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Presentation of the Content

In volume nine, issue twenty-seven, as the first article we present, *Metacognition in Sebastian's Door: mathematics, education and art*, by RAMOS-JAUBERT, Rocío Isabel, CEPEDA-GONZÁLEZ, María Cristina, SANCHEZ-RIVERA, Lilia and ALVARADO-CORTÉS, Julio César, as a second article we present, *E-commerce for sale of ornamental flowers*, by ESCORZA-SÁNCHEZ, Yolanda Marysol, ALAMILLA-CINTORA, Cuitláhuac, CAMARGO-RUÍZ, Adriana and GÁLVEZ-GONZÁLEZ, Fabián, with an appointment at the Universidad Tecnológica del Valle del Mezquital, as a third article we present, *Characterization of SARS-CoV-2 cases and COVID-19 deaths in the State of Baja California through five waves using machine learning*, by LUNA-RAMÍREZ, Enrique, SORIA-CRUZ, Jorge, RAMÍREZ-BÁEZ, Ramón Fabio and DÍAZ DE LEÓN-MORENO, Alejandra del Carmen, with secondment at the Tecnológico Nacional de México, Campus El Llano Aguascalientes, as fourth article we present, *Use Khan Academy in the mathematics teaching-learning process*, by MOTA-MACÍAS Silvia Elena, HUIZAR-RUVALCABA, Diego, TRUJILLO-GARCÍA, Fabricio Raúl and SOLANO-PÉREZ, Gabriel, with secondment at the Centro Universitario del Norte de la Universidad de Guadalajara.

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Metacognition in Sebastian`s Door: mathematics, education and art

Metacognición en La Puerta de Sebastián: matemáticas, educación y arte

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Abstract

The aim is to show metacognition in how mathematics and culture are related in the sculptural work of Master Sebastián; with a deep playful character from which it emerges. Constituting a kind of artistic syncretism of apparently divergent beliefs between the plastic world, pure mathematics, abstract geometry and computational cybernetics. Methodology, study with a qualitative approach, the variables to consider were: Bach's baroque music with the canon and fugue, Gödel's theorem with the incompleteness of the axiomatic system; Eschery lithographs the reiteration of forms; Borje's literary-mathematical paradoxes; recursive programming routines in artificial intelligence systems (expert systems, mathematics) and Sebastián's sculpture. In conclusion, the convergence between Bach's baroque music can be identified, through the generation of the canon and the fugue; Gödel's theorem on the incompleteness of the axiomatic system, the reiteration of forms that invent themselves in Escher's lithographs, the literary-mathematical paradoxes in the stories of Jorge Luis Borges, and the use of recursive routines in the programming of expert systems or artificial intelligence. This game of plastic metamorphosis with which Sebastián surprised us a few years ago, turns out to predate the concept of the transformers, long before Hollywood made them a commercial success. As in the most diverse efforts of syncretism, Sebastián has traveled close to profanation as the staunch conservatives of the elite of scientists and artists can describe it.

Resumen

El objetivo es mostrar la metacognición en cómo se relacionan las matemáticas y la cultura en la obra escultórica del maestro Sebastián; con un profundo carácter lúdico del que surge. Constituyendo una especie de sincretismo artístico de las creencias aparentemente divergentes entre el mundo plástico, las matemáticas puras, la geometría abstracta y la cibernética computacional. Metodología, estudio con enfoque cualitativo, las variables a considerar fueron: la música barroca de Bach con el canon y la fuga, el teorema de Gödel con la incompletud del sistema axiomático; litografías de Eschery la reiteración de las formas; paradojas literario-matemáticas de Borje; rutinas recursivas de programación en sistemas de inteligencia artificial (sistemas expertos, matemáticas) y la escultura de Sebastián. En conclusión, se puede identificar la convergencia entre la música barroca de Bach, mediante la generación del canon y la fuga; el teorema de Gödel sobre la incompletitud del sistema axiomático, la reiteración de las formas que se inventan a sí mismas en las litografías de Escher, las paradojas literario-matemáticas en los cuentos de Jorge Luis Borges, y el uso de las rutinas recursivas en la programación de los sistemas expertos o de inteligencia artificial. Este juego de metamorfosis plástica con el que Sebastián sorprendió hace algunos años, resulta que antecede al concepto de los transformers, mucho tiempo antes de que Hollywood los volviera un éxito comercial. Como en los más diversos esfuerzos de sincretismo, Sebastián ha transitado cerca de la profanación como lo pueden calificar los acérrimos conservadores de la élite de científicos y artistas.

Metacognition, Mathematics, Art

Metacognición, Matemáticas, Arte

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Introduction

In times when the reduction of thought that hovers through specialty and subspecialty prevents the human being in general but the educator in particular, not to be able to observe what is in other areas of knowledge and how they come together in the borders that are indivisible for those who have a teacher training, it is for this reason that metacognition is to go beyond (*meta*), from what goes together (*co*) to what is known (*gnosis*) and that what is known may depend on the subjective source of God (subjectivity), of man himself (subjectivity) or of the object for what it is (objectivity); This is why this study is relevant to know how topics that are of science, education, culture and society are immersed in the simple fact that they arise from the human being *per se*.

The added value of this study lies in the fact that the variables of the study are compared, focusing on the characteristics that each one of them has, the problem to be solved is that it is required that the human being has a perspective beyond what he knows in an area of knowledge, being able to observe their relationships, going beyond the reductionism of education that prevails in the specialty and subspecialty.

The following are the elements analyzed, what each one of them means, the methodology of analysis and variables based on a qualitative approach; the results and conclusions reached; the line of research derived from the study and, finally, the proposal of the study.

The canon and the fugue

The canon is a musical theme so wonderfully shaped that it can serve itself as an accompaniment when played in another key, so successively up to seven times, an expression that constitutes a masterpiece. Such efforts in the musical realm are compared to beating 75 opponents at chess, playing all of them at the same time and blindfolded (Batlisti, 2013).

The work of Johann Sebastian Bach (1685-1750) the Art of Fugue, is one of the best examples of metalanguage in the musical realm. Fourteen fugues and four canons are based on the same theme in D minor that serves as accompaniment, as well as in its execution in another key. That is to say, it makes reference to itself.



Figure 1 Joahan Sebastian Bach

Source:

<https://www.nationalgeographic.es/historia/2019/07/la-anatomia-de-bach-podria-haber-potenciado-su-excelencia-musical>

Gödel's theorem

The theorem of the Russian Kurt Gödel is the proof that there are mathematical truths that cannot be proved from any set of axiom systems or basic truths. He would say that they *constitute formally undecidable propositions* of the *Principia Mathematica and other appendices*, referring to the magnificent, but unfortunately incomplete effort of the construction of the axiomatic edifice elaborated by the philosophers Alfred Whithead and Bertrand Russell.

The work "*Principia Mathematica*" constitutes the major mathematical edifice with which Alfred Whithead and Bertrand Russell attempted to form an axiomatic system from which all the theorems of first-order logic could be proved (Russell, 1913; Basti, 2019).

Gödel's great contribution was to demonstrate with the use of metalinguistic statements that there are propositions that are false and true at the same time.

To understand the mechanism of statement formulation, we can turn to the axiomatic MIU system developed by Douglas Hofstadter in his "*Golden Braid*".

The MIU system consists of only three letters M, I, U, so that the statements or propositions are formed with a sequence between these three characters.

The mechanisms of demonstration of the MIU system are based on 4 axioms:

1. If a string ends with an I, a U can be added to it ($xI \dot{\iota} xIU$).
2. Any string after an M can be fully duplicated ($Mx Mxx$).
3. Where there are three consecutive I's (III) they can be replaced by a U ($xIII \dot{\iota} xU$).
4. Two consecutive U can be eliminated or cancelled ($xUU \dot{\iota} xy$).

According to the conception of metacognition, the MIU System is a synthetic example of a propositional system where each sequence is a statement, which can have a false or true sense, characteristic of first order logic, also known as predicate logic, predicate logic or predicate calculus. There are other forms of logic with statements that can have degrees of truth or falsity.

The issue in the MIU System is to generate the MU chain from MI. When attempting to enunciate, in succession, the subsequent chains on which MU is inferred, it is confirmed that its demonstration or enunciation is impossible. That is to say that MU is a formally undecidable proposition in the MIU system. Come on, it cannot be demonstrated. Then a jump out of the system is required to deduce that MU exists, but it is indemonstrable or formally undecidable.

