ΣΟΦΙΑ–SOPHIA

Methodology for the construction of learning virtual objects supported in augmented reality

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How cite

Bernal, L., Ballesteros-Ricaurte, J.A (2017) Methodology for the construction of learning virtual objects supported in augmented reality. *Sophia,* 13(1)

ISSN (electrónico): 2346-0806 ISSN (impreso): 1794-8932

UNIVERSIDAD La Gran Colombia
Fundada en 1951

Sophia-Education, volumen 14 Isuue 1. English versión

Abstract

In this article we present the results obtained from a degree work entitled Methodology for the construction of Learning Virtual Objects (OVA, for their initials in Spanish) supported by technological innovations such as tools of Augmented Reality (AR), for being reused in a virtual platform of the University of Boyacá; this work is product of an academic activity intended to obtain the Master's degree in Computational Systems with Emphasis in Networks and Communications. The main objective of the research was to construct a methodological proposal for the creation of Learning Virtual Objects, which include in their structure technological innovations such as Augmented Reality tools.
The result of the proposed methodology for the creation of learning objects is based on the study of the most recent advances in this field, the results of the analysis of some methodological references for the construction of learning virtual objects, the definition of learning object, the conceptualization of the methodology and its structure, as well as the different phases that compose it. A methodology for the creation of Learning Objects of the University of Boyacá is then proposed, which can be applied as a general reference for any other education institution, and which becomes a mediating element supported in a quality control phase that organizes processes and validates information, in order to be able to publish objects that meet the pedagogical and technical requirements of the new learning standards.

Keywords: AVA, LMS, learning virtual object, augmented reality.

Introduction

New technologies, capable of innovating in the field of education, have caused that human beings be in constant change, because as technologies evolve, the processes to interact with humanity do the same. For the above, the way of relating tools changes in search of improving the productivity, both of the individual and of the methodology in the teaching - learning process. Starting from this principle, one of the paths that points towards the evolution for change in education is augmented reality and its different applications and service models.

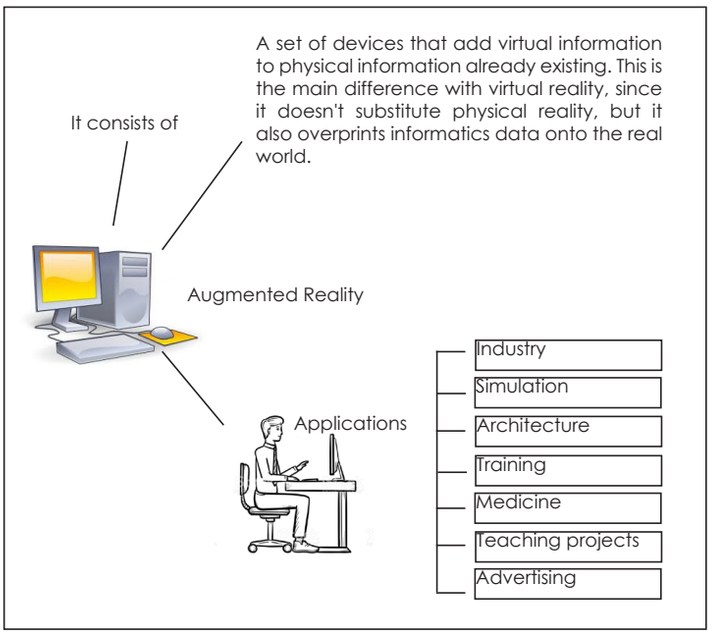
This text presents in its first part an approach to augmented reality by means of features, examples and some free software tools in the context of higher education. Then, an approximation is made to the pedagogical model of the University of Boyacá, and how it is articulated to the genesis of a methodology for creating learning virtual objects; specifying as a result the steps that must be followed to create a learning virtual object, its characteristics, conceptualization, design and construction.

Materials and methods

Augmented Reality

Augmented Reality (AR), defined in figure 1, includes real and virtual objects, which is why it is said that it goes a step beyond the known *virtuality*. The mass use of the personal computer and the interaction with the network (Internet) has revolutionized and placed in evidence the need to improve the communication process between them. The applications of AR have certain characteristics that make necessary new techniques and interaction devices different from those used in traditional applications (mouse, keyboard, among others).

