Evaluation of a virtual learning object with augmented reality technology for teaching of the computer parts.

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Abstract. This article refers to the evaluation of the Virtual Learning Object (OVA) Computer AR, OVA with augmented reality technology to facilitate the teaching-learning of the concepts of computer maintenance, related to the internal parts of the computer, with the sixth grade students of the COLMERCEDES educational institution. The methodological design with a quantitative and descriptive approach involved the application of the OVA quality assessment instrument called LORI (Learning Object Review Instrument), under OVA quality assessment dimensions and criteria, which determine that it is a quality digital teaching resource. The quantitative descriptive analysis focuses on the assessments of students and teachers when exploring the tool and its contents, aspects such as motivation, usability, accessibility, among others, are measured, so that the relevance of designing and using interactive virtual objects with augmented reality technology for teaching and learning the basic concepts related to the internal parts of the computer is concluded. Among the results obtained were positive, it was evident that the OVA designed met the quality criteria to obtain a high assessment by the population under study, concluding that it was appropriate to design an OVA with augmented reality to generate contributions to the teaching and learning processes on concepts related to the internal parts of the computer. The data in the dimensions of evaluation with a low tendency indicate that it should be complemented with a contextualized setting, so that it can be adapted to the characteristics and needs of the students.

1. Introduction

Information and communication technologies (ICT) make it possible to access information in such a way that it is available in any space and time, and they are a support tool in different professional fields such as social, health and education. In education, for example, they serve as a pedagogical support [1], ICTs are recognized as innovative resources that allow teachers to implement various teaching strategies [2], and they provide environments to monitor the learning of each student, improving the performance of students and teachers [3]. The demand for technological resources in educational environments has generated in teachers who teach subjects such as technology the need to seek strategies that enhance the work of teachers so that students have more than one alternative for learning, so in education with face-to-face mode is important to include new technologies and the application of quality educational material standards adapted to emerging trends every day. Among the strongest is mobile learning and augmented reality, in short, the trend towards mobility, ubiquity and permanent access to information in a virtual, interactive and closer to reality, so that the classroom is not the only environment available for learning.
The teaching of technology has become one of the needs in educational environments, where the most relevant issues are those related to recognizing the difficulty of teaching the parts of the computer in educational institutions that lack the physical resources to guide such classes. The Computer AR application provides a battery of opportunities to teach students the different parts of the computer, visualizing in real time and virtually the components such as: the processor, RAM, power supply, hard disk, memory card reader, etc. The students will be able to see and hear through the "app" each of these parts as well as their concept. It is worth mentioning that in the academy the teaching and learning of concepts related to computer parts is not easy given the scarce access to such components and that these internal parts of the computers are very delicate and prone to damage with constant or inadequate manipulation, especially in students between the ages of 9 and 14 years who belong to the sixth grade of educational institutions such as COLMERCEDES, whose computer room does not have this resource as opposed to external parts that allow greater manipulation without incurring damage.

In response to this perspective and problem, the objective of this research is to evaluate the Virtual Learning Object (VLO) with students in the sixth grade at COLMERCEDES using the LORI (Learning Object Review Instrument), a validated tool that allows for the evaluation of learning objects [4], which measures the quality of an OVA in nine dimensions. The OVA Computer AR was designed to teach concepts related to the internal parts of the computer, under the OVA design model called MOVA (Model for the design of virtual learning objects for the subject of computer maintenance). This model was the result of research carried out by a group of thesis students at the Antonio José de Sucre educational institution in 2018. In this context, Computer AR is an OVA with augmented reality technology with the potential to provide a virtual environment for teaching and learning that is appropriate for the needs of the context, offering students the opportunity to learn about the internal parts of the computer. In this sense, it is pertinent to validate it in order to identify some characteristics that contribute to the redesign or adaptation of the presentation of the virtual object. At the end, the results of the present investigation and together with the diagnostic evaluation, it will be tried in a future proposal to implement and to adapt the OVA, so that this one adapts to the own characteristics, the needs and the interests of the population object of study.

1.1 Learning through mobile devices

Movil Learning: The use of mobile tools such as laptops and tablets, MP3 players, smart phones and mobile phones. As more and more students are bringing their personal mobile devices to higher education institutions, this trend offers an unprecedented opportunity to use these devices for teaching and learning [5], [6]. Mobile, personalized, portable, cooperative, interactive and contextualized learning has unique characteristics not found in traditional e-learning [7]. The former emphasizes access to information at the right time [8], since instruction through it can take place anywhere and at any time. As an aid to formal and informal learning, it therefore has enormous potential to transform educational provision and training. Mobile learning is becoming one of the solutions to the problems facing the education sector. This is why UNESCO's programme of activities is based on a growing number of joint initiatives to explore how mobile technologies can support the achievement of Education for All. Its partners include Nokia and the United States Department of State [9].

