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Enseñanza de la Matemática mediada por la tecnología
Mathematics Teaching mediated by technology

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Resumen: El uso de las Tecnologías de la Información y las Comunicaciones en la educación, específicamente los Ambientes Virtuales de Aprendizaje, le han dado un nuevo matiz al proceso de apropiación del conocimiento por los estudiantes y el modo de enseñar por los docentes. Se realiza una reflexión sobre diferentes estudios basados en el uso de las Tecnologías de la Información y las Comunicaciones y con ello los Ambientes Virtuales de Aprendizaje, en el proceso de enseñanza-aprendizaje de la Matemática, dando importancia a la metodología b-learning dadas las bondades demostradas en los últimos años.

Palabras clave: Ambientes Virtuales de Aprendizaje, Enseñanza de la Matemática, Tecnologías de la Información y las Comunicaciones, Aprendizaje

Abstract: The use of Information Technology and Communications in education, specifically the Virtual Learning Environments, has given a new nuance to the process of appropriation of knowledge by students and the way of teaching by teachers. A reflection is made on different studies based on the use of Information and Communication Technologies and with it the Virtual Learning Environments, in the Mathematics teaching-learning process, giving importance to the b-learning methodology given the benefits shown in recent years**.**

Keywords: Virtual Learning Environments; Mathematics Teaching; Information and Communications Technologies; Learning

Introduction

The development of Information Technology and Communications today, allows the application of mathematical concepts to the different problems that are currently present in the life of the human being. The use of Virtual Learning Environments (AVA), in educational processes, is a modality that has taken a boom due to the advantages they offer in communication among people given the need to acquire knowledge at the rate that the life of each individual allows. However, there are still limitations in theoretical support, as well

as in the most appropriate methodologies for its optimal implementation in educational practice.

Research on virtual education and the design of virtual learning environments are very diverse, so it is difficult to find meeting points that can guide their implementation in educational practice. Mathematics 'teaching-learning process has gone through several models, such as the one raised from a theoretical perspective of mathematical knowledge, Dubinsky (1996), and Asiala et al. (1996), consider that individuals make mental constructions to obtain meanings of mathematical problems and situations; these mental constructions are developed and controlled by construction mechanisms.

In the field of Mathematics Didactics, we can mention the contribution made in Spain, Godino (2010) that tries to clarify the nature of Mathematics Didactics and its relations with other disciplines, synthesizing the main lines or perspectives of research ; reflect on the relations of Mathematics Teaching with the practice of teaching, educational technology and scientific knowledge; analyze the dependence of research problems on research paradigms and methodologies; reflect on the current state of institutional consolidation of Mathematics Teaching in the international scene.

On the dynamics of the teaching-learning process of Mathematics based on computational technologies, several authors have also researched such as Cruz and Puentes (2012), Faustino and Pérez (2013), among others, which demonstrate how important is the methodological use of the computational technologies in the mathematical formation, which contributes to reach levels of quality and effectiveness.

Another of the elements associated with the evolution in the use of ICT resources is the concept of knowledge society, which had its appearance in very early stages of technological development (Drucker, 1969), and was understood as a proposal to consider knowledge as the central axis of wealth and productivity; at present it is understood as a pluralistic concept, focused on social, economic and cultural transformations and characterized by the ease of access to information, linguistic variety and freedom of expression (Unesco, 2005).

Development

Research related to the use of virtuality in the teaching of Mathematics that has been carried out, for example, in the United States, Wellings and Levine (2009) questions the use of ICT in teaching because the studies carried out are not yet conclusive about their benefits. However, the generation of the so-called digital natives or net generation (Tapscott, 2009), have shown that the use of these technologies is undoubtedly positive today.

It is no longer important to question whether or not they should be used in the classroom, but rather how to obtain maximum benefit and study its true reach, especially when there is speculation about qualitative changes in the cognitive abilities of young people due to constant contact with the technologies (Unesco, 2013).

On the other hand, Lancheros (2014), in an investigation carried out in Colombia, suggests that there is evidence that the use of ICT encourages motivation towards education and that tools such as technological platforms (LMS-Learning Management System), such as in the case of Moodle, offer possibilities to develop new strategies for teaching and school learning, using them in a didactic way through b-learning. In this research, a b-learning model was applied through the use of the Moodle platform in students in cycle five and an increase in school performance and the acquisition of mathematical skills was demonstrated.

