented the first prototype, Karma [Knowledge-based Augmented Reality for Maintenance Assistance], at the conference on interface design, the research project interfaces laboratory at Columbia University. The system aid to maintaining a laser printer. (MacIntyre, 1994).

In 1999 Hirokazu Kato ARToolKit develops software which is still used in some applications development through the use of open source libraries and is available for free download on the site http://artoolkit.org (Kato and Billinghurst, 1999). ARQuake in 2000 was the first outdoor game with mobile AR. In a version of Quake, a video game fashion around the world at the time, the user carrying a suitcase with everything needed to display the game in addition to a pair of glasses, a Wi-Fi antenna and a helmet with a webcam built (Thomas et al., 2000). Currently the method of AR) is applied in many areas of knowledge, but is advertising who has driven its development. Virtually all major brands have some kind of web application that uses AR to interact with its users. In the area of design, use of AR has been limited to the representation of 3D models. In some Spanish universities (such as the Polytechnic University of Catalonia), it has used this method for students of the School of Architecture view their urban design projects directly in the space for which were designed by them. This project pioneered the use of AR in the representation of architectural projects. The research group that conducted this project designed markers that were displayed by students from their digital tablets and smartphones (Sanchez Redondo and Fonseca, 2012).

Discussion

Learning is a process that allows individuals to manipulate instruments of knowledge. These instruments are all those tools that provide insight and understanding reality (Squire, 1987). In the last decade, the development of technology has expanded these instruments have now been incorporated into the classroom digital, portable tables, smart phones and all the tools of Web 2.0 that the teacher wants to include: blogs, wikis, forums (Dror, 2008). Since 2000, the AR has been undergoing a major evolution through the development of applications designed primarily to marketing and advertising that have taken advantage of this new technology to impact your customers with 3D content. In education, this new tool have different ways and it is important to analyze the learning process and user experience (Portalés Ricart, 2007).
From a constructivist pedagogical (Gruber and Vonêche, 1995), the use of these tools could facilitate students to construct their own learning environment, considering that each individual has a unique way of creating knowledge. Each individual recreates a subjective reality that cannot be assimilated or ultimately. The role of the teacher in this learning process is to provide information, to be a guide, a facilitator (Ausubel, 1968).

Currently, despite existing tools, this process is not interactive and in some cases teachers simply limited to display information. The student is a taxable person who focuses on storing information, limiting their learning process and leaving it to a rote level. There is no construction or creation of knowledge by the student, a situation that sometimes affects their motivation to acquire new knowledge (Di Serio, Ibañez and Delgado, 2013). When students are motivated, they participate and interact with the contents exposed in the learning process. Construction and improvement knowledge was activated. The student makes it to acquire a skill that will allow you to apply this knowledge and appropriate it. The question arises: could these new learning technologies change the passive attitude of the student? To Dror (2008), to promote three aspects: control, challenge and commitment was used the technology.

This is where the AR can improve this process and enable these three aspects, in addition to improving the participation and interaction, which improves the cognitive processes of student learning.

The AR has some elements in common with the virtual reality but it has two features that make it a very useful tool in the classroom. These are, one allows the transformation of a collaborative environment by recreating a real environment with objects 3D, they have created; and, two, it allows tangible interaction, which helps students create their own learning environment, personalization of content and elements that activate. These contents (such as bookmarks, graphic elements that activate 3D content) plus motivate students to improve their learning and to share this experience with the rest of the class.

Method

The academic population that was part of this experience were eighteen students of architecture first course. The age of participants ranged between 17 and 19 years. As research, tools and in situ observation survey. Developed in sixteen weeks of which half with traditional methods and the other half-using AR.

The project started with drawing 3D models. For this, the free version of Sketch Up program that allows you to export models to collada extension (*.dae) which is accepted by any program that generates content for RA was used. The site Moodle course were uploaded the contents, for students entering the web page and download 3D models by class. The computers had installed the program Sketch Up and using the monitor as display volumes.