Figure 1. Augmented Reality Concept

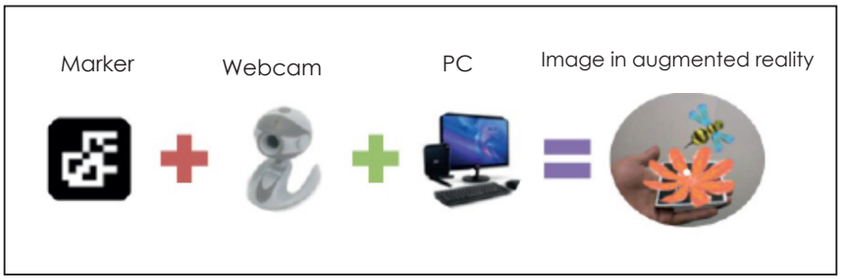


Source: Bernal (2012)

These new interaction features allow observers to perceive, in the reality that surrounds them, new elements in 3D that they can manipulate thanks to the projection of a webcam or supported by some special devices such as helmets or lenses, or vision devices of Augmented Reality.

This system (see Figure 2) analyzes the image recorded by the video camera in search of a graphic pattern (a black square frame, with a different design inside it intended to calculate the spatial orientation of the object), starting from the original position that was recorded by the image. When this pattern is detected, the coordinates of its four corners are analyzed and thanks to the values of each of those four spatial points placed on a plane, it obtains the position and orientation in the Cartesian space of the camera that took the image relative to the frame (Kato & Billinghurtst, 2008). With this technology, it is possible that a mechanic can detect a failure in an engine without having to disassemble it, because by means of the AR, he can appreciate the whole structure by only highlighting the marked sections in the engine, using a helmet conditioned with video (camera). This is a single example, since there are multiple applications of AR in industry, simulation, medicine and education among other fields, being limited the real potential of this technology only to the creativity of the user.

Figure 2. How Augmented Reality works



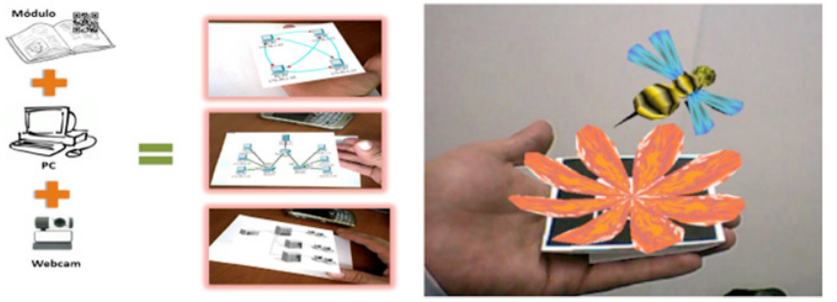
Source: Bernal (2012)

Although it is still in its experimental phase, this technique is beginning to be used in educational applications, LO (Learning Objects), entertainment systems and in technical projects for fluid simulations and industrial design processes.

Analysis of free software tools for the management of augmented reality

Taking into account that one of the differentiating elements in the new learning environments is the inclusion of technological innovations such as AR (example figure 3), which allow defining a direct or indirect vision of a physical environment of the real world. The physical reality is not replaced, but it superimposes the computer data to the real world generated by a computer (Bernal Zamora, 2011).

Figure 3. Augmented Reality as innovation



Source: Bernal (2012)

Therefore, it is essential to select an open source development environment that allows to integrate and develop the thematic contents of the learning object. Table 1 shows a selection of the main tools and their free software features (Monsalve and Aponte, 2012) for managing Augmented Reality.

