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Artículo Técnico

Nombre de Proyecto: “CONSTRUCCIÓN DE UNA APLICACIÓN DE COMPONENTES ELECTRÓNICOS BÁSICOS UTILIZANDO LA REALIDAD AUMENTADA PARA LAS NIÑAS, NIÑOS Y JÓVENES DE LA ZONA 1 DEL ECUADOR”.

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Construction of an application of basic electronic components using “Augmented Reality” for children and youth in Zone 1 of Ecuador.

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Abstract—The project aims to build an application of basic electronic components using “Augmented Reality” for children and youth in Zone 1 of Ecuador.

The application consists of 10 basic electronic components, which are mentioned below: diode, transistor, resistor, led, capacitor, DC motor, photoresistor, potentiometer, switch and battery. “Augmented Reality” is used to display the basic information of each electronic component that will be associated with a marker, for display is used a cube which allow use each side thereof to integrate a marker that shows the basic information of each selected item for the application.

For the development of the application was used Cinema 4D that is a designed platform with 3D graphics and animations and the AR-media software, that is an advanced platform for developing applications using “Augmented Reality”.

Keywords— ICTs, Augmented Reality, marker.

I. INTRODUCTION

The use of ICT in education is fundamental for the teaching and learning process as “Augmented Reality”, which has positioned itself as an interactive tool to enhance knowledge and increase the motivation of students with different learning styles and provide information, in addition, “Augmented Reality” adds value compared to traditional teaching resources, and expect to contribute to the academic development and to form a technological culture.

Today education in Ecuador is oriented to academic excellence and therefore should be included and know that ICT in education allow yourself to be immersed in technological advances and the use of these help improve teaching enabling new forms of access, display and as providing the information.

The application of basic electronic components for children and youth in the area 1 Ecuador is one, different from traditional, innovative tool to a knowledge society where it is essential to integrate teaching with new technologies at an early age to achieve it is in front through motivation strengthen knowledge and research. The application will also benefit the tutor is in

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charge of the group of students using the application as it will improve their skills in the pedagogical and didactic field as all the traditional educational material such as posters, maps and models can become an interactive material displayed through a monitor with the help of a webcam and markers, gaining a better appreciation of the subject studied.

The application wants to show new ways to provide information in this case the electronics, to awaken the ingenuity and identify early skills in children and youth to this matter, therefore in the stage of higher education may form in related fields of electronics. The development of this application aims to provide motivation and tools to the technology community to create more applications with this technology to facilitate and transform the traditional educational practice towards education that this pace of technological advances for application in the student community in the country.

II. THEORETICAL FOUNDATION

The following definitions and concepts are needed to know to have theoretical basis in the development of the project.

A. *Augmented Reality*

It is the technology that combines the real environment with virtual 3D objects and interact with them in real time. To improve understanding of this concept the realities of Continuous Milgram, in which the relationship between the real world, augmented reality and virtual displays used. [1]

B. *Virtual Reality*

It is the technology that allows to create spaces, objects and actions in three dimensions in an interactive way so that not resemble or real environment, under a set of techniques based on computer a whole artificial simulation is generated in which the user can be immersed.[2]

C. *Virtual Reality vs Augmented Reality*

At first glance it is considered virtual reality and augmented reality are similar terms but actually represent quite different things. It must be remembered that as technological progress the two technologies have been developed and improved considerably in appearance and application requirements to make use of them in different fields in which the beneficiary is always the end user. [3]

TABLE 1.
COMPARISON OF SYSTEMS AUGMENTED REALITY AND VIRTUAL REALITY

CHARACTERISTICS	AUGMENTED REALITY (RA)	VIRTUAL REALITY (RV)
User immersion	Partial	Total
Replacing the physical reality	No	yes

Control of sensory organs	Partial	Total (view) , Partial (others)
Presence of objects in the real world	yes	No
Real-time interaction	yes	yes
Three-dimensional models	yes	yes

D. Components of Augmented Reality

Augmented Reality system to be functional needs of four main elements:[1]

1) Camera

This element is responsible grabber to capture the real environment and marker and submit it to the program that will process your information to replace it with a 3D object or action. You can use the cameras on computers or mobile phone.