In some schools of architecture programs using CAD (computer-assisted design) in teaching geometry and has virtually replaced the traditional methods of graphic expression, i.e., pencil and paper were popularized. However, not all schools have migrated to these new technologies, and in some cases, this change is unthinkable. For this reason, in many of the meetings in which this project has been presented, the paper ends with a "demonstration" that allows attendees understand the benefit of this methodology. The transition between 3D models and scenes AR it was resolved with Augment, a computer program open license for educational applications that allowed associate the model to a graphic mark that triggers the projection contained in RA to put on the webcam. The application is cross-platform allowed that in digital was

installed by tablets and smartphones, which facilitated the visualization of 3D models. See Figure 1.

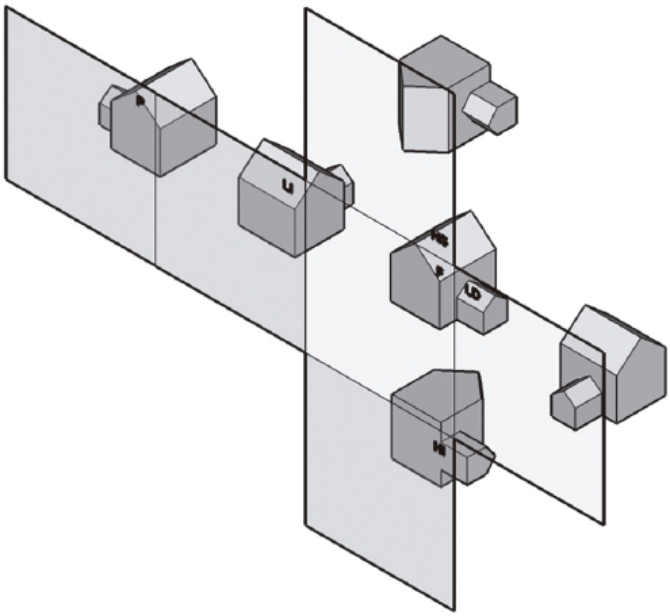

Figure 1. View of a model in all views projection, modeled by the author.

In this case, the method of RA allowed to manipulate the 3D object in real time and helped the student to understand the three-dimensional space and, more specifically, to understand the projection planes. Augmented reality allows students to mix with the 3D model projections in the same environment. Traditionally this it is done independently. When the student identifies how the views of the planes are projected acquires competition to visualize a 3D object from 2D projections (Figure 3). It was determined that this new methodology improved the perception of three dimensions in the eighteen students of the course. Using the traditional method (pencil and paper) was performed an evaluation. To draw a 3D model in isometric perspective and then the results of these exercises viewing AR were compared the models. The method increased the percentage of AR met goals set at the beginning of the year. In exercising, in the development of the drawings but in the process of interpretation of a three-dimensional model to a two-dimensional plane was not assessed the skill, in each of the methods (Table 1). The methodology used to evaluate the two methods was to compare the drawings submitted by students and determine which of the two is closer to the initial objective of the exercise, that is, represent the views of a 3D volume. According to this representation a rating from 1 to 5. The rating of the presented work was done randomly among students without teacher intervention was. This method allowed students to improve the perception of three dimensions using AR, as well as improving communication between teacher and student.

