International Journal of Psychosocial Rehabilitation, Vol. 24, Issue 08, 2020
ISSN: 1475-7192

Interactive Learning Objects: Support tools for the teaching of Natural Sciences

Elsa María Figueroa Sandoval[1], María Rodríguez Gámez[2], Esthela María San Andrés Laz[3]

***Abstract*---*The use of tools for virtual teaching is more frequent every day, this trend is driven by the range of available technological resources, which allows cost reduction and allows to avoid some restrictions such as mobility restrictions that some students present, within Information and communication technologies, didactic resources called interactive learning objects are used, these play an important role for the support of teachers than various teaching modalities. The research aims to characterize interactive learning objects and their application for the development of skills in the area of natural sciences in high school students. This research was developed using the Desk Research methodology, based on the review of theoretical concepts on learning objects and their subsequent analysis that allowed determining the advantage of their use in natural science subjects. Finally, it was possible to determine how Interactive Learning objects can contribute in the processes of inquiry, understanding and interpretation of the results required in the study of different natural phenomena and the theme of natural sciences, in addition to the advantages for the realization of the experiential experimentation using multimedia resources.*

Keywords*---*significant learning, ICT, simulation, digital resources, motivation

I. Introduction

Classes taught in the same physical space with students and teacher, are tending to be displaced towards virtual spaces, due to technological, economic factors and even physical restrictions on displacement. This change in scenario does not mean a loss of relevance for the teacher, but rather a change in their role, which requires training processes for the management of Information and Communication Technologies (ICT), and new pedagogical elements that it will have for its teaching-learning activity (Echeverría, 2000), which will now be aimed at developing significant learning (Moreno & García, 2018), generating a new dynamic of participation of teachers and students increasingly involved in processes collaborative learning (Pérez, Rodríguez, Rodrìguez, & Villacreses, 2020).

One of the concerns of the teachers involved in the virtual teaching process is the selection of resources that can serve them in their online academic tasks. A significant set of hours are usually used to search for teaching materials, in this sense authors such as (Cabero, 2001), point out that the contents: “should be designed not focusing exclusively on the organization of information; rather, they should foster the creation of reflective environments for the

[1] Pontificia Universidad Católica del Ecuador Manabí, Portoviejo Manabí, Ecuador
Email: efigueroa@pucem.edu.ec ORCID: https://orcid.org/0000-0002-5627-1198
[2] Pontificia Universidad Católica del Ecuador Manabí, Portoviejo Manabí, Ecuador
Email: mrodriguez@pucem.edu.ec ORCID: https://orcid.org/0000-0003-3178-0946
[3] Pontificia Universidad Católica del Ecuador Manabí, Portoviejo Manabí, Ecuador
Email: esanandres@pucem.edu.ec ORCID: https://orcid.org/0000-0003-3462-8528

Received: 27 Mar 2020 | Revised: 20 Apr 2020 | Accepted: 05 May 2020

student, contemplating the possibility of emphasizing the complexity of any process, promoting the development of critical thinking "..., laying the foundations for the development of new criteria in the selection of content (Cardeño, Muñoz, Ortiz, & Alzate, 2017). For all of the above, a new vision for the generation of didactic strategies is born (Prendes, Sánchez, & Porlán, 2008).

Within the set of didactic strategies that have emerged are the Learning Object (OA), which are digital resources that can be used in various fields of teaching, as didactic tools in subjects such as: mathematics, physics, statistics, science natural, among others (Jiménez & Quintero, 2018), whose purpose has been designed and consists of three internal components: content, activities and contextualization elements (Cardeño et al., 2017).

Although there is no consensus among the authors, on the appearance of the term Learning Objects, it is around 1992, when Wayne Hodgins made reflections on learning strategies, motivated by the usefulness of Lego pieces, to make mini structures, This allowed him to extrapolate this concept to the development of structured and interchangeable learning pieces, which was given the name of Learning Objects (Jacobsen, 2001).

In the following years, the idea of LOs continued to be developed, including the concept of Reusable Learning Objects (RLO), promoted by the company Cisco System, which, in turn, were made up of a number of 5 to 9 Reusable Information Objects (RIO), which were grouped to teach specific tasks, becoming classes or lessons. This concept, together with the continuous advancement of ICT, has generated the evolution of new didactic strategies for teaching-learning worldwide (Barritt, Lewis, & Wieseler, 1999).

The OA seek to support, through pedagogical and innovative tools, the way in which the objectives of a subject can be taught, facilitating interaction in the teaching process. Among the characteristics presented by the OA are the following: their content will be educational aimed at didactics (what, for what, with what and who learns), it must be reusable (that is, they can be downloaded and modified for other sessions), modifiable, interactive, with standardized formats and characterization (metadata, Scorm, etc.) and variable granularity (capable of containing more or less components) and its accessibility (Moreno & García, 2018; Poveda, 2011).