2) Monitor

This element is responsible for displaying projector combining the real environment with Augmented Reality ie virtual objects. You can use the computer screen, mobile phones or devices that allow clearly visualize the RA.

3) Markers

This activating element plays a very important role within a system of RA as it allows positioning the virtual information within the real environment, it is recognized and processed by the software of RA. The marker is a vector printed on a sheet with square shape.

4) Software design

To develop a system of RA is a need for programs that help the processing of information and also have dedicated to designing 3D models with programs and tools necessary to meet all the conditions of a system of RA:

Cinema 4D

It is software for designing graphics and 3D animations, The main functions of Cinema 4D are the creation, animation and texturing combined three-dimensional models with all kinds of forms, plans and camera movements, with a very high speed render, has a customizable interface and flexible. [4]

AR-media plugin

It is an advanced platform for developing applications with Augmented Reality, the plugin allows you to improve the characteristics of design software and you can create content with RA capabilities for computers or mobile phones.. [5]

AR-media player

It is a software that allows you to play files created with Augmented Reality AR-Media Plugin, this player supports files RA ".armedia".[5]

E. Types of augmented reality system

Augmented reality systems are basically classified by the manner or method used to obtain information, states: [6]

1) System based on the recognition of markers

Markers are basically papers with square, which indicate where to locate the virtual object combined with the real environment, the AR system recognizes patterns or marks

using the device camera is used, the software processes the information at its base data and displays the information associated with the marker.

2) System based on golocation

Uses GPS to obtain the geographical position of the user, are widely used for mobile devices take advantage of the characteristics of the same, compass, accelerometers for orientation and tilt of the device, making know by coordinates which place you point the camera, to where you point the camera, the device will display the information associated with the virtual image.

3) System based on shape recognition

It is similar to the system of brand recognition, that is the system and not seek specific brands but known forms, the device camera tries to recognize ways to display information associated with it, has a higher cost level software and algorithms recognition.

F. Applications

Augmented Reality began as a research subject to testing, currently is in the stage of action, ie, improvements in their development and using technological advances have allowed this technology can be applied in different fields in a way mass to the public:[7]

1) Entertainment

Game development for Nintendo DS and PSP Vita. Reality Fighter, where the stage for fights was the real environment.



Figure 1. Reality Fighter

2) Education

Application development with a mix of education and entertainment that has its own term "Edutainment" English Education + Enterteiment. educational books such as AR-solar or solar system.



Figure 2. AR- Solar

3) Medicine

Application development and support, training and medical training. Surgery Guide used in a real medical operation.

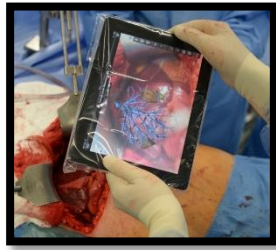


Figure 3. Surgery Guide

4) Tourism

Developing applications for mobile devices with additional information important sites of where we are, replaces traditional tourist guide. Layar and Wikitude are collaborative applications with regard to tourism.

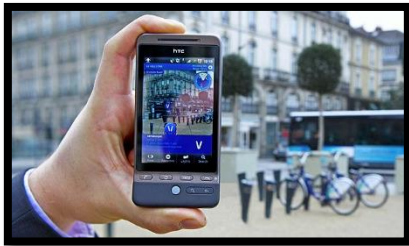


Figure 1. Layar

G. Digital Image Processing

Image recognition is a very important process in augmented reality systems, it is basically to extract the necessary information from the images received from the user device to identify the real environment that is to be increased with this technology. Then the techniques used for image recognition system shown augmented reality. [8]:

1) Image Acquisition

It is to build the imaging system to enhance the visual characteristics of objects, like shapes, lighting and colors using photographic techniques. This step is performed automatically in known devices capture images.

