Towards the Development of Emotions through the Use of Augmented Reality for the Improvement of Teaching-Learning Processes

Benjamín Maraza-Quispe*, Olga Melina Alejandro-Oviedo, Kelly Shirley Llanos-Talavera, Walter Choquehuancu-Quispe, Simón Angel Choquehuayta-Palomino, and Nicolas Esleyder Caytuio-Silva

Abstract—This research aims to determine how the use of Augmented Reality technology propiciates learning achievements through generate emotions in students. The methodology used for development of this research was the selection and application of ARToolKit open-source software, specialized in augmented reality implementation, after that, we implemented a 3D model on the topic “Cell Biology” developed in “Unity3D”. A Likert scale test according to main emotions is applied to a sample of 50 students selected through simple random sampling from a total population of 100 students. The sample is divided into two groups, 25 students for the experimental group and 25 students for the control group. In experimental group, Augmented Reality will be used during three learning sessions. In control group Augmented Reality is not used. In both cases the Likert scale test will be applied after each learning session. At the end of the three learning sessions, a competency-based evaluation is applied according to selected criteria. The results show that 80% of the 25 students in the experimental group improved their academic performance with respect to the control group, which maintained a standard average academic performance of 50%. In conclusion, we can say that the use of Augmented Reality technology in the development of sessions in teaching-learning process, generate emotions in students who are able to improve their learnings.

Index Terms—Augmented, emotions, e-learning, learning, reality, teaching.

I. INTRODUCTION

The value of this research lies the in the use of Augmented Reality technology in teaching-learning process, allows the students to elect the contents to work in, increasing their autonomy for learning and makes viable self - evaluation based on this app and increases the competence capacity when they achieve each objective in the proposed activities.

Thus, this learning system offers interactivity and their essential parts provides interaction between sense of sight, sense of hearing and sense of touch, in addition to improve students’ attention and a better understanding of the contents and the concepts in learning process. At present, the use of AR Technology is closer to teachers more than ever before. A few years ago, it was not possible to imagine this technology simplified at its complexity and usability to be used in classrooms by teachers and students or even to create their own content.

There is an interaction between emotions and learning, but this interaction is more complex than all the past educational theories have could articulated. The Augmented Reality technology is one of 21st century emerging technologies, which has several applications in daily life [1]. In the educational environment the Augmented Reality Technology would fit perfectly like a support tool in students training using emotions [2]. Being that, there is no learning without emotion. According to [3] “You only learn what you love, therefore it is essential to know the world of emotions to capture the essence of teaching”. At the same time, Augmented Reality technology is one of the best ways to make a connection between the real and digital world, stimulating, in that way the emotions, this feature would complement and reinforce students learning with educational content. Likewise, Natural Sciences field needs a tool with the characteristics mentioned above. In the same context, [4] states the following: "Teaching science involves to increase a constant interaction between reality and knowledge, not only through theory but also by conducting experiments that suggest questions based on scientific reasoning". In this way, the use of Augmented Reality in education can influence positively, in the emotions, for the achievement of learning objectives in Natural Sciences field. Likewise, “student motivation is a critical variable for science teaching.” [5]. Certainly, we can say that attitudes and expectations of students about the scholar duties, affect their learning achievements. Augmented Reality has the ability to transform the sensory perception of the real world, adding inventions based on virtual reality, generating mixed models of reality, which overcome the limits of the real world, making complex or abstract phenomena and elements, much more perceptible [6].

According to [7], Augmented Reality is based on the superimposition of virtual information on physical spaces in real time, through digital devices. Transforming, in this way, an interaction between the real world and digital resources, influencing the perception of people making them believe that the real and the unreal world are blended in a same place.

So augmented reality could be defined as that additional information obtained from the observation of an environment, captured through the camera of a device that previously has a specific software installed. In agreement with [8] supported by [9] there are 4 levels of augmented reality, which are
students during educational processes in the twentieth century. 

Emotions become capital in the development of learning, processes of emotional scaffolding.” [15]. This is how reached a desired goal; and anger, rage, fury and violence. 

Danger; disgust, strong dislike and disgust; happiness, had discouragement, or disappointment; Fear, perception of a result of an unexpected or unforeseen event; Sadness, grief, 

A functional response to an event in daily life [13]. [14] distinguishes six basic emotions of human beings: Surprise, as a result of an unexpected or unforeseen event; Sadness, grief, discouragement, or disappointment; Fear, perception of danger; disgust, strong dislike and disgust; happiness, had reached a desired goal; and anger, rage, fury and violence. 

