

Making didactic use of augmented reality in regular basic education

Jhon Edilberto
Monroy Barrios
UNSA
Arequipa-Perú
(054)974437150
jhoedmon@gmail.com

Roger
Quispe Riquelme
UNSA
Arequipa-Perú
(051)951867141
royprac@gmail.com

Roni Guillermo
Apaza Aceituno
UNSA
Arequipa-Perú
(054)959775544
roniguil@icmc.usp.br

Jose Alfredo
Herrera Quispe
UNSA
Arequipa-Perú
(054)945302065
jherreraq@gmail.com

ABSTRACT

We explore the technologies related to Augmented Reality as a type of complementary didactical tool in the classroom. We describe how to integrate Augmented Reality with regular teaching methods. In the experimental phase we used the Augmented Reality in three classrooms from a public institution, with twenty five students in every classroom, the childrens ages are between three years old to five years old. This work used the FLEX BUILDER 3 Framework from the ADOBE Family to develop the software that was applied in the classrooms because other tools do not have a didactic approach. The results show the importance of Augmented Reality in the education. This shows a new way to increase commitment and enthusiasm from students.

Keywords

Teaching methods, learning , augmented reality, learning objects.

1. INTRODUCTION

Concepts of Augmented Reality (AR from here on) have been applied to academy and corporations in the last few decades. Lee adverts that AR helps improve compatibility and applicability in our daily lives [1]. Due to improvements in processing and Information technologies considerable advances have been made. [2]. AR is now being used to improve education and learning from both teachers and students.

Using AR in the classroom increases the motivation in the students [3,4]. Learning outcomes are also elevated [5]. Johnson, et al. [6] declared: "Augmented Reality has a strong potential to enable learning experiences and at the same time a powerful context for exploring and discovering the real world. It also gives a powerful contextual vision that teachers can employ in their educational environments. This content can appeal to different senses such as sight, hearing, touch and smell" [7]

We propose using the standards for Technological Literacy (ITEA / ITEEA, 2000/2002/2007), which can improve visual abilities of students, besides emphasizing contents with a ludic side which facilitates self-learning. An AR application design must start by identifying academic contents using a systematic approach to this end, which is an integral vision of the whole educational context.

In Peru exists a important problem with the education in public institutions, the project have the no principal objective to improve the way that the instructor teaches some concepts for young

children, the young children have abilities to use new technologies, for this reason that is the population of the project.

This paper is organized as follows. Section 2 describes Augmented Reality, section 3 describes Augmented Reality Educational Applications, section 4 describes a justification of Augmented Reality as a didactic tool, section 5 describes considerations of Augmented Reality applied to learning, section 6 describes learning objects and Augmented Reality, section 7 describes development of multimedia content, section 8 describes the methodology, section 9 describes the results, section 10 describes the conclusions and section 11 describes the recommendations.

2. AUGMENTED REALITY

This technology allows superimposing computer generated virtual objects over a real environment in real time [8]. Therefore is the Augmented Reality. From a wider point of view, AR is an interactive application that combines reality with synthetic information -such as 3D images, sound, video, text, haptic feedback- in real time and accordingly to the point of view from a user [9].

AR appeals to a constructivist approach to learning, by allowing teachers hands-on interaction and manipulation of virtual objects [10]. This allows customization which is precisely the key to develop the so called multiple intelligences [11], this improves the knowledge from students thanks to a pedagogic and didactic model [12], learning by discovery is also enriched and enhances creativity, risk taking and removes consequences from mistakes.

AR complements teaching, improving the capacity of students to visualize intricate virtual models, this enables a more holistic approach to learning, because concepts and ideas are no longer seen as isolated facts and procedures [13], instead visual and spatial relationships can be determined. This allows students a more active role.

2.1 Execution sequence in AR

AR executes the following four task in a sequential manner [14]]:

1. Scenery capture.
2. Scene identification.
3. Mix reality with augmented information.
4. Visualization of augmented scene.

2.2 Characteristics

According to Azuma [15,16], an AR System must fulfill the following characteristics [17]:

1. Combine a real and a virtual world: The system incorporates synthetic information to images captured from the real world.
2. Interactive in Real Time: with its physical environment and responds to stimuli from it in a determined time lapse.
3. 3D alignment: Virtual world information must be three dimensional and must be correctly aligned to the real world.

2.3 Advantages:

Draws attention to the learning activity. It adds surprise and interest from students for not a wide spread technology.