1.2 Augmented Reality

Augmented reality in education: Augmented reality -AR is a technology that provides seeing the digital world in the real world, through a technological device that supports such technology, the AR what it does is to superimpose images that are generated through a computer, a smart phone or augmented reality glasses in a real physical space so that the user sees a better perception of things. Therefore, AR adds virtual information in an existing physical environment, i.e. digital information is superimposed on a surface with scarce information and combined with other types of technology it is possible for the object to be displayed to become interactive. The applicability of AR is in any field because it allows to add layers of visual information about the real world around us [10].
1.3 Learning Object and Virtual Learning Object

**Virtual Learning Object in education:** Recognizing that existing definitions are intended to meet the particular needs of the bodies issuing them and can be very ambiguous in relation to the educational value, the Ministry of National Education, with the support of experts from various higher education institutions, has agreed on the following definition, within which the Ministry's initiatives on the subject are framed. A learning object is a set of structural elements. The structure of an object of learning has taken several important turns over time that demonstrate the analysis that the academic community has made of the subject. At the beginning, without using the term of object of learning, we talked about resources that could be reused in different contexts, such as documents or images, whose structure was self-contained in the document's summary, key words or simply the name. Later on, it evolved towards interoperability, where the structure of an object of learning had to contain all the necessary aspects, both technical and pedagogical, in order to "connect" two or more objects, where the initiatives of object description and metadata standards emerged, thus integrating the virtual learning objects - OVAs. The pedagogical value is present in the availability of objectives, contents, activities, and contextualization elements of the OVAs [11].

According to the user manual of the instrument for the evaluation of OVAs, LORI, an OVA: "is an information resource or interactive software used in online learning. A single image, a page of text, an interactive simulation, or a complete course are examples of learning objects" [12].

1.4 OVA Quality

**OVA Quality in education:** Authors [13] affirm that it is possible to determine the quality of an OVA in a specific context by taking into account the user's perspective. They also describe that the quality of OVAs focuses on identifying the various ways in which the student perceives information and is measurable through the evaluation of the OVA. The LORI OVA evaluation instrument includes 9 criteria or dimensions necessary for quality OVAs, each with specific quality characteristics [12]. Content-quality OVAs have a positive impact on the teaching-learning process and help to strengthen use in educational settings [13].

1.5 Computer AR

**Characteristics of the Computer AR Virtual Learning Object:** Computer AR is a mobile application that incorporates augmented reality technology, uses markers designed based on the sketch of each component of the computer, as seen in the image, so that when the user uses the application and focuses a marker is displayed 3D model of the associated component, with information in audio and text, allowing zoom in and out for better exploration of the component, images 1 and 2, illustrating the internal components of the computer.
2. Materials & Methods

2.1 Methodological Design

This research has a quantitative and descriptive approach that seeks to understand the students' perspective and to deepen their experiences, perspectives, opinions and meanings [16].

For the evaluation of the OVA Computer AR, the LORI (Learning Object Review Instrument) was applied, which is a validated tool that allows for the evaluation of learning objects [4], with characteristics according to evaluation criteria to determine the quality of the OVA, in terms of the quality of the technological and didactic design, and which applies dimensions according to the general criteria for evaluating the quality of OVAs [17]. In this context, it should be considered a valid educational tool for future implementation in the population under study.

In applying the LORI instrument, the parameters of the noncomparative continuous rating scale were taken into account, as they allow the measurement of the opinion of the interviewees, presenting various response alternatives in which numerical ratings can also be used [18].

The procedures used to interpret and analyze the data collected from the instrument were the organization of the data using descriptive statistics, specifically central tendency measurement techniques [16]. The use of the mean allowed the categorization of the variables under study (OVA quality level, student and teacher perspective) [17], taking into account the dimensions according to the criteria for evaluating the quality of the OVAs.

A complete inductive logic research method was used, in which the final reflections and conclusions were generated from the study of the results obtained from the population under study, i.e. from each and every member of the [4], [19].

2.2 Participants

The evaluation of the OVA Computer AR was carried out with 80 students of the subject Technology and computer science of the sixth grade of the educational institution COLMERCEDES, with ages between 9 and 11 years and 43 students who studied the subject computer maintenance, in both subjects the learning of the parts of the computer is oriented. In total there were 123 students and 3 teachers.

