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Presentation of Content

In the first article we present, *The teaching of Mathematics and the historical development of Euclidean space*, by ORTIZ-SANCHEZ, Pedro Alfonso Guadalupe, ORTIZ- Y OJEDA, Pedro Tomás, SÁNCHEZ-ITURBE, Patricia Guadalupe and BASAVE-TORRES, Rosy Ilda, with adscription in the Instituto Tecnológico de Mérida and Instituto Tecnológico de Tuxtla Gutiérrez, as the following article we present, *Student satisfaction about the online teaching of the Engineering in Business Management program of the Technological Institute of Toluca*, by AGUIRRE-BRITO, Dorian, PALOMAR-FUENTES, María del Pilar, ORDOÑEZ-HERNÁNDEZ, Lucía and ALVARADO-ALDAMA, Daniel, with adscription in the Instituto Tecnológico de Toluca, as the following article we present, *Virtualization of educational environments for international collaboration: students as builders of their own learning*, by JUAREZ-SALOMO, Norma Angélica, CUEVAS-OLASCOAGA, Miguel Ángel and SILVEYRA-ROSALES, Mariana Teresa, with adscription in the Universidad Autónoma del Estado de Morelos, as the following article we present, *A proposal of strategies to promote study habits in virtual learning objects*, by ARREDONDO-SALCEDO, Daniel, MIRELES-MEDINA, Antonia and MOLINA-WONG, Ma. Refugio, with adscription in the Instituto Tecnológico Superior Zacatecas Norte.

Content

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The teaching of Mathematics and the historical development of Euclidean space

La enseñanza de las Matemáticas y el desarrollo histórico del espacio Euclidiano

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Abstract

The historical analysis of a concept allows us to understand its evolution and determine the processes of construction of that knowledge, in the case of the Euclidean space, the theoretical representation entails understanding difficulties during its teaching, which can be attributed to the epistemological obstacle as it will be examined in this article. The historical development of the concept of space is briefly analyzed, in documentary form, first within geometry and later in its generalization as a vector space. Finally, the historical perspective is contrasted, to succinctly examine a didactic proposal, which establishes the conclusion that it is necessary to build knowledge based on the elements that characterize epistemic development, which will possibly originate new pedagogical proposals.

Space, Geometry, Didactics

Resumen

El análisis histórico de un concepto permite comprender su evolución y determinar los procesos de construcción de ese conocimiento, en el caso del espacio Euclidiano, la representación teórica conlleva dificultades de comprensión durante su enseñanza, que puede atribuirse al obstáculo epistemológico tal como se propone en este trabajo. Se analiza brevemente, en forma documental el desarrollo histórico del concepto de espacio, primero dentro de la geometría y después en la generalización como espacio vectorial. Finalmente se contrasta la perspectiva histórica, para examinar sucintamente una propuesta didáctica, que establece la conclusión de que es necesario construir el conocimiento en base a los elementos que caracterizan al desarrollo epistémico, lo que podría originar nuevas propuestas pedagógicas.

Espacio, Geometría, Didáctica

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Introduction

It is to be considered that there are several stages of mathematical thought in relation to its formal construction process. Under this perspective we find the historical element of Pythagoreanism as the starting point of mathematics and its philosophical reflection of epistemological character. It can be continued in the same way, with Euclid and the birth of the axiomatic method for the construction of mathematical knowledge.

In the same context is Archimedes, as the person who applies with technical mastery the processes of approximation and mechanical solutions to solve mathematical problems in an ingenious way. In the Middle Ages we find Bacon, a philosopher who considers that the philosophical vein of mathematics is found in the construction of the formal knowledge of science.

Continuing with the historical development of mathematics, a fundamental turn originates with Cartesianism, whose thought is installed as a toral knowledge for the construction of mathematical elements under the process of analysis, as the tool to develop new concepts and solve mathematical problems.

According to Arancibia (2016, p 10):

"The Cartesian notion of space corresponds to a specific concept situated within a particular conception of the world. Although it can be applied to describe and understand material objects, it does not give way to a defined way of projecting or constructing space-that is why the description of works of art, more radical in their ways of projecting space than architecture, is more productive. This is not only because of the descriptive and metaphysical nature of the concept, but probably because for Descartes, the material world is a given fact and created by God, and therefore does not give off a projective intentionality, but his aim is to try to establish a firm truth in science in relation to the existing world around him."

In the search for a firm truth Descartes developed the philosophical idea of rationalism, where the main element of knowledge is reason, establishing with this philosophical stance, one of the bases of human knowledge.

It is considered that the pre-relativistic space-time relationship, according to Penrose (2019), corresponds to a representation in terms of a geometric framework in the motion of particles and bodies, using as a basis the Aristotelian, Galilean and Newtonian structures for space, in which the reference to Euclidean space is always found.

Later in the historical timeline, the discussion of the concepts of space and time is sketched by the speculations of Kant's critical-mathematical philosophy in the form of *a priori* knowledge, in order to lead to a methodological resource that is applicable both to the natural sciences and in general.

Since the systematization of geometry by Euclid, it was considered the science of space; in the 19th century, the methodology applied began to be questioned, since it had two variants, the analytical and the synthetic, the debate on these methods significantly affected the teaching, the rigor of mathematical work and its progress.

The historical development of algebra in the 19th century led to the appearance of algebraic geometry, which renewed the methods of the study of curves and surfaces based on synthetic and analytical geometry, and with the appearance of projective geometry, non-Euclidean geometry was born.

The above brought as a consequence the appearance of vector space as a concept to develop hyperspace, which currently has repercussions in the teaching process, in difficulties of explanation and understanding, being this even more complicated than for Euclidean space, which must be demolished by didactic proposals implemented in various pedagogical alternatives of educational mathematics.

Thus it is possible to ask whether, first, the logical structure of a concept is sufficient to articulate learning and, second, whether and with which elements historical-conceptual reconstruction can help to develop didactic strategies. We propose to discuss these two questions.

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On the other hand, in the book Geometría (Bruño, 1970), in the preliminary definitions it is stated that: "The observation of material objects provides us with the ideas of space, volume, surface, line and point. A material body occupies a portion of absolute space", and also considers that: "once these notions are acquired, one can dispense with their experimental origin and conceive of a volume, a surface, a line, a point, independent of any material body".

Thus, taking up again what Pecharroman (2013) explained, the didactic process of geometry has as an initial obstacle the discordance of reality with the ideal representation of the object, being that, of the point, the line and the plane there are only ideal representations, of the real objects, they do not exist, that is, the concrete reality is evoked by means of an object, in an abstract form.

It can be considered that space is an epistemological obstacle, due to the exclusion of its conceptual roots in Cartesian rationalism, which considers that the whole is made up of parts, so this conception is the point to develop the conceptual formation of vector space and therefore the generalization of space in mathematical form.

To systematize the process of conceptual approach to the idea of space, there are proposals such as those of Piaget, called of spatial concepts and that of Pierre van Hiele and Dina van Diele-Geldof that establish five hierarchical levels to describe the understanding and mastery of spatial notions and skills (Arancibia, 2016).

Thus, according to Gómez-Carrasco, et al. (2019), the historical reconstruction of space shows that the use of language is very important for the identification and classification of objects surrounding the environment and to symbolize their representation; however, logic is subsequently resorted to in order to establish the intrinsic characteristics of the figures.

The observation of the development of these ideas, allows us to recognize that the inquiry of a perspective for the didactic understanding and transfer of concepts should be approached, for its investigation, based on a phenomenological perspective.

Methodology

The theoretical character of science and history, influence the methodology in a reciprocal way and in relation to mathematics; because its structure is the basis of intrinsic logic, which participates in the construction of mathematical knowledge and by the part of history, which reproduces the image of the world and of man, this finally has repercussions in a philosophy, known as the theory of unique conceptions.

In the formalization of knowledge, one passes from concrete elements to abstract concepts by means of an idealization of reality, having the truth of knowledge as a guiding thread and knowledge as the ultimate goal. Thus, it can be considered that the development of predicative logic occurred when it turned to the fundamental element of knowledge, which is the attainment and demonstration of truth.

However, according to, Descartes (2015), considers that the very serious defect of Aristotle's logic, is in its inability to invent, since it is considered that: "The syllogism cannot be a method of discovery, since the premises (which may be false) must necessarily lead to the conclusion".

Under this perspective, one must "Put culture in a state of permanent mobilization, replace closed and static knowledge, by an open and dynamic knowledge, dialecticize all experimental variables, finally give reason reasons to evolve" (Bachelard, 2018), and thereby open the opportunity for inquiry of conceptual construction.

Also language as an external element, is seen in terms of formalization as a vehicle to transmit knowledge, in the form of a truth that is implicit in it and that has the fundamental characteristic of being objective, i.e. the relationship that keeps the value it contains, is the product of a predicative representation. Under this vision, the development of the concept of space is analyzed in this essay.

Thus in current geometry, only shape and size are considered, so that geometric solids have three characteristics, length, width and height; surfaces are the limits that separate the solid or body from the space that surrounds it, with its fundamental characteristics of length and width.

The main obstacle to construct mathematical space is the Archimedean property, which established that two magnitudes could not be compared unless a multiple of one of them could exceed the other, so the sum of areas with lengths or with volumes could not be developed, Descartes' innovative proposal was to consider that the product of two lines is a line, not an area.

This allowed to interpret all geometric magnitudes in linear form, (Rodriguez, 2022) using algebraic operations and to perform operations with segments of straight lines, that fulfilled the condition of a given relationship, which graphically is possible to represent with two segments, one of length X as axis and another of length Y also as axis, separated by an angle between the two, this idea was imposed by necessity, because originally Descartes used an axis without reference to the other. Descartes also proposes the philosophy of rationalism based on the ideas of Aristotle, and in terms of proceeding by operations that depend only on reason, independently of experience, as is the case of mathematics being considered as a rational science.

There are different shades of this position, such as Kant's critical rationalism in which the a priori of reason correspond to the experience that predefines and organizes them. Hegel, for his part, considers that rational thought is capable of reaching absolute truth insofar as its laws are those that obey a real representation.

Currently rationalism considers that reason is in the possibility of reaching the real, through scientifically elaborated knowledge, taking into account the historical evolution of reason, of an open or dialectical rationalism (Bachelard, 2018).

Considering Cartesian rationalism, and as a fundamental reference to the work of Descartes called Discourse of Method, in the second rule, it is established that: "divide each of the difficulties that I examine in as many parts as possible and in as many as their best solution requires" (Descartes, 2015).

This rule establishes what etymologically is: *analuein*, that is to say, to untie, so that corresponds to the translation, it defines the concept of analysis as the procedure of decomposing a defined whole in its parts or components, as the analysis of a concept.

In mathematics, the concept of analysis has two meanings, one of Greek origin that recognizes analysis as the method of demonstration that starts from a conclusion, and then inversely arrives at the synthesis. The second, modern version, corresponds to the name applied to the branch of mathematics that studies the dependence relationships of certain magnitudes.

Under these ideas, a didactic strategy can be established as a perspective to investigate the development of some concepts. For all of the above, the methodological process to develop the inquiry begins with a staging, starting from the Euclidean ideas and their historical transit, in terms of epistemic obstacle and the *analuein*, referred to a course of linear algebra.

The construction of the mathematical space of the linear algebra course was based on emphasizing two fundamental operations, addition and multiplication, following the basic idea of Cartesianism that the whole is equal to the sum of the parts in the construction of dependence, independence, base and dimension, following a path to avoid the epistemic obstacle from the historical perspective.

Taking into account human nature, which is defined in terms of a subjective voluntarism of learning, it was possible to consider a research methodology that is related to a qualitative and ideographic vision of science, which is characterized by the interpretation of phenomena as they are experienced, lived and perceived by the student, eliminating the description, and taking into account the scientifically valid and useful essence of the didactic phenomenon. Due to the above, being this an exploratory, descriptive and totally documentary study, and having as a basis to analyze a perspective to develop a didactic strategy, an interview was organized on the subject of learning vector spaces and their linear transformations, under a subjective inquiry structure.

Due to the prevailing Cencia et al. (2021) situation of the Covid19 pandemic of virtual work, a random sample was not selected by any statistical method, but rather by the accessibility of each student who freely decided to answer, the student population on which it was applied was formed by groups of teachers who agreed to participate.

As a preliminary analysis, an unstructured interview was conducted with 8 students, out of a group of 10, who freely decided to participate, on the topics of vector spaces and linear transformations, under a methodology of subjective inquiry, and based on an ontological revision of nominalism, which is defined by the epistemic vision of anti-positivism, as outlined in this essay, and also considering the epistemic in its historical character.

This is developed through the rationalism applied by Bachelard (2018), which allows developing a historical analysis of the formation of science to establish the difference between each scientific knowledge, and concludes that there is no general science, but specific sciences and they are characterized by having different problems to reach the scientific truth.

Furthermore, the process of advancement of the sciences and their development are not made in a continuous and linear way, but by modifications or radical changes in their categories of knowledge and methodologies, which at the time had been considered as fundamental, i.e. as dogmas or traditions.

However, modifications or radical changes are known as epistemological breaks, which are obtained by the characterization of science in its historical development, in its phases or steps, from one phase to another or from one step to another, allowing to distinguish scientific theories from non-scientific discourses according to, Bachelard (2018, p 45).

When one investigates the psychological conditions of the progress of science, one soon comes to the conviction that one must pose the problem of scientific knowledge in terms of obstacles.

It is not a question of considering external obstacles, such as the complexity or transience of phenomena, nor of incriminating the weakness of the senses or of the human spirit: it is in the very act of knowing, intimately, that hindrances and confusions appear, by a kind of functional necessity. It is there that we will show causes of stagnation and even regression, it is there that we will discern causes of inertia that we will call epistemological obstacles.