Educational processes are ultimately conceived as processes of emotional scaffolding.” [15]. This is how emotions become capital in the development of learning, however, there is a lack of attention to the emotions of students during educational processes in the twentieth century.

It should be noted that the work done by [17], relating emotion and the power of educational processes, proposes that emotions are built based on experiences.

The teaching of a science such as Biology needs a constant interaction between reality and knowledge and not only by concepts but also through experimentation that makes students to formulate questions based on scientific reasoning [4]. All this must been seeing since a didactic perspective for this reason [18] demands the use of "active methodologies" which encourage inquiry in science fields. Because of that, it is very necessary counting with interaction environments for learning development and for a good classroom climate, a good example of interaction between the theory and the students are the technological resources such as the augmented reality [19]. In addition, motivation is considered as a critical variable for science teaching as it is related to students’ attitudes and expectations, together with "active methodologies", represent the method to get closer the science and the students [5]. Thus, Augmented Reality becomes an indispensable tool for science teaching, supporting student motivation and being complementary in an innovative methodology for learning achievements.

Emotions induced by augmented reality are positive for the acquisition of new knowledge [20]-[22]. According to, [19] state that Augmented Reality, is able to transform the sensory perception of the real world, thus counting with virtual reality models that overcome the limitations of physical and abstract representation in our world. "According to the perception of students learning with educational objects with augmented reality is a positive, pleasant and rewarding emotional experience." [20]. This relationship has been verified by the work of [15], where a greater presence and variety of positive emotions for learning was detected. In addition, it is suggested to "turn on" the emotion first, through the use of methodologies and resources that provoke the student's curiosity about what he/she wants to learn [3], [22]. This is important according to [23]: "When a student acquires new knowledge, the emotional and cognitive parts operate in an interrelated way in his/her brain. Moreover, emotion acts as a guide to the acquisition of that learning, so that it labels experiences as positive and therefore attractive to learn or as negative, therefore likely to be avoided" [2].

In a cafe, in a journey or while you are driving a car, radio may be a good choice, however no one watches a radio on Internet these days when they have a chance of watching a TV channel. Virtual Radio Centers, including access to several radio channels and compatible with mobile phones should be more common in future. These centers will help people to visualize what's going on and will give them a chance to participate both physically and virtually. Nonetheless, a Virtual Radio Center will make the sounds visible! [21].

In [22] examines the conceptual design of AR applications as a learning activity with low technical requirements. With the help of the learning activity, the principles of AR and of the subject area can be conveyed, and the learners’ engagement with the learning content should be stimulated. In this study, Bachelor students of civil engineering \(N = 71\) have been assigned the task of an AR application for the subject domain of technical infrastructures, such as traffic management or energy supply.
The students describe the design of the AR application with an own photo shot of the technical infrastructure with the augmentation on the photo and an explanatory text of 100–200 words. Combined these three elements serve as an illustration, which is made available to fellow students in an online gallery for peer review by means of a questionnaire. The peer review is intended both to examine the quality of the students' assessment of learning success. Although the study only suggests actual learning outcomes of the learning activity, it demonstrates how complex technologies, such as AR, can be integrated into learning contexts with low technical requirements [24].

The research answers the question what extent does the use of augmented reality promote the achievement of learning through the development of students' emotions?

II. METHODOLOGY DEVELOPED

A. Research Objective
To determine to what extent the use of augmented reality favors the achievement of learning through the generation of students' emotions.

B. Research Hypothesis
The use of augmented reality is conducive to the achievement of learning through the generation of students' emotions.

C. Research Variables
Independent Variable: Application of Augmented Reality.
Dependent Variable: Achievement of learning through emotions.

Controlled Variables: Number of students with whom we will work using Augmented Reality and Time Regulation.

D. Population and Sample
The population is constituted by 100 students, from which through a simple random sampling 50 students were chosen, where each element of the population has the same probability of being selected to be part of the sample [25]. The sample is divided into two groups: Experimental and Control Group. As shown in Table I.

E. Academic Context
The research will be developed in the biology course, in students of Secondary Education of Regular Basic Education.