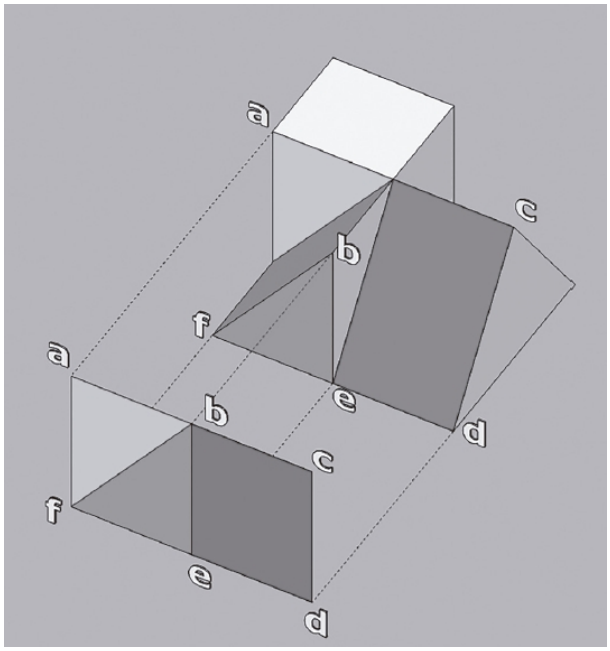

Figure 2. 3D model created to explain the vertical projection, modeled by the author.

Proposed exercises	Percentage of successful exercise. Traditional method	Percentage of successful exercise. Augmented reality
Identify points in projected views	45%	85%
Identify a plane in one of the views	42,5%	81,5%
Draw the 3 orthogonal views correctly	39,9%	71%

Table 1. Results of the evaluation and source: elaborated by the author.

The virtual platform of the university uploaded to 3D models, the student could download the model according to the subject, at home or in any workplace. According to the topics developed in the course by the models, starting with point and ending with volumes composed of inclined planes (Figure 2).

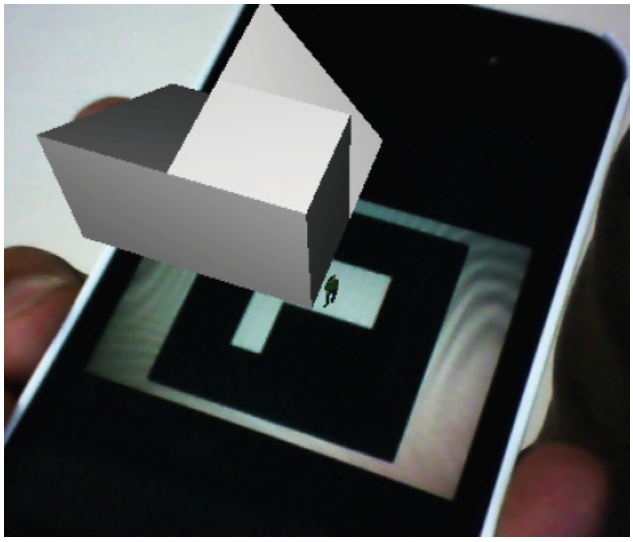

Figure 3. 3D volume using AR, source the author.

Some students with smartphones could visualize patterns directly on their cell phones, which for them was really a novelty. 3D models of the course made these technological devices have an educational use, something that was unthinkable for them (considered these devices for entertainment and communication). In addition to test scores in geometry class a teacher interested in the topic he implemented this methodology in Technical Drawing class in a course of education at the Cooperative College La Calera. The results obtained were similar to those observed in the Descriptive geometry class. Although not made an assessment of the results that this methodology the interest aroused in students. Interest was such that some students individually decided visualize 3D models developed independently under the supervision of Professor Pedro Ayala. Low cost and easy assembly was what encouraged the teacher to use this unprecedented tool in a High School in Colombia.

Results

Students responded at the end of the course entirely a survey based on questionnaires ISO 9241-11 [Ergonomic requirements for office work with visual display terminals (VDTs) - Part 11: Guidance on usability] (Mark, 2006). This was made virtual and anonymously, using the application form designed for cloud Google Drive that allowed insert this form and sent to institutional mail each student. All participants answered the questionnaire by and its main objective was to establish the levels of efficiency, effectiveness and student satisfaction with the presented product and RA watching 3D models as an innovative element (Figure 1). The overall rating of the course was 4.44 points out of five, it that gives an idea of the level of satisfaction. In the correlation between global views of the course with the other variables a very close relationship between the representation of the models and understanding of the concepts detected, which is very important in this type of project because it allows us to establish that students they perceived an improvement in their learning process. The students can did other correlations but overall the survey gave an overview of how they perceived this new technology. Proof of this is that 100% said they would use the RA method as a tool in other courses.