1. Computer interaction enables a experiential learning.
2. AR is a novel methodology for it uses new didactic resources.
3. Infrastructure is simple and relatively cheap. A computer and a webcam is all that is needed.
4. Its use is intuitive and the learning curve is short. It achieves good results soon and with little previous knowledge.

3. AR EDUCATIONAL APPLICATIONS

The challenge of adopting AR as a complement to traditional learning methodologies implies the need of applications offering detailed, three-dimensional interactive environments, which would allow exploring and acquiring concepts in a way not possible by a books or screens.

Different software packages are available for our purpose [18]. Such as: environmental sciences [19], micro-biology [20] biomedics [21], math reasoning [22], Medical sciences [23], development of visual poetry [24], Virtual life cycles of a many butterflies [25]. These applications work with a number of universal formats.

3.1 Cuadernia

It allows creating digital books with multimedia content, including AR since version 2.0. To this end, a special blueprint allows selecting. DAE4 objects which users can later rotate.

3.2 Atomic authoring tool

This GNU GPL licensed tool permits creating AR applications. It was developed in the Processing programming language.

The main motivation of ATOMIC is to offer the community an open source tool which does not require too many technical knowledge to access AR technology.

3.3 Smart

This educational system uses AR to teach correct usage of transportation means, animal taxonomy and similar semantic categories via a set of rackets used to manipulate a TV-show-styled game with 3D models over imposed to the video feed. Results suggest that SMART is effective in maintaining high

levels of motivation in children and also has a positive impact in learning experience, especially in weaker students [26].

3.4 Augmented biology

Used to study anatomy and body structure in biology. With it teachers could use AR to show 3D models representing human organs. On the other hand, students can carry independent learning via markers and a portable computer with built-in webcam.

3.5 Mathematics and geometry education

Designed to teach mathematics and geometry in 3D. Teachers and students can share a virtual collaboration space to construe geometrical shapes. They can later superimpose computer generated images over the real world.

Furthermore, Kaufmann determined AR that can be used in dynamic geometry education for a wide variety of shapes. For example, using AR teachers and students can explore intuitively the properties of interesting curves and shapes and other geometrical forms [27].

3.6 Augmented Books

In these applications a camera focuses over pages of a book and computer generated additional information is aggregated and displayed on a screen. Several authors report using AR in books with positive results. Among the main ones are: [28,29,30].

4. JUSTIFICATION OF AR AS A DIDACTIC TOOL

Barfield and Caudell, define AR as a tool to support educational environment, for it stimulates the desire to learn, awakes interest and encourages a investigative spirit in students, as well as many other factors that help understanding and assimilation to be much easier [31].



Figure 1. ISTE Standards [31]

Taking TIC standards for students into account, we take ISTE(International Society for Technology Education) as a reference, that was showed in Figure 1 [31].

Criteria for technological basic education for students is divided in six great categories, they are very concrete and pertinent for Latin American education [31].

4.1 Technological Literacy norms (ITEA / ITEEA, 2000/2002/2007)

According to design standards 8,9 and 10 from these norms, AR can be used to improve abilities of visual learning students.

1. Standard 8, because students have a tendency to comprehend design attributes through visualizing and manipulating models from different perspectives.
2. Standard 9, students can develop comprehension of the engineering design process; this can be fulfilled by evaluating components and relationships through spatial analysis.
3. Standard 10, where students "develop an understanding of the problem solving role, research and development, invention, innovation and experimentation". All these examples present additional resources which teachers can use to motivate students and create a richer learning experience.

Given this, AR is a very effective tool in learning. Students can improve knowledge and abilities, especially in complex theories, machinery and mechanisms of systems [32].

5. CONSIDERATIONS OF AR APPLIED TO LEARNING.

AR can be applied to computer assisted learning. This allows designing attractive learning materials which at the same time can be used in beneficial situations to regular basic education [33]. However, we must also consider that some applications can be a overwhelming cognitive overload due to the complexity of the activities [34], navigation and the scientific investigation process [35], or team decision making [36] another important consideration is to integrate and manage perspectives from designers and teachers, to them, a minimum of two to three facilitators is required to guarantee a correct application without technical mistakes [37]. Moreover, an application success can be dependant in great measure of a good teacher who introduces and facilitates key experience points [38].

Finally, another consideration to take into account is the current state of the art in technologies based on location and movement. Most technical problems found during experimentation involve GPS error [34].