In the didactics of mathematics, the concept of epistemological obstacle is resignified by Brousseau, in Barrantes (2006) where he conceptualizes the epistemological obstacle approaching it to the causes that lead to errors, as he points out: "The error is not only the effect of ignorance, uncertainty, but it is the effect of a previous knowledge, which, in spite of its interest or success, now reveals itself to be false or simply inadequate". Thus, when mentioning the epistemological obstacle, this author does not necessarily refer to erroneous knowledge; but to types of knowledge that are hindering the acquisition (construction) of a new one.

In both cases there is the difficulty of apprehending knowledge by a rational process, and thus applying these characteristics to Euclidean space and its conceptual generalization, in vector space, recognizing that it is necessary to make a historical review of the genesis of the concept of mathematical space. Therefore, the generated space can be considered as an epistemic obstacle that hinders and develops confusions for knowing, and the n-dimensional space additionally accuses the full category of didactic challenge for the acquisition or construction of mathematical knowledge.

Thus, the pedagogical process of constructing space falls fundamentally on constructivism as a common denominator, both in Piaget's proposal and in that of Pierre van Hiele and Dina van Diele-Geldof, as well as that of Brousseau, who can be situated in cognitive or socio-cultural constructivism, conceived as a dialectical process of the construction of reality.

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Results

In accordance with the above and with the history of mathematics, the appearance of the concept of vector and its generalization in the form of tensor, in the 19th century, generated alternatives of conceptual development for geometry and consequently the representation of space, with the appearance of the notion of vector space, whose development can be synthesized as follows for the construction of the didactic process:

First was the mathematical representation of the plane initiated by Descartes, which arises by associating it with the intersection of two orthogonal straight lines, which facilitates the Algebra-Geometry relationship for a full representation of mathematical objects and their numerical relationship of the straight line with the points and the real numbers, to thus define a set of two numbers that identify a position in the plane.

Then, it is recognized that the vector space is constructed from a fundamental idea of the intuition of the numerical calculation of addition and multiplication used in analytical geometry, as well as the direct relationship that exists when associating a number with a point, and that successively generates a numerical line, according to the Euclidean concept that a succession of points forms a line.

Returning to the previous idea of Descartes (2015) and in contrast, we can identify the notion that the whole is equal to the sum of its parts and also considering that multiplication is an abbreviated sum, then we have the elements to mathematically construct the n-dimensional space using addition and multiplication. As an initial part of the preliminary results of this research and as a result of the detailed analysis of the answers given to the interviews mentioned above, Table 1 was obtained:

Onto-Epistemic Sieve				
	Measure	Metrics	Space	Form
Epistemology	What is possible to conceive is perceived	Understanding the meaning	Euclidean Representation	Lack of intrinsic meaning
Ontology	Connection with conceptual interpretation	Idea of generalization	Qualitative assessment	Not stable conceptual invariants

Table 1 Onto-epistemic sieve
Source: Own Elaboration

In the table of our own elaboration, with the data obtained in the preliminary analysis, as previously pointed out was applied to the students who agreed to participate, in their answers, it is possible to perceive, that the concept of space is defined by the epistemology, identified with the subject, based on the intrinsic meaning, and by what he understands of mathematical knowledge, as well as the ontological, identified by the object that is determined in terms of a general concept with reality and its historical context, in this case without establishing conceptual invariants.

This makes it necessary to characterize the previous categories, mean, metric, space and form, in a finer form, to propose the genesis of a didactic strategy for the concept space, based on the historical development, in which the epistemic obstacle for the construction of vector space is identified, which is possible to consider as part of the fundamental teaching of vector space, as the process of decomposing a defined whole into its parts or its components, in this particular case of vector space by means of abbreviated multiplication.

Conclusions

Clearly explain the results obtained and the possibilities for improvement. Each epistemic position tends to be displaced by another that better explains reality and allows the development of better concepts of geometric space of Euclidean characteristics. This is currently characterized in science by time defined in a functional relation of relative time-space, explained and formulated in a general way by tensor quantities.

Thus each epistemological posture represents an instant that is transformed into a historical moment of the integration of a general system of knowledge and its multiple vision, corresponding to the varied requirement of the problems of representation, explanation and formalization, having as a fundamental element the evolutionary continuity of scientific knowledge. The relationship of knowledge and its conceptual evolution lies in a continuous record of unfinished overcoming and transformations that denote the phases of intellectual development, implying the continuous development of thinking, systematized by the formalization and relativization of previous ideas.

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This fact gives enough guarantee to maintain a continuous development of mathematical thinking without meaning that it is necessary to reach an absolute perfection of knowledge, recognizing that this characteristic is not achieved at any point of human knowledge, which is why it is recognized that there are no didactic processes that are always successful, so it is not possible to establish so far an infallible formula that leads the learning process along a path traced by a path of achievements.

Positivism as a philosophical position promotes the establishment of general laws, allowing scientific knowledge to be classified and organized according to mathematical logic, as an integrated whole, leaving behind speculative processes of knowledge. Positivism considers that the development of humanity passes from the theological and metaphysical state to a positive state of knowledge.

Thus in positivism the concept of space, experienced a generalization based on a logical formalization as a certifying element of its subjective belonging, appearing different algebras that generalize this concept and that its didactic process is based on educational behaviorism as a didactic strategy.

On the contrary, instead of using logic, the concept of space can be developed as the construction of didactic strategies based on the concept of epistemological obstacle, developed in terms of a historical-conceptual reconstruction, in which the interrelation between geometric and algebraic reality must appear as a fundamental element, through the operations of addition and multiplication, as analyzed above.

In synthesis, this posture will allow the development of didactic strategies that adapt to the concept of space in a meaningful way for the student, starting from the process of construction of knowledge determined by fundamental ideas such as addition and product as basic operations that will determine the epistemological development and its possible obstacles of the idea of space.

In this way, a vein of conceptual inquiry would be generated, to fully answer the questions initially raised, and to answer the questions related to the concept, as was seen in the onto-epistemic sieve, and it is also possible to be complemented with the tools of didactic analysis to investigate the construction of mathematical space, such as those of Piaget, Pierre van Hiele and Dina van Diele-Geldof, Brousseau, Guershon Harel, Jean Luc Dorier and Ed Dubinsky's Action-Process-Object-Scheme (known as APOE), thus fulfilling the objectives proposed in this research proposal.

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Student satisfaction about the online teaching of the Engineering in Business Management program of the Technological Institute of Toluca

Satisfacción Estudiantil sobre la enseñanza en línea del programa académico de Ingeniería en Gestión Empresarial del Instituto Tecnológico de Toluca

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Abstract

In the year 2020, educational institutions worldwide found it necessary to modify the way of teaching in response to the recommendations of health agencies to maintain social distancing to reduce the circulation of SAR-COV 2 and the development of COVID 19. The traditional way of teaching in which a classroom was attended in person, became staying at home and connecting to an electronic device that allowed the transmission of classes online. Given this new modality, this research aims to collect information through a student satisfaction survey of the academic program of Engineering in Business Management at the Technological Institute of Toluca of online classes during the semester of August-December 2020, period in which it was in pandemic. The variables to be considered were: Teaching, Academic Organization and Infrastructure and University Services. It is concluded from the results obtained that the students are satisfied with the performance of the teacher, however, there are also areas of opportunity in the management of digital platforms, as well as in the feedback and the time that is assigned to carry out conduct assessments online.

Student satisfaction, Teaching, Online education

Resumen

En el año 2020 las instituciones educativas a nivel mundial se vieron en la necesidad de modificar la forma de enseñanza ante las recomendaciones de los organismos de la salud por mantener un distanciamiento Social para reducir la circulación del SAR-COV 2 y el desarrollo de COVID 19. La forma de enseñanza tradicional en la cual se asistía a un aula de manera presencial se convirtió en permanecer en casa y conectarse a un dispositivo electrónico que permitiera la transmisión de clases en línea. Ante esta nueva modalidad, la presente investigación pretende recabar información mediante una encuesta de satisfacción estudiantil del programa académico de Ingeniería en Gestión Empresarial en el Instituto Tecnológico de Toluca de las clases en línea durante el semestre de Agosto-Diciembre 2020 periodo en el cual se estuvo en pandemia. Las variables por considerar fueron: la Enseñanza, Organización Académica e Infraestructura y Servicios Universitarios. Se concluye a partir de los resultados obtenidos, que los estudiantes se encuentran satisfechos con el desempeño del profesor, sin embargo, también existen áreas de oportunidad en el manejo de las plataformas digitales, así como en la retroalimentación y el tiempo que se asigna para llevar a cabo las evaluaciones en línea.

Satisfacción estudiantil, Enseñanza, Educación en línea

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Introduction

The Instituto Tecnológico de Toluca (ITTOL) is a higher education institution belonging to the Tecnológico Nacional de México (TECNM) that during the year 2020, like other educational institutions, was forced to implement the online education modality, due to the health contingency caused by the worldwide pandemic caused by the SAR-COV2 virus, in which the isolation of the population was the main way to combat it. Teaching strategies changed drastically, in the institutions, virtual classrooms were created by means of devices that allowed classes to be held synchronously as a way of substituting the classrooms in the school where students attended to attend their classes. The ITTOL has 9 educational programmes in the area of engineering, including the academic programme of Engineering in Business Management with an enrolment of 478 in the January-June semester and 557 in the August-December 2020 semester, according to the records of the Instituto Tecnológico de Toluca.

In the first section we consider the reference framework that shows the main aspects of the evolution of education until online education and its virtual environment are defined. The objective of the present research is to know the student satisfaction of the academic programme of Engineering in Business Management of ITTOL in relation to online education, which was presented in the year 2020 taking into account the following variables to measure it: Teaching, Academic Organisation and Infrastructure and University Services The Teaching variable considers aspects where it is sought that the actions carried out by the teacher contribute to the assimilation of new knowledge, it groups aspects of methodology, mastery of the subject and evaluation techniques applied by the teacher; The variable of Academic Organisation brings together aspects of ease of communication with teachers, organisation of time, and the variable of infrastructure and university services, for the online modality that was studied, the technical resources to attend online classes were considered to be the computer and the internet, on the other hand, the infrastructure considered the conditions of the physical space such as lighting, ventilation and privacy.

In order to know the student satisfaction it was necessary to apply surveys to a representative sample of students of the academic programme of Engineering in Business Management of the Institution, whose procedure is shown in detail in the methodology.

The analysis of the results is shown graphically, which allows us to better identify the behaviour of the indicators of the variables. We end with the conclusions in which the values obtained in the survey are highlighted.

Frame of Reference

Human beings are constantly evolving, proof of which is their ability to adapt to the new conditions prevailing in the environment. Since the confinement by the Covid-19 pandemic, new scenarios have been generated where learning has been developed in virtual environments, according to (Aguilar Vargas & Otuyemi Rondero, 2020) the concept of "virtual environments" is associated with software or a computer application, space or medium in the network that facilitates communication. Their characteristics are collaboration, interactivity, flexibility, standardisation and scalability. They further conclude that there are different ways of defining "virtual learning environments" and, based on the results of their study and literature reviewed, they are presented as spaces, software or computer applications that are equipped with didactic materials and technological resources, where communication and interaction are essential, as they are intended to be as close as possible to a real space, a classroom in which face-to-face communication is handled, thus functioning in collaboration with pedagogical and learning processes.

(Abreu, 2020) points out that online education is conceptualised as electronically supported learning, which relies on the Internet for teacher/student interaction and the distribution of class materials. From this simple definition emerges an almost infinite number of ways of teaching and learning outside traditional classrooms and away from university campuses. With online education, students can participate in a virtual classroom from anywhere with Internet access and electricity.

It can include audio, video, text, animations, virtual training environments and chats with teachers. It is a rich learning environment, with much more flexibility than a traditional classroom. In the institution where the present work was carried out, online teaching was adopted to continue with the educational process, in this type of teaching students and teachers interact in their class schedules through the Teams platform, this Microsoft tool is an online communication and collaboration platform, It is a product focused on organising work groups in an efficient way, it is very useful because among the main functions it is possible to develop the topics with screen projection or share the blackboard where everyone can participate and solve doubts in real time, the communication is through video and active microphones, the students can expose in teams and interact with their classmates.

Regarding the term online teaching (Abreu, Art. Cit.), many active members of the academic community have been hotly debating the terminology on social media, and "emergency remote teaching" has emerged as a common alternative term used by online education researchers and academics to establish a clear contrast with what many know as quality online education. Some readers may disagree with the use of the term "teaching" over options such as "learning" or "instruction". Rather than discuss all the details of those concepts, "teaching" was selected because of its simple definitions: "the act, practice or profession of a teacher" and "the concerted exchange of knowledge and experience", along with the fact that the first tasks performed during emergency shifts in delivery mode are those of a teacher/instructor/lecturer.

Covid-19 in education

The educational environment was affected by Covid-19, the change in the modality of traditional education where teachers and students converge in a classroom was abrupt, in the last week of March 2020, the indication was received that due to the health emergency, non-essential activities were suspended, education being one of them, classes would continue remotely - indefinitely - establishing a traffic light system by regions and clarifying that educational activities could be resumed until the traffic light was green.

For the follow-up of procedures and services, guards were set up among administrative and education support staff. Higher education institutions were forced to move to remote education. They did so at very different times, depending on the capacity of each one, or of each sub-system, to carry out the technological migration. The differences were significant: non-formal education was able to continue without interruption, as were some private universities. In general, universities and technological institutes interrupted classes for periods ranging from one to four months. All of them faced, to varying degrees, the difficulty of access to technology and the internet for their students.