A documentary research carried out in Venezuela by Zambrano and Areque (2016) of a qualitative approach, resulted in the dynamics carried out by teachers through b-learning methodologies depending on the conceptual framework, the area of knowledge, the context and the socioeducational reality. They concluded that the multiple definitions of the topic usually create confusion in teachers who are interested in making use of this educational practice.

On the other hand, Balladares (2018), from the Pontifical Catholic University of Ecuador, proposes digital and informational skills to achieve a necessary educational digital inclusion inside and outside the teaching area. Believes that a digital inclusion in education offers guidance to achieve an education in diversity. A digital gap divides challenges education to

seek equal opportunities for access to information and knowledge for all. In addition, digital inclusion seeks to ensure educational quality, considering ICT as strategic allies for this purpose and promoting the development of digital and informational skills in teachers.

It is said that when an instructional model is effectively implemented, educators can facilitate a classroom that focuses efficiently and effectively on student learning and personalization of instruction to meet the unique needs of each student while preserving the pedagogical authenticity of each teacher.

In a research on academic performance carried out in Colombia, the results obtained show that, the final average grade of the students was superior in 20.33 points for the academic period where the b-learning strategy was used. It was found that student dropout between academic periods of study went from 12.33% to 2.81%; evidencing that b-learning helped improve the student retention rate. Consequently, it is concluded that the implementation of b-learning improves both the approval percentage of the course, as well as student retention, so its implementation in distance education courses is recommended. (Ángel and Castiblanco, 2019)

In the research: "Complex thinking and academic performance" by Melo and García (2018) it was obtained as a result that it is important to make a diagnosis of the advantages and disadvantages that occur in the learning of students who show the predominance of a certain style of learning, to then analyze the possible difficulties (blocks) of cognitive, affective or cultural type that may occur, bearing in mind that the first step in the treatment of these blocks is to know them and then get rid of them, which will significantly improve intellectual progress.

Principles on the School Mathematics teaching

The professional organization of the United States of America, National Council of Teachers of Mathematics (NCTM), published the text Principles and standards for school mathematics in 2000, with the intention of being a resource and a guide for general mathematical education, since the Early childhood education until middle school. Its authors propose:

> The decisions taken by teachers, school administrators and other education professionals, regarding the content and nature of school mathematics, have important consequences for students and society. These decisions should be based on a solid professional guide. Principles and Standards intends to provide this guide. The Principles describe the particular characteristics of a high-quality mathematical education. The Standards describe the contents and mathematical processes that students should learn. Together, they constitute a proposal to guide educators in their efforts for the continuous improvement of the teaching of mathematics in classes, in schools and in educational systems. (NCTM, 2000, p. 11)

These principles constitute statements that reflect fundamental basic provisions to achieve a quality mathematical education. The Technological principle stands out, because when students use technological tools, they have more time to develop concepts and make modeling, they can make decisions more easily, reflect, reason and solve problems.

Although the concept of technology is much broader, since, as such, technology can also be considered a set of knowledge of a practical and scientific nature that, articulated under a series of procedures and technical methods, are applied to meet the needs of individuals. The Dictionary of the Royal Spanish Academy defines it as: "Group of instruments, technical resources or procedures used in a certain field or sector." (Royal Spanish Academy, 2018)

From the point of view of learning it is worth mentioning that algorithmic learning in Mathematics has played an important role, where an algorithm is understood as a finite series of rules to be applied in a specific order to a finite number of data to arrive at a certain number result (that is, without indeterminacy or ambiguities), in a finite number of steps, each of which is only an instruction.

However, in recent times, heuristic-based learning, defined by Müller (1987), has been preferred as:

> … A scientific discipline applicable in all sciences and includes the elaboration of principles, strategies, rules and programs that facilitate the search for ways to solve

> problems, that is, for non-algorithmic tasks of any kind and of any scientific domain or practical. (p. 8)

On the other hand, Müller (1987) proposes heuristic procedures as a scientific method, which can be divided into principles, rules and strategies.

Heuristic principles: they constitute suggestions to find - directly - the idea of solution; it makes possible, therefore, to determine both the means and the solution way.

Within these principles, analogy and reduction (modeling) stand out.

Heuristic rules: they act as general impulses within the search process and help to find, especially, the means to solve the problems.