2.3 Application of the instrument

2.3.1 Virtual Learning Object assessment tool -LORI

For the evaluation of the OVA Computer AR, students and teachers responded to a checklist on functional, technical and pedagogical aspects of the Virtual Learning Object, according to the quality standards of the learning objects, in which the pedagogical, technological and human-computer interaction dimensions should be considered, as proposed by the scientific studies of [20] and [4],
Applying the LORI (Learning Object Review Instrument), LORI is a tool for evaluating learning objects [21], which applies the dimensions for evaluating the quality of virtual learning objects, as demonstrated in a study by the University of Antioquia, which compared it with a model from the University of Salamanca proposed by Morales and others, LORI shows and includes characteristics according to the criteria for evaluating the quality of OVAs [4], [17], [20].

Training was provided on the administrative management and operation of the OVA Computer AR. Students were also trained in the use and operation of the OVA. The OVA evaluation process was carried out using the LORI (Learning Object Review Instrument), which evaluates the relevant aspects of a Virtual Learning Object as contemplated by the Ministry of Education [22]. The LORI tool has been researched and applied with validated results since 2002 [21]. This tool LORI proposes to measure the following aspects of the OVA:

1. Quality of content: truthfulness, accuracy, balanced presentation of ideas and level of detail appropriate.
2. Alignment of learning objectives: coherence between objectives, activities, assessments and student characteristics.
3. Feedback and adaptability: adaptive content directed at each student's response student and his learning style.
4. Motivation: Ability to motivate and create interest in learners.
5. Design and presentation: the design of audiovisual information favours the adequate processing of the information.
6. Usability and interaction: easy navigation, predictive user interface and quality of interface help resources.
7. Accessibility: the design and presentation of the information is adapted for people with some type of disability and for mobile devices.
8. Reusability: ability to be used in different learning scenarios and with students of various contexts.
9. Compliance with standards: Consistency with international standards and specifications

Each aspect was evaluated on a scale of 1 to 5, with 1 being the Low level and 5 the High level, as follows: 1 - Low, 2 - Medium Low, 3 - Medium, 4 - Medium High, 5 - High.

Although the tool offers flexibility on the choice of items, it is important to highlight that none of the items proposed by the LORI were excluded since they are all considered to be aimed at the correct evaluation of the educational material. However, it should be taken into account that the Accessibility item should be considered only from the point of view of accessibility through desktop or mobile devices and the adaptability to the use by disabled people should be excluded, since this aspect is not within the scope of the present project.

3. Results

3.1 Teachers' evaluation

3 teachers participated in the evaluation, who were guiding the subject of Technology. The average OVA score given by teachers was 4.3 and by students was 4.5, which corresponds to a High score on the LORI scale [21]. This rating serves as an indicator that the designed OVA largely meets the objectives set, as well as the quality standards required for this type of educational material. This shows that the OVA design largely satisfies the expectations of the teachers in the Teacher Survey, and they agree that it meets the pedagogical and technical elements required to achieve the goals set in terms of encouraging student motivation and providing a platform that contributes to improving information accessibility, under quality standards.
3.2 Students’ evaluation

The aspects best evaluated by the students were the quality of the contents (4.7 - High), the adaptation to the learning objectives (4.6 - High), Design and presentation (4.6 - High), the other dimensions were at a Medium-High level. This showed that the design of the OVA Computer AR greatly satisfies the expectations of the students and meets the quality criteria of OVAs, which is why it is considered a useful and relevant tool in the learning processes of the computer parts of the Technology and Information Technology subject in the sixth grade of COLMERCEDES and that the students manage to identify that the OVA reflects the themes of the subject and offers feedback and adaptability to their learning process. It is also observed that the motivational component is considered high and that the OVA is in line with current quality standards. 123 students participated in the evaluation, 80 students in the subject Technology and Computer Science in the sixth grade and 43 students who had previously taken the subject.
4. Conclusions & Discussion

4.1 Conclusions
The research showed that the OVA Computer AR was accepted and highly rated, 69% in High and 21% in Medium High, the quality of content was rated 75% in High and 22% in Medium High, the adequacy of learning objectives, The design of the presentation and reusability showed a high and medium-high level rating of over 90% by students and 70% by teachers, showing that the topics, activities and evaluations proposed were in line with those proposed by teachers and students at the COLMERCEDES educational institution, followed by the item motivation by 61% at the high level.