Some of them facilitated students' access to electronic devices, mostly tablets or laptops. Many had to struggle with the lack of experience in the use of technology by teachers and students, and in all cases, with the lack of teacher training for distance education, which was also solved by each institution or sub-system according to its possibilities. There were no additional resources from the government for public higher education in this emergency, so institutions had to use their previously approved budgets to migrate to distance education (Schmelkes, 2020).

The lack of technological equipment and poor internet access at home becomes a major problem for students as they become indispensable tools to ensure the continuity of their studies, in addition to the preparation for the use of digital platforms, in this sense and with respect to digital (Lloyd, 2020) mentions that Mexico is quite bad off. In 2016, the country ranked 87th in the world and 8th in Latin America in access to ICTs, behind Uruguay, Argentina, Chile, Costa Rica, Brazil, Colombia and Venezuela, in that order, according to indicators from the International Telecommunications Union (ITU), based in Switzerland.

Mexico's position is worrying, and if we add to this scenario the economic inequality of the regions in our own country, the situation is becoming increasingly difficult. The present study measures student satisfaction in a public higher education institution.

With regard to the technological gaps at this academic level (Lloyd, Art. Cit.), he mentions that there are strong differences between the higher education subsystems: between the most established private universities, federal public universities and state universities, on the one hand, and the technological institutes and universities, teacher training colleges and recently created state universities, on the other. The case of the 11 intercultural universities (UI), which are part of the latter group, is particularly worrying.

These institutions, which serve indigenous students and members of other historically marginalised groups, have had to find creative solutions to continue the education of their students, many of whom do not have internet or computers at home. Even before the pandemic, UIs faced difficulties with ICT use, due to students' limited prior knowledge and the scarcity of available computers, according to an analysis by the Coordinación General de Educación Intercultural y Bilingüe (CGEIB), the federal body that coordinates the intercultural university subsystem.

(Schmelkes, Art. Cit) points out that in order to understand the magnitude of the immediate and long-term impact of the pandemic on higher education, it is necessary to take into account the confluence of three factors: 1) the economic problems derived from the decrease in productive and commercial activity during the pandemic and the consequent unemployment or loss of sources of income; 2) the enormous digital divide that goes hand in hand with socio-economic inequality and is superimposed on it; and 3) the difficulty for higher education institutions to face the educational crisis derived from the pandemic.

The actors in the teaching-learning process during the health contingency have had to adapt at a dizzying pace. In this sense (Gordón, 2020) carried out an essay whose objective was to reflect on the implications of the transition from learning in face-to-face scenarios to virtual learning in times of pandemic, concluding that there are students with special educational needs in which the learning process is incomplete due to inadequate curricular adaptation by teachers, who in turn have difficulty adapting to virtual reality.

From the above it can be concluded that the teaching-learning process has been an arduous path for both the teacher and the student, and this virtual learning process continues to be a challenge for the educational community.

In his article (Ordorika, 2020) he concludes that it will be necessary to establish a new agenda of transformations for Higher Education Institutions (HEIs) in general and for each one of them based on their particularities, a deep reflection on teaching-learning processes, pedagogical models and the use of technologies will be necessary. It also mentions that the COVID-19 pandemic has profoundly affected the institutions, actors and processes that take place in higher education. As in other spaces and activities in society, there have been effects and changes whose duration and transcendence are difficult to foresee. It seems appropriate, however, to move beyond a first stage of forced reactions, inevitably hasty and accelerated, to give way to careful reflections on the future of higher education.

Student satisfaction in online learning

(Álvarez Botello, Chaparro Salinas, & Reyes Pérez, 2017) consider that student satisfaction is determined by various factors that affect their university education, among these factors are the quality of the teachers and their teaching for the academic, professional and human training of the student, the services provided by the Institution, the Infrastructure that the University has, the student's own self-realisation and other factors that will ensure that the student's expectations and needs are met in the best way possible.

According to the case of customer satisfaction in an educational services institution presented by (Calderón Ríos, Zenteno Bonola, López Arista, Aguirre Brito, & Ordoñez Hernández, 2017), the main strengths detected in the higher education institution are: The recognition by students of the quality of teaching, mainly due to the preparation and updating of the teaching staff, as well as respect for the form of evaluation given by the professors; the sports facilities are adequate, as well as the security of the facilities.

It also mentions that the Administrative Services variable was the best evaluated by students, both in terms of school services and in the re-enrolment and credentialing process. The areas of opportunity are present in practically all areas, since on average acceptance is less than 50%, the most worrying being the evaluation system in Mechatronics Engineering, as well as the computer centres where this degree course is provided.

The objective of the research carried out by (Talaveras Pichardo, Paz López, Silvestre, Montes Miranda, & Figueroa Gutiérrez, 2021) was to determine student satisfaction with the virtual modality and to find out the technical conditions for accessing virtual classes. Within the category of student satisfaction, the following factors were taken into account: teaching practices, students, communications and interactions, and finally, technical conditions and support for connectivity. Within the category of technical conditions of access to virtual classes, the following factors were studied: platforms, internet access, devices used.

The results obtained in the category of student satisfaction indicate that, in the factor of pedagogical practices, the variable that the students valued most positively was the accompaniment and monitoring carried out by the teachers. This result highlights the value of the teacher in educational processes, especially in contingency situations, their humanity, attention and guidance generates security and confidence in the student, on the other hand, students point out the excessive load of activities and materials as a factor that negatively affects their satisfaction, which could cause disinterest, stress and demotivation. It is advisable to think about the essentials and isolate the ancillary. An important task for universities is to train teachers in the definition of resources and activities that facilitate the development of the expected learning, giving priority to student autonomy.

He also mentions as a result of his article, that students show dissatisfaction with the communication spaces that are generated among them, and something that the authors suggest is that educational systems consider the social nature of learning, as insisted upon in the approaches of modern pedagogy.

Physical isolation in education should not represent distance in human relations, but rather the resources employed by educational institutions should facilitate this type of interaction.

In terms of the Connectivity category, three important variables are highlighted that deserve to be discussed: the inefficient institutional response when technical problems are reported, the prevalence of the use of mobile phones in their studies, and the limitations of the internet service they are using. What is impossible to deny is that there was no preparation for the "new normal"; that it has been necessary to prepare classes on previously unknown platforms, training for both students and teachers and access to the internet, as well as technological resources that may not have been available, however, the virtual classes were carried out, the present work refers to the student satisfaction of the degree in Business Management Engineering at the Instituto Tecnológico de Toluca, with respect to online teaching, according to (Mejías & Martínez, 2009) the customers are the students and their satisfaction is related to the way in which the educational institution meets their needs, expectations and interests; Thus, Student Satisfaction is defined as the level of mood that students have with respect to their institution, as a result of the perception they have with respect to the fulfilment of their needs, expectations and requirements.

(Chamizo González, Blázquez Resino, Gutiérrez Broncano, & Cano Montero, 2013), argue that, in order to know the effectiveness of internal university quality systems, it is necessary to identify the variables that students value most and, from these, establish relevant indicators in the quality of university life according to their perception, and thus allow us to identify the elements that significantly influence student satisfaction with respect to three aspects: resources and facilities, teaching aspects and social aspects. Thus, the results obtained show that both academic and social aspects are influential dimensions in student satisfaction. Teaching and academic reputation are considered to be the most influential academic variables.

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In their study to develop an instrument to measure student satisfaction (Mejías & Martínez, Art. Cit.), they propose four conceptual dimensions of student satisfaction in higher education, the first one refers to teaching which is related to methodology, techniques and evaluation given by the teaching staff, the second one to academic organisation, the third one is related to university life as the participation of the school in expansion activities, skills and physical abilities and the last dimension refers to infrastructure and services.

Theoretical dimensions and indicators of student satisfaction variable		
Teaching	Methodology, techniques and evaluation provided by teaching staff	Preparation, updating and pedagogical conditions of teachers. Evaluation system used Teaching methodology Incorporation of new technologies in teaching
Academic Organisation	Student satisfaction with regard to the knowledge and attention shown. Hearing the administrative and teaching staff and their abilities to inspire credibility and trust, as well as the willingness and readiness to help the student and provide the service.	The content of the programmes The organisation of time Ease of communication with teachers Ease of communication with administrative staff Tutorial action Practical training and the link with future workplaces
University Life	School participation in physical expansion, skills and abilities activities	Access to a variety of cultural and recreational events. Formation of personal skills and traits
University Infrastructure and Services	Appearance of physical facilities, communication equipment and materials, and with the operation of student services.	Habitability of facilities Adequate teaching and study spaces Adequate sports facilities good library service Adequate functioning of cafeterias Adequate functioning of computer facilities Equal opportunities for participation in activities Safety and security of facilities Adequate attention in the enrolment and registration processes.

Figure 1 Theoretical dimensions and indicators of the student satisfaction variable
Source: (Mejías & Martínez, Art. Cit.)

Object of study

The Instituto Tecnológico de Toluca (ITToluca), is part of the 248 sister technological institutes and 6 Development and Research Centres (254) that make up the Tecnológico Nacional de México (TecNM), which were created to provide an educational offer linked to the needs of the productive sectors of the regions, at national and international level and with coverage throughout the country's territory, in its 32 federal entities, which under a vision of the development of Mexican engineering, contribute to the training of 41% of Mexico's engineers.

In the particular case of ITToluca, as part of the 126 federal technological institutes, it provides higher education services in the most populated state in the country, the State of Mexico, which, located in Metepec, is part of the Toluca Valley, where the most important industrial development poles of the Mexican territory and the capital of the state are located.

With 46 years of academic life, this institute currently offers 9 undergraduate programmes and 3 postgraduate programmes, and has delivered thousands of graduates to society, who in addition to raising the quality of life for their families, have been drivers of industrial development in the Toluca Valley and even beyond its borders; its high academic level has given great prestige to ITToluca, considered by various productive sectors and society, as the most important engineering school in the State of Mexico.

In order to continue with its positioning and to be a reference of technological higher education in the local, national and international sphere, institutional planning is fundamental, which allows to outline the most appropriate lines of action for the efficient and effective construction of the institution to meet the challenges that the nation and the world demand. (Instituto Tecnológico de Toluca, n.d.).

The academic programme of Engineering in Business Management (IGE) is part of the degree programmes offered by the ITToluca, its objective is to train professionals who contribute to business management and process innovation.

As well as to the design, implementation and development of strategic business systems, optimising resources in a global environment, with ethics and social responsibility.

The competences that GSE graduates have, among others, are: Management and engineering skills in the design, management, strengthening and innovation of organisations for effective decision-making, with a systemic and sustainable orientation; Applies quantitative and qualitative methods in the analysis and interpretation of data and systems modelling in organisational processes, for continuous improvement in accordance with world-class standards; Designs and undertakes new businesses and sustainable business projects in competitive markets, to promote development; Interprets financial information to detect opportunities for improvement and investment in a global world, to promote business profitability.

Uses new information and communication technologies in the organisation to optimise processes and effective decision-making; Promotes the development of human capital to achieve organisational objectives, within an ethical framework and a multicultural context; Applies research methods to develop and innovate models, systems, processes and products in the different dimensions of the organisation; Manages the supply chain to develop and innovate models, systems, processes and products in the different dimensions of the organisation. Manages the supply chain of organisations with a process-oriented approach to increase productivity; Etc. (Instituto Tecnológico de Toluca, n.d.).

According to the definition of the Royal Spanish Academy, student refers to "The one who studies" as an adjective, and "Person who studies in an educational establishment". As the object of study of the present work, it will be understood that the student is the person who has a relationship with ITToluca as an educational institution, where their correspondence is limited within the academic environment, in which ITToluca is committed to the student to achieve the following educational objectives, among others:

To promote the integral and harmonious development of the student in relation to others, to himself and to his environment, through an intellectual formation that trains him in the handling of methods and languages, sustained in the principles of national identity, justice, democracy, independence, sovereignty and solidarity; and in recreation, sport and culture that allows him a healthy mind and body.

To offer professional profiles that integrate the specific regional needs so that the graduate contributes satisfactorily to the development of the community, especially the productive plant.

These objectives are aligned with the institution's mission to offer quality, equitable and pertinent Higher Technological Education services, oriented towards the integral formation of the human being by offering accredited educational programmes that promote sustainable development for the creation of a just and humane society.

Problem Statement

Due to the change in the teaching-learning process from a face-to-face form to a scenario where classes are online using the Teams platform, it is extremely important to know how the sessions have been developed, the support given by the teachers, the fulfilment of the academic programmes and their evaluation, as well as the technical resources available to the students, Therefore, the objective of this work is to know the degree of satisfaction of the students about the online teaching of the academic programme of Engineering in Business Management of the Instituto Tecnológico de Toluca. Based on the results obtained, it will be possible to implement actions oriented to increase student satisfaction.
For the present study, student satisfaction is understood as "The perception that students have of the degree to which their needs and expectations have been fulfilled. According to (Calderon Rios, Aguirre Brito, Zenteno Bonola, & Ordoñez Hernández, 2019), one of the consequences of student dissatisfaction is dropping out of school, understood as the voluntary departure of students before completing their studies because the educational institution failed to meet one or more of the needs established by them.

They also conclude that the results obtained highlight the areas that require immediate attention from the client's (students') perception, and that this information constitutes the basis for developing strategies for continuous improvement.

It is clear that the teaching-learning processes in the virtual modality are in constant evolution, which implies that both teachers and students are in a position to use the available resources, which are being innovated day by day to promote learning and ensure student satisfaction, which means that it is necessary to start from a solid and sustained basis of those variables that increase satisfaction and those that need to be taken into account for their adaptation.