Heuristic strategies: they behave as organizational resources of the resolution process, which especially contribute to determining the solution to the problem addressed Barrows (1986) defines problem-based learning (ABP) as "a learning method based on the principle of using problems as a starting point for the acquisition and integration of new knowledge" (p. 17). In this methodology the protagonists of learning are the students themselves, who assume the responsibility of being an active part in the process. There are several general theories that support the teaching-learning process of Mathematics, and by extension also the inclusion of ICT. It can be mentioned for example the behaviorism, which has its origin in the experiments that psychologists such as Petrovich, Pavlov and Skinner performed with domestic animals. The most notable representatives of behaviorism are Thorndike, Burrhus and Skinner, and more recently Gagné. It is also worth mentioning Gestalt's theory, which is the perception of a complete structure or form as something more than simply the parts that constitute it. (Garcia, 2001)

No less important have been the psychological theories of cognitivism, where Broadben stands out, with his publication Perception and Communication, in 1958; and constructivism, pedagogical current created by Ernest von Glasersfeld based on the theory of constructivist knowledge, which postulates the need to provide students with tools that allow them to create their own procedures to solve a problematic situation.

One of the most important and valid theories in recent times is the socio-historical-cultural theory of Vygotsky (1934), whose work began to be known and appreciated in the western world around 1960 and that with the publication of Krutetski (1976) served to popularize these ideas in the field of mathematics teaching. The socio-historical-cultural theory arose from the work of Vygotsky (1934), in response to behaviorism his main idea is based on the fact that the most important contribution to individual cognitive development comes from society and relationships between individuals.

Integration of ICT in the teaching-learning process of School Mathematics

ICTs offer possibilities for adapting teaching to the special needs of each student, those who are easily distracted can focus more intensely on tasks with computers; those with organizational difficulties can benefit from the restrictions imposed by their environment and, students with physical disabilities radically increase their mathematical possibilities with special technologies.

For ICTs to be an essential part of math classes, they must be selected and used in ways that are compatible with the educational objectives, with the characteristics of the students and their way of learning individually.

The teaching - learning process of Mathematics requires a substantial change in the way it develops and in the expected results of the students. The use of ICTs does not definitively solve the pedagogical gaps and conceptual deficiencies that are presented to students when they study the subject, but they do constitute an important option to start generating positive transformations.

In that sense, importance should be given to developer learning, where (González and García, 2012) state that:

> to direct the learning of students with a developer approach it is necessary to consider that the current class must transform the student's participation in the search and application of knowledge from a passive position to an active position, a teaching that leads to the development of potentialities in the student (p. 72)

This research assumes the term virtual education given by Loaiza where he states that:

> virtual education is an educational strategy that facilitates the management of information and allows the application of new pedagogical methods focused on the development of significant learning, which are focused on the student and active participation. It allows to overcome the quality of face-to-face resources, adjusts to the personal schedule of students and facilitates continuous interaction between classmates and the teacher through virtual means. (2002, p. 32)

ICTs are a resource for exploration and visualization, they are important in mathematical teaching, as the student through them can establish relationships among mathematical objects and can become familiar with them, making them tangible, observable and manipulable, as an advantage over traditional teaching. where generally these objects are more abstract.

Virtual Learning Environments

Many terms related to virtuality have emerged such as: Virtual Learning Environment (VLE), Learning Object (LO), Virtual Learning Object (VLO), Virtual Information Object (VIO), Virtual Teaching and Learning Environment (VTLE), and others. It is not an objective of this research, to theorize about the terminologies used, however, the large number of definitions given by various authors, some even conflicting. However, it is important to assume a critical position regarding the concepts that will be addressed in this study to avoid conceptual ambiguities.

The Colombian National Ministry of Education developed and assumed its own definition of Learning Object:

> an Object of Learning is a set of digital resources, self-contained and reusable for an educational purpose and consisting of at least three internal components: content, learning activities and contextualization elements. The Learning Object must have an external information structure (metadata) that facilitates its storage, identification and recovery. (Ministry of National Education, 2006)

However, this definition has the disadvantage that it refers to the Learning Object (LO) as something "virtual" when it is not necessarily so, for example, García (2005) states that:

> A learning object may consist of a more or less complex question or a similar tone response, an image or simulation; exercises, questionnaires or diagrams can also be a learning object, as well as a slide or set of them; a table, experiments, games or animations; a video or audio sequence, some sentences or paragraphs of a text, part of a lesson; some computer applications -Flash, PowerPoint, Java, Applets ... -; case studies, URLs, etc. That is, objects can acquire very different shapes and be presented in different formats and media. (p. 1)

As you can see, not all learning objects are virtual, in fact, the first ones used in teaching were tangible, real objects. For this reason, the definition of the Colombian National Education Ministry is preferred, but not for (LO) but for Virtual Learning Objects (VLO).