The evaluation showed that the OVA was adapted to international standards and specifications, and that it was highly valued as a technological and educational tool that can be used in different learning scenarios and with students from different contexts. The usability, feedback and accessibility, as well as compliance with standards tended to be in the range of 60% to 70%, showing that future implementations should take into account improving accessibility to the disabled and adapting the OVA to the ages of the sixth grade. Some of the observations were to include the OVA Computer AR in a digital primer so that the presentation would be more age-friendly, to include help text, and to improve audio quality, which is not within the scope of this research but is important to consider for future implementation.

4.2 Discussion
The role of the new information technologies in the processes of social and cultural change is particularly relevant in the field of education. Certain conceptions of education system reform attribute to the incorporation of new information technologies a decisive effect in improving the quality of teaching and learning processes. But these cannot be determined without an analysis of the political and social conditions that structure teaching practices. The economic, social and political transformations that took place in the seventeenth century stimulated scientific development, setting in motion the technological production processes that characterized modernity, in which knowledge began to respond predominantly to an instrumental or technical rationality". 23], with this it can be understood that the development of computing and its influence on economic and social sectors contributed greatly to the evolution of societies and to the form of communication and interaction with the environment. Taking into account the evolution of information technologies in education, it can be stated that the construction of strategies mediated by ICT has been the result of the work of researchers interested in increasing knowledge regarding the application of strategies that improve and facilitate current teaching methodologies, the principle included audio-visual media, then programmed instruction, as is the case with Skinner when he implemented his teaching machines based on laboratory research in working condition, triggering a powerful movement with the purpose of revolutionizing teaching by trying to base it on scientific principles [24].

Worldwide, the learning of the internal parts of the computer has been one of the aspects that has received the most attention from teachers who teach this area of knowledge because of the complexity of teaching with few resources. At the end of 2010, the National Government of Colombia, with the presentation of the Education Policy for Prosperity, assumed the commitment to close educational gaps and affirmed that in order to advance in the consolidation and implementation of innovative projects, individual and collective actions and practices are required that respond to a planned, intentional, deliberate and systematized process for both their gestation and their development. The National Innovation System aims to make innovation a condition and aspect of educational practice, strengthen conditions and capacities for the educational use of ICTs in the Colombian education sector and meet the needs of educational communities [25].

Information and communication technologies are a fundamental component of citizen training in this millennium, which is why this field has become an element of interest for scientists and computer engineers and a complementary component for various areas of knowledge. However, research has shown that there are difficulties in the teaching-learning process of technology in secondary education [26], and that it is necessary to generate computer tools to try to solve the many problems that arise in this process,
Of the needs to integrate ICT tools in education, especially in the teaching-learning process of the subject of Technology, it is important to include Virtual Learning Objects, since they allow the student to have moments of significant learning, so the Virtual Object behaves as an additional aid to the teacher, knowledge and learning that the student must acquire, in which the teacher promotes and induces the development of innovative skills aimed at significant learning [26], [27], and through them it is possible to reuse educational processes [28]. OVAs is used worldwide as a tool to support the learning process: "The global Learning Object initiative allows any teacher or student to access the material published in the different Learning Object Repositories (LOR)" [22].

Learning Objects could be designed and developed for any kind of subjects. The Object is a resource or tool different from the traditional or conventional ones, with educational games, that is, elements with playful and didactic characteristics that contribute and allow improving the processes involved in the teaching and learning of knowledge [29]. It can be pointed out that the game can be used as an effective teaching-learning strategy to be applied in our educational environments [30]. It has been demonstrated through research that incorporates the game as a pedagogical strategy, based on the educational point of view, appreciating its virtues and designing, implementing, applying and validating a pedagogical proposal in a formal educational context [31].

Technologies make it possible to take advantage of various possibilities for interaction between students and knowledge using resources such as augmented reality, OVAs, serious video games, or social games or gaming [33]. These technologies are the basis of m-learning and e-learning, they are communication methods that enable a learning experience and will transform all forms of education and learning in the 21st century, since communication is at the centre of all forms of educational interaction, which proves that it has an enormous potential worth exploiting by including it in teaching and learning strategies [34]. Virtual educational resources such as OVAs with RA influence the development of cognitive skills in students and the promotion of their capacity for analysis, synthesis and understanding, and also favor motivation, accessibility and appropriation of knowledge. It is important to evaluate OVAs with instruments such as LORI that measure quality characteristics to ensure a good teaching-learning environment [4], [35].

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