Metodology

The type of research approached was descriptive research, as it seeks to systematically refer to the characteristics of a population, situation or area of interest; in this case, the characteristics that influence student satisfaction.

With respect to the determination of student satisfaction with the online teaching of the Business Management Engineering programme at the Instituto Tecnológico de Toluca, in the present work the conceptual dimensions Teaching, Academic Organisation and University Infrastructure and Services proposed by (Mejías & Martínez, Art. Cit.) will be taken up again in order to develop the variables that allow us to conclude the degree of student satisfaction.

It is important to clarify that the dimension University life is not taken into account, as this refers to the institution's participation in expansion activities, skills and physical abilities, which have not been implemented in online education; as for university infrastructure and services, we will study those aspects related to the resources that students have at their disposal to take classes, as well as the habitability and lighting of the study spaces.

The variables analysed are opinion variables, as the focus is on the level of satisfaction that students have with online teaching. The evaluation instrument is a questionnaire consisting of 12 questions.

A 5-level Likert scale was used, the levels used being: very satisfied, slightly satisfied, indifferent, slightly dissatisfied and very dissatisfied. The questionnaire was designed and subsequently tested; the questionnaire was applied to a small group of students, and the measuring instrument was validated as there were no observations. Given the circumstances of the health contingency, it was decided to apply surveys virtually through the Teams platform, the enrolment data by programme for the June-December 2020 semester was 557 students, this figure was taken from Table 19 "Enrolment by gender at undergraduate level Semester August-December 2021 and 2020" of the Accountability Report 2021, published on the official website of the Instituto Tecnológico y del (Instituto Tecnológico de Toluca, n.d.).

Determination of the sample

Since the student population is known, the formula was used to determine the sample size of a finite population (Münch G. & Ángeles E. 1995)

$$n = \frac{z^2\, pq*N}{e^2(n-1)+z^2 p*q} \tag{1}$$

Where:
z= confidence level
n= sample size
p= probability at factor
q= probability against
N= population or universe
e= estimation error (precision in the results)

A confidence level of 95% with a margin of error of 5% will be used, then the formula will be as follows:

N= 557
Z= 95% .95-1= 1.96
e= 0.05
p= 0.5
q=0.5

$$n = \frac{557 * 1.96^2 * 0.5 * 0.5}{0.5^2(557-1)+1.96^2*0.5*0.05}$$

Result = 176

Thus the sample will be 176 students currently studying for a degree in business management engineering.

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Collection of information

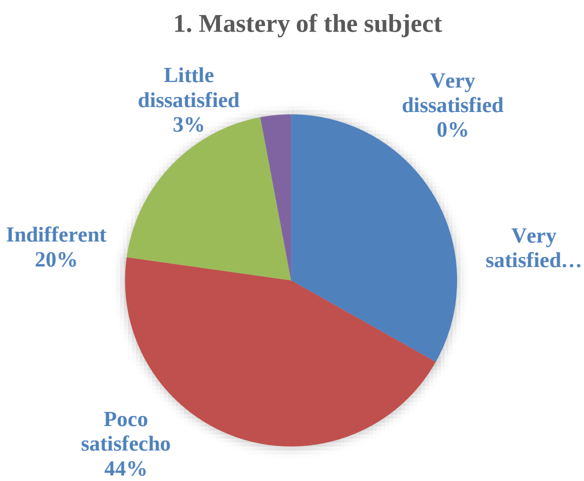
The direct survey technique was used, for which a questionnaire was designed consisting of a set of structured questions regarding the variables to be measured (Hernández, Fernández, & Baptista, 2010). The questionnaires were applied through the Teams platform, obtaining 202 responses to the instrument sent, it is important to mention that, although the result of the sample is 176 elements for a confidence level of 95%, there was a greater participation of the student community.

Results

The graphs presented in this section describe the behaviour of the variables of: Teaching, Academic Organisation and Infrastructure and University Services that are considered most relevant in student satisfaction for this research of the students of the ITTOL Business Management Engineering degree course.

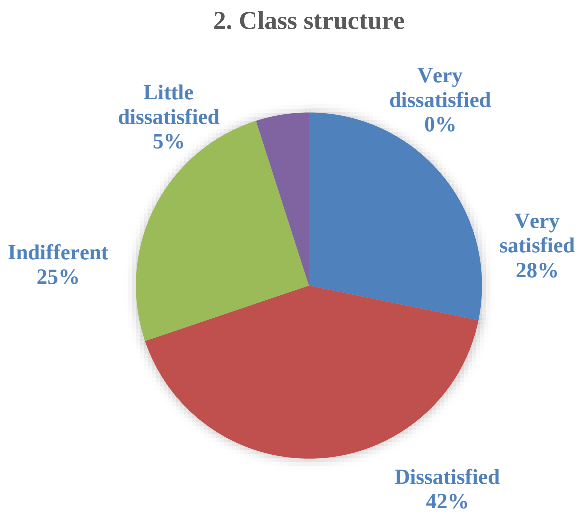
These results are the product of the information obtained through the direct survey.

With regard to the Teaching variable, which seeks to ensure that the actions carried out by the teacher contribute to the assimilation of new knowledge, it groups together aspects of methodology, mastery of the subject and evaluation techniques applied by the teacher, with the following results being obtained:



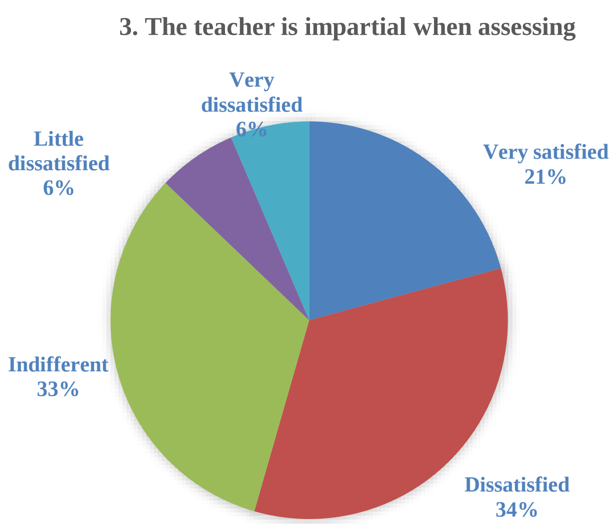
Graph 1 Subject Mastery
Source: Own Elaboration

Graph 1 indicates the students' appreciation of the teacher's mastery of the subject, as can be seen, a high percentage of students, represented by 77%, were satisfied, of which 44% are not very satisfied and 33% very satisfied, which shows that teachers at the institution are prepared in the subject they teach.



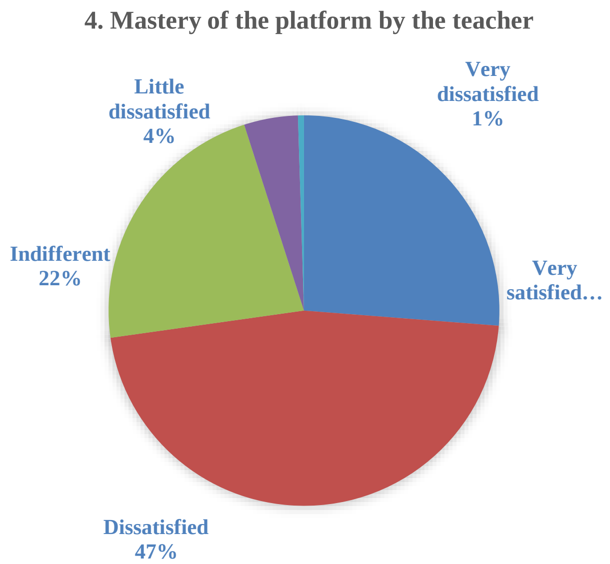
Graph 2. Class structure (Introduction, Development, Conclusion)
Source: Own Elaboration

Graph 2 shows that the teacher structures his lessons with an introduction, development and conclusion, 42% were not very satisfied and 28% were very satisfied with the structure of his lessons. On the other hand, a minority of 5% were not very dissatisfied with the structure of their lessons.



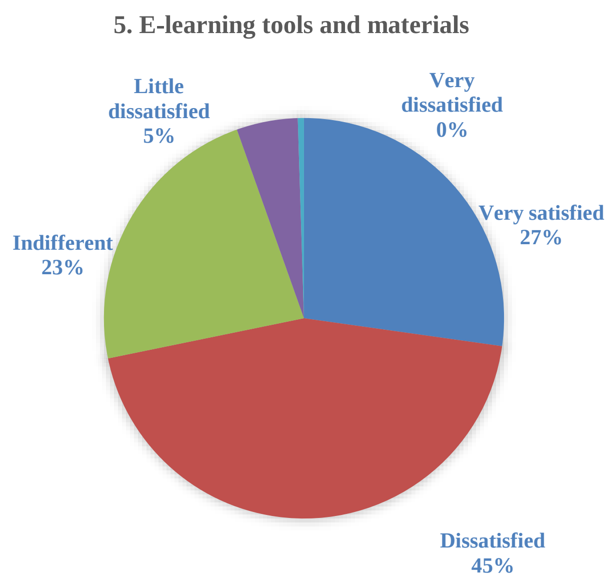
Graph 3 Impartiality at the time of assessment by the teacher
Source: Own Elaboration

Teacher impartiality is very important in teaching, as it represents fairness among young students when they are assessed. Figure 3 shows the student perception of teacher impartiality when assessing, where 54% of the students are not very satisfied and 54% are very satisfied. It should be noted that 33% were indifferent.



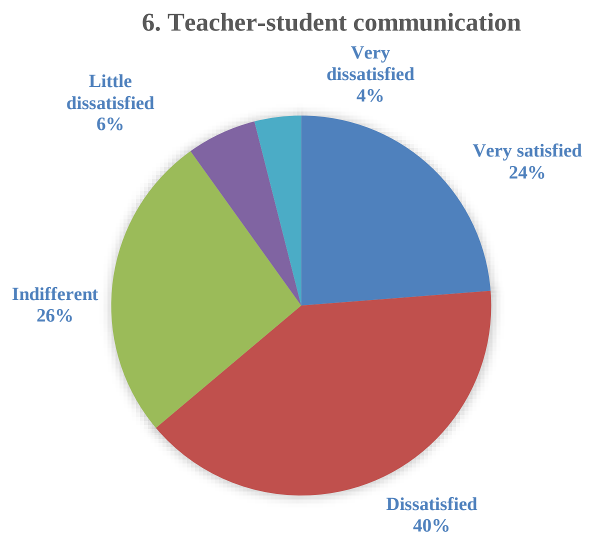
Graph 4 Mastery of the platform by the teacher
Source: Own Elaboration

In graph 4 concerning the mastery of the platform, in this case the Teams tool was used, 73% of the students recognise mastery of the platform by choosing the two most satisfactory options. It is important to mention that the above results reflect the intensive courses that the teachers received to prepare them to respond to the online modality.



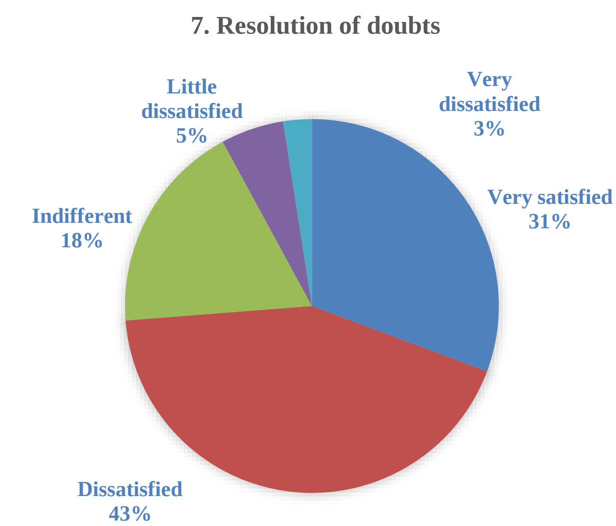
Graph 5 Learning tolos
Source: Own Elaboration

In order to identify the use of virtual learning tools and materials such as platforms, videos, chats, etc., students were asked about the use of these by the teacher, 72% were slightly dissatisfied and very satisfied with the use of these in the teaching-learning process. The variable of Academic Organisation concentrates on aspects of ease of communication with teachers, organisation of time, and in this respect the following questions were considered:



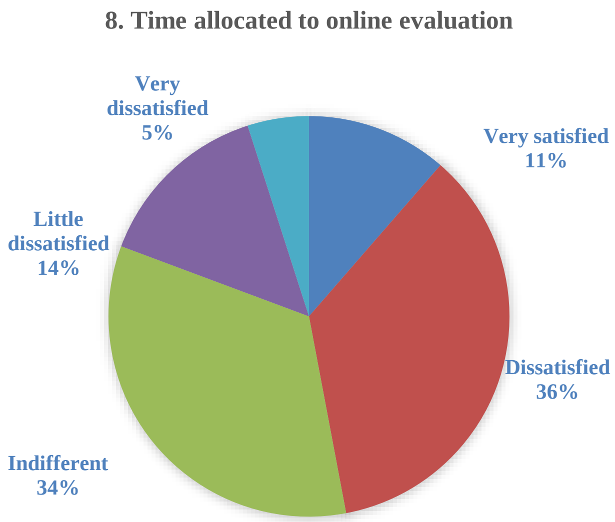
Graph 6 Teacher-student communication through the platform
Source: Own Elaboration

In graph 6, regarding teacher-student communication through the platform, 40% of the students consider it not very satisfactory and 24% very satisfactory, however, it is important to highlight that 26% of the students are indifferent, which represents an area of opportunity.