F. Methodological Design
The methodological design followed is shown in Table II.

<table>
<thead>
<tr>
<th>Group</th>
<th>Tool used</th>
<th>Assessment of learning</th>
<th>Likert scale test</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A:</td>
<td>Augmented Reality is used in the</td>
<td>The same evaluation will be given to both groups.</td>
<td>A test based on the Likert scale will be applied in different dimensions of the learning sessions.</td>
<td>3 weeks</td>
</tr>
<tr>
<td>Experimental</td>
<td>learning sessions developed.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group B:</td>
<td>Augmented Reality is not used in</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>the learning sessions developed.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

G. Procedure
- Selection of the software "ARToolKit, open-source software specialized in the implementation of Augmented Reality.
- Implement a 3D model on the topic "Cell Biology" developed in "Unity3D".
- To train the teacher in charge of case "A" on the use of Augmented Reality.
- To elaborate a Likert scale test according to the main emotions.
- In the Experimental Group, Augmented Reality will be used during three learning sessions, unlike the Control Group, which will not use this tool; however, in both cases the Likert scale test will be applied after each learning session.
- At the end of the three learning sessions, a competency-based evaluation will be applied according to selected criteria.
- The data obtained will be collected for subsequent analysis and interpretation.
- A Likert scale satisfaction test has been implemented according to the following dimensions: Topic Substantiation Dimension, Use of Tools for Learning Dimension, Satisfaction before Assessment Dimension, Satisfaction after Assessment Dimension, and Topic Conclusion and Self-Assessment Dimension.

H. Data Collection Instruments
The data collection instruments are shown in Table III.

III. ANALYSIS AND INTERPRETATION OF RESULTS
Table IV shows the results by dimensions of satisfaction degree of students in the Experimental Group according to the
Likert scale test applied.

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>N° of Students</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topic Rationale</td>
<td>25 students</td>
<td>4.21</td>
</tr>
<tr>
<td>Use of Learning Tools</td>
<td></td>
<td>4.59</td>
</tr>
<tr>
<td>Satisfaction before the Evaluation</td>
<td></td>
<td>3.97</td>
</tr>
<tr>
<td>Satisfaction after the Evaluation</td>
<td></td>
<td>4.03</td>
</tr>
<tr>
<td>Topic Conclusion and Self-Assessment</td>
<td></td>
<td>4.51</td>
</tr>
</tbody>
</table>

Table IV shows the results by dimensions of satisfaction degree of students in the Experimental Group where Augmented Reality is not used in the learning sessions.

The method used to measure the dimensions in Table IV consisted of the application of 25 items, 5 items for each of the 5 dimensions; from the lowest satisfaction degree 1 to the highest satisfaction degree 5. In this study, the Likert scale is used to validate the students’ evaluations, where: 1=strongly disagree, 2=disagree, 3=neither disagree nor agree, 4=agree and 5=strongly agree. This in turn allows us to obtain a very structured and transparent evaluation process at the moment of obtaining the students’ opinions.

Table V shows the results by dimensions of satisfaction degree of students in the Control Group where Augmented Reality is not used in the learning sessions.

The following is a comparative analysis of the results of the degree of satisfaction by dimensions established in the Experimental Group and the control group.

In Fig. 1, can be noticed that satisfaction emotions presented by the Experimental Group are greater than those that belong to Control Group; the students of the experimental group were “Satisfied” with the dimension of the foundation of the subject and the Control Group only managed to feel “Neither Satisfied, Nor Dissatisfied”. The difference is large between these two groups. Why does this wide difference in satisfaction occur? According to [26], the use of new technologies generates an environment of social interaction where new knowledge is demanded or generated. Which means that the students of the Experimental Group have generated learning, due to social environment that also generates emotions. The school is an apparently neutral educational system; however, the school reproduces, as [27] would say, “a demanding social structure that executes power, is violent and makes social equality impossible. These facts, of course, favor the generation of certain emotional states at the collective level, so that the pedagogical actions of this social space make students feel valuable or worthless”.

In Fig. 2, in the dimension: Use of learning tools, the Experimental Group has advantage over the control group. This dimension measures the degree of acceptance of the students in the use of Augmented Reality that generates more emotions. According to [28], Augmented Reality presents different functionalities for information processing, access to knowledge, communication channels, social interaction environments, etc., besides being a new technology among students, it somehow attracts their attention.

According to Fig. 3, it is observed that in the dimension: Satisfaction before evaluation, the experimental group
presents greater satisfaction. According to [29]. Since the students could feel anxiety, i.e., "that may simply be a previous experience of blocking an exam, or have been unable to remember known answers".