2) Digital Processing

Try to quantify and encode the video signal or received in the form of photographic image, this step aims to obtain a new image to improve its quality or highlight any important attribute of it, for example, highlight edges and regularize colors.

3) Segmentation

Is the process of dividing a digital image into several groups of pixels, with the aim of simplifying an image and analysis easier, image segmentation includes the location of objects (groups of pixels) and the location of the boundaries in an image.

4) Representation and description

To improve the defect, the morphological processing, a processing step that aims to enhance the shape and geometry of objects in the scene is used.

5) Recognition and interpretation

It is the final stage of image processing, your goal is to automatically interpret the scene based on the results obtained in the previous stages. To complete this process,

it is segmented associate each with a set of numerical values or attributes element characteristics called vectors, pattern matching locates regions in an image that match a model known reference.



Figure 5. Image recognition process

H. Pedagogical Substantiation

1) TICs

Are the set of technologies that allow you to manage and present information in the form of voice, images and data found in nature, using electronic technology to develop audiovisual, information technology and telecommunications make it possible to send and receive information in any destination. [9]

2) TICs and education

Contribute as tools that facilitate learning, development of skills and new ways of learning, TIC addressing universal access to education to manage and administer more adequate educational systems, however we must not forget that ICTs are not an end, it is a means to provide solutions to education. [10]

3) Functions of ICTs in education

ICTs are present in all human activities and the education sector is no exception, in Table 2 some functions that help develop creativity in the educational process are shown: [11]

TABLE 2.

FUNCTIONS OF TICs IN EDUCATION

FUNCIÓN	CONCEPT	EXAMPLE OF INSTRUMENT
Means of expression and multimedia creation	Generates and shares information through writing, drawing, through multimedia presentations and web pages.	Word processors, picture editors, sound and video. Presentation software, web page editors. Photo cameras.
Communication channel	Improves interpersonal communication, exchange of ideas, materials and collaborative work.	Email, chat, video conferencing and discussion forums.
Instruments for information processing.	They allow you to create databases, prepare reports, perform calculations, ie, create information from data.	Spreadsheets, database processors. Programming languages.

Open source of information and resources	ICT is a means of transmitting various types of information, in large quantities and easily.	On the Internet there are specialized "search engines" to help locate the information needed. CD-ROM, video, DVD, radio, television, mass mailings.
Cognitive instrument	Supports certain mental processes of people, assuming aspects of a task: memorize, analyze, synthesize, conclude, and so on.	All the above instruments considered from this perspective and intentionally created for educational processes, for example, software and interactive games as tools to support learning or cognitive processes.
Teaching tool	Reportedly, exercise skills, ask questions, guide learning, motivates.	Multimedia teaching materials (CD or Internet). Simulators. Educational radio programs, video and television.
Assessment tool	Provides rapid correction, reducing time and costs, ability to follow the "trail" of the student, on any computer (if it is networked or connected to the Internet).	Programs and interactive web pages to assess knowledge and skills.
Playful means	Cognitive development.	Video games, movies, educational programs, cartoons, soap operas.

4) Use of new technologies in education

The use of new technologies in education can be mentioned that the integration of ICT in education systems aims to create environments enriched learning (AAE), with focused and effective use of ICTs, the AAe seek to promote, facilitate and enrich the compression own themes and important concepts of core subjects in the process of teaching and learning and on the other hand develop educational materials based on technology.[12]

III. CONSTRUCTION AND TESTING OF IMPLEMENTATION AUGMENTED REALITY

A. Design of markers

Development of markers is taken into account using a cube to display the information on the application, that is why markers have a number that will differentiate one face of the other.

1) Construction Method

The Ar-media Plugin software provides a template of an ideal marker, which will be published in the tool design and editing images very popular as it is Photoshop CS6.