In the human mind, knowledge is in essence a large set of statements which can be demonstrated from axioms; that is, from the rules of statement generation. The set of statements makes up our knowledge and the way of constructing them constitute the mechanisms of argumentation of the criteria of verification.

The axioms and the chains of demonstration make up the procedural system. Memory activates the ways of generating sequences to infer successive chains of statements. These statements can make sense and can refer to themselves in concepts that express their own logical value. In this way, knowledge defines itself.

In the same way, although with more complex processes, Gödel showed that there are mathematical truths that cannot be proved from the set of axioms of the *Principia* (Russell, 1913, Basti 2019).

The first idea that arises in the face of this paradox is to include those truths to the axiomatic system. However, Gödel also showed that as soon as more axioms are integrated, other statements appear that are true in practice but are also impossible to prove from the axioms, so that the first-order axiomatic system will always be incomplete.

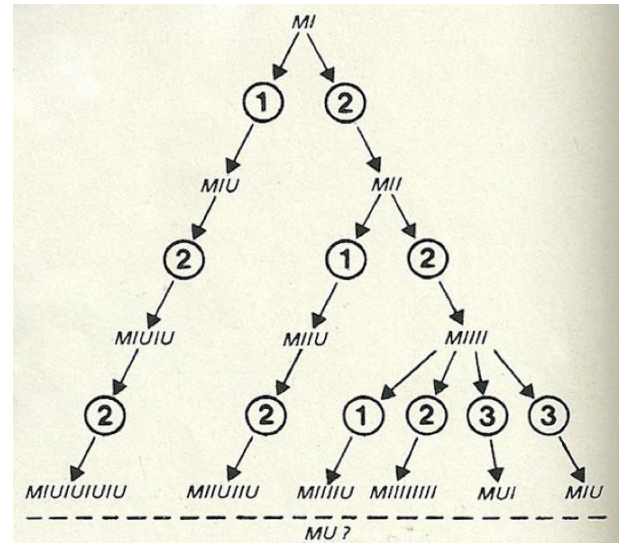


Figure 2 Gödel's theorem

Source: <http://adolescentesyamas.com/el-sistema-miu-de-hofstadter-del-libro-godel-escher-y-bach-un-eterno-y-gracil-bucle/>

Expert systems

For its part, the theoretical underpinning of the programming of expert computational systems is based on self-referencing routines, which call themselves or recursive would say the specialists in systems (Russel, 1913, Basti 2019). That is, the construction of cybernetic metacognition is possible from the formulation of metalinguistic statements and recursion in programming.

The classic example of metalinguistic subroutines is the definition of the factorial. The factorial of a positive integer n equal to or greater than 1!, expressed as n!, is the multiplication of all the positive integers less than or equal to n.

This means that, $n! = 1 \times 2 \times 3 \times 4 \times \dots \times (n-1) \times n$. That is, the factorial defines itself metalinguistically as: $n! = nx(n-1)!$

Artificial intelligence is supported by the integration of subroutines that call themselves as in this example of the factorial (Russell, 1913, Basti 2019). In this way, it is possible for a computational system to increase its metacognitive pool or acquire cybernautical expertise. For example, traditional chess computer game programs are based on move probabilities. In that case, it would not be possible to build a perfect program because the analysis of probabilities would take unlimited sequences in infinite time.

The solution is to build an expert system based on metacognition in such a way that it learns to play with the skills of each opponent. Thus, as a system plays, it incorporates into its metacognitive pool a greater number of statements that make it more efficient. This mechanism is supposed to be similar to the way metacognition is built in the human mind.

In the same way, the programming of the mechanisms for demonstrating the MIU System's statement-strings is the principle for building an expert system. Suppose, for example, that an expert system is built to identify the operation problem of a nuclear power plant.

This type of plant requires immediate responses to an outage situation. The problem is stated and at the moment of developing the chains to reach it, it represents for the expert system the mechanism to identify the origin of the failure and to be able to act accordingly.

The greatest potential of fourth generation programming languages lies precisely in the possibility they have to build self-referential routines as is the case of C (Russel, 1913, Basti 2019) which has an enormous potential in the construction of self-referential subroutines (Brian, Dennis & Kate, 1991; Rodríguez Alvira, 2012; Guio, Navarro & Lukin, 2017).

Escher's lithographs

The inexhaustible play between figure, background and form in the chains of metamorphosis in Escher's lithographs, whose efforts in drawing summon the imaginary of endless circles, like the constant fall of water or the inexhaustible walk in a labyrinthine castle, are examples of metacognition in the plastic arts.

Or in his case, the construction of endless worlds in the literary imaginary of the "*Fictions*" of Jorge Luis Borges as in that Universe, which others call the library and which is composed of an indefinite or perhaps unlimited number of hexagonal galleries, enclosed by very low railings and from where each hexagon the upper and lower floors can be seen endlessly (Escher, 2000; Russel, 1913, Basti 2019). Likewise, the logic and self-reference games that appear in the book "*Alice in Wonderland*" by Lewis Carroll (1832-1898) (Carroll, 2011; Rodríguez Alvira, 2012; Hofstadter's, 2013).

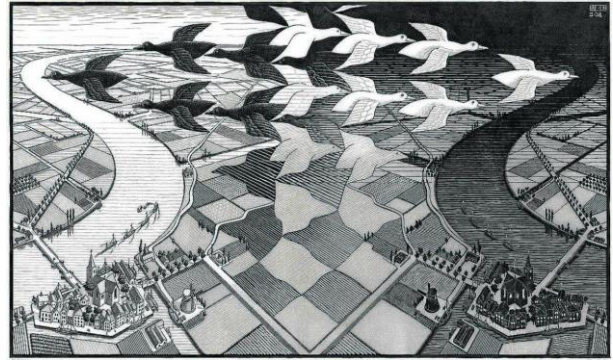


Figure 3 "Birds": Background and form in Escher's work
Source:

<https://webpages.ciencias.ulisboa.pt/~ommartins/seminario/escher/obra2.html/>

The door of Torreón

It is precisely in the field of plastic art that one can glimpse the masterful quality of Sebastián's sculptural work (Enrique Carbajal González, November 16, 1947) and some of its keys, given that it is integrated with forms that repeat themselves or self-generate in such a way that they invite infinite reiteration (Escher, 2000; Batistri, 2013; Hofstadter's, 2013).

Hence, one can identify in the sebastian work plastic loops that reproduce themselves, but also jump out of the system, or the subject of a specific form that as in the baroque canon, which serves as background and form at the same time. That is to say that a three-dimensional body is repeated per se while accompanying itself as a figure, to later manifest itself as a background. The path of geometric fish, whose scales metamorphose into spherical bodies.

As all the magicians of the world have known, Merlin in the British and Celtic tradition, Gandalf in the Scandinavian and evocative heritage of Tolkien; Mephistopheles in the Germanic tradition; Houdini in the theater or George Méliès the magician of light in the language of cinema; Sebastián knows perfectly well that the authentic and true magic is created from the optical illusion and the traps set by the human being's own visual perception, which is always discontinuous. A defect, between quotation marks, of the eyes that have even allowed the invention of the cinematograph.

Strictly speaking, the relationship between sculpture and the mathematical principles of geometry has been a very old amasiato, since the classical world where even the search for aesthetics, for beauty, was based on the investigation of symmetrical forms.

However, it is in the Renaissance where this symbiosis, sculpture, mathematics and geometry has a full expression in the work of Filippo Brunelleschi (1377-1446) (Escher, 2000; Batsitri, 2013; Hofstadter's, 2013), for example, by creating those wonderful arches, he also explores in the field of mathematical demonstration.

For the same reason, the resonance of the baroque is evidently identified in Sebastian's work, due to his constant eagerness in the exacerbation of forms. However, there is a capacity to maintain the Renaissance spirit and heritage, enriched with the symbolic character of surrealism and cubism. Sebastián's work emerges at a precise moment in the framework of a cybernetic society that recreates itself in the visual imaginary and draws from the geometric world as an extension of the experiential territory of the human being. A fusion of visual beauty and mathematical truth, where the pre-Columbian tradition, the Baroque and the Renaissance soul meet (Hofstadter's, 2013; Rodríguez Alvira, 2012, Nagel & Roy, 2008).