Graph 7 Resolution of doubts presented by the students
Source: Own Elaboration

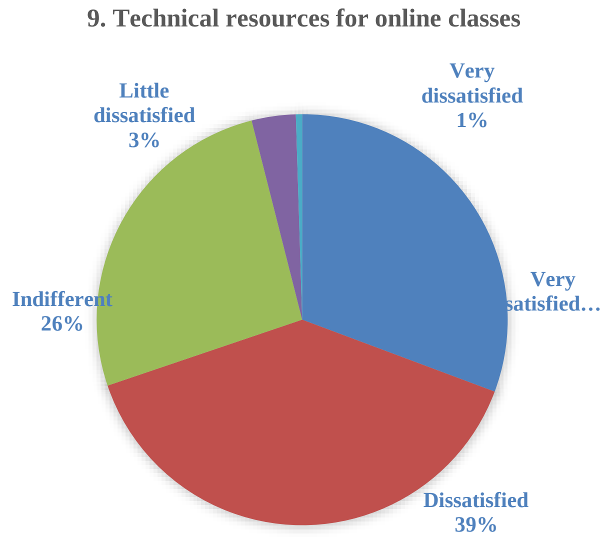
With regard to the resolution of doubts, 74% of the students who responded to the survey perceived that teacher-student communication in the virtual environment was satisfactorily answered by the teachers, as shown in graph 7; however, 8% were dissatisfied with the communication obtained from the teachers.



Graph 8 Time allocated to online evaluation
Source: Own Elaboration

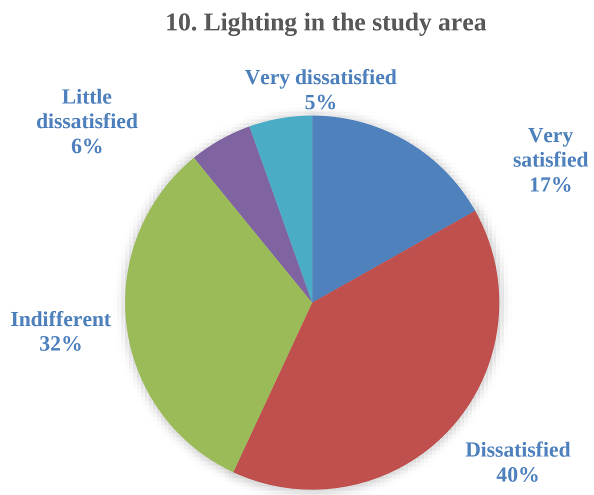
Graph 8 shows information about the time allocated for the assessment; out of the 202 students 72 students are satisfied, it is important to highlight that 68 students were indifferent to the question, which represents 34% of the surveyed population. 19% do not agree with the time allocated to online assessment.

In the variable of infrastructure and university services, for the online modality that was studied, the technical resources to attend the online classes were considered to be the computer and the internet, on the other hand, the infrastructure was considered to be the conditions of the physical space such as lighting, ventilation and privacy that each student creates at home.



Graph 9 Technical resources such as computer and internet to attend online clases
Source: Own Elaboration

It is very important to consider that without the technical resources the students could not have attended the online classes, for this reason in graph 9 shows that 70% of the students were satisfied and very satisfied with the necessary resources to take their classes online, and for 26% they are indifferent to the means used to attend the online classes.



Graph 10 Lighting in the study área
Source: Own Elaboration

Graph 10 represents the students' appreciation of the lighting in the study area, most of them were satisfied with the lighting in their study area and those who were not satisfied with improving it because it is directly related to their performance, only 11% showed little satisfaction with it.

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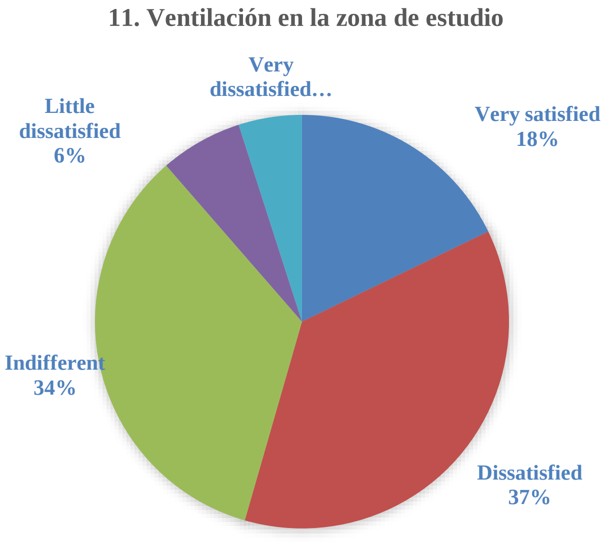
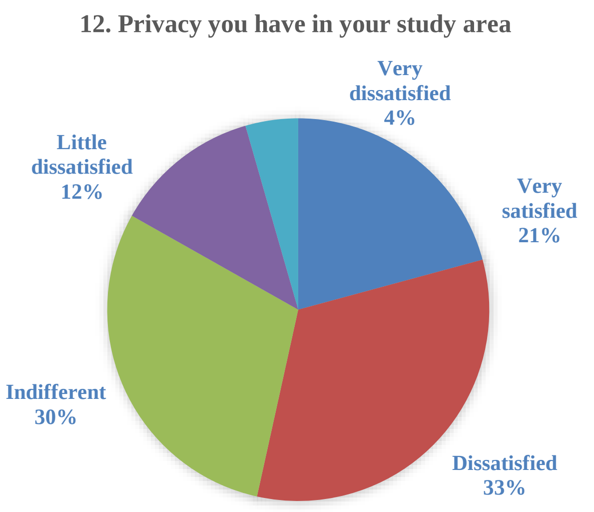


Graph 11 Ventilation of the study área
Source: Own Elaboration

Graph 11 shows how they evaluate the ventilation, they were asked how they considered this element in their space and 6% of the students were not very dissatisfied and 5% were very dissatisfied with the ventilation in their study area, 89% answered that they were satisfied.



Graph 12 Privacy in the study área
Source: Own Elaboration

In graph 12, compared to the results of the previous questions, the privacy they have in their study area presents a lower percentage than the one represented in this question, around 17% of the 34 students feel little dissatisfied and very dissatisfied with the privacy they had in their study area, and it is understandable since they take classes in spaces they share with their family or in environments where they cannot have complete control over the environment where they took the classes.

Analysis of the results

The objective of this research was to determine student satisfaction in the online modality during the August-December 2020 semester of the Business Management Engineering academic programme at the Instituto Tecnológico de Toluca, with an enrolment of 557 students.

To measure the above, indicators were used in the behaviour of the variables of: Teaching, Academic Organisation and Infrastructure and University Services that are considered most relevant in student satisfaction and by means of the structured survey technique according to the Likert scale with the following levels: very satisfied; slightly satisfied; indifferent, slightly dissatisfied and very dissatisfied. This measurement instrument was applied virtually through the Teams platform, with a response of 202 students, which exceeded the sample in accordance with the procedure described, due to the desire to participate.

The results of the evaluation of the Teaching variable were as follows, as shown in the graphs:

In the question whether the teacher has mastery of the subject, 77% of the students were very satisfied and not very satisfied, with satisfaction prevailing in this indicator.

In the question of whether the teacher structures his classes, i.e. starts with an introduction, presents a development and ends his class with the conclusion, 141 students, representing 70%, were slightly and very satisfied, considering the two options satisfactory, 25% of the students were indifferent.

Fairness at the time of evaluation is very important in teaching, 54% of the students were very satisfied and not very satisfied, it is worth noting that 33% of the students showed indifference in this indicator while only 12% showed their dissatisfaction.

As for the mastery of the platform, students were asked if the teacher had this indicator, 157 students representing 73% of the sample answered both options satisfactorily, while 22% were indifferent.

On this issue, it is worth highlighting the training provided to teachers during the first semester of 2020 for the continuity of online classes.

In the use of virtual learning tools and materials by the teacher, 72% of the students were very satisfied and slightly dissatisfied with the teaching-learning process, which shows that they have a certain degree of satisfaction.

In the Academic Organisation variable, the following aspects were grouped together: ease of communication with teachers, resolution of doubts and the time allocated to online assessment.

With regard to teacher-student communication through the Teams platform, 129 students, representing 64%, are satisfied to a certain degree, 40% of the students consider it not very satisfactory and 24% very satisfactory. It is important to highlight that 26% of the students are indifferent with 53 students, which indicates an area of opportunity.

With respect to the resolution of doubts, 74% of the students who responded to the survey perceived that the communication between teacher and student in the virtual environment was satisfactory; however, 8% were dissatisfied with the communication obtained from the teachers.

The last indicator of the Academic Organisation variable refers to the time allocated for online assessment; of the 202 students, 72, representing 47% of those surveyed, were satisfied. It is important to note that 68 students were indifferent to the question, representing 34% of the population surveyed, and 19% disagreed with the time allocated.

It is very important to consider that without the technical resources the students could not have attended the online classes, for this reason 70% of the students were satisfied and very satisfied with the resources necessary to take their classes online, and 26% were indifferent to the means used to attend the online classes.

The following indicators that measure this variable of university infrastructure and services were adapted to the conditions of each student in their home or work area from where they connected to attend online classes, as they were carried out in a synchronous manner.

Most of the students were satisfied with the lighting in the study area, and it was up to them to improve it; only 11% showed little satisfaction in this respect.

In relation to ventilation, they were asked how they considered this element in their space. 13 students (6%) were slightly dissatisfied and 5% were very dissatisfied with the ventilation of their study area, while 107 students (89%) answered that they were satisfied.

The last indicator of the University Infrastructure and Services variable, compared to the results of the previous questions, shows a lower percentage than the one represented in this question, around 17% feel slightly dissatisfied and very dissatisfied with the privacy they had in their study area and it is understandable since they take classes in spaces they share with their family or in environments where they cannot have complete control over the environment where they take classes, even so 108 students representing almost 54% have a certain degree of satisfaction when evaluating the privacy they have in their study area.

Conclusions

Based on the results obtained, the following strategies are proposed:

Regarding the variable Teaching, where the mastery of the subject by the teacher, the structure of the classes, and the impartiality at the time of evaluating the students were measured, in these indicators the highest satisfaction was reflected in the mastery of the classes, so it is a strength of the teaching staff; On the other hand, the indicator with the lowest degree of satisfaction is that of impartiality when assessing, one of the strategies to be followed by the teacher is to establish assessment rubrics and make them known on the first days of classes so that students are aware of them in detail and can clarify any doubts they may have regarding the integration of their qualification.

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In terms of the ease of handling technology such as mastery of the platform and virtual learning tools and materials, the assessment was not very satisfactory, due to the haste of entering virtual environments, despite the fact that intensive courses were given on virtual platforms, constant practice in these digital environments is essential to achieve skill in their use and handling.

With regard to the variable of academic organisation, which was evaluated with the aspects of teacher-student communication and the resolution of doubts, the students are not very satisfied, which indicates an area of opportunity for improvement and the implementation of new strategies that allow for adequate communication between them.

On the other hand, the time allocated to online assessment presents an important area for improvement, as the majority of students are dissatisfied and dissatisfied, so it would be advisable to carry out an in-depth analysis of the subject and type of assessment in order to remedy this problem.

In the variable of infrastructure and university services for the online modality studied, the technical resources to attend online classes were considered, such as computer equipment, i.e. computer, tablet and internet service.

The infrastructure took into account the conditions of the physical space such as lighting, ventilation and privacy that each student creates at home. It is important to note that without having the optimal conditions that exist in the classrooms, there was a commitment to create the necessary conditions to attend online classes.

Finally, given this situation, which is not foreseen in any educational institution in the world, the commitment of the institution to carry out teacher training, contracted resources such as digital platforms and the responsibility of students to adapt their areas of study and be able to attend online classes, which have the characteristic of being synchronous from their homes or work areas, is highlighted.

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Virtualization of educational environments for international collaboration: students as builders of their own learning

Virtualización de entornos educativos para la colaboración internacional: Los estudiantes como constructores de su propio aprendizaje

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Abstract

The incorporation of communication and information technology (ICT) has been a permanent theme in the most recent decades, generating an intense debate about its implications and efficiency, the possibilities to integrate more effectively educational proposals, among other aspects. However, to think in a compulsory use of technologies as the only way to pursue studies was unthinkable. Even though multimodal education models and diverse experiences in e-learning already existed, at the beginning of 2020, the COVID-19 pandemic triggered a crisis due to the impediment of carrying out face-to-face activities in the classrooms around the world. Considering all the emerging situations due the pandemic, the spirit of this article is to share, three years after, the vision of some Mexican students, participants, and ex-participants in virtual and on-line experiences from public universities, regarding mediatized education, and how they consider their learnings in this regard.

COVID-19, Learning experiences, Multimodal education, Students

Resumen

La incorporación de las tecnologías de la comunicación y la información (TIC) han sido un tema recurrente en las últimas décadas, generando un intenso debate sobre sus implicaciones y su eficiencia, las posibilidades de integrar de manera más efectiva las propuestas educativas, entre otros aspectos. Sin embargo, pensar en un uso obligatorio de las tecnologías como la única forma de continuar estudios era impensable. A pesar de que ya existían modelos de educación multimodal y diversas experiencias en e-learning, a principios de 2020, la pandemia de COVID-19 desencadenó una crisis por el impedimento de realizar actividades presenciales en aulas de centros educativos de todo el mundo. Considerando todas las situaciones emergentes por la pandemia, el espíritu de este artículo es compartir, tres años después, la visión de algunos estudiantes mexicanos participantes y ex participantes en experiencias virtuales y on-line de universidades públicas, respecto a la educación mediatizada, y cómo consideran sus aprendizajes al respecto.