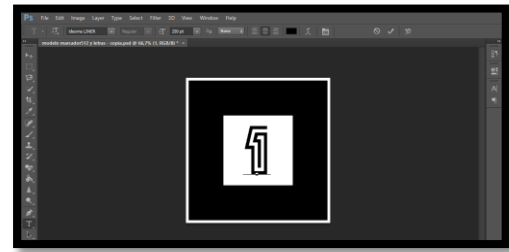


Figure 6. Editing the template marker

B. 3D design models

At this point the selected electronic components such that when being displayed not lose possessing similarity 3D models with actual models is modeled.

1) Construction Method

In the development of each of the modeled 3D with Cinema 4D software of basic electronic components a series of systematic steps were performed, it began with the design from primitive forms, then modeling and finally add materials and textures. Besides the name, symbol and basic information on it with the tools of this software is modeled.

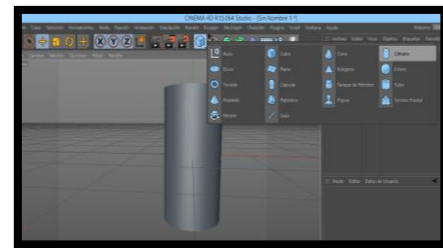


Figure 7. Cylinder Primitiva



Figure 8. Design and Model diode

C. Integration of 3D models and markers

The AR-media plugin is an advanced platform for developing such applications and in conjunction with Cinema 4D software will allow for the integration of models with a simple way markers used.

1) Construction Method

Cinema 4D and AR-media plugin

In the Cinema 4D software, use the AR-media, plug in the AR-media ARPluginToolbar Marker window Generator is chosen to add bookmarks previously created for Augmented Reality. In the window ARPluginToolbar Show the main control panel is

chosen to add bookmarks in the library plugin AR-media, this is done using the .ARPATTERN file corresponding to each marker.

the bookmark you want to use the library is selected, the Attached Objects tab is selected to add the information to the marker, such as 3D modeling, name, symbol or basic information from it.



Figure 9. Integration of AR markers

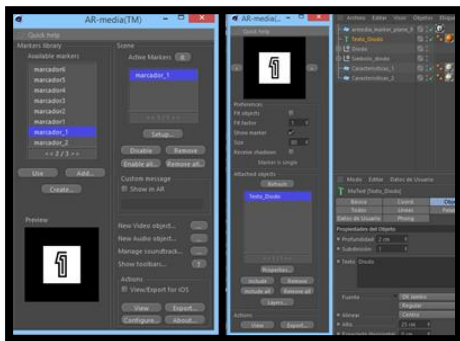


Figure 10. Integration of 3D models and markers

Creating the executable file for the electronic component

To create the executable file, previously you need to export the materials and textures of the electronic component in the export tab .fbx File menu option which is compatible with the AR-media plugin is chosen and the route is selected to save it computer. Finally in the Toolbar window ARPlugin Create an AR-media Resource file option is selected, a name is placed to the executable file and stored on the computer selected route.

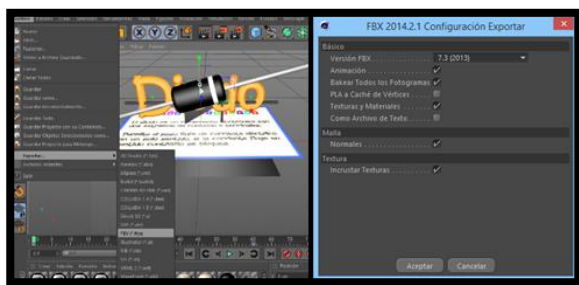


Figure 11. Export of materials and textures

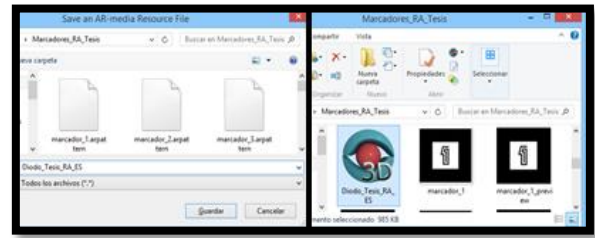


Figure12. Executable application file

AR-media player

Plays the Augmented Reality executable files that were created with the AR-media plugin, this player is compatible only with files with extension .ARMEDIA. To open any application file double click on the executable file is made, the player will automatically start and streaming webcam to interact with the cube with markers will be activated.