For the same reason, he celebrated the splendid fabrication of the Torreón Gate that has been integrated in such a way with the character and vocation of the laguneros; that it is already identified with the city itself, in an indivisible way as it constitutes for example Pisa and its Tower, which are not known one without the other.

Much has been said about the enormous symbolic potential of master Sebastián's sculptures; however, little is explored in the exercise of interpreting the meaning of these symbols. The invitation in general is to appreciate that Sebastián's work is closely related to the act of interpreting it, because doing so is also a way of belonging and redefining oneself with it (Escher, 2000; Nagel & Roy, 2008; Rodríguez Alvira, 2012; Hofstadter's, 2013).

In the initial project of this magnificent Puerta de Torreón, the spikes and the chain of the 38 municipalities that make up the state of Coahuila de Zaragoza were proposed, in addition to being the entrance and welcome to its border with Durango.

But Sebastian goes much further. For example, in the light of the interpretation of the symbols of the cabala and the tarot, what connotation could be inferred from this work. First, in its indivisible integrity, it speaks of the need for unity of the work of art, of its indivisible character, of its individuality; that is, it summons to speak one's inner self, to the inner capacity to make magic (Tajonar, 2017).

Likewise, the Gate is erected from the earth, as the mother that gives the creative force, it is built from yellow columns, where the color evokes the internal fire that must be sustained by firm traditional values and knowledge that constitute the columns themselves, same that end up uniting; that is to say that all efforts and knowledge must be oriented towards the same end (Tajonar, 2017).

For its part, the direction towards the sky, this wonderful blue lagoon sky, summons to always keep the mind open towards the new, so open that one can even go beyond the frame in which they are immersed or imprisoned, that frame of the lower door that must be crossed to transcend towards the highest ideals.



Figure 4 Sebastian's gate

Source:

<https://www.mexicoenfotos.com/estados/coahuila/torreon/la-puerta-de-torreon-MX12182383097189>

Methodology to develop

The objective is to show the metacognition in how mathematics and culture are related in the sculptural work of master Sebastian.

It is a research with a qualitative approach in the content analysis of what is referred to in the theoretical foundations, in addition to the relationship of the variables to be considered, which were: Bach's baroque music with the canon and the fugue, Gödel's theorem with the incompleteness of the axiomatic system; Escher's lithographs and the reiteration of the forms of expert systems; Borges' literary-mathematical paradoxes; recursive programming routines in artificial intelligence systems and Sebastian's sculpture.

Results

In the world, there are known things and unknown things, between the two are the doors. Between the order of the concrete and the spiritual ascension lies this Sebastian's Gate.

In these adverse times where materialism has taken root in the hearts of modern man, through the Gate of Torreon the dearest yearnings of unity rise and the dearest of our gods of the past pass through every day in silence.

To construct a geometric form of self-reference is to generate a mental structure of chains of statements that allow us to generate new knowledge from basic principles or axioms.

The more solid the axiomatic bases of the cognitive systems, the greater the capacity to generate and demonstrate existing truths.

The most direct and effective application of metacognition is in the field of cybernetics, in the creation of expert systems and in the programming of artificial intelligence where the key is the use of self-referential subroutines. The greatest expression of human intelligence is sustained in the generation of self-referential statements, i.e., in metalanguage and metacognition, i.e., going beyond specialty and subspecialty by interrelating the different subjects of culture and science in the development of the areas of knowledge.

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Conclusions

Known and unknown things are identified, the relationship between the two is where the doors between the areas of knowledge are found.

Between the order of the concrete and the spiritual ascension is the Gate of Sebastian.

The Gate of Torreon elevates the dearest longings of unity and transits every day in silence, the dearest of the gods of the past.

To build a geometric form of self-reference by generating a mental structure of chains of statements that allow generating new knowledge from basic principles or axioms.

The solidity of the axiomatic bases of the cognitive systems allows to increase the capacity of generation and demonstration of existing truths.

The use of self-referential subroutines allows the direct and effective application of metacognition in the field of cybernetics, in the creation of expert systems and in the programming of artificial intelligence.

Metacognition with metalanguage favors the expression of human intelligence, based on the generation of self-referential statements.

Two are the lines of research that emerge from this study; the first is the possibility, as confirmed by the geometry of the Hebrew alephbeth where each word has a phonetic value, a signifier and also a numerical value that links it with the meaning of the words that have the same numerical value; the second, lies in the similarity that the attractors are the set of points towards which a dynamic system tends, after a high number (infinite, ideally), to achieve from the expert systems the variation in initial conditions and where its obtained values are never repeated with exactitude, given the great variety of initial conditions of a system.

It is proposed that, in order to open the mind (open mind) of the learner, to seek the relationship and integration of phenomena in different areas of knowledge, allowing to permeate, filter, learn to learn, be self-taught and go beyond the limits imposed by the specialty and subspecialty, in short, go beyond the general culture, learn to relate the various topics of the different areas of knowledge, expanding their horizons in knowledge.

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E-commerce for sale of ornamental flowers**Comercio electrónico para la venta de flores ornamentales**

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Abstract

The objective was to develop an e-commerce system for a flower shop located in Ixmiquilpan, Hidalgo, Mexico; which allows the diffusion of cut flowers in arrangements and their online sale, through different payment methods. An agile methodology for its development called Scrum was used and the software tools used were MySQL, XAMPP, Laravel, Visual Code Studio and Paypal SDK. As a contribution, this tool allows the florist to have an additional option for their business that allows them to sell and deliver their floral arrangements, despite the occurrence of an event that forces them to suspend their business face to face, as in this case was the worldwide impact of the COVID-19 pandemic and that on the recommendation of the health and government authorities, non-essential activities, such as the sale of ornamental flowers, were suspended.

Resumen

El objetivo planteado fue desarrollar un sistema de comercio electrónico para una florería ubicada en Ixmiquilpan, Hidalgo, México; el cual, permita la difusión de flores de corte en arreglos y la venta en línea de estos, a través de diferentes métodos de pago. Se empleó una metodología ágil para su desarrollo denominada Scrum y las herramientas de software utilizadas fueron MySQL, XAMPP, Laravel, Visual Code Studio y SDK de Paypal. Como contribución, se tiene que, esta herramienta le permite a la florería, contar con una opción adicional para su negocio que le permite vender y entregar sus arreglos florales, a pesar de que ocurra un evento que le obligue a suspender su negocio de manera presencial, como en este caso lo fue la afectación a nivel mundial de la pandemia por COVID-19 y que por recomendación de las autoridades sanitarias y de gobierno, las actividades no esenciales, como la venta de flores ornamentales, fueron suspendidas.

E-commerce, Ornamental flowers, Pandemic**Comercio electrónico, Flores ornamentales, Pandemia**

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Introduction

The COVID-19 pandemic, in addition to being a health problem, caused economic, employment and social problems. In terms of health, at the national level, as of July 2022, there were 6,448,477 cases and 326,504 deaths (Statista, 2022).

According to INEGI, between March and April 2020, 12.5 million jobs were lost in Mexico. However, informal workers absorbed the greatest impact. Of the initial job losses, 10.4 million were in the informal sector and 2.1 million in the formal sector (Government of Mexico, Hacienda and Consar, 2021, p.1). In economic terms, by 2021, 1.6 million businesses had disappeared nationwide, including microenterprises (INEGI, 2021, p.2).

Faced with this problem, a web system has been proposed that allows the sale of flowers online through e-commerce for the Rosita flower shop located in the municipality of Ixmiquilpan, Hidalgo, Mexico.

Specifically, the following objectives have been set:

- To carry out an analysis to determine the requirements and needs of customers when making a purchase of flowers through an Internet web system.
- To implement a catalogue of floral arrangements that will be divided into categories of events so that the customer has a wide variety of options.
- Develop the code of the web system using the results of the analysis to meet customer requirements.
- Perform testing to verify the functioning of the web system and avoid errors.

This e-commerce application allows the Rosita flower shop to disseminate its products and is an additional option that allows it to sell despite the occurrence of an event, as in this case, the pandemic, and, therefore, will enable it to stay in the market or be a more competitive company.

The following sections will address some data on the impact of the COVID-19 pandemic on businesses established in Mexico, the theoretical framework, the methodology used for the development of the project, the results obtained and conclusions.