Human beings constantly carry out interactions with their environment, under this principle they were designed with a type of OA called Interactive Learning Object (OAI), its proposed use is wide in virtual environments, due to the fact that it presents a dynamic option of information exchange between students and objects of knowledge, using different forms, segments or episodes of interaction, facilitating the study and understanding of natural phenomena, integrating observation skills, instrumental and linguistic application, linked to groups of objects and events (Mares, Benítez , Pineda, García, & Leyva, 2004).

The interaction established through the OAIs can be very useful for its use with respect to the subject of the natural sciences, because the learning of this subject is not purely theoretical (Mares et al., 2004), but requires the observation of objects of knowledge, the management of procedures and instruments to come into contact with them, as well as the development of practices that allow the student to contrast theory with reality and therefore the assimilation of such knowledge (Rodriguez , Perez, Lituma, & Perez, 2020), for which the use of simulators and virtual laboratories is very useful (Pérez, Rodriguez, Vázquez, & Bowen, 2020; Rodriguez et al., 2020).

In addition, different ICT tools have been used that promote the adaptation of this knowledge in students in the teaching-learning process, several authors have implemented different tools in classrooms such as video games, musical intelligence, among others (Meneses, Moya, & Rodríguez, 2020), (Mero, Zambrano, & Rodríguez, 2020), (Mero, Pazmiño, & Rodríguez, 2019).

All of the above, allowed us to determine the need to carry out a study with the aim of characterizing the interactive learning objects that can contribute to the teaching of the subject of natural sciences in high school.

II. Materials and Methods

The selected methodology for the development of the study is Desk Research, it is a technique that allows to identify, locate, extract and analyze information from public or private databases, on data and studies that address the subject matter of objects of interactive learning (Gandhi, Sucahyo, & Ruldeviyani, 2018; Guerin, Janta, & van Gorp, 2018). In this, five sequential steps were followed, which are the following: 1) Identify the research topic, 2) Identify the research sources, 3) collect the existing data, 4) Combine and compare the selected information and 5) Analyze and discuss data found to generate conclusions on the subject. In the research, the following guiding questions were used as a guide for the selection process of the studies to be considered: What characteristics do Interactive Learning Objects present that allow the development of competences in high school students? How can Interactive Learning Objects contribute to the teaching of natural sciences?

III. Analysis and Discussion Results

The results achieved in this research started from the proposed objectives, among them a first objective, which was to characterize the interactive learning objects (OAI), for this we proceeded to characterize the learning objects, existing types, among them specifically the OAI. In this sense, the desk research methodology was applied, performing a search in several databases, specifically the databases were considered: redalyc, sciencedirect and google academic, finding that, in all of them, the OAI theme has been continuously increasing Publications since 2001, we find that the year 2019, until now, is the year with the largest number of publications in Spanish and English regarding this topic.

The name interactive learning object (OAI) was used as a search criterion. Initially and subsequently, the OAI developed for the subject of natural sciences of secondary education was specified, in the second search those works

whose publication was earlier were discarded. in the last 5 years, because a set of 32were finally selected for analysis on the topic studied papers. ICT represents a set of valuable tools to support the teaching-learning processes of educational institutions (Carrillo, Tigre, Tubón, & Sánchez, 2019), which can have these resources in their different teaching modalities: face-to-face, semi-face-to-face environments and virtual learning environments, either as: learning objects, means to learn, or to support learning (Gamba & Moreno, 2014).

The learning objects that are currently used are organized structures and designed with the purpose of supporting and incentivizing the teaching-learning training processes, carried out through digital or non-digital entities, such as: multimedia content, software, content and tools. Instructional, electronic pages, among others, these resources only become important for teaching when they are specifically related to the contents of a learning (Veytia, Lara, & García, 2018), otherwise they are simply informative objects. The Learning Objects (LO) can be classified in different ways, one of them is, according to the moment in which they are developed or the need that satisfies in the teaching-learning process (Valdés & Rueda, 2009).

An existing classification for LOs establishes 4 types of them, which are the following: a) instructional objects aimed at guiding the student in following procedures and instructions, b) collaboration objects that allow the strengthening of participation dynamics in groups and the construction of collaborative learning, c) practical or interactive objects aimed at achieving that through the experimentation and changes in variables the behavior of a phenomenon or model is understood and therefore self-learning is generated in the students, d) objects of evaluation these It allows assessing the scope of the objectives of the course by the students (Veytia et al., 2018).

Table 1 below shows each of the types of OA that can be used in the teaching-learning processes.