Figura 13. Executable application file

D. Construction hub for visualization of Augmented Reality

1) Final Prototype

During construction cube used in the application, it is necessary to mention that two prototypes were made, the first began with the construction of three cubes of different sizes, design markers test and an example of Augmented Reality was also performed. In the second prototype it was decided to use a cube of 8 cm paper since its size was acceptable for further handling with the application test markers was added to each of its faces.

Finally taking into account the results obtained and the considerations to improve the design and construction of the cube in the second prototype, to the final prototype modifications were made:

Markers for application is 6 which represent each side of the cube, and a discreetly indicate an order for interaction with the Augmented Reality application.

The cube was built in an acrylic material white for its strength and lightness for handling, it should be emphasized that the material of acrylic is white to be used as a basis for markers and subsequently these will be printed on a sticker black material mate.

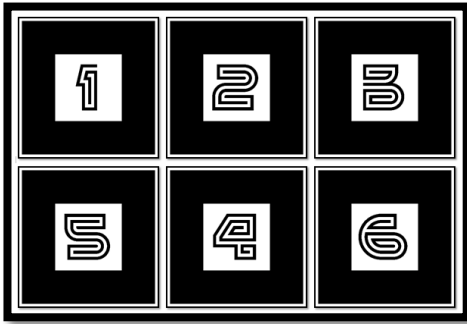


Figure 14. Markers final prototype

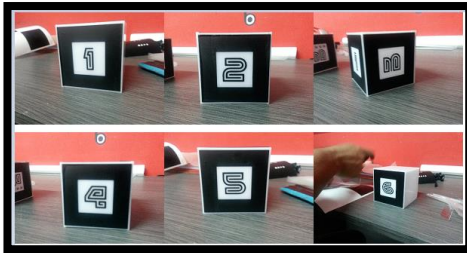


Figure 15. Construction cube

2) *Tests and results of the final prototype*

The application consists of 10 basic electronic components, which are mentioned below: diode, transistor, resistor, led, capacitor, DC motor, photoresistor, potentiometer, switch and battery.

The tests were performed with the cube finished in white acrylic material with adhesive matte black markers were executed with diode executable file to verify that the Augmented Reality experience is acceptable and proper operation. Each electronic component of the application must contain information that is displayed according to the marker to be shown to the webcam, then detailed information:

- Marker #1: Displays the name of the electronic component.
- Marker #2: Shows the 3D model of the electronic component.
- Marker #3: Shows the symbol of the electronic component.
- Markers #4, 5, 6: Show the characteristics of the components.



Figura 16. Diode name displayed with Augmented Reality



Figure 17. 3D modeling diode visualized with Augmented Reality

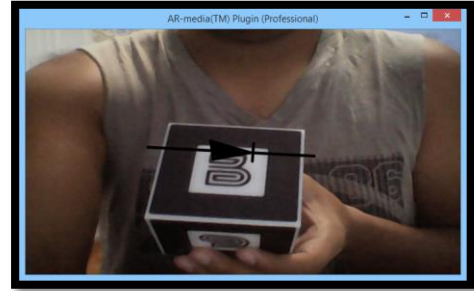


Figure 18. Diode symbol displayed with Augmented Reality

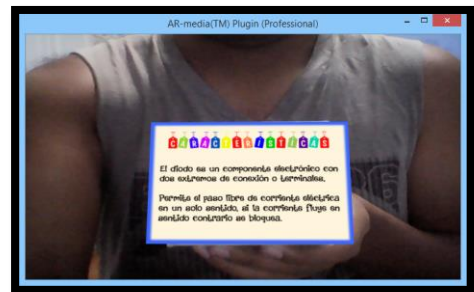


Figure 19. Diode characteristics displayed with Augmented Reality



Figure 20. Diode characteristics displayed with Augmented Reality



Figure 21. Checking the recognition and marker display

E. Referential budget

Economic analysis of the materials used to design the prototype of the application as well as the components necessary for the construction of it is detailed.