Data on the impact of COVID-19 on established businesses in Mexico

In 2019, there were 4.9 million businesses in Mexico, of which; according to size, 94.9% belonged to the micro classification, 4.9% were small and medium-sized, and only 0.2% were considered large (INEGI, 2021, p.2). Following the COVID-19 pandemic, in 2020, health and government authorities took measures to prevent the spread of the virus, including constant hand washing, use of masks, use of antibacterial gel, confinement and closure of businesses whose activities were not considered essential. These measures had consequences, and by the year 2021, 1.6 million businesses (INEGI, 2021, p.2), mostly small ones, had closed nationwide, but 1.2 million new businesses had opened (INEGI, 2021, p.2).

Another consequence of the COVID-19 pandemic was the increase of e-commerce in micro, small, medium and large businesses. In 2020, according to the Mexican Association of Online Sales it increased by 81% with a value of 316 billion pesos, however, in 2021, it slowed down (2021, p.11).

For flower and plant producers, 2020 was a difficult year as sales of cut flowers fell by 70% and ornamental plants by 30% (Forbes, 2021).

Locally, businesses located in Ixmiquilpan in the state of Hidalgo were affected by the aforementioned pandemic, with some micro-enterprises, in particular, disappearing.

In general, the businesses that remained, survived or emerged had e-commerce platforms, while others had to innovate and adapt to new ways of marketing their products in the face of the pandemic that forced them to avoid face-to-face transactions.

Theoretical framework

According to Gayosso, the management of ornamental plants arises from the origins of man and is part of his culture (2015, p. 11), since ancient times they have been used to decorate the environment for religious, festive or historical reasons (Carrodegua-González, Zúñiga-Orozco and Ortiz-Cruz, 2021, p.41).

Ornamental plants are cultivated and traded for decorative and cultural purposes, they can be classified by their use (indoor, outdoor), aesthetic characteristics, such as flowers, leaves, the peculiarity of their foliage, fruits or stems, by their colour, shape, texture or a combination between them (Pérez-Nicolás, et al., 2021, p.2).

Cut flowers are flowers and buds with stems and leaves that are removed from the plant for ornamental purposes. The cultivation of cut flowers, called floriculture, is a specialised value-added crop (González, 2016, p.120), linked to the global economy and represents an economic income opportunity for families (Vargas et al., 2021, p. 9).

On the other hand, according to Jiménez, Martínez and Silva, e-commerce "is the buying and selling of products or services through the Internet" (2021, p.5); or simply, it can be conceived as "commercial transactions through the Internet" (Robayo-Botiva, 2020, p.5). It is a channel increasingly used by businesses and customers, through online platforms online forms a diversified network of consumers and suppliers internationally (Salas-Rubio, Abrego-Almazán and Mendoza-Gómez, 2021, p.153);

"E-commerce takes place through diverse business relationships, involving any possible combination of consumers (C), businesses (B) or governments (G)" (OECD, 2019, p.16).

Therefore, e-commerce can be classified into several types (Herrera, Vázquez and Jacobo, 2019, p.64) which are identified below:

- Business to Consumer (B2C): the process of buying and selling goods or services is between businesses and end consumers.
- Business to Business (B2B): the process of exchanging goods or services, in addition to the purchase of goods or services, takes place between companies, i.e. between wholesalers or manufacturers.
- Consumer to Consumer (C2C): sales and purchase transactions are carried out between end consumers, usually through social networks.
- Government to business (G2B): allows product or service transactions between governments.
- Business to employee (B2E): refers to companies that offer electronic services.

There are authors such as Montenegro-Ramírez, et al. (2019, p. 23) who add an additional classification called M-commerce, aimed at the sale of products or services through mobile devices.

Methodology

Scrum was used for the development of the project, as an agile methodology, since it makes it possible to develop software projects in a short time and with the participation of a small team and with a short time for its development.

In the first phase of Scrum, called initiation, the project vision was established, the Scrum Master was identified and the roles of the other members of the Scrum team were defined. The epics were developed, which in this case were considered to be seven. The list of epics is shown in table 1.

The first version of the prioritised Backlog was formalised (table 2) in the second phase called Planning and Estimation. In this phase, seven work blocks were established, ordered by delivery priority. Each of the blocks corresponds to the number of iterations and deliverables. Accordingly, the first or highest priority Sprint is related to the visualisation of the flower catalogue.

Development of epics	Nº H. U.	User Stories
As a customer I need a username and password to make an online purchase.	HU-1	Display the interface to access the system.
	HU-2	Validate the username and password entered by the administrator or employee.
	HU-3	Display the welcome portal to the system in case of access.
	HU-4	Recover password in case of forgetting it.
As a customer I need to view the flower catalogue.	HU-5	List flower arrangement catalogues available by event.
	HU-6	Search for specific flower arrangements.
	HU-7	View details of a specific arrangement.
As a customer I need to view the catalogue of accessories.	HU-8	
	HU-9	List the add-on catalogues that are available by event.
	HU-10	Search for specific add-ons.
As a customer I need to add floral arrangements and/or complements to my shopping cart.	HU-11	List flower arrangements and accessories in the cart.
	HU-12	Remove flower arrangements and accessories from your shopping cart.
	HU-13	Modify floral arrangements and accessories in the cart.
	HU-14	Get a quote.
As a customer I need to order flower arrangements and/or accessories that are in my shopping cart.	HU-15	Enter shipping details.
As a customer I need to pay for the order of flower arrangements and/or accessories in my shopping cart.	HU-16	Choose payment method.
	HU-17	Display the taxes generated by the payment.
As a customer I need to receive confirmation of the purchase of flower arrangements and/or accessories in my shopping cart.	HU-18	Receive notification of purchase via email.

Table 1 List of epics

Source: Own elaboration

The prioritised backlog for Sprint 1 is shown in table 3. Also, in this phase, the user stories were created and the estimate in days for their completion was made. The user story for Sprint 4 is shown in table 4. Mockups were also created for the design of interface prototypes.

Development of epics		N° H.U.	User Stories
SPRI NT 4	As a customer I need to add floral arrangements and/or complements to my shopping cart..	HU-1	Add flower arrangements and accessories to the cart.
		HU-2	Remove flower arrangements and accessories from the cart.
		HU-3	Modify flower arrangements and add-ons in the shopping cart.
		HU-4	Get a quote.
SPRI NT 2	As a customer I need to have a username and password to make an online purchase.	HU-5	Show the interface to access the system.
		HU-6	Validate the username and password entered by the administrator or employee.
		HU-7	Display the welcome portal to the system in case of login.
		HU-8	Recover password if forgotten
SPRI NT 5	As a customer I need to place an order for flower arrangements and/or accessories in my shopping cart..	HU-9	Enter shipping details.
SPRI NT 6	As a customer I need to pay for the order of flower arrangements and/or accessories in my shopping cart..	HU-10	Choose payment method.
		HU-11	Display the taxes generated by the payment.
SPRI NT 1	As a customer I need to view the flower catalogue.	HU-12	List flower arrangement catalogues available by event.
		HU-13	Realizar búsquedas de arreglos florales en específico.
		HU-14	View details of a specific arrangement.
SPRI NT 3	As a customer I need to view the catalogue of accessories.	HU-15	List the catalogues of accessories that are available per event.
		HU-16	Search for specific add-ons.
		HU-17	View details of a specific add-on.
SPRI NT 7	As a customer I need to receive confirmation of the purchase of flower arrangements and/or accessories in my shopping cart.	HU-18	Receive notification of purchase via email.

Table 2 Prioritised backlog

Source: Own elaboration

In the third phase called Implementation, the first deliverable related to the first sprint was created.

In the next phase called Review and Foresight, the first block of work was compared with the desired objective, and functionalities were added that had not been contemplated in the first instance; again, virtual meetings were held with the Scrum team through the Zoom platform.

In the last phase, Launching or Closing, tests were carried out for each user story, three types of tests were performed: unit, integration and acceptance; subsequently, the requested changes were checked.

Once the first block (flower catalogue) was completed, the credentials block was continued and iterated again. The iterations were repeated until the blocks were completed; subsequently, the first version of the system documentation was produced.

Prioritised backlog of the final product for the first sprint	
HU-12	List the flower arrangement catalogues that are available by event.
HU-14	View details of a specific arrangement.
HU-13	Search for specific floral arrangements.

Table 3 Prioritised backlog for the first Sprint

Source: Own elaboration

The programming language was Php, the database used was MySQL. The software tools for the development were Laravel and Visual Code Studio, while the web server used was XAMPP. All of the aforementioned are freely licensed. For the e-commerce part, the Paypal SDK was used for the integration of payments in Laravel.