The Dictionary of the Spanish Language (2018), defines the word environment as:

"Environment, what surrounds" and also as: "Set of characteristics that define the place and the way of execution of an application".

It also defines the word environment as:

> "That surrounds something or someone as an element of their environment", hence many authors use interchangeably as Virtual Learning Environments and Virtual Learning Environments in the space where this virtual education takes place.

Suárez (2002), defines EVA as: “an action system that bases its particularity on an educational intention and on a specific way to achieve it through info-virtual resources” (p. 32), for its part Dillenbourg (2000) distinguishes VLE such as:

> a space where the characteristics in which the information is provided is designed, the stated environment must be social where the virtual space is a representation and the students are active actors, multiple tools are integrated and this virtual environment overlaps with the physical environment. (p. 12)

Osorio (2012) states that:

> Virtual Learning Environment is a space in which there is a pedagogical process mediated by technologies. Virtual environments become systems in which the

> didactics, tools and resources that teachers use with students, whether virtual or face-to-face, are compiled. (p. 12)

For this reason, the term Virtual Learning Environment (VLE) is preferred, to define that space to carry out the pedagogical process mediated by technology.

B-learning as a teaching-learning methodology

Blendedlearning or b-learning is understood as the organic integration of face-to-face approaches and virtuality in education. This methodology is based on the needs of education in the current era by merging the face-to-face and virtual communicationally (Garrison and Vaughan, 2013).

The blendedlearning makes possible the use of technologies in a classroom, while generating several mixed moments or integration during the educational process. Face-to-face activities are stimulated and motivated by the use of ICT, while stimulating knowledge management outside the classroom. The possibility of combining both teaching methods, (face-to-face and virtual) makes the advantages of each one take advantage and a greater impact on the learning of new students in the twenty-first century.

Lin et al. (2017), suggest that traditional teaching complemented with computer-assisted teaching methods can be used in the teaching-learning process of mathematics in high school.

In the teaching and learning of mathematics, students sometimes face difficult problems to solve in a face-to-face environment, where using technology maximizes their time and solution.

An investigation developed by Herrera and Montaña (2015), "Problem-based learning supported in b-learning environments as a teaching strategy to improve the academic performance of students in higher education" with the use of a quantitative methodology of basic type and applying a descriptive correlational approach, obtained as a result that problem-based learning constitutes an important support in semipresence or b-learning environments.

Manjarres and Chiappe (2012) carry out the research “Incidence of a Blended learning environment, in the transformation of mathematical competences in university students”, which is a case study of qualitative approach. The results obtained in the research allowed to identify some transformations in the students, especially in their ability to solve problems, abilities to communicate orally and in writing and in the ability to apply mathematical knowledge to the field of Civil Engineering.

For his part, Córdova (2016) in his master's thesis "B-learning and the development of mathematical thinking in 11th grade students of the José Elías Puyana Industrial Technical College, Colombia (2015)" states that there is a positive Moderate and significant relationship between blendedlearning and mathematical communication, in addition to positive and significant between blendedlearning with mathematical reasoning, positive and significant between blendedlearning with mathematical thinking in 11th grade students.

It is also important to select the appropriate computer tools to carry out the task of educating students through the b-learning methodology. An important example is the use of the Moodle platform, due to the advantages it offers and because its work philosophy is consistent with the socio-historical-cultural paradigm. Several researches have shown the benefits of using Moodle in secondary education, such as: (Kok, 2008; White, 2010; Lu and Law, 2011); who argue that Moodle had pedagogical advantages since it was built according to the teaching approach that emphasizes the construction of knowledge through active and interactive learning, and learning of multisensory experience through multimedia.

Conclusions

It is necessary for teachers to continue conducting research that allows a more effective use of technological resources in the teaching-learning process of School Mathematics. The diversity of studies, with different methodologies, demonstrate that fair teaching must be adapted to the individual characteristics of each student.

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