1) Used hardware

Costs entailed in the redesign and as well as additional materials that were used and electronic tools used to develop the application with Augmented Reality

TABLE 3.
REDESIGN OF THE CUBE

QUANTITY	MATERIAL	UNIT COST	TOTAL COST
5	A3 sheet	\$ 0.10	\$ 0.50
1	Scissors	\$ 0.50	\$ 0.50
1	Glue Stick	\$ 1.50	\$ 1.50
1	Instant glue	\$ 0.50	\$ 0.50
3	White acrylic cubes	\$ 15.00	\$ 45.00
18	custom markers in black matte adhesive	\$ 1,00	\$ 18,00
TOTAL		-	\$ 66,00

TABLE 4.
DEVELOPMENT TOOL

QUANTITY	MATERIAL	UNIT COST	TOTAL COST
1	Asus Computer x555L	\$ 1100.00	\$ 1100,00
1	HD Web Camera	\$ 15.00	\$ 15.00
TOTAL		-	\$ 1115.00

2) Used Software

For the design of 3D models, textures and the development of Augmented Reality technology different software used to design 3D models Cinema 4D was used, which has a student version free download, for the development and integration of Augmented Reality AR-media plugin that features a free downloadable version was used.

TABLE 5.
DEVELOPMENT TOOL

QUANTITY	MATERIAL	UNIT COST	TOTAL COST
1	Student Cinema 4D version	\$0.00	\$0.00
1	AR-Media Plugin	\$0.00	\$0.00
TOTAL		-	\$0.00

IV. RESULTS

A. Type of investigation

The research is of applied type, because it will allow to observe the behavior of students in their classrooms, in addition to analyze and gather information on how the application with Augmented Reality interacts with students and teachers who manipulate this application, if they are comfortable or familiar with this type of technology such as a contribution to the process to support teaching and learning. [13]

B. Stage of investigation

The selection of the sample took the student population of Imbabura Technical Institute, he was selected eighth year of basic conjunction with their teachers. The course has a total of 37 students and 2 teachers, who were with the best disposition to collaborate with the investigation.



Figure 22. Exhibition Augmented Reality technology in Imbabura Technical Institute



Figure 23. Student using the application with Augmented Reality



Figure 24. Teacher using the application with Augmented Reality

C. Data collection technique

The survey as a technique for data collection, it is aimed at students and teachers that make up the sample, in order to share their experiences regarding the use of the application with augmented reality as a support was used to process this investigation teaching and learning. The survey data were tabulated and analyzed. [14]



Figure 25. Students and teachers responding to surveys

D. Analysis of results

For the application of basic electronic components Augmented Reality meets the proposed objectives, it was necessary to perform a test in a real environment because it is very important to observe the interaction and degree of acceptance of the application by students, seeking to achieve a greater retention of knowledge and a new teaching and learning tool for teachers.

The survey and data collection technique, in order to obtain information about the application with Augmented Reality eighth grade students and teachers of basic Imbabura Technical Institute was used. The most important questions in the survey were selected to conduct the examination.

According to the results of the survey of students, it is assumed that the degree of acceptance with the Augmented Reality application was successful, because when interacting with the same expressed interest, concentration and understanding of the topic. As part of the survey students knowledge questions with which the retention of information was evaluated, where the results were positive as most of the students matched the response building their knowledge supported by ICTs were made.