COVID-19, Experiencias de aprendizaje, Educación multimodal, Estudiantes

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Introduction

Facing the educational crisis motivated by the planetary health emergency of COVID-19, an interdisciplinary group of Latin-American researchers from Mexico, Colombia, and Costa Rica carried out, during the past two years, initiatives to participate actively in the comprehension of the unexpected situation. This year, the responsibility for the third part has been assumed by a research group from the Autonomous University of the State of Morelos, with the participation of undergraduate and graduate students. The stages prior to this study, in a very general way were:

a. At the beginning of 2020, a preliminary diagnosis research was conducted, done with the participation of teachers from eight Latin American countries. Considering the results, a comprehensive program of pedagogical strengthening was designed, through on-line and virtual environments, based on a pinwheel model that continues in action to date, and platforms such as Moodle, Microsoft Teams, divers free access applications, etc. (Juárez-Salomo, 2020).

b. In 2021, a second stage started, students from selected seminars, took an active part in their own learning, designing initiatives to acquire and strengthen their global consciousness through virtual environments, sharing the experience with students from Central and South America under the model of Collaborative on-line International Learning -COIL- (Juárez-Salomo et.al., 2021; SUNY-COIL, 2017).

As a part of this previous stages, a new initiative was conceived, related to how the students visualize the pedagogical challenges faced and their opinions for the near future. It is important to mention that both research antecedents gave the impetus for the development of some courses, oriented towards university students who, incorporating the concepts of emerging pedagogies and social innovation, had found strategies to enrich and make their own learning process, more meaningful, making proposals, both theoretical and practical.

With the collaboration of their international colleagues (Juárez-Salomo, N. & Cárdenas, G. 2020). For this 2022, fronting the gradual restart of face-to-face learning model, it is important to recover the lived experiences, concentrating energies on the main actors: the students. Although the previous stages were aimed at strengthening the skills (pedagogical and didactical strategies) of teachers and graduate and undergraduate learners, the primary reason has always been able to provide relevant and timely support, so that students can strengthen their learning, despite the existing challenging conditions, therefore, a third phase was developed.

The project presented below is based on two fundamental questions: What do the students think about the changes made during the pandemic? and how they handle, after these two years of experience, the responsibility for their own learning? The general idea is to know if the participants consider that their learning through virtual and/or on-line resources, had been a useful and enriching way to learn, and if they believe it´s important to conserve at list a blended model or, contrary, the mediated education what they experienced, was more forced by the situation and they keep the desire to return to "normality".

Review of Literature

Answering to the unexpected arrival of COVID-19, the various population sectors, including the educational, had to adopt extraordinary measures. Due to the impossibility of continuing teaching in person, the professors faced the need to take virtual or e-learning training in an accelerated way to incorporate techno-educational tools to keep in touch with their students during the pandemic. From their homes, they had to devise quick solutions to teach their classes, even without having prior knowledge of e-learning and virtual education. Related to this pressing situation *Francesc Pedró*, director of the UNESCO International Institute for Higher Education in Latin America and the Caribbean stated that the pedagogical world continuity required, more than ever, technological solutions within the reach of institutions, teachers, and students (IESALC, 2021).

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Since the beginning of the pandemic, an enormous number of instructional activities and materials with technological tools have been devised, under conditions in which the creation times vary from a few days to a few weeks, adapting to an educational modality never experienced before, making this process a highly frustrating and overwhelming one. This stressful situation was coined as "*coronateaching*" (UNESCO, 2020), ironically to describe the need to respond from teaching to update itself overnight in front of the global state of emergency, but also to point towards all the possibilities of development to come.

In various forums and webinars held throughout the confinement and still in the present, the speakers repeatedly fall into misconceptions about concepts and scope of the various educational models, pedagogical approaches and even the difference between platforms, tools, or sites, to mention some aspects, and very often, teachers adapted the strategies and models they knew to digital environments, without a fully understanding of their scope and possibilities. For this reason, it is important to clarify in this article some basic concepts.

To start, based on the definitions provided by the Observatory of the Institute for the Future of Education and the Technological Institute of Monterrey, Table 1 summarize different emerging learning methods that have been applied to classes, such as online, virtual, distance, and remote emergency education, to name a few (Ibáñez, 2020):

Model	Definition	Teacher Rol	Tools Examples	Advantages
On-line Education	Teachers and students participate and interact in a digital environment, through technological resources using the facilities provided by the Internet and computer networks in a synchronous manner.	Tutors: Accompany and assist the student in their learning process.	Schoology, Edmodo, Blackboard, Zoom, Google Hangouts y Google Scholar, etc.	Openness Flexibility Efficiency Personalized accompaniment Economy Community
Virtual Education	This model requires mandatory technological resources (computer, smart phone, or tablet), internet connection and the use of a multimedia platform. It works asynchronously. Method. It is like distance education, but strictly with technological resources. Course materials or documents uploaded on the selected platform. Doubts are usually discussed in public forums for the whole group.	Share reference and work materials through platforms, where students can upload their activities for review. Provide feedback for students to see their areas of opportunity.	Plataformas como Moodle, Canvas, Blackboard, Edmodo, Schoology o por correo electrónico.	Flexibility Efficiency
Distance Education	Unlike virtual education, distance education may have a face-to-face percentage and a virtual one, however, this may vary depending on the institution where it is taught. Students have control over the time, space, and pace of their learning, because an Internet connection or computer resources are not required. The materials used are normally physical, such as notebooks, pens, colors, or USB sticks, CDs, among others. Many programs even send educational materials and lessons by mail, radio or TV Channels.	Once the learning resources such as activities, USB, or CD are delivered, teachers are responsible for qualifying and accrediting them and giving feedback by phone, email, or text message. In some cases, teachers have the role of recording the session or class that is going to be broadcast on television or radio.	Television, radio, email, postal mail, physical resources such as notebooks, books, notebooks, pencils, etc.	Flexibility Accessibility
Emergency Remote Education	Concept born because of COVID-19 that consisted of adapting educational methods in a very short period to continue teaching classes to all students. Move face-to-face courses to a remote, virtual, distance or online classroom. The term emergency remote education is completely new, as the roles and tools are not defined.	It may vary depending on the method used.	Varían dependiendo del método.	This method prioritizes the emergency and looks out for the well-being of its students. This new term groups together all the actions coming from governments, companies, non-governmental organizations, and people to find solutions and stay constantly updated, so it can change suddenly if the emergency changes.

Table 1 Emerging Learning Methods
Own Elaboration based on Ibáñez, 2020)

To understand properly the advantages mentioned in the last column of Table 1, Ibáñez (2020) defines each of these advantages:

- **Openness:** Access to information is expanded while this method reduces geographical barriers, since anyone, regardless of their location, can join the courses.

- **Flexibility:** It favors self-management of dedication times. Activities can be managed asynchronously; students have more personal space to have flexible schedules and manage their personal and professional time as they prefer.

- **Efficiency:** This method promotes the development of personal autonomy, so that the student can manage himself. It is handled in a session-feedback way, so this helps topics move quickly, distractions are avoided, and students go at the same pace.

- **Personalized accompaniment:** Online education is distinguished by offering personalized accompaniment to the student,

- **Economy:** Expenses for the use of physical spaces are reduced, in addition to transfers.

- **Community:** Debate and dialogue are promoted more, in addition to a community linked to academic knowledge.

- **Accessibility:** Distance education programs have more range and reach people of all socioeconomic levels thanks to the simplicity of the technological resources required for classes.

Just as the favorable aspects of pedagogical methods based on or supported by technological resources are mentioned, various sources of information refer to the disadvantages or challenges that student face (EUDE. 2021) such as:

- Requires self-discipline and perseverance. Flexibility in studies can apparently be an advantage, but it also requires significant willpower since one will be the main person responsible for fulfilling and keeping everything up to date.
- Social isolation. Studying online is a very lonely activity since student will not socialize with their classmates or teachers beyond communicating for study-related topics. It is currently the most appropriate due to the pandemic, but in the long run you may miss contact with people.
- Less practical training. Being an online training, the practical part of the subjects will be significantly reduced since one will not have a physical space to carry out the practices.
- Requires good technology. To be able to do the online classes properly, it is necessarily to have a good computer that works correctly and a good internet connection.
- Low quality offer. The fact that there is a wide range of training does not imply that everything is of quality. Everyone must be careful to detect which ones are good or not.

Additional to the mentioned aspects, the experience showed various situations such as little personalization or assessment or follow-up, less participation of students in class, absences, "fictitious" attendance or abandonment of courses, inadequate evaluation strategies, large number of hours in front of the screen, few spaces for students to interact with each other, various distractions, inadequate study spaces, greater possibility of cheating in evaluations or deliveries of work, among other aspects.

It is important to mention that it is not the intention to make an exhaustive analysis of the educational models related to the ways in which the students responded during the pandemic, but it is important to include an even more elaborate concept that is not yet registered in the Observatory of the Institute for the Future of Education and the Technological Institute of Monterrey, that was taken as a basis for Table 1, possibly due to its complexity, and refers to the “educational multimodality” that points out to the various ways of developing and accessing information and knowledge, making use of technological cartographies.

In virtual environments, knowledge is built through the dialogue of multiple intersubjectivities, creating a polyphony of voices that share knowledge, experiences, ideologies and different positions regarding life and social spaces such as education.[1]

Due the pandemic, the world is experimenting diverse educational changes, and any type of useful learning methodology is welcome, seeking for alternatives to reconduct initiatives to clarify the future of current generations. In the past, distance education was a revolutionary way to reach people out of the traditional educational centers, and in the present, through digital environments, has become very relevant, and new technologies have become the main resource in the process as they help teachers and learners stay connected without having physical interactions.

This historic phenomenon will remain as an example of what the educational actors had to do to continue, as well as the learning of what should be foreseen in the face of phenomena of planetary magnitudes to be doubly aware of the decisions that must be taken. As an advanced example, the internationalization strategies that became very popular during the pandemic among universities from various parts of the world were the initiatives based on the International Online Collaboration Model (COIL), focused on the exchange between academic peers and students, to seek the development of involving the participants in "*glocal"*[2] action dynamics (SUNY COIL, 2017; Juárez, N; Cuevas, M, and Gama, G. 2017).

An additional concept to emerging pedagogies is the "emerging technologies" that George Veletsianos (2010) proposed a little over a decade ago specifically for education saying that "...emerging technologies are tools, concepts, innovations, and advances used in various educational contexts at the service of various purposes related to education.

Furthermore, I propose that emerging technologies ("new" and "old") are evolving organisms that experience cycles of hype and, while potentially disruptive, have not yet been fully understood or sufficiently investigated. (Veletsians 2010, pp. 3-4)

Finally, as theoretical support for the educational transformation caused by COVID-19, it is essential to mention the need to seek significant, useful, transformative learning by various means. Coinciding with Ausubel (2002), meaningful learning is characterized by building knowledge in a harmonious and coherent way, so it is learning that is built from solid concepts. Ausubel mention that is like a series of communicating vessels that interconnect with each other forming networks of knowledge. Understanding is a good start, but what must be verified is the interconnection achieved by the student, and with respect to their classmates and teacher.

Methodology

Background:

The learning process, in a positive and innovative sense, requires providing the students opportunities to learn, know and experience, whether in face-to-face, virtual or hybrid environments, to stimulate the intellects of young minds, eager to exist significantly on the planet. It is vital that school learning experiences go beyond traditional forms, styles, and schedules, allowing students more authentic experiences and application of knowledge in real life (OECD, 2020).

Clearly, the COVID 19 pandemic represented a huge and unexpected challenge for education, taking to the limit the tolerance of parents, students, and teachers. During the pandemic, people had to adapt in fast track to a new routine and the partial or total incorporation of learning models in line. For this reason, it is crucial to recover the facts and generated information to know the opinions of those involved; to think the implications working at home; to reflect about the number of hours in front of a computer; the understand the need to unlearn to adopt alternative paths of study; the possibilities of reinvention.

[1] The concept of multimodality has been addressed by various authors, among which were taken for this article. Santamaría (2015); Fainholc, B. (2004); Cabero (2006); Martos (2009); Plaz y Vessuri (2000) & (Borràs (2005).

2 The adjective "glocal" is a well-formed acronym from global and local, which is frequently used in the economic field, but also in others such as culture (Fundéu RAE, 2019).

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It is necessary to understand the similarities and/or the differences between remote or virtual education and “traditional” methods, finding ways to build bridges instead of gaps.

Clearly, there are enormous differences between the educational systems and resources of each nation, and there is a huge distance between what is desirable and what is possible. Despite having advanced in the needs and characteristics of learning, technologies and economical resources still represent enormous defies and inequalities in opportunities, institutionally and for individuals (teachers, parents as well as students). For this reason, it is necessary to insist on the generation of formal research to document and underpin specific proposals for action to be ready and anticipate possible challenges like the current ones.

Considering the multiple challenges, it is not easy to identify the variables and ways of approaching the information. However, taking as inspiration a consultation carried out by Google and UNICEF on September 11, in which more than 850 young people between the ages of 14 and 19 participated, the aim was to find out how adolescents adapted to distance education in times of COVID-19? What learning modalities were incorporated during the pandemic, and if they would like to maintain it when face-to-face classes return? (Google[3]-UNICEF[4], 2020).

As has already been mentioned, this is the third part of a research carried out from a public university in Mexico and its Latin-American partners. At the beginning, the idea was to work with students exclusively from local university, to generate an instrument for making decisions in an internal informed manner, but its design and methodology sparked interest of students and professors from the previous working groups, and it was decided to share again the questionnaire with participants from Colombia, Costa Rica, Chile, Peru, Argentina, with which collaboration ties are maintained, as well as Mexico.