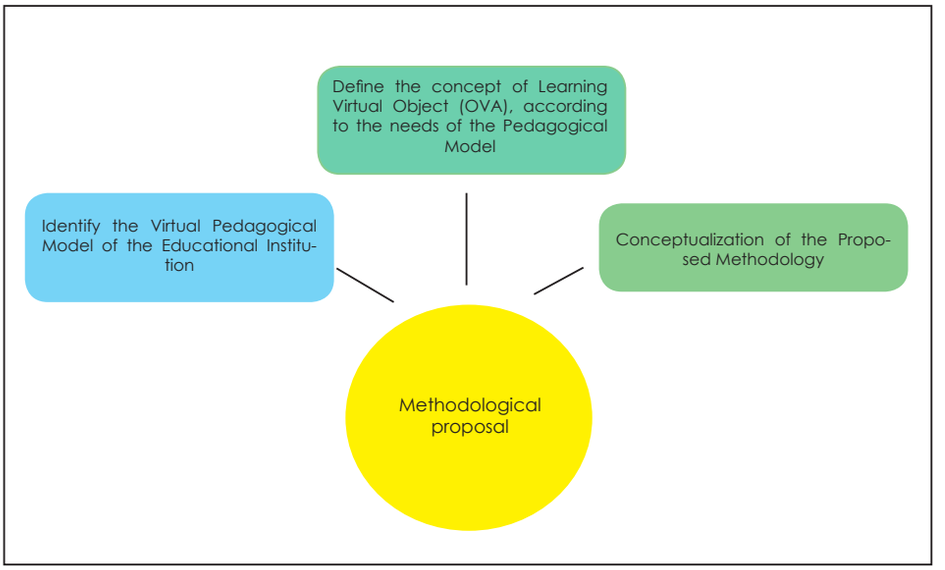
Table 1. Augmented Reality free tools

Tool	Usability	Web/application	Compatibility	Help/Tutorials	Open code
ARToolkit	Yes	Application	Yes	Yes	No
FLARToolkit	Yes	Application	Yes	Yes	No
BuildAR	Yes	Application /Web	Yes	No	No
ATOMIC	Yes	Application	Yes	No	No
SketchUP	Yes	Application	Yes	Yes	No
Exflar	Yes	Web	Yes	Yes	Yes

Development

For the correct development of a methodological proposal for the creation of Learning Virtual Objects that includes within its structure (APRLO, 2008) technological innovations such as Augmented Reality tools, it is essential that every educational institution identify and complete the following phases (See Figure 4):

Figure 4. Proposed phases for creating the methodological proposal

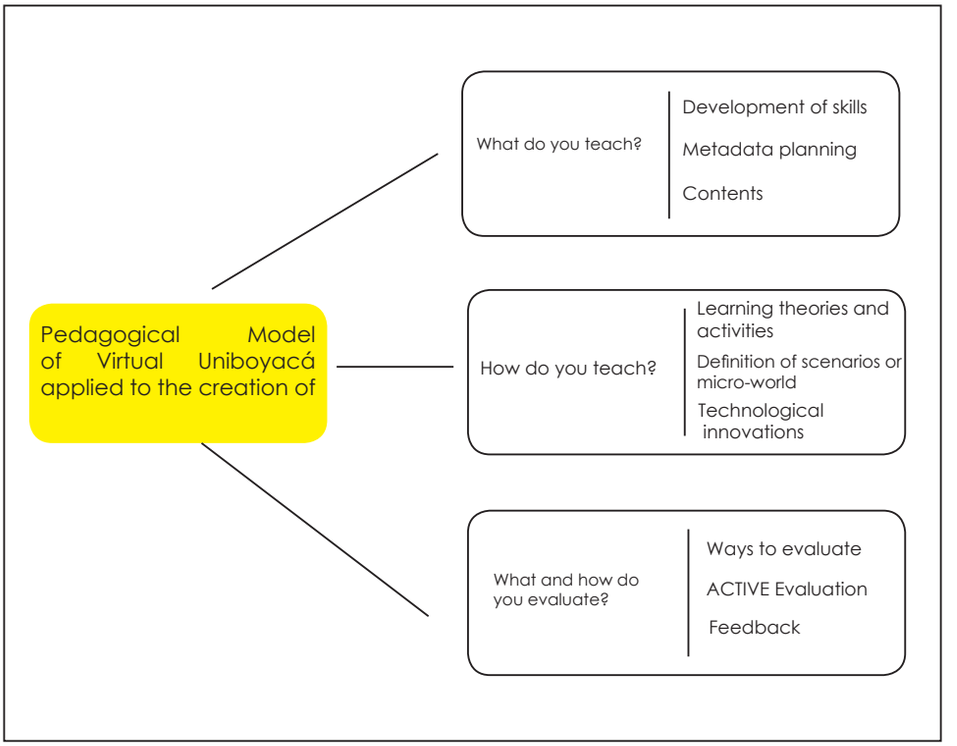


Source: the authors

Identification and recognition of the virtual pedagogical model of the University of Boyacá

In (Bernal and Ballesteros, 2014), it is shown the result of the analysis of the virtual pedagogical model of the University of Boyacá, in which the levels of requirements to be taken into account for the construction of learning virtual objects are: conceptualization, design, production and distribution, adapted to answer these questions: What does it teach? (Correl and Montañez, 2009), How does it teach? What and how evaluate?