According to Fig. 4, this dimension shows the superiority of the Experimental Group over the Control Group. When feeling "Satisfied" the Experimental group, it means that their grades in terms of academic performance are satisfactory.

According to Fig. 5, this dimension shows the superiority of the Experimental Group over the Control Group. When feeling "Satisfied" the Experimental group, it means that their grades in terms of academic performance are satisfactory.

A. Comparative Analysis according to Learning Achievements

The knowledge and understanding acquired by students are then measured through an assessment that includes items with indicators for the achievement of skills such as: Mastery of concepts, to Select and apply relevant information and concepts, to demonstrate strong problem-solving competence, to develop detailed explanations of complex phenomena, and to communicate in a good manner, using appropriate terms.

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>No of Students</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concept mastery</td>
<td>25 Students</td>
<td>3.31</td>
</tr>
<tr>
<td>Selects and applies relevant information and concepts</td>
<td>25 Students</td>
<td>3.19</td>
</tr>
<tr>
<td>Demonstrates strong problem-solving competence</td>
<td>25 Students</td>
<td>3.37</td>
</tr>
<tr>
<td>Develops detailed explanations of complex phenomena</td>
<td>25 Students</td>
<td>3.28</td>
</tr>
<tr>
<td>Communicates in a good manner and with appropriate terms</td>
<td>25 Students</td>
<td>3.55</td>
</tr>
</tbody>
</table>

Table VI presents the results of grades of students in experimental group according to the criteria taken.

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>No of Students</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concept mastery</td>
<td>25 Students</td>
<td>2.77</td>
</tr>
<tr>
<td>Selects and applies relevant information and concepts</td>
<td>25 Students</td>
<td>2.89</td>
</tr>
<tr>
<td>Demonstrates strong problem-solving competence</td>
<td>25 Students</td>
<td>2.96</td>
</tr>
<tr>
<td>Develops detailed explanations of complex phenomena</td>
<td>25 Students</td>
<td>3.17</td>
</tr>
<tr>
<td>Communicates in a good manner and with appropriate terms</td>
<td>25 Students</td>
<td>3.27</td>
</tr>
</tbody>
</table>

Table VII presents the results of grades of students in control group according to the criteria taken. This is followed by an analysis for each learning criterion:

According to Fig. 6, the Experimental Group presents high scores in the Concept Mastery criterion compared to the control group. This is due to the implementation of Augmented Reality. This group has more mastery of concepts, while in the traditional way of teaching there is not much motivation to develop this ability in the students.

According to Fig. 7, a significant improvement is noted in the experimental group compared with the control group in the evaluation of the criterion select and apply relevant information and concepts.

According to Fig. 8, the Experimental Group shows better scores in the criterion: Demonstrates competencies to solve problems. This criterion evaluates how the student uses his
knowledge to solve a problem.

According to Fig. 9, in the dimension: Elaborate detailed explanations of complex phenomena, the superiority of the experimental group is notorious. This is due to the fact that through the use of augmented reality in the teaching-learning processes, the phenomena are explained in detail.

Fig. 10, in the criterion: Communicates in a good way and with appropriate terms, the experimental group was more attentive and noticed to the terms, unlike the control group that was not so excited and did not pay attention to the development of the session.

B. Comparative Analysis of Results between the Experimental and Control Groups

According to Fig. 11, it can be seen how students in the Experimental Group had generated more emotions than the Control Group.

Fig. 12 shows the superior academic performance of the experimental group compared with the control group, likewise with respect to the satisfaction degree also shows a higher satisfaction in the experimental group with respect to the control group, demonstrating the influence of the use of augmented reality in the teaching-learning processes.

C. Degree of Covariation between Student Emotions and Learning Achievement

Pearson's correlation, which aims to measure the strength or degree of association between two quantitative random variables that have a joint bivariate normal distribution, is applied [26]. This correlation will be applied to results of each session to verify that the emotions are affecting the grades and continue with the comparison of these ones. As shown in Table VIII

<table>
<thead>
<tr>
<th>TABLE VIII: PEARSON CORRELATION TO MEASURE THE DEGREE OF ASSOCIATION BETWEEN VARIABLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>$r = 1$</td>
</tr>
<tr>
<td>$0 \leq r &lt; 1$</td>
</tr>
<tr>
<td>$r = 0$</td>
</tr>
<tr>
<td>$-1 &lt; r &lt; 0$</td>
</tr>
<tr>
<td>$r = -1$</td>
</tr>
</tbody>
</table>

Table IX shows that the result is greater than zero, but less than one, so the variables have a positive correlation, that is, they are related. This helps me to prove that emotions are indeed affecting learning achievement. After the application of Pearson for each group, these are the results:
Moreover, emotions are fundamental elements of students’ enjoyment of learning is beneficial, while anxiety, identity and well-being, implying that emotions are a fundamental element of students’ identity and well-being, so emotions are also important, beyond their functions for academic learning. For all these reasons, educators should pay attention to students’ emotions.