User story title: Add flower arrangements and add-ons to cart.	Id: HU-1
Description: As a customer of FloresVent I want to add flower arrangements and complements to my shopping cart.	
Acceptance criteria: The application is installed free of charge via the internet browsing link.	
Responsible: Yolanda Marysol Escorza Sánchez	
DoD: Approved by the developers of the application.	
Observations: Test the functionality of the application.	
Priority: 1	Estimate: (1 hour)

Table 4 User story

Source: Own elaboration

Results

The result of the project was an e-commerce system containing catalogues of the cut flower arrangements offered by Rosita Florist. The main interface is shown in figures 1 and 2. The catalogues of flower arrangements classified by event are shown in figure 3, including arrangements for all occasions, for cars, weddings, quinceañeras, first communions and baptisms, among others.



Figure 1 Main interface

Source: Own elaboration



Figure 2 Main interface (continued)
Source: Own elaboration



Figure 3 Catalogue of flower arrangements
Source: Own elaboration

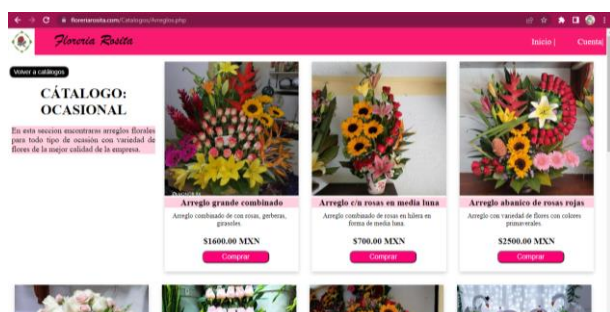


Figure 4 Details of the floral arrangements
Source: Own elaboration

In turn, each catalogue contains the products offered, with the details of these, including characteristics and prices.

If a customer wishes to make a purchase of floral arrangements or details, he/she must register the first time or log in with his/her user name and password the subsequent times.

Figure 5 shows the user registration interface, while Figure 6 shows the login of a previously registered user.

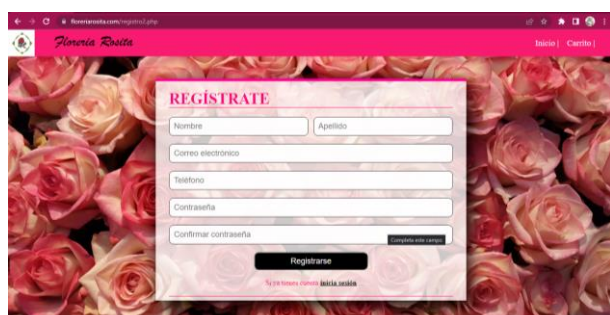


Figure 5 User registration
Source: Own elaboration

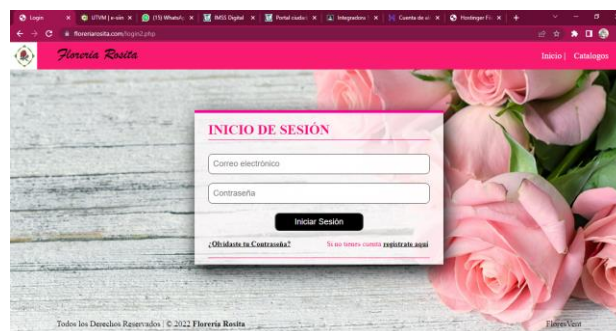


Figure 6 User login
Source: Own elaboration

Once the floral arrangements have been added to the shopping cart and the shipping information has been entered, proceed with the payment of the purchase, this can be PayPal, Mercado Pago or credit or debit card, as shown in figure 7. The shipping information must be entered, as requested in figure 8.

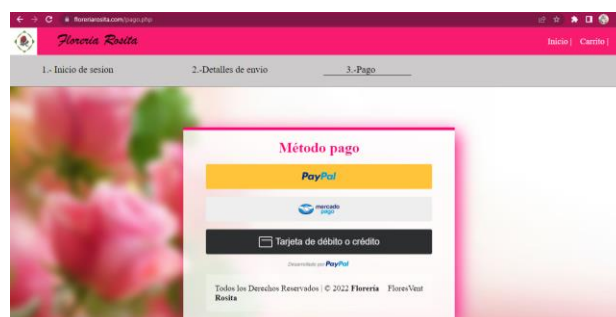


Figure 7 Choice of payment method
Source: Own elaboration



Figure 8 Shipping data
Source: Own elaboration

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We would like to thank the Rosita flower shop for all the facilities provided for the realisation of this project. This project was not supported by any source of funding.

Conclusions

The e-commerce web application presented above aims to be an additional option to market flower arrangements for the Rosita flower shop; in addition, it allows a greater dissemination of its products, which enables it to position itself not only locally, but also at state and national level, and therefore to be a more competitive microenterprise.

At the beginning of the project, the general objective was to sell flowers online through e-commerce for the Rosita flower shop; this objective was achieved, since, as shown in the results section, an e-commerce application was developed that meets the determined objectives, through the dissemination of online product catalogues (floral arrangements and accessories), shopping cart, payment of products through various methods and delivery of products to the customer's home.

Specifically, an analysis was carried out through user stories to determine the requirements of customers when making a purchase of flowers through an Internet web system, which allows the first specific objective to be met.

To meet the second specific objective, not only a catalogue of floral arrangements was implemented, but also a catalogue of complements that was classified into event categories.

Subsequently, the web system was coded based on customer requirements, and with this, the third specific objective was achieved.

Finally, tests were carried out to verify the functioning of the web system and to avoid errors, firstly, unit tests were carried out for each user story that was being released, then integration tests with other user stories and acceptance tests with the Rosita flower shop.

Therefore, it can be concluded that both the general objective and the specific objectives that were set at the beginning were met.

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Characterization of SARS-CoV-2 cases and COVID-19 deaths in the State of Baja California through five waves using machine learning

Caracterización de casos SARS-CoV-2 y muertes por COVID-19 en el Estado de Baja California a lo largo de cinco olas utilizando aprendizaje automático

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Abstract

The Mexican State of Baja California, located in the north of Mexico, is a region of great importance due to its proximity to the United States, reason why it is of interest an analysis of the historical behavior of the pandemic caused by the SARS-CoV-2 virus in this region. Thus, based on the official data provided by the Mexican federal government during the years of the pandemic, particularly on Baja California, we undertook the task of preprocessing such data in order to generate classification models and identify rules of the behavior between virus infections and COVID-19 deaths. To carry out our study, as in previous works, we used the KDD methodology and specialized machine learning tools, beginning the study with the preprocessing of data and continuing with its exploitation for generating models with a high rate of correct classification, which were validated with the help of the cross-validation technique. In this way, the five waves that have occurred between March 2020 and October 2022 were characterized according to the relationships occurred between cases infected with the SARS-CoV-2 virus and COVID-19 deaths.

Baja California, SARS-CoV-2, COVID-19, Machine learning

Resumen

El Estado mexicano de Baja California, ubicado en el norte del país, es una región de gran importancia económica debido a su vecindad con Estados Unidos, razón por la cual es de interés un análisis del comportamiento histórico de la pandemia causada por el virus SARS-CoV-2 en esta región. Así, con base en los datos oficiales provistos por el gobierno federal de México durante los años de pandemia, particularmente sobre Baja California, nos dimos a la tarea de preprocesarlos con la finalidad de generar modelos de clasificación e identificar reglas de comportamiento entre los contagios de dicho virus y las muertes por COVID-19 en este Estado. Para llevar a cabo nuestro estudio, al igual que en trabajos anteriores, utilizamos la metodología KDD y herramientas especializadas de aprendizaje automático, iniciando el estudio con el preprocesamiento de los datos y continuando con su explotación para generar modelos de un alto índice de clasificación correcta, validados con la técnica de validación cruzada. De esta manera, las cinco olas que se han presentado entre el mes de marzo de 2020 y el mes de octubre de 2022 fueron caracterizadas con base en las relaciones ocurridas entre los casos infectados por el virus SARS-CoV-2 y las muertes por COVID-19.