Figure 5. Virtual pedagogical model of the University of Boyacá applied to the creation of OVA.

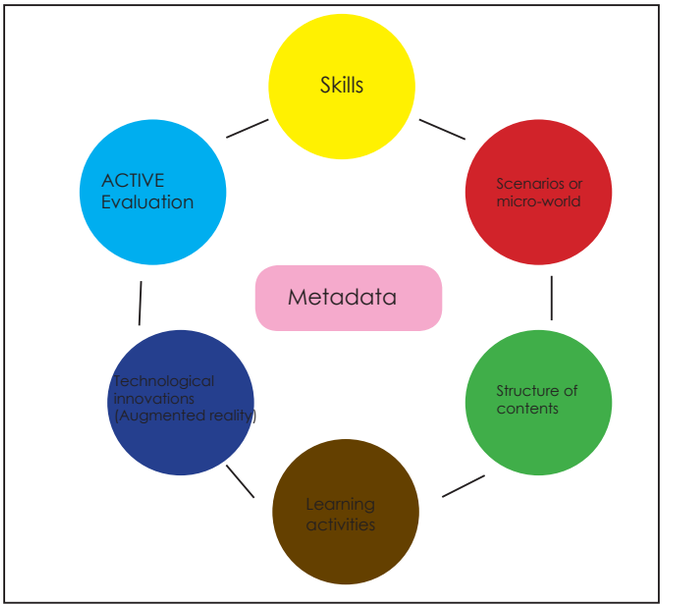


Source: Bernal (2012)

Definition of the Learning virtual object for the University of Boyacá

This definition includes the agreement of the professionals in the unit responsible for managing the platform of the University of Boyacá, as well as the elements or internal structure and their relationship to describe this type of resources (Bernal and Ballesteros, 2014). In figure 6, it is specified the definition of the learning object of the virtual platform of the institution: *Digital content for educational purposes, composed by: Skills, Scenario or Micro World, Content Structure, Learning Activities (Borrero, et al., 2009), inclusion of Technological Innovations (Example: Augmented Reality), Active Evaluation and Metadata.*

Figure 6. Definition of learning Object for a virtual platform of the University of Boyacá



ACTIVE Evaluation Source: Bernal (2012)

Conceptualization of the Methodology for the Development of Learning Objects - UBoa of the University of Boyacá

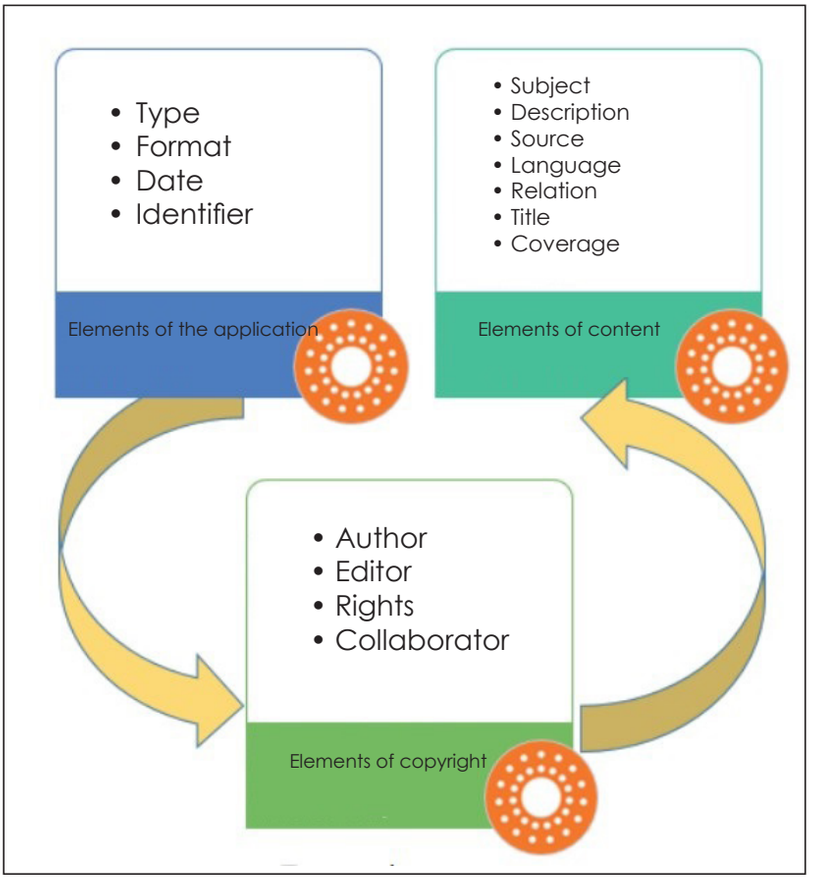
The integration of LO to the teaching-learning process allows to offer educational contents that respond to specific skills and allows students to be responsible for their learning; in the same way, it allows teachers to be trained in the use of new technologies. UBoa becomes a reference when it comes to planning and developing learning virtual objects, contributing an internal organization to the process, the identification and selection of the skills to develop, as well as the type of cognitive activities and their evaluation (Bernal and Ballesteros, 2014).