6. LEARNING OBJECTS AND AR

A learning object is a collection of information objects put together using metadata to correspond to the necessities and personality of a particular learner [39].

A didactic proposal for building AR applications must emphasize contents with a ludic dimension, to enable self-learning starting with the identification of the learning context.

An AR application must start by identifying the academic contents employing to this end a systemic approach which is an integral vision incorporating knowledge, learning and teaching actors, support from technological and didactic-communicative resources to create an interactive learning universe. At the same leaning leans towards playing, which is recognized as a ever more important strategy in educational environments, specially because it escapes instrumentalist pretensions which characterize traditional teaching [40].

The premises for the development of Augmented Reality software were taken of a previous work[40]; it is shown in Figure 2.

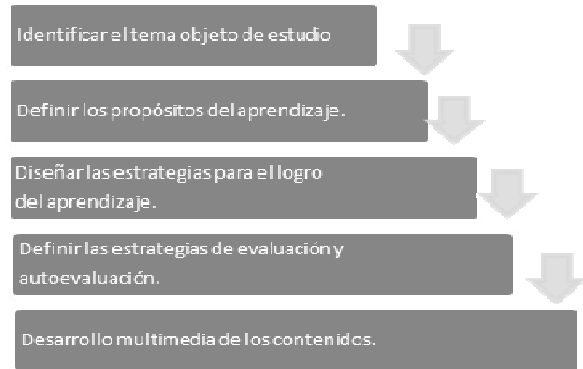


Figure 2. Software development proposal [40].

7. DEVELOPMENT OF MULTIMEDIA CONTENT

To develop AR content, FLEX BUILDER 3 Framework from the ADOBE Family was used. It allows creating ActionScript and compile them to Shockwave SWF files, which can be executed in most operating systems: Windows, Linux, MAC OS, etc.

The libraries used were papervision3D and GLP licensed FLARTOOLKIT. It allows creating AR applications in a ActionScript3 port to Shockwave Flash, which allows indentifying the marker and calculate the position where 3D objects will be superimposed; Papervision3D is a open source 3D engine for Shockwave containing classes to manipulate 3D objects in flash, we can therefore create a scene in our swf with 3D objects a webcam, besides allowing 3-axis rotation.

When marker is identified by the webcam, this is linked by the library and superimposed to the augmented model. As such proper AR content is generated, because real world objects are enriched with virtual objects

8. METHODOLOGY

According to the concepts raised above, it is necessary to make a test case and for this we have the help of children school cradle garden of the National University of San Agustin. In developing experimentation with augmented reality it will be penetrated with a new experience that was to entrench the issue of recognition of colors provide patterns each children which show objects of basic and secondary colors obtained repository objects 3D 3dwarehouse1.

Subsequently, a dynamic where every child children mentioned and associate a color to an object and later to observe the object they had in mind is performed.

8.1 Sample:

Test subjects are children from a pilot school, age of children varies between 3 and 5 years old, who are studying in a cot garden (pre preschool education institution) of the National University St. Augustine, there are 25 children in every classroom and for the research that is used 14 children of 3 years old, 19 children of 4 years old and 23 children of 5 years old, this population of students from baseline in a big city has a sample of various

origins, customs and environments, which were homogenized age for this study, Figure 3 shows the participants in the activity of RA.



Figure 3. Children participating in the activity of RA

8.2 Data collection:

This research has a qualitative methodological approach. Which attempts to identify the profound nature of reality, its system of relationships and their dynamic structure, in order to obtain information relevant to carry out the investigation. To carry out this research, he also sought to understand the actions seen in the context where the research was conducted, using observation and interviews with teachers and children on the initial level.

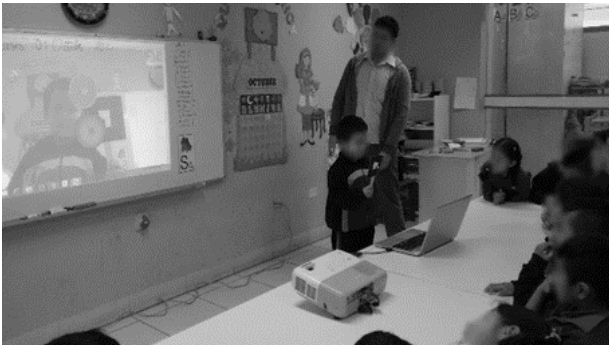


Figure 4. Participation of teachers and students is shown with the application of RA

Simple observation on the group of children was used in this investigation because these subjects are not eligible for other types of data collection and survey were also made other method as was the interview.