Baja California, SARS-CoV-2, COVID-19, Aprendizaje automático

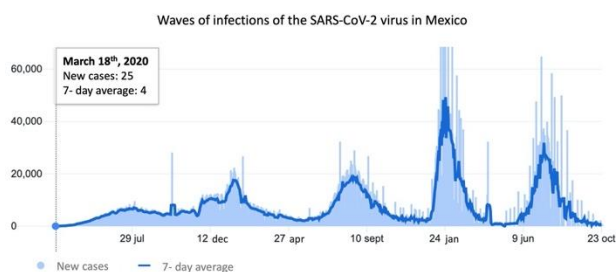
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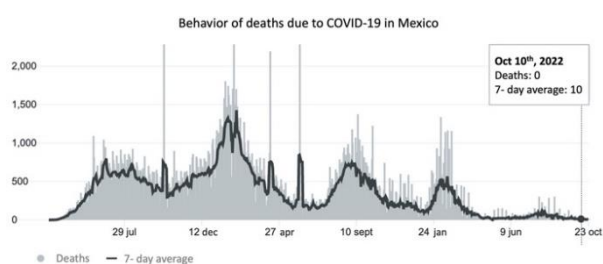
Introduction

Since the first case of SARS-CoV-2 occurred in Mexico, on February 22nd, 2020, and diagnosed on February 28th of the same year, five infection waves of this virus have occurred until October 2022, as shown in Graphic 1.



Graphic 1 Five waves of infections SARS-CoV-2

Associated with these infection waves are the COVID-19 death waves, observing the second wave being the one with the highest lethality, despite this wave has not been the one with the highest contagion. This fact can be observed by comparing Graph 1, SARS-CoV-2 infections, with Graph 2, COVID-19 deaths.



Graphic 2 Behavior of deaths due to COVID-19

From the previous graphs, it can also be inferred that, although the last two infection waves are the highest, they are the ones with the lowest lethality, consequence for sure of the growing application of anti-COVID vaccines, supplied every day to the different sectors of the Mexican population. In the particular case of Baja California, these patterns of infections and deaths are similar and will be discussed in more detail in later sections.

Theoretical framework

In principle, this work is based on concepts of machine learning techniques, which allow to extract knowledge of interest, hidden in large volumes of data. In addition, as part of the theoretical framework, some works related to the application of machine learning in the context of the COVID-19 disease were analyzed and taken as references. Such works are described below.

Folorunso et al. (2021) carry out data classification for early diagnosis and prognosis of the COVID-19 pandemic using CXR images. Their classification consists of a supervised learning activity that uses labeled data to assign items to different classes.

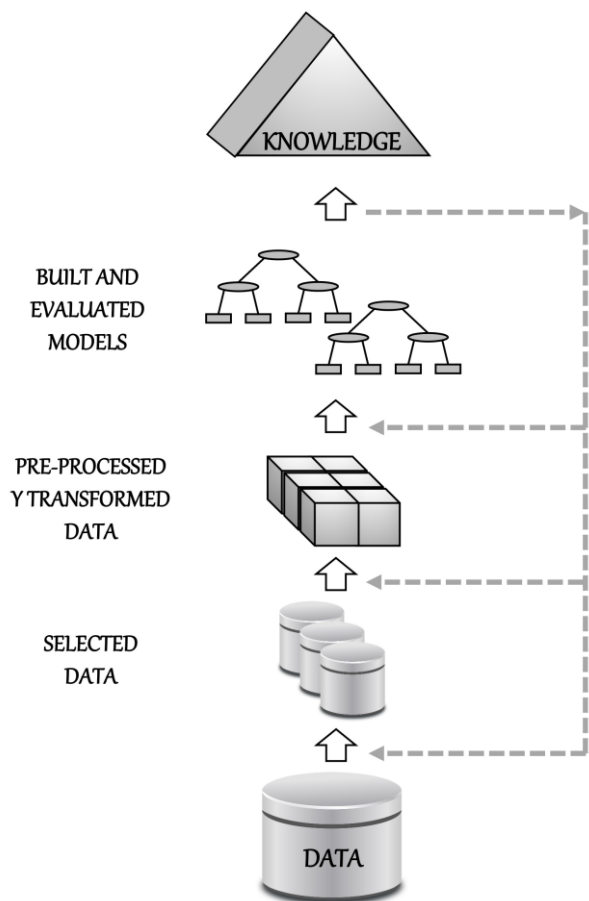
Gupta et al. (2021) carry out a study of the COVID-19 cases that occurred in different States of India. According to the authors, the dataset they used contains multiple classes, so they perform a multi-class classification on the preprocessed data. In this way, the authors perform forecasts of all classes based on random-forest techniques, linear modeling, support vector machine techniques, decision trees and neural networks, identifying that the random-forest technique produced the best prediction model, which was evaluated using the cross-validation technique.

Rahman et al. (2021) present Artificial Intelligence approaches that, according to the authors, have significant contributions in the field of health care, particularly in relation to the fight against COVID-19, in aspects such as its detection and diagnosis, as well as definition of procedures for its treatment, drug research and development, social control and services, and the prediction of outbreaks. Their work addresses the link between technologies and epidemics with the introduction of machine learning and natural language processing tools.

Shahid et al. (2021) present an overview of the role that machine learning has had so far in the fight against SARS-CoV-2, mainly from the perspective of detection and forecasting, as well as vaccines. They present a comprehensive study of machine learning algorithms and models that can be used in the fight against such a virus.

Methodology

To carry out this work, it was used the so called KDD methodology, shown in Graph 3. Thus, following the five stages marked out in this methodology, the start is the data provided on SARS-CoV-2 infections and COVID-19 deaths by the federal government of Mexico through the General Directorate of Epidemiology (<https://www.gob.mx/salud/documentos/datos-abiertos-bases-historicas-direccion-general-de-epidemiologia>).



Graphic 3 KDD Methodology

Table 1 presents a sample of the data provided for the State of Baja California.

UPDATE_DAT	ID_RECORD	SOURCE	SECTOR	SEX
24/09/20	04b69d	1	4	1
24/09/20	059d21	1	4	2
24/09/20	0d0308	1	12	2
24/09/20	0d3a3b	2	12	1
24/09/20	0aeb14	2	12	2
24/09/20	1d5eef	1	4	2
24/09/20	0b09f9	2	12	1
24/09/20	13e871	1	6	1
24/09/20	0dffdd	1	4	2
24/09/20	1929f8	2	4	2
24/09/20	0c2927	2	4	2
24/09/20	0729a5	1	6	1
24/09/20	33795	2	12	1
24/09/20	181571	1	12	2

Table 1 Data provided for Baja California

As the second stage of the methodology, only those variables considered significant for our study were selected. By way of example, the ID_REGISTRO variable is not significant at all, since it does not provide relevant information, that is, it only contains particular identifiers of the people and therefore it would not make sense analyze case by case in a sea of data. On the contrary, the SEXO variable is essential for our study because it provides information about the gender of people, which obviously is absolutely relevant. Thus, the sixteen variables selected as significant are shown in Table 2.

No.	Name
1	SEXO
2	TIPO_PACIENTE
3	FECHA_DEF
4	INTUBADO
5	NEUMONIA
6	EDAD
7	EMBARAZO
8	DIABETES
9	EPOC
10	ASMA
11	INMUSUPR
12	HIPERTENSION
13	CARDIOVASCULAR
14	OBESIDAD
15	RENAL_CRONICA
16	TABAQUISMO

Table 2 Variables selected as significant

Regarding the third stage of the KDD methodology, referring to the pre-processed and transformed data, it is important to note that the data provided by the federal government were basically numbers associated with a catalog of codes, so it was necessary to recode them so that they could be processed and exploited by Weka (<https://www.cs.waikato.ac.nz/ml/weka/>), used as the main tool in our study. Table 3 presents a sample of recoded data.