[3]Google: Google is an internet search engine. It uses a proprietary algorithm that's designed to retrieve and order search results to provide the most relevant and dependable sources of data possible.
[4]UNICEF: United Nations International Children's Emergency Fund. In 1950, the UNICEF mandate was broadened to address the long-term needs of children and women in developing countries everywhere.

Methodological design

The design work of the instrument began in February 2022, based on the information generated in previous stages of the research and some ideas from the survey carried out by Google and UNICEF in 2020, but since they were students of a higher age range, the selected variables were grouped into the four priority aspects to be addressed, as illustrated in figure 2:

Figure 1 Variable Groups Included
Own Elaboration, 2022

Prior to the design of the instrument, a focus group was held in which academics and researchers from the university participated to discuss general aspects such as discussing, when talking about the paradigm shift in education, how is it going to be understood? Likewise, concepts such as distance education, virtual education, tele-education, mediated education, multimodal education, among others, were pointed out, to harmonize concepts and be able to build a common conceptual base. Another important reflection was to reflect on how multimodal education impacts the Institutional Educational Model. As well as what considerations should be made for teaching practice? Exchanging ideas related to planning, didactics, learning (significant and useful) strategies to measure learning (evaluation), especially facing the reality of state public universities.

In the case of a topic with very diverse variables, the idea is not to carry out exhaustive research, but to take the pulse of the students in relation to their learning considering recent events. To start, within each item, some elements were defined:

Cognitive aspects

This item considers prior knowledge about the management of technologies for educational purposes, as well as notions to access, prepare, present works, do research or make presentations including multimedia materials, know how to work in various virtual environments such as platforms, applications, reservoirs, among others.

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Behavioral aspect

This section explores, for example, attitudes, disposition, study habits, discipline, work organization, especially those behaviors related to initiatives that have contributed to carrying out learning activities, considering the collaboration and active participation in the sessions. synchronous, such as complementary activities.

Emotional Aspects

This section is one of the most sensitive because it seeks to know how the students have felt in a range that goes from indifference or apathy to moments of crisis, of hope, uncertainty, anger, among others.

Appreciative aspects

Finally, a space is opened for students to express opinions about the situations experienced with their teachers, classmates, at home and they are invited to share which is the direction that, according to their opinion, education will take when "normalizing" school activities.

Starting from the idea that ICT only acquire meaning when they are ordered to goals that are not themselves, such as the comprehensive development of people using technology in activities such as research (Viejo, Cabezas, & Martínez, 2013) in this paper colaborators seek to find spaces to understand the meaning and relevance of the use of technological resources considering the point of view of the students.

Opportunities and Challenges Analysis

The development of Communication and Information Technologies has been acquiring greater presence, generating great transformations in society linked to labor, educational, intellectual, sports, communicative and recreational relations, among many others. ICTs have caused various cultural alterations, creating a new society, to which the prefix cyber is placed, framed within the consumerism of information and the computer revolution (electronics, telecommunications, information highways...).

The growing interconnection between users fosters possibilities in multiple areas of life, and education is no exception. For at least three decades, universities have been in the task of aligning their policies, models, plans and specific actions, to comply with an environment that cries out for planetary efforts to solve common problems. It is enough to think of the Sustainable Development Goals proposed by UNESCO to know that the common planetary destiny requires coordinated attention among nations (ONU-UNESCO, 2015).

The common agenda has intensified since the COVID19 contingency, causing a practically mandatory migration of academic activities to virtual environments and models, requiring the accelerated development of comprehensive teaching, and learning strategies that involve the use of information technologies. and communication (ICT) but in a coherent, purposeful, and innovative way, based on new models, and the need to train professionals capable of facing global problems, reinforce the argument for action.

Clearly the COVID 19 pandemic represents and will continue to do so in various aspects of life, for parents, students and teachers, a great challenge, having to adapt to a new routine and the partial or total incorporation of learning models in line. For this reason, it has been important to give structure to homework, and although following a routine is beneficial, it was not desirable from the beginning for students to spend many hours in front of a computer. For this reason, this research is proposed to allow what has been experienced to be part of a process of unlearning, or rather, of reinvention to understand that a traditional program as it was known is not the same as a virtual one such as the one required.

Implications of the Research

Even though the initial goal was to have at least one hundred students, the instrument was applied to 143 participants from Mexico, Peru, Colombia, Argentina, and Costa Rica, most of them at the bachelor's level (83.9%), master's level (11.2%). and (4.9%) doctorate. As previously mentioned, the questions were divided into four aspects that served as a guide to determine the items and variables: cognitive, behavioral, emotional, and appreciative.

In this segment, the most relevant results are shared that lead to understanding the characteristics and challenges faced by students when continuing with their training process, both in undergraduate and graduate studies. As a first part, the previous knowledge of the students about the use of technologies is explored. 67.1% state that they have previously worked with technology, but only 38.5% had taken an online or virtual course on a platform.

The most used digital resources for non-formal learning are the creation of documents, spreadsheets, and presentations with 84.6%, the use of information search engines with 81.1% and applications, sites and image, audio and/or video tools. by 67.8%. Likewise, messaging services with 65% and mobile services with 46.9%.

During the pandemic, the main resources and platforms used were Meet (69.9%); Microsoft Teams (55.9%) and Moodle (28.7%), highlighting WhatsApp (82.5%) and email (75.5%) as basic and/or support services. 74.8% assured that they had prior knowledge of these resources even before the pandemic. The most used resources for the design and/or delivery of works were PDF (90.9%), Word (89.5%), Power Point (85.3%) and photographs of handmade documents (69.2%).

When asked if the platforms, applications, and digital programs used by teachers were motivating and/or captured their interest, 74.8% gave a positive answer and 90.2% said they use digital resources frequently. 38.5% declared that adapting to classes in remote mode was complicated, but they managed to adapt and 26.6% considered it simple and their adaptation process was almost immediate. Only 15.4% say they have not adapted and hope that classes will be restored as they were before the pandemic.

Regarding the technological resources preferably used to connect to virtual classes, the cell phone stood out with 43.4%, followed by a laptop with 44.1% and the rest with a Tablet or desktop computer. Almost half of the students connected from their room (49.7%) and 34.3% from a common area of the house (living room, dining room, kitchen, etc.).

The participants mentioned that the Internet connection used was stable, but occasionally had failures (70.6%) and only 18.9% declared that they had a very stable connection and with a signal for the entire class, facing poor Internet connection among the main challenges (65.7 %), house noises (65%), boredom (48.3%) and housework (39.2%).

To investigate a little about the emotions experienced during the pandemic, the students who felt negatively affected shared having felt above all anxiety (49.4%), apathy or discouragement (12.6%) and headaches and body aches 5.6%, however, a 15.4% stated that they had not had any problems and even 11.2% declared that they felt comfortable at home.

Regarding the lack of contact with their peers, 46.9% mentioned feeling affected only occasionally and not feeling affected at all (25.9%) or rarely (48.3%). The face-to-face activities most missed were coexistence in general (65%), practical activities and outings (53.8%), classes in general (42.7%), classmates (25.9%) and teachers (15.4%), accepting that the activities proposed by them were helpful to achieve learning in 85.3%.

Regarding the main appreciations of the students about the learning events experienced during the pandemic, the general assessment was positive towards the flexibility of schedules (52.4%), the variety in the sources of information and resources (26.6%) and the availability of resources. (12.6%), as well as the diversity in the forms of evaluation (8.4%).

93% considered that most teachers made efforts to adapt to the alternative way of working and think that soon there should be more work with the support of technology (74.1%), while 24.5% value that it will be the same as now.

Finally, regarding the question of whether they feel prepared to learn independently and manage information and communication technologies by deciding their own learning path, 58.8% answered no or, leaving 41.3% who answered affirmatively.

Conclusion and Recommendations

Reflecting on participants responses, there is a gap between what is desirable and what is possible and, despite having advanced in the needs and characteristics of learning through technology, there are enormous inequalities in opportunities and resources, both institutionally and in the economy, both for teachers and for students and therefore, we must insist on the generation of studies that document and support specific proposals for action.

The set of resources, processes and tools of Information and Communication applied to the structure and activities of the educational system in its various fields and levels must be carefully reviewed and analyzed to respond cautiously to the new challenges and needs in the educational field, not only instrumentally, but also considering the implications in the development of a digital culture in classrooms.

When planetary challenges such as the COVID-19 pandemic find a solution in the use of information technology, that is, in the use of computers and more telecommunication equipment for data storage, transmission and manipulation, users must reflect on the use of technological devices for educational purposes. Based on recent experience, students can access much more information through the implementation of new technologies that, by the way, also open up new recreational spaces and the creation of training spaces.

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Article

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A proposal of strategies to promote study habits in virtual learning objects

Propuesta de estrategias para fomentar hábitos de estudio en objetos de aprendizaje virtuales

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Abstract

The recent events produced by the global pandemic COVID-19 have conclusively demonstrated the need to strengthen various learning mechanisms, including e-learning and self-learning, and the adaptation of the use of technology as a fundamental tool in the teaching process. -learning. The objective of this article is to propose strategies to promote study habits in the development of virtual learning objects (VLO), by including a catalog of suggested techniques for strengthening time distribution, reading optimization and exam preparation, encapsulated and standardized with SCORM and reusable in various e-learning platforms. Our contribution is to collect and adapt study habits techniques in a methodology for the development of virtual learning objects

Learning objects, Study habits, SCORM

Resumen

Los recientes acontecimientos producidos por la pandemia global COVID-19, han demostrado fehacientemente la necesidad de fortalecer diversos mecanismos de aprendizaje, entre ellas el e-learning y el autoaprendizaje, y la adaptación del uso de la tecnología como una herramienta fundamental en el proceso enseñanza -aprendizaje. El objetivo de este artículo es proponer estrategias para fomentar hábitos de estudio en el desarrollo de objetos de aprendizaje virtual (OVA), mediante la inclusión de un catálogo de técnicas sugeridas para el fortalecimiento de la distribución de tiempo, optimización de lectura y preparación de exámenes, encapsulados de manera estandarizada con SCORM y reutilizables en varias plataformas e-learning. Nuestra contribución es recopilar y adaptar técnicas de hábitos de estudio en una metodología para el desarrollo de objetos de aprendizaje virtuales.

Objetos de aprendizaje, Hábitos de estudio, SCORM

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Introduction

The pandemic situation that is still ongoing in the world has had a direct and important impact on the field of education, because it has forced educational institutions to seek, propose and implement teaching strategies that encourage the use of technologies in the teaching-learning process and as a consequence provide mechanisms to promote study habits; These are fundamental in the learning process of students, since through them they acquire customs that facilitate the acquisition of knowledge.

(Padilla et al., 2022) they point out that social isolation, anxiety and depression, are the main difficulties or concerns experienced by students during the COVID-19 pandemic, for which they showed difficulty in adapting to the use of technological resources. Hence the proposal of this article is to provide the facility for students to foster study habits and make use of technological resources to facilitate their learning.

In this respect (Quesada-Jure, 2018) they affirm that educational processes are increasingly versatile in the face of the evolution of societies, so that every day it is necessary to see the school as a place of personal and community development. The course towards a school of education more contextualized to the social reality depends on the focus directed towards research as the engine of apprehension of the student's interest in learning. The research carried out by the authors mentioned in this paragraph had the purpose of strengthening the habit through the improvement of literacy based on Information and Communication Technologies as a strategic tool.

Improving the teaching-learning process in university students involve, not only the preparation of the teacher, also today it is necessary to quantify and better understand the student in each context. Knowing the university student in the areas of time distribution, preparation, class activity, management of social networks and cyber tools, can facilitate the implementation and quantification of the effectiveness of introducing cyberspace tools as a form of contact and approach to the student.

That is why (Antonia Mireles Medina *et al*., 2020) in this study that is the background of this research article, they previously carried out a study where they have identified the study habits of a group of students corresponding to the area of Computational Sciences.

Problem Statement

The recent events produced by the global pandemic COVID-19 have reliably confirmed the need to strengthen various learning mechanisms, including e-learning, self-learning and the adaptation of the use of technology as a fundamental tool in the teaching process. -learning, the authors of this study have never been oblivious to this situation that continues to lacerate one of the most important that exists in society: education. Where now the teacher is no longer the center of the teaching-learning process, consequently and moreover rather the facilitator or instructor who has the duty to provide the elements, techniques, strategies and tools so that their students can acquire knowledge in a more accessible and easier, especially in these times where the conditions of the context have changed and there is a need to adapt teaching strategies that are within the reach of students.

General objectives

Generate a proposal of didactic strategies to promote study habits in the development of virtual learning objects (VLO), through the inclusion of a catalog of suggested techniques for strengthening the distribution of time, optimization of reading and preparation of exams.

Specific objectives

Design and develop a proposal of didactic strategies to promote study habits in the development of virtual learning objects (VLO), through the inclusion of a catalog of suggested techniques for strengthening the distribution of time in higher level students.

Design and develop a proposal for didactic strategies to improve reading optimization, through reading comprehension strengthening techniques applied in the development of virtual learning objects (VLO).

Strengthen applied knowledge evaluations in presential and online courses for higher level students, through exam preparation techniques applied in the development of virtual learning objects (VLO).

Justification

In a study conducted by (Lezama & Galdámez, 2017) the results of their research demonstrate the existence of a statistically significant relationship between the levels of study habits and the levels of academic performance of students taking algebra, Sic. the authors in mention based on (Villegas, Muñoz, & Villegas, 2016) mention that the interest in the study habits of university students has become a topical issue both nationally and internationally due to the high percentage of failure. Also returning to (Peña, 2014) Lezama and Galdámez say in their article that one of the biggest challenges currently facing the national education system is the low academic performance that students present in areas of knowledge such as Spanish and mathematics.