The UBoa methodology becomes a collaborative process that implements learning strategies for E-learning training (Fernandes, et al., 2008). The objectives of the UBoa methodology are: to make known the different phases of the life cycle, as well as the basic elements for the creation of the metadata; to implement the structure or organization of content of the LO for the virtual platform; to incorporate learning activities, active evaluation and technological innovations in the development of LOs; and to guarantee quality through the implementation of quality control formats in the instructional design and communication design of the LOs in the different phases of their development.

Taking as reference the life cycle of a software development, the UBoa methodology has been structured taking into account five phases: Conceptualization, Design, Production, Publication and Quality Control, each one with its respective activities and specification of results.

- Conceptualization: part of each one of the skills of each one of the tutors that make up the academic body of the university, and especially, that material or information collection; the central idea is to transform this content into learning objects which must be linked to the skills and abilities that students will acquire with the thematic content proposal. Metadata (see figure 7) allow the location and storage; and in the same way, they allow to comply with the characteristics (Osorio, Muñoz, Álvarez and Mercado, 2010) inherent to a Learning Virtual Object.

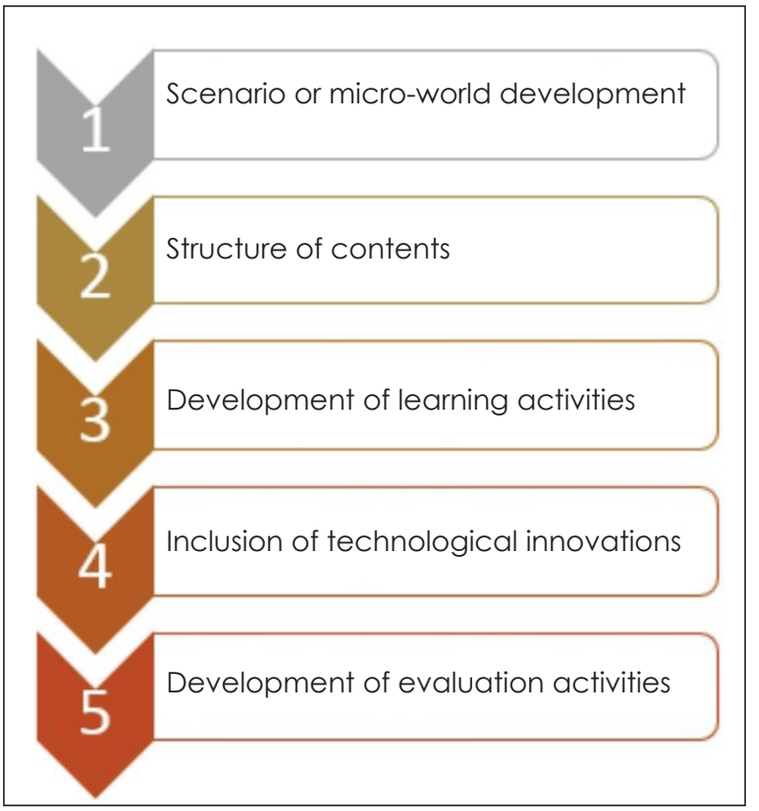
Figure 7. Dublin core metadata implementation by (using) UBoa methodology



Source: the authors.