Table 1. Classification of Learning Objects (Smartforce, 2002)

CATEGORY OF OA	CASES
Instructional objects	Lesson, Work-shops, Seminars, Articles, White-Papers Case Studies,
Collaboration Objects	Exercise Monitors, Chats, Forums, Online Meetings
Practice Objects	Simulations-Role, Playing Software, Simulation Hardware, Simulation Coding, Simulation Conceptual, Simulation Business Model, Online Labs, Research projects
Evaluation objects	Pre-evaluation, Pro-efficiency evaluation,

The OA construction process includes a set of activities, such as: conceptualization, design, creation and integration to achieve the involvement of curricular pedagogical competences and technological (Valdés & Rueda, 2009); but this process can be obviated in many cases, because fortunately there are a significant set of OA banks worldwide and even local in Latin American countries, which can be freely used for various educational scenarios and are easily accessible for teachers, facilitating their selection by subject and academic level (Aguirre, Griffin, & Lee, 2018; Molano-Puentes, Alarcón-Aldana, & Callejas-Cuervo, 2018).

It is of particular interest to the area of natural sciences, the study of OAI interactive learning objects, which owe their name to the ability to establish a bidirectionality of information (dialogues) between the students and the computer, this confers a set of challenges and potentialities to the student, given that the computer presents a response condensate that it can offer, before the different demands and requests that the student can raise, which in addition to adapting to their requirements, facilitates the establishment or the type of dialogue through which a learning construct is obtained (Valdés & Rueda, 2009).

Among the characteristics presented by OAI, are that the student can freely explore and interact with technology, the interaction is carried out from the data supplied by the student, giving the possibility of interacting with the model that defines a study phenomenon, simulation can be carried out in different ways according to the concept of study, in some cases it is possible to edit and append graphics, interaction is possible between the OAI and several students simultaneously, facilitating the sharing of data, among other characteristics (Ruíz-Velasco, 2004).

Interactivity is a characteristic to highlight in the OAI, understanding by this, the ability that these means provide so that students can communicate (synchronously and asynchronously) through interaction, and this characteristic allows generating cognitive interactivity (Ruíz-Velasco, 2004), which occurs due to the series of didactic, sequenced and ordered actions, facilitated to the students in the OAI for the meaningful reconstruction of the contents.

Another highlight in OAI is precisely the use of curiosity as an emotional response that seeks to deepen the interaction to search for certain information, and to the extent that the student's unconscious finds benefits in the information provided, it will be the starting point for That the brain of the apprentice (student) is ready to enter the didactic activity, facilitating that the new information obtained can be fused with previous knowledge already obtained and therefore achieve significant learning (Serna, 2018), a requirement to achieve lasting learning (Ausubel, 2012).

The use of OAI allows significant learning to be achieved, validating itself as well as motivating elements, because the more novel the information is for the student (apprentice), the more it will gain their attention, depending even on the volume of information it can provide (Muñoz, 2016), it is through this relationship and integration of new

knowledge, with previous knowledge (constructivist theory) and according to the tasks involved in this interaction, that the development of different cognitive levels of the Bloom scale will be achieved, and therefore The integration of this new knowledge will be facilitated (Serna, 2018).

Among other advantages that OAIs present, they are that: it allows exploring and interacting with technology without risks for students (Pérez, Jesús Alberto et al., 2020), integrating different forms of simulation depending on the subject of study, admitting the entry of different data to observe the behavior of the model or phenomenon, the interaction with different *software* and with different interfaces, in addition to the interaction between students. The fundamental characteristics of the OAI are outlined in figure 1.