SEX	PATIENT_TYPE	DATE_DEATH	INTUBATED	PNEUMONIA	AGE
Mujer	Hospitalizado	Fallecido	No	Si	88
Mujer	Hospitalizado	Fallecido	Si	Si	81
Hombre	Hospitalizado	No fallecido	No	Si	47
Hombre	Ambulatorio	No fallecido	No aplica	No	25
Mujer	Ambulatorio	No fallecido	No aplica	No	53
Mujer	Ambulatorio	No fallecido	No aplica	No	34
Mujer	Hospitalizado	No fallecido	Si	Si	52
Mujer	Ambulatorio	No fallecido	No aplica	No	47
Hombre	Ambulatorio	No fallecido	No aplica	No	5
Hombre	Hospitalizado	No fallecido	No	No	69
Mujer	Hospitalizado	No fallecido	No	Si	78
Hombre	Ambulatorio	No fallecido	No aplica	No	73
Hombre	Hospitalizado	No fallecido	No	No	47
Hombre	Hospitalizado	No fallecido	No	No	55
Hombre	Hospitalizado	No fallecido	No	Si	64
Mujer	Ambulatorio	No fallecido	No aplica	No	44

Table 3 A sample of recoded data

Thus, the original data associated with all the significant variables, except for the EDAD (age) variable, were recoded (preprocessed). As an example, the original data of the SEXO variable were recoded from 1 and 2 to “Mujer” (female) and “Hombre” (male), respectively, while the same codes of the TIPO_PACIENTE variable were recoded to “Ambulatorio” and “Hospitalizado”, respectively. In the same way, the code “9999-99-99” of the FECHA_DEF (date of death) variable was recoded to “No fallecido” (non-deceased), and “Fallecido” (deceased) in any other case. Regarding the fourth and fifth stages of the KDD methodology, model-building and knowledge-extraction, these will be addressed in the next section as part of the results.

Results

Returning to Graphs 1 and 2, it can be seen that the transition months among the different waves are November 2020, May 2021, December 2021, May 2022 and October 2022, assuming that in the latter case a sixth wave could occur. Based on this, in this section, the classification models that were generated for each of these months will be presented and the most significant rules for each case will be discussed. It is important to note that all the models were validated with the cross-validation technique.

The classification model corresponding to November 2020 is shown in Figure 1, where it can be seen that 5382 SARS-CoV-2 positive cases were processed with a percentage of 51% for women and 49% for men. In this case, the most significant rule indicates that 70.5% of the cases were treated in an ambulatory way, with no deaths. However, 5.8% of the cases were intubated and died, in addition to another 5.6% of those hospitalized, older than 70 years, that also died.

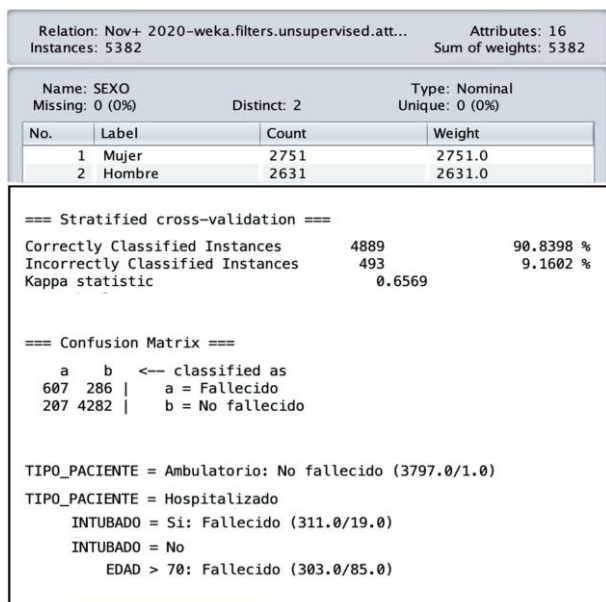


Figure 1 November 2020 classification model

The classification model corresponding to May 2021 is shown in Figure 2, where it can be seen that 485 SARS-CoV-2 positive cases were processed with a percentage of 47% for men and 53% for women. In this case, the most significant rule indicates that 58.4% of the cases were treated in an ambulatory way, with no deaths, while 1.9% of the cases corresponding to men older than 55 years and 2.7% of the cases corresponding to women older than 36 years, who were intubated and had pneumonia in both cases, died.

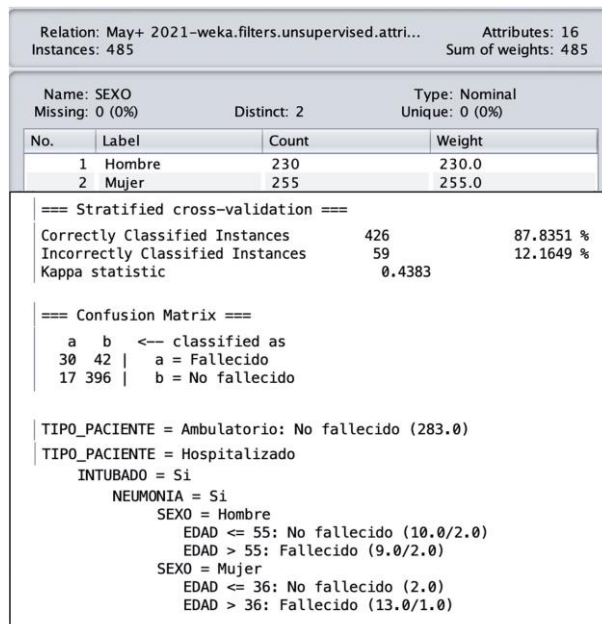


Figure 2 May 2021 classification model

The classification model corresponding to December 2021 is shown in Figure 3, where it can be seen that 2360 SARS-CoV-2 positive cases were processed with a percentage of 53% for women and 47% for men. In this case, the most significant rule indicates that 54.2% of the cases were treated in an ambulatory way, with no deaths. Regarding the cases that did die, there were 7.2% of cases intubated, 1.6% of cases older than 58 years with cardiovascular disease and 1.3% of cases older than 72 years with pneumonia and diabetes.

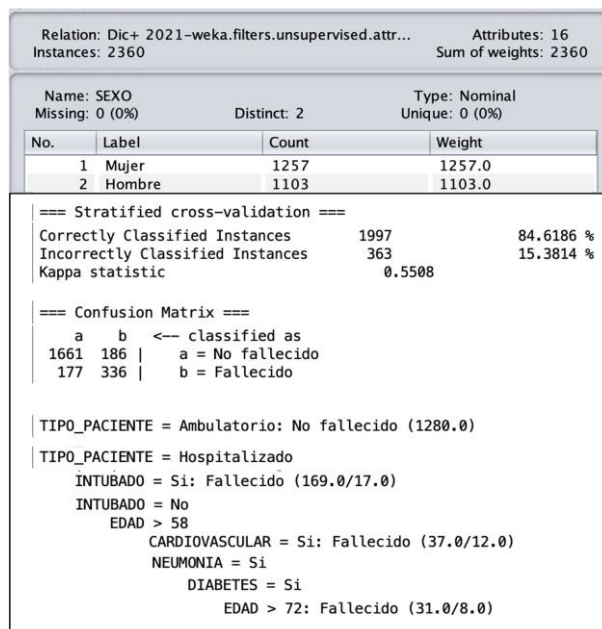


Figure 3 December 2021 classification model

The classification model corresponding to May 2022 is shown in Figure 4, where it can be seen that 170 SARS-CoV-2 positive cases were processed, observing a drastic decrease of cases compared to previous months, with a percentage of 66% for women and 34% for men. In this case, the most significant rule indicates that 94.7% of the cases were treated in an ambulatory way, with no deceases, and that only 3.5% of the cases died, corresponding to people who were hospitalized and had pneumonia.

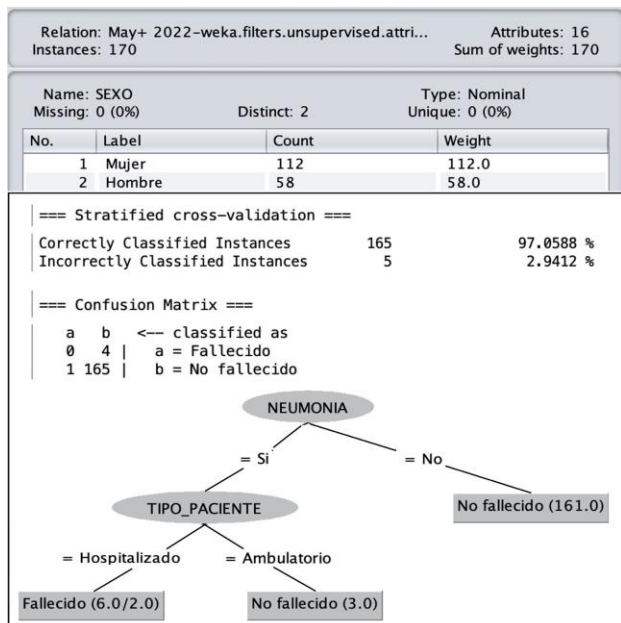


Figure 4 May 2022 classification model

The classification model corresponding to October 2022 is shown in Figure 5, where it can be seen that only 115 SARS-CoV-2 positive cases were processed with a percentage of 69% for women and 31% for men. In this case, in the model with a 97.39% of correctly classified data, only two diseases were observed.