- Design: once conceptualized, it is designed the LO; this phase corresponds in the first instance to understand that teaching is a complex activity which requires three types of knowledge: Disciplinary, Pedagogical and Technological. The challenge is to compose these three types of knowledge to balance the competencies that teachers require in order to consistently integrate technology into teaching.
- Production: in this phase (figure 8) the author tutor (Montañez, Bernal, Sandoval and Ojeda, 2010) must convert and transform the results obtained in the conceptualization and design phases, in order to build the main architectural elements of the Learning Object.
- Distribution: this phase corresponds to the publication or integration of the Learning Object final product of the previous stages of conceptualization, design and production, using as a learning tool the virtual platform of the University of Boyacá.
- Quality Control: the quality control phase of the UBoa methodology of the University of Boyacá defines each of the processes or steps that the authors tutors and the interdisciplinary team of the Virtual Education Vice-rector office must follow, in order to consolidate a final LO product from a pedagogical view of quality, focused on supporting teaching and learning mediated by information technologies.

Figure 8. Phases in the production of the UBoa methodology



Source: Bernal (2012)

The main purpose of this phase is to monitor and control the applications of the LOs by the tutors in both the B_learning and e_learning modalities, in order to efficiently advise the preliminary conceptualization and design phases (Margain, Muñoz and Álvarez, 2009), as well as following up on the production phase itself and the final distribution phase of the LO.

Design and construction of learning object - LO_, supported by augmented reality tools, implementing the UBoa methodology

Once the UBoa methodology is conceptualized and is defined each one of its phases, *Conceptualization and Design, Production and Distribution*, the following section describes the design and construction of an LO called: (UBoa001) Learning Object: Network Topologies.

The instructional design: For the UBoa methodology, the instructional design covers the phases of Conceptualization and Design. Once a teacher has made the corresponding request for the creation of their LO, they must complete the corresponding completion of the instructional design card, which includes 5 information cards corresponding to the Conceptualization and Design phases of the UBoa methodology:

- Card 1. Identification of the LO
- Card 2. Conceptualization of LO
- Card 3. Generation of LO Metadata
- Card 4. Teaching and Learning Strategies of the LO
- Card 5. Active Evaluation Strategies

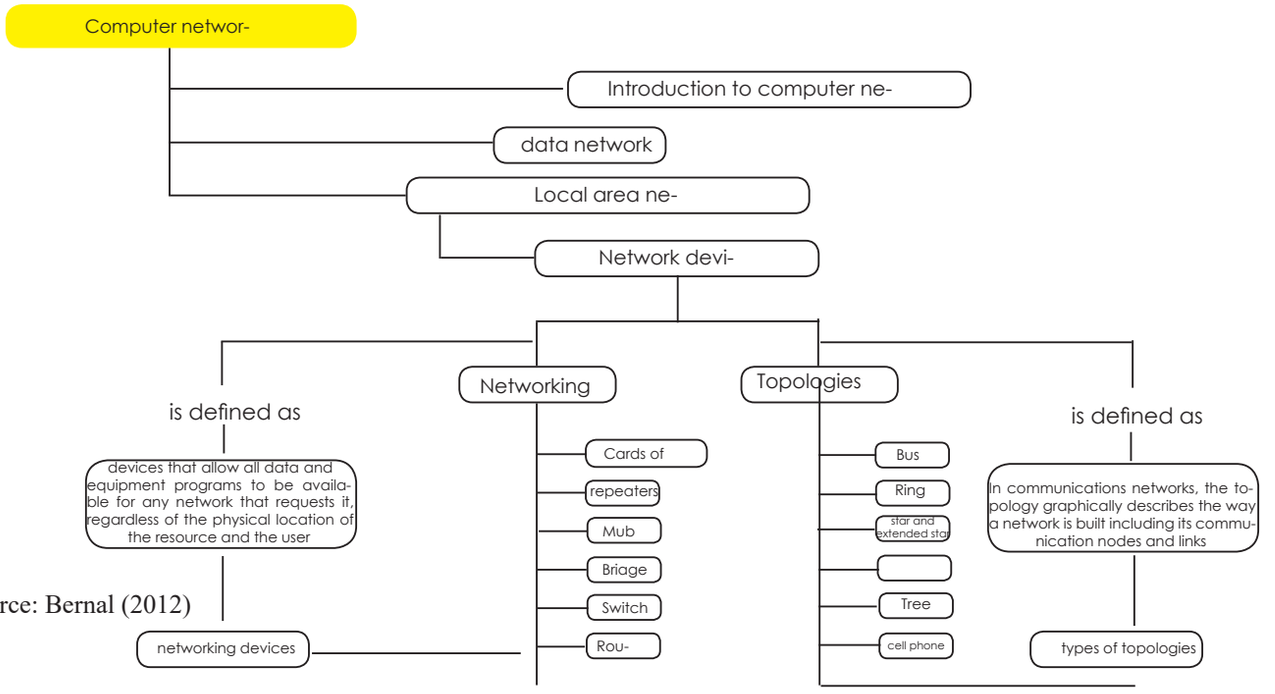
The communicational design:

It corresponds to the activity embodied in the instructional design; this action is performed by the teacher with support and advice from the multidisciplinary group of the vice-rectory office of Virtual Education of the University of Boyacá. Each teacher is trained in the use and management of the graphic editor of the virtual platform of the University of Boyacá, resulting in a respective module that applies the methodology; an example can be seen in Figure 9. Each module complies with the structure according to the UBoa methodology; in Figure 10, the structure of contents can be seen, as an example of Network Topologies for this case.

Figure 9. Communicational design. OA Presentation. Network Topologies.

University of Boyacá

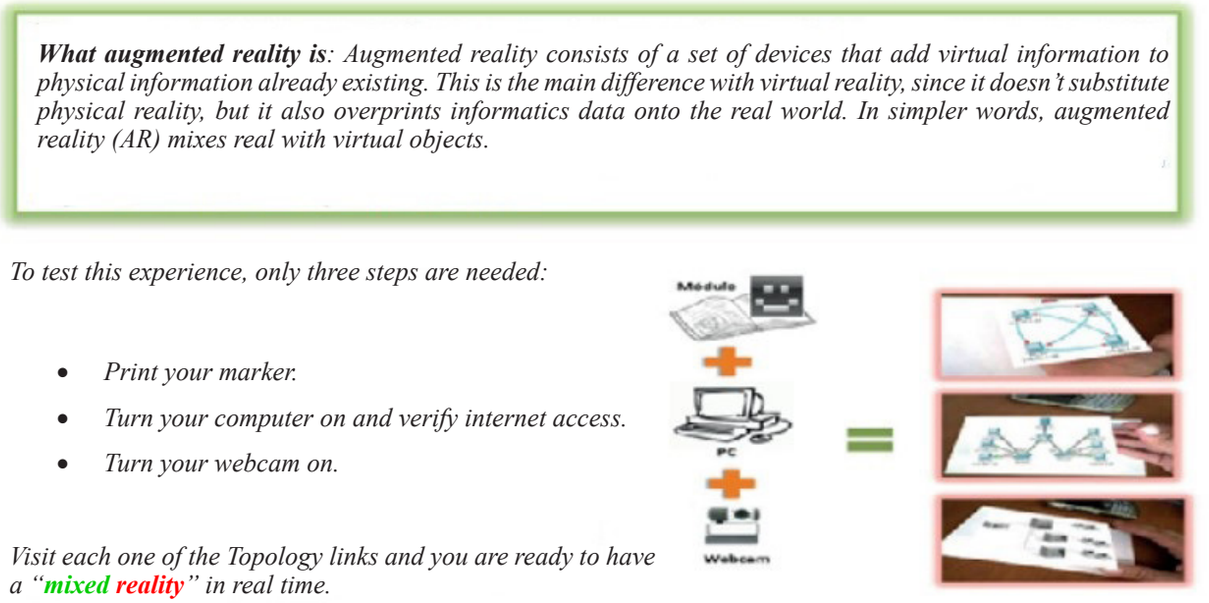
Figure 10. Communicational design. Contents structure – OA- Network Topologies.



Source: Bernal (2012)

In figure 11, we can see the steps that students must follow, in order to be able to use augmented reality, as a learning activity; and one that meets the objectives of the methodology.

Figure 11. Communicational design. RA Technological Innovation - OA Network Topologies.



Source: Bernal (2012)

Conclusions

This proposed methodology, which is product of a research work, meets the academic and pedagogical standards contemplated in any educational institution; with this, it is guaranteed its applicability in any virtual platform or LMS.

Regarding augmented reality, the benefits in education have generated a growth in the use of learning platforms. They capture the attention of target groups, motivating them to participate more actively in the experiences of traditional face-to-face classes, as well as those that take place completely at a distance.

The differentiating factor in the methodological proposal for the construction of learning virtual objects lies in the Quality phase, where the final product (LO) complies with the minimum requirements endorsed by a quality pedagogical view focused on supporting teaching and learning mediated by information technologies.

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