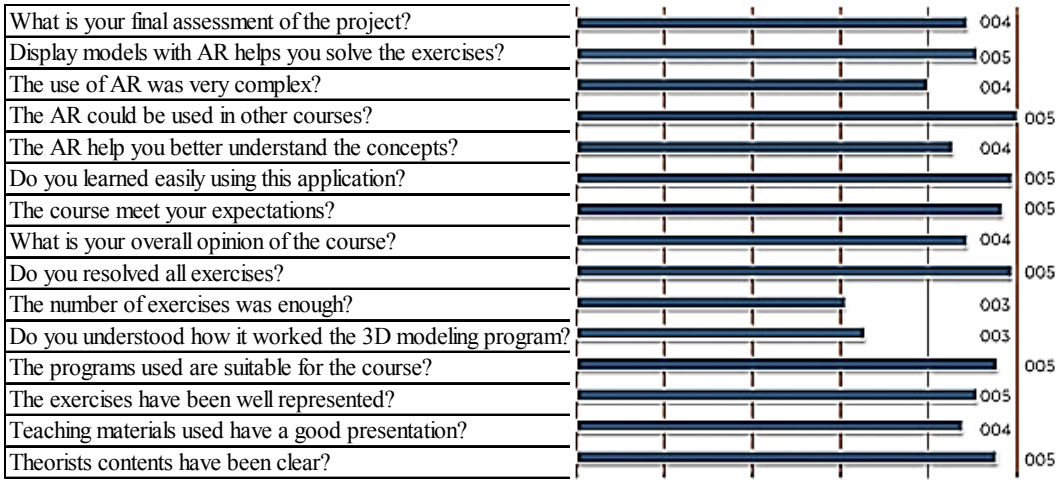

Figure 4. Survey questions effectiveness, efficiency and satisfaction, source: the author.

The RA as visualization tool had a positive effect from the pedagogical point of view. It was possible to meet the objectives of the course and the concentration level improved significantly, while increasing satisfaction levels.

Conclusions

In the last decade AR applications by publicity, marketing and engineering, among others were developed. Pedagogical applications for RA are still incipient. However, because most programs used to develop such projects are open source, the number of research proposals in this area can increase considerably.

RA in this project improved dimensional perception students. Thanks to the 3D models, the student understood how the dihedral projection system and the basic elements of descriptive geometry works: point, line, plane and volume. The relationship between teacher and student it enriched by the interest aroused among students using this technology, which was reflected in an increased interest in the contents of the class. Building a more interactive environment that involves the student in the learning process is a challenge that with more commitment by the teachers. The application of these tools facilitates this process and encourages the student to participate as an actor and not as a spectator.

In line with the new educational trends constructivists, "constructivism asserts that knowledge resides in individuals, that knowledge cannot be transferred intact from the head of a teacher at the head of apprentices" (Ilabaca Sánchez, 2004: 77). That sentence perfectly defines the essence of this concept in collaborative learning has its main tool. In this project, the student builds from visualization and experience, concepts that are the basis of descriptive geometry and applied throughout his career and later in their professional lives. Hence the importance of this educational experience.

This experience wants to show the academic community that the use of these technologies is not very complex. There are many ways to implement augmented reality in education. Although one cannot speak of a perfect solution or a magic

formula, simply because it is not a research project focused on educational aspects, we observed that its implementation in the classroom shows to be in tune with some aspects of collaborative learning. Students also present a problem of lack of attention and understanding as a simple solution.

According to the PISA 2009 report, 20.4% of Colombian students is at level one performance in science. This means that they are not only difficult to participate in situations related to scientific and technological domains but also reveal limitations to use scientific knowledge in order to benefit from future learning opportunities (ICFES, 2010). The use of new technologies of representation still has a long way to go. AR applications in architecture and teaching are becoming more innovative time, considering that you can incorporate animation and 3D models.

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