There are several ways to help students increase positive emotions and decrease negative emotions. Most importantly, educators can help students to develop self-confidence, interest, and intrinsic value that promote enthusiasm for learning and decrease negative emotions. This can be done by providing high-quality instruction, using one’s own positive emotions as a teacher, creating mastery goal structures in the classroom, employing mastery standards to inform students about their learning progress, avoiding high-stakes testing, involving parents, and caring for the classroom. In addition, teachers can contribute to the achievement of educational goals related to emotions by helping to organize schools and educational systems in an emotionally appropriate way.

Technology through the use of Augmented Reality in teaching-learning processes becomes a support tool to achieve educational objectives [30], [33].

The generation of augmented reality in the research is implemented with two specific free access applications ARToolKit and Unity 3D, limited to the development of emotions, through the development of teaching-learning sessions; however, for future development of the research it is recommended to use more sophisticated augmented reality applications.

**Conflict of Interest**

The authors declare that they have no conflict of interest in relation to the research carried out.

**Author Contributions**

Benjamin Maraza-Quispe implemented the methodological design, Olga Alejandro-Oviedo reviewed the background, Kelly Llanos-Talavera performed the statistical analysis, Walter Choquehuana-Quispe analyzed the data, Simón Choquehuayta-Palomino implemented the discussion and Nicolás Caytuio-Silva contributed the conclusions and recommendations.

**References**


Benjamín Maraza-Quispe is a doctor in computer science. He currently works as a research professor at the Faculty of Education Sciences of the National University of San Agustín de Arequipa-Peru. He is a consultant and lecturer on educational technology issues, as a researcher in this area he has published many research articles in journals indexed to databases such as Web of Science and SCOPUS. He has been recognized by the government of his country with the awards: "Magisterial Palmas in the degree of Teacher in 2016" and "Teacher who leaves a mark in 2018" among other recognitions. He has also been the winner of several international educational innovation competitions, such as: "The Microsoft World Forum", held in Barcelona in 2014: the "International Science, Technology and Engineering Fair, INTEL-ISEF-2017-2018" held in the USA.

Olga Melina Alejandro-Oviedo is the director of the Graduate Program in Education. She holds a doctorate degree in education, master's degree in higher education in education, second specialty in primary education FCE-UNSA, second specialty in Psychomotricity, bachelor's degree in early education, bachelor's degree in educational sciences. She is a student of the master's degree in educational and digital competencies and full professor of the Faculty of Educational Sciences of the National University of San Agustín de Arequipa, research professor in the line of Early Childhood and in Technologies Applied to Early Childhood Education.

Kelly Shirley Llanos Talavera holds the bachelor of communication science. Currently she is a student of master in University Teaching and Management Educational at UAP University. She was graduated from Second Specialty in Educational Informatics at San Agustin University. She is an administrative staff and journalist at San Agustin University.

Simón Angel Choquehuanca Palomino currently holds a PhD in computer science and works at the Faculty of Education Sciences of the Universidad Nacional San Agustín de Arequipa as a teacher-researcher. He is passionate about technology innovation and the aim of finding solutions to everyday problems with the help of technology.

Walter Choquehuanca-Quispe holds a doctor in educational sciences, is a research professor at the Universidad Nacional San Agustín de Arequipa - Peru. He is a professional identified with his vocation, critical and analytical, likes challenges and work under pressure, besides being a humanist and concerned about the political and social problems of the issues that concern society.

Nicolas Esledyer Caytuero Silva is a junior researcher. Currently he is a student of systems engineering at the Catholic University of Santa Maria, Arequipa - Peru. Among his main skills are research, innovation and management of educational projects. He is passionate about technology and innovation with the aim of finding solutions to everyday problems with the help of technology, which in turn seek to generate impact on international society.