Referential framework

Virtual Learning Object (VLO)

One of the decisive factors in the incorporation of ICT for the generation of new learning scenarios in the educational field is the figure of the teacher, and in this sense, their adequate digital competence is decisive (Lorenzo-Lledó et al., 2018). For this reason, the authors of this article intend to provide a proposal that allows promoting study habits using Information and Communication Technologies. That, although according to (José Luis Díaz Vega, 2006) in his work he considers the following study habits: Distribution of time, motivation in the study, distractions in the study, notes in class, reading optimization, exam preparation and attitude towards the study.

The authors of this research aim to propose strategies to encourage study habits in the development of virtual learning objects (VLO), by including a catalog of suggested techniques for strengthening the distribution of time, optimization of reading and preparation.

Of exams, in the design and implementation of learning objects encapsulated in a standardized way with SCORM and reusable in various e-learning platforms. While the contribution is to collect and adapt study habits techniques in a methodology for the development of virtual learning objects.

(Morales & Gutiérrez, 2016) consider that a VLO (Virtual Learning Object) refers specifically to learning objects that correspond to digital materials and that allow students to learn at their own pace and autonomously. (Hernández Suarez et al., 2020) carried out research in basic education that aims to develop a virtual learning object (VLO), to develop numerical skills through basic mathematical operations, where they considered the ADDIE model for the construction of the VLO. The technique and instrument were a Likert-type questionnaire.

The evaluation of the quality of the VLO was through an evaluation team, which issued its opinion on the didactic and technological nature of the VLO. The authors of this study consider that not all students have numerical skills, the foregoing is based on the high failure rates that occur in the subject of Differential Calculus derived from this, this proposal is focused on developing a series of Virtual Learning Objects in relation to this subject that all the students of the Tecnológico Nacional de México Campus Zacatecas Norte, in the first semester, the proposal is especially focused on the students of Computer Systems Engineering.

Differential Calculus is a subject that contains five learning units (Tecnológico Nacional de México, 2016):

1. Unit 1. Real numbers
2. Unit 2. Functions
3. Unit 3. Limits and continuity
4. Unit 4. Derivatives
5. Unit 5. Applications of the derivative

For the proposal of the development of the VLO, the content of unit two is considered, specifically the topics: 2.1 Definition of variable, function, domain and range; 2.2 Real function of real variable and its graphical representation.

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Information technologies and study habits

The technological means of information and communication are useful tools for accompanying educational processes; however, their excessive use generates effects that deserve a review. The mass media make up a socialization system: they influence our ideas, habits and customs (Rodríguez, Nathalia Concepción & Mag. Rosanna Ester Dávalos Krivorotoff, 2017); Sic., they mention that addressing the problem represented by the lack of reading habits in youth society is highly relevant, since through said analysis, it will be possible to reach possible improvement actions. And the authors of this document consider that not only of improvement but of a constant impulse on the habit of reading through attractive and easy-to-use didactic strategies for students.

(Paredes, 2015) mentions that educational institutions have reading teaching as one of their activities. This they carry out quite efficiently and gradually better because they know the scientific principles that guide the methodology of this teaching. However, the great challenge that the school has been facing is to train readers, that is, to create or foster the habit of reading. It is not an easy task because there are no magic recipes. As it is not an easy task due to such a situation, it is proposed that through VLO the reading habit be promoted or as I would say (José Luis Díaz Vega, 2006) the optimization of reading.

(Mondragón Albarrán et al., 2017) they carried out a study where they have considered as an objective "to determine the incidence of study habits and their academic performance in students of the degree in Administration of the Unidad Académica Profesional Tejupilco dependent on the Universidad Autónoma del Estado de México. The population was 173 students of both sexes from the 2016 B period. The Study Habits Inventory instrument was used, with a qualitative approach, to calculate the frequency of use. The results show that in the scales of environmental conditions of study, study planning, use of materials, assimilation of contents and sincerity, the students present a level of use from normal low to normal high.

Finally, in Pearson's correlation, the five scales were not statistically significant ($P<0.05$)." Mondragón et al. identified equivalent results to those reported by Cabrera and Sánchez (2004) in other studies, who reached a non-significant relationship ($P<0.05$); instead, Valdés (2001) found a significant relationship in the elements of distribution of time, motivation to study and optimization of reading in academic performance.

"It is also important to mention the distribution of time in students, currently they do not make adequate use of their time, because they spend most of their time on technology, spending much of the afternoon on social networks and thus forgetting about their respective obligations that are even worse without physical activity" (Silva Ruiz, 2016). In this regard, the authors of this manuscript consider that it is possible to promote the distribution of time using VLO, since it will allow them greater flexibility of schedules, places and availability of these.

In exam preparation, it is seen how the student studies before taking his exam, if he studies the same day, waits for an exam date, studies a certain time every day, prepares a plagiarism, checks the notes on the day of the exam, exam in class, messing up the topics during the evaluation and taking the exam without having studied (Uscamaita Carrasco, 2022). This study habit is also encouraged when using OVL, regularly failure rates are given for having prepared an exam conscientiously, it is for this situation that this habit is also taken into account so that it is encouraged in students.

"Mendoza (2011), in his study, concludes that the study habits that they practice, 52% of the students of the 2nd academic year of agronomy of the Universidad Hermilio Valdizan de Huánuco (UNHEVAL) are not the most appropriate, therefore the low academic performance, it also determined that there is an influence of study habits on academic performance" (Uscamaita Carrasco, 2022). Hence the importance of generating proposals that encourage and promote study habits in students through innovative, practical, easy-to-use, easy-to-carry and access to them at any time, as is the case with the VLO.

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Shareable Content Object Reference Model (SCORM)

(Soto et al., 2015) indicates that SCORM is a set of technical standards that allow the generation, sharing and reuse of electronic didactic content in a standardized way, so that they can be included in e-learning platforms. SCORM is one of the most popular specifications used in many software tools, such as Exe-Learning, Articulate Storyline, Adobe Captivate and Reload Editor, which allow importing and exporting content and learning objects through different e-learning platforms or other compatible ones.

Methodology

The proposed research is based on the methodology published in the Guide for the design of virtual learning objects VLO (Nieves, Morales, 2016), which consists of five stages:

1. Identification and registration of the VLO
2. Analysis
3. Specific conceptual requirements.
4. VLO Design
5. Review, testing and implementation of the VLO

In the identification and registration stage, the Differential Calculus functions of the engineering program of the National Tecnológico Nacional de México (TecNM) were selected as the subject. In the analysis, the target population was identified as decentralized technological engineering students, who take the subject of Differential Calculus, both in presential and E-learning, whose needs are to improve the understanding of the concepts related to functions and foster habits of study in e-learning. Facing the difficulty in self-learning about Differential Calculus functions and promoting study habits to improve performance in learning presential subjects.

The specific conceptual requirements focus on the topic of functions, with the aim of understanding the concepts of functions, variable, domain and counter-domain, and their graphic representation of a real variable, based on the pedagogical strategy of e-learning and self-learning with readings, examples, exercises and quizzes.

There are various techniques to strengthen various aspects of the learning process, at this stage the compilation of table 1, it is proposed, referring to strategies to promote study habits for the distribution of time, optimization of reading and preparation for exams.

Study habit	Technique
Time distribution	Use of estimated time per topic. Pomodoro technique. Use of degree of difficulty. Eisenhower's box Kanban board Schematic How to do this (GTD) Seinfeld Technique 5-minute technique
Reading optimization	Underlining study technique. diagonal reading Scanning Skimming Promotion Promotion of speed reading
Exam preparation	Exam simulation. Study guide. Conceptual paintings. Mental maps. Voice notes.

Table 1 Techniques of study habits
Source: Own Elaboration.

For this virtual learning object, the technique of Estimated time and degree of difficulty were selected, providing a suggested duration of the subject and the degree of concentration required, with the aim that the student foresees his distribution of time, avoiding interruptions and planning his activities.

In the VLO design stage, the compilation, adaptation and generation of the didactic material and its learning activities are carried out, the learning object of the function's topic contains information on the main concepts, examples and exercises of the graphic representation of a function.

At the beginning of each topic, a technical sheet is presented as in Figure 1, providing information on the estimated time to allow planning the study schedule, recommending having the suggested time to maximize concentration; the degree of difficulty provides a suggestion of the degree of concentration and experience that you must have to improve the understanding of the content; the goal states the desired outcome after completing a topic.

Additionally, the student can apply the Pomodoro technique to improve the administration of the time dedicated to an activity, through interspersed periods of concentration and rest.

Figure 1 Example topic sheet
Source: Own Elaboration

The reading resources are based on an underlining technique with the purpose of optimizing reading, where the color code allows the elements of the reading to quickly identified, making it easier to increase the speed of comprehension of the written material. For this learning object, the main ideas will be highlighted in green, secondary ideas in yellow and examples in blue, see Figure 2. This technique can be adopted by the student and use their own color code.

Figure 2 Underline Color Code Example
Source: Own Elaboration

At the end of each topic, a reinforcement of the preparation for exams is conducted through quiz simulation activities that allow the student to conduct a self-diagnosis of their understanding of the main ideas, allowing the review of the material and improving their repair for quizzes to be applied in an appropriate way presential, see figure 3.

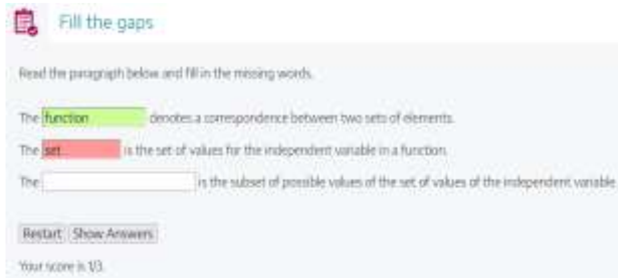

Figure 3 Self-diagnosis example
Source: Own Elaboration

In the review, testing and implementation stage, eXeLearning was used, which is an open-source software to create educational content that can be exported to the Shareable Content Object Reference Model (SCORM) set of specifications, see Figure 4.

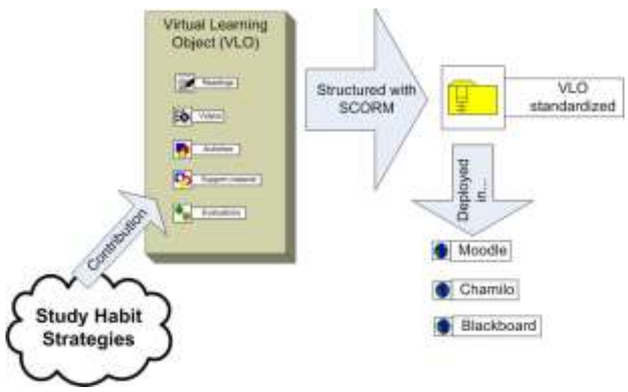

Figure 4 VLO Implementation
Source: Own Elaboration

The benefits of using eXeLearning and SCORM are to generate educational resources in an open and standardized way that can be implemented on different platforms such as Moodle, Chamilo, SCORM Cloud, among others. The foregoing facilitates the incorporation of learning objects to most e-learning platforms and promotes the exchange of learning objects with other authors, see figure 5.

Figure 5 VLO preview
Source: Own Elaboration

Results

The results of this proposal are made up of enriching a methodology to generate learning objects by adding a collection of strategies to promote study habits of time distribution, reading optimization and preparation for exams and demonstrating its implementation in a learning object. virtual learning about functions in the subject of Differential Calculus.

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Conclusions

The use of information technologies offers great advantages in academic development and expands the scope of the teaching-learning process, in this context, learning objects are an appropriate tool in e-learning platforms. It is recommended that virtual learning objects have the characteristics of being self-contained, modular, standardized (SCORM), reusable, with reasoning, reading and comprehension activities, with estimation of time and effort and indicated with a rate of progress.

Derived from the proposal of this article, we conclude that the development of learning objects, which include the promotion of study habits, is possible through the incorporation of strategies focused on the distribution of time, optimization of reading and preparation for exams, however, the accompaniment of the teacher is recommended to support study planning and monitoring of student performance. These learning objects, due to their modular and portable nature, can be used both in self-learning modalities as well as in support of presential or virtual classes.

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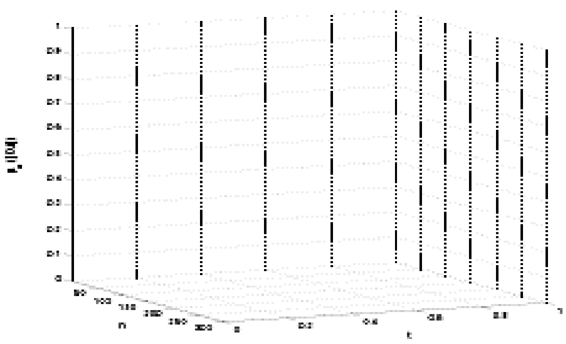

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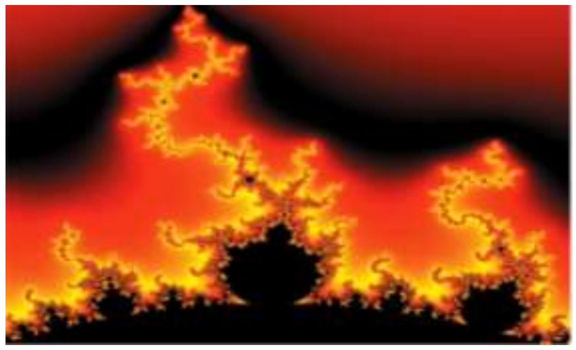

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