Moreover, the results of the survey of teachers show that the application with Augmented Reality has a high degree of acceptance, because when using a new system of education allows students to give more attention and interest and to interact directly with materials, and clear your concerns.

The use of ICTs in education is fundamental to the process of teaching and learning based as it is positioned as an interactive tool to enhance knowledge and increase the motivation of students with different ways of learning, the use of Augmented Reality shows the advantages over traditional resources with educational content.

V. CONCLUSIONS

Collection the necessary information about augmented reality had a positive impact on strengthening knowledge about this technology because the features and components needed for application development and the importance of using ICT in the educational process was determined.

El The analysis of literature sources of electronic allowed to select the basic electronic components and information from them for application development augmented reality, it was decided that the ideal content of the application displays the name, 3D model, symbol and characteristics of diode, transistor,

resistor, led, capacitor, DC motor, photoresistor, potentiometer, switch and battery.

Tools for application development augmented reality compared, therefore, Cinema 4D was selected for the 3D and animation application modeling because this software has a clear and intuitive interface for designing 3D models also the AR-media plugin for the creation and integration of augmented reality was used because it is an advanced platform for creating applications with augmented reality computer and is compatible with Cinema 4D software which allowed integrate bookmarks and modeled more easily, quickly and efficiently.

The construction of the application of basic electronic components augmented reality allowed to use a new educational materials to support teaching and learning electronics on children and youth in the area I Ecuador as it was observed how this technology adds value with its models in three dimensions than traditional methods such as the blackboard, markers and books do not, plus the use of new technologies ICTs in educational institutions is encouraged, since according to the census conducted by the INEC in December 2013 indicates that the use of computer and the Internet is 43.6% nationally, that is, people who are between 16-24 years and 67.8% people aged 5 to 15 years 58.3%, enabling enable students have access to computers in homes and educational institutions to use the application as well as for information. A user manual was performed for students and teachers to use the application, which allowed to publicize the requirements for the augmented reality system to function in a proper way and how to interact with the cube of markers and executable files the application of basic electronic components.

The survey as a technique for data collection in order to obtain information about using the application with Augmented Reality and know the degree of acceptance of it was used the survey to students and teachers in the eighth year of basic held Technical Institute of Imbabura, the results show that the degree of acceptance of students and teachers with Augmented Reality application is successful, interest, concentration, greater understanding and knowledge retention was manifested; also it concluded that the use of ICT is fundamental to the process of teaching and learning base, Augmented Reality is positioned as an interactive tool to enhance knowledge and increase the motivation of students with different learning styles.

A referential budget of the application in which the costs of acquisition of materials and tools for the design and development of application components is explained performed, this led to the conclusion that the development of interactive teaching materials using augmented reality is cheaper since the content of the application is customized and can be updated to correct errors and easily add information, as opposed to traditional teaching materials, such as a book and its cost of printing on paper.

VI. RECOMMENDATIONS

For the authorities of educational institutions are advised to take the initiative and promote training for teachers and students regarding the use of new technological tools to strengthen the process of teaching and learning, such as Internet access and in this case the Augmented Reality.

For a second phase of the project, it is recommended to add more functionality to the application such as increasing the number of electronic components and add the audio option.

For handling the different software used in this project, such as Cinema 4D and Ar-Media plugin, you should have a basic knowledge of them because in this way the development of the application with Augmented Reality will be held at a time much lower.

At the time of filing the application with Augmented Reality, it is advisable to make prior coordination with the teacher, because in this way you can better manage students to introduce them to the new method of teaching using ICT.

Is recommended for proper system operation Augmented Reality consider the environment in which it is used and the light incident on the marker, a bright environment affect recognition also for better capture the scene and processing 3D models, use a camera of 2 or more megapixels.

To reduce costs in the development of the application of basic electronic components with augmented reality for children and youth in the area 1 Ecuador, we recommend using free software or gratuititas existing versions on the market.

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