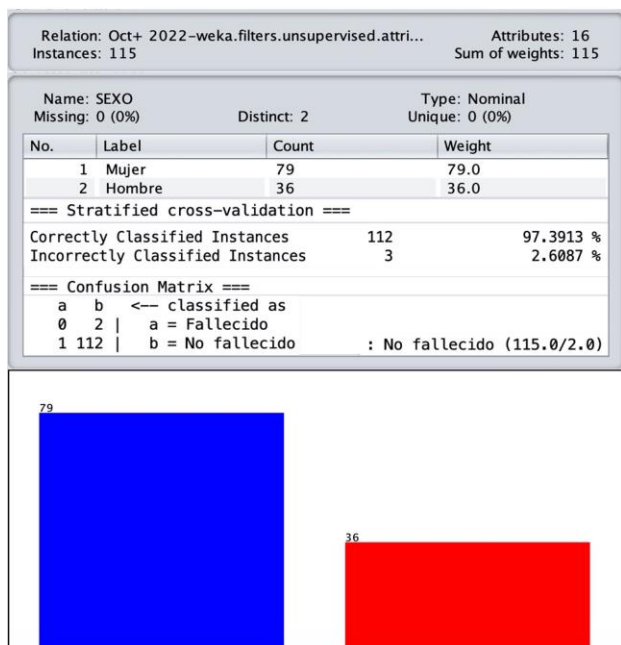


Figure 5 October 2022 classification model

In this way, various classification models and significant rules were presented.

Conclusions

In first instance, based on the patterns (rules) observed in this study, it can be concluded that the pandemic caused by SARS-CoV-2 virus in the State of Baja California has drastically reduced its lethality rate. As a summary, the following table shows the lethality rates in each of the months analyzed in this paper:

Characterization of Lethality in the State of Baja California

Month	Positive cases	Deaths	Lethality
November 2020	5382	1098	20.40%
May 2021	485	176	36.30%
December 2021	2360	730	30.90%
May 2022	170	39	22.90%
October 2022	115	2	1.70%

These percentages are in accordance with what was observed at the national level, that is, the second wave with the highest lethality and then drastically decreasing in the fifth wave as a consequence of anti-COVID vaccines applied to most of the population in Mexico, particularly in Baja California.

Nonetheless, a light analysis of the latest data published by the General Directorate of Epidemiology shows that lethality at national level has increased a little at the end of October 2022 compared to the rest of the month, perhaps because of the lack or incomplete schemes of vaccination in some sectors of the population of Mexico and particularly of Baja California, in combination with the relaxation of the measures established for the containment of SARS-CoV-2 infections. If, in addition to this, it is considered the drop in temperatures in the following months and the possible emergence of new variants of the virus, it is likely that a sixth infection wave will occur. However, if so, it would be expected little lethal.

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Use Khan Academy in the mathematics teaching-learning process

Uso de Khan Academy en el proceso de enseñanza-aprendizaje en matemáticas

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Abstract

The technology platforms implementation in the educative field such as Khan Academy (KA), has increased in a significative way due to the pandemic for learning management, which implies a significant change in content approach for both students and teachers. This paper's objective was to analyze students' experience using KA within three dimensions: motivation, learning, and innovation. From a methodological perspective, it was designed a descriptive investigation based on the quantitative analysis that describes perceptions (attitudes) about the use of the mathematics teaching-learning platform in two educative programs from Centro Universitario del Norte (CUNorte). The results obtained show that the majority of interviewees felt motivated to learn, considering that the platform's use advantages of their learning, it allows them to develop math skills, improved their grades, and learned in an innovative way. In addition, it will allow assessing the benefits and limitations in order to improve the application of the platform in the teaching practice.

Resumen

La implementación de plataformas tecnológicas en el ámbito educativo como Khan Academy (KA), se incrementó de manera significativa con la emergencia de la pandemia para la gestión de los aprendizajes, lo que implica un cambio significativo en el abordaje de contenidos tanto de docentes como de estudiantes. El objetivo del trabajo fue analizar la experiencia de los estudiantes en el uso de KA en tres dimensiones: motivación, aprendizaje e innovación. Desde la perspectiva metodológica, se diseñó una investigación descriptiva basada en un análisis cuantitativo que describe las percepciones (actitudes) sobre el uso de la plataforma en la enseñanza-aprendizaje en matemáticas en dos programas educativos del Centro Universitario del Norte (CUNorte). Los resultados obtenidos muestran que la mayoría de los entrevistados se sintieron motivados por aprender, considerando que el uso de la plataforma favorece sus aprendizajes, les permite el desarrollo de habilidades en matemáticas, mejoró sus calificaciones y aprendieron de forma innovadora. Además, permitirá valorar los beneficios y limitaciones para la mejora en la aplicación de la plataforma en la práctica docente.

Implementation, Platforms, Innovation, Significant

Implementación plataformas, Innovación, Significativo

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Introduction

This work was developed at the University Center of the North (CUNorte), as a dependency of the University of Guadalajara, which is present throughout the state of Jalisco, through 15 University Centers, is a multi-thematic center, where 12 educational programs are offered at the undergraduate level and 6 graduate programs in various disciplinary areas.

CUNorte carries out its activities based on the educational model of the University of Guadalajara (2007), where academic activities are centered on the student, their ways of being and learning to be, to know, to do, to live together and to undertake. Consequently, its implementation is based on the constructivist perspective that proposes the search for new ways of working with greater flexibility adjusted in a pertinent manner for the development of competencies, abilities, skills, aptitudes and attitudes necessary for personal fulfillment.

With the emergence of the pandemic generated by COVID-19, teaching was affected in a disruptive way in the approach to the thematic contents, going from a face-to-face modality to a totally online one; where it was necessary the implementation of diverse tools and educational platforms to strengthen the students' learning. Therefore, students found the need to experience the use and management of educational platforms with the guidance of the teacher, among them Khan Academy (KA), so it is relevant to know from the student's perspective, the impact of the use of the platform in the generation of learning. In such a way that it invites the teacher to investigate and innovate the approach to content with the incorporation of technological tools understood not as an end but as a means.

In relation to KA, it is an educational platform to strengthen learning in mathematics, benefits have been identified on its use as those made by Murphy (2014), suggesting that its use is positive and better results were obtained in the tests applied as well as greater confidence in the individual capacity of students.

Research conducted by Brijaldo (2016), indicates the benefits of the use of the platform in the autonomous promotion of student learning, likewise in their KA site document the research conducted by Alberson Family Foundation (2018), in which they point out that students who complete 60% of mathematics in their grade increase 1.8 their expected growth in the NWEA MAP test, conducted for the evaluation of academic progress.

On the other hand Ramirez, and Vizcarra (2016), point out that students when using this tool increased their academic performance, at the same time anxiety is decreased when feeling evaluated in mathematical processes, this due to considering it as an academic game.

The present study is carried out from a descriptive quantitative approach, which has allowed us to know the perceptions of CUNorte students about the use of the KA platform for teaching and learning mathematics with respect to three dimensions: motivation, innovation and learning.

As a result, the question is answered: in what way does the use of the KA platform motivate and innovate the generation of learning of CUNorte students in mathematics? The knowledge derived from the research will allow us to find the benefits and limitations that improve the application of the tool in practice.

Background

ICT in education

Information and Communication Technologies (ICT) have had an impact on the educational field for years, and their integration seeks to improve the effectiveness of teaching and learning in educational organizations.

In this regard Rueda and Guzmán (2018) state that the use of ICT in the educational field allows pedagogical innovation, digital literacy for students and teachers, knowledge management, strengthening the teaching-learning process and educational quality.

Hence, great advances have been evidenced in educational processes due to the incorporation of ICT, in this regard Herrera, "apud Rueda and Guzmán" (2018), states that they are opening an era of change in the teaching-learning process allowing to propose innovative strategies that facilitate the development of professional competencies.

Currently there is a great variety of tools and platforms of free access in the educational field, in recent years their use has been increasing, which has allowed new ways of learning. Students are the