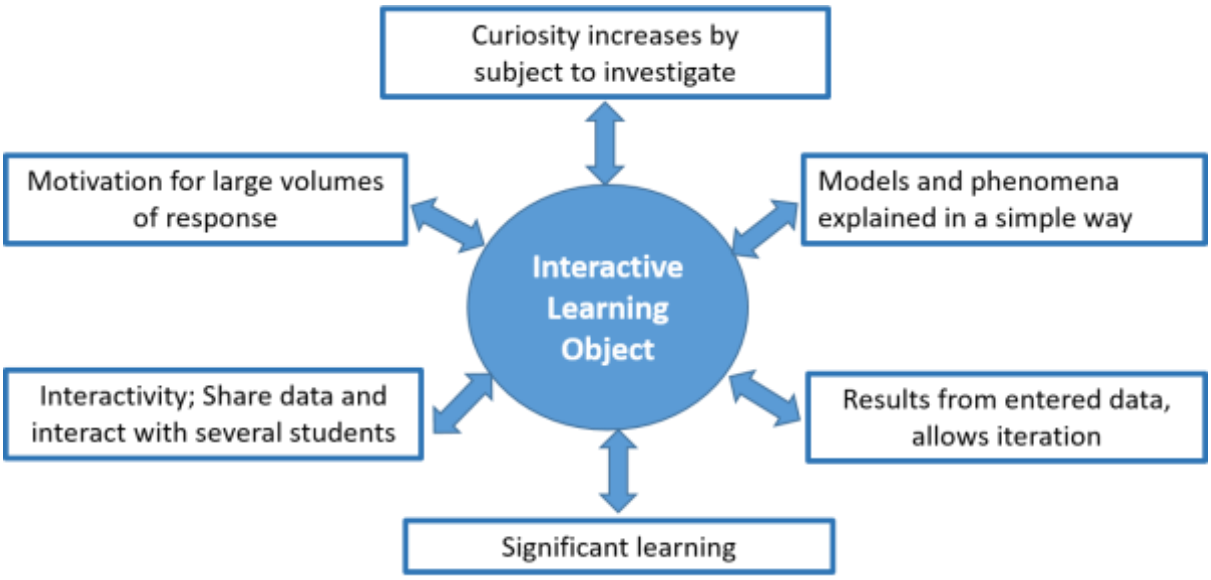

Figure 1. Characterization of the Interactive learning object

The set of characteristics presented by the OAIs, make it easier to capture the interest of the students, are easily accessible to teachers, and there is a wide range of them available through the banks of OAI worldwide, directed specifically for the teaching-learning process, so it requires little time investment and almost no cost for teachers.

In relation to the second objective proposed in the research related to the contribution of OAIs to the teaching of natural sciences in secondary education space. It was based on the identification of the academic characteristics and needs of the high school students to later indicate how the OAI can contribute to meet these needs.

Secondary education courses at the baccalaureate level require motivating the development of language and writing skills, skills necessary for the understanding of the subject, for the interpretation of processes, solving problems related to science, applying mathematical models and showing solutions verifiable (Tahull, 2016). In the case of natural sciences, the basic competences that must be developed according to studies carried out are the understanding of

knowledge and scientific inquiry, and the explanation of phenomena (Gutiérrez, 2018). Other studies indicate that in the subject of associates to the natural sciences (physics, chemistry, biology) (Ministry of Education, 2016) it merits the interpretation of graphs, identification of variables, unknowns and equations of study problems, among other aspects.

The elements previously exposed allow us to specify the importance of using OAI in the teaching of natural sciences, since these resources are aimed precisely at motivating and developing the processes of inquiry, understanding and interpretation required in these subjects (Sánchez, Gallegos, & Fernando, 2015), allowing students to develop scientific competencies of inquiry, experimentation (trial and error tests) and data interpretation, to finally reach conclusions of a phenomenon through interactive processes (Gutiérrez, 2018; Salgado, 2017).

The use of OAI to The learning of natural science content is attractive not only due to the deployment of multimedia resources that are available, but also because of the motivating and attractiveness of these resources for adolescents who belong to the digital age, their possibilities of combining multiple strategies, among them playful and gamification (Espinosa, 2017; Ortiz, Jordán, & A gredaI, 2018), in addition to offering the possibility of repeating the contents multiple times, to solve doubts, errors in calculations, which avoids feelings of frustration and rejection that can be experienced in learning these subjects (physics, chemistry, biology) by adolescents (Gutiérrez, 2018).

The use of OAI for experimental processes in subjects such as natural sciences, allows to achieve significant learning in students, regarding the understanding of natural phenomena, models, systems of equations and their scope of application, because they are based on the construction and transformation of representations (Sánchez et al., 2015), which are set in virtual environments that can include 3D environments, and even augmented reality. These elements are particularly relevant for the construction of meaningful learning, based on the theories that knowledge must be recognized as multidimensional, and it is precisely the realization of simulations using: emulators, educational software, virtual laboratories, interactive games, among others, that bring the knowledge object to its context.

To the question formulated in this research: in what way can Interactive Learning Objects contribute to the teaching of natural sciences? It is possible to answer by indicating that OAIs can contribute with multiple multidimensional resources that facilitate the role of teacher in teaching Natural science learning, being available a significant set of these resources in the Learning Object bank, and web platforms, freely and under a large number of formats, which facilitate them to students and guide them for their interaction, allow them to develop learning significant in the subject of high school natural sciences.

IV. Conclusions

The Interactive Learning Objects present among their characteristics the ability to capture the interest of the students towards the experimentation of science, motivated by the great amount of response that they can provide, through processes of interaction between one or more students, allowing to achieve Through the use of these resources,

the three fundamental competences for the study of science, inquiry, understanding and interpretation of the results from experiential experimentation. The Interactive Learning Objects provide teachers of the natural sciences area with a display of resources for the teaching-learning process, which only merits adequate planning for their approach, considering a wide set of free formats and types of resources, such as: emulators, educational software, virtual laboratories, interactive games, among others

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