This interview was conducted in the presence of teachers and other children, the actions performed by children was spontaneous, because children did not expect the visit of researchers associated with the research, which It reinforces the fact that they have prior knowledge of the use of the devices, Figure 4 the participation of teachers and students is shown with the application of RA.

The process of data recolection was supported by a video digital recording of the educational environment where the children interact and learn. The conditions of the environment were adequate for carrying out the experience.

Seeing the video digital recording of AR experience with children was observed more detail. But the analysis focuses on the number of interventions involving children and skill using patterns.

9. RESULTS

At the end of the assessment activity it was observed where it was highly productive interaction of children with RA Technology was held. These results are reflected in Figure 5.

In assessing the results of the interaction between children and the application of augmented reality we see that in the course of the experience promoted the following positive characteristics, according to the research team:

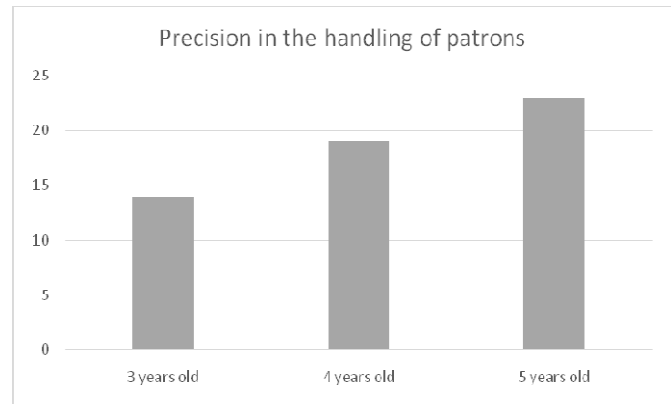


Figure 5. Participation of teachers and students is shown with the application of RA

- Encourages cooperation, solidarity and improved classroom climate, which is shown in Figure 6.
- Group work is constant and information is easily assimilated.
- Improving the participation of children.

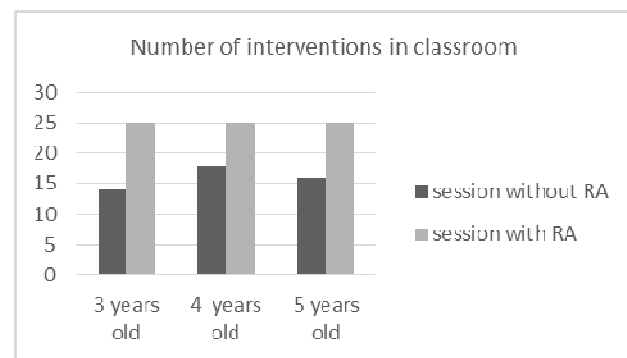


Figure 6. Number of interventions in classroom

Also the surprise of the children was observed when the object appeared in 3D and more when to realize they could move, this can be seen in Figure 7. They had children that usually do not normally participate in educational activities given by the teacher, but to see what was happening began to come forward to participate and interact with the 3D object showing great enthusiasm and joy in doing.



Figure 7. Children participating in the activity of RA

They are fascinated to see themselves reflected in the image at the same time this was built in a combination with the 3D object, all they wanted to interact with the image that did not exist in reality, but in the superposicionamiento of images, for example they wanted to Sometime touch or bite objects as fruits, reinforcing the fact that augmented reality provides new possibilities for teaching and general acceptance.

10. CONCLUSIONS

The presented references show that AR is an emerging technology which requires a strong consideration as a complementary didactic tool in education programs, given that the presented strategic model leverages teaching aspects from constructivism and enriches them with information management notions and a systemic approach. The presented model is a condensed version of the dynamic of information management and knowledge, prioritizing strategies to collect, process and deliver data and information. Results are encouraging in contexts where technology has been applied, also we must reflect upon coherence in pedagogic and didactic designs and how this converges with technology, for it is not only about working the contents, but also about quality from what is learned and what can be achieved with it.

11. RECOMMENDATIONS

1. AR systems can be better taken advantage of by using images or models with previous knowledge in graphic designs and 3D modeling.
2. If teaching times are extended we run into the risk of not finishing a learning session in time.
3. AR applications are promising: education, biology, tourism, astrology, medicine, military training and commerce. A transcendental space to encourage their propagation in academic, scientific and commercial circles is very important
4. Reduce AR applications which employ GPS because lack of preciseness causes most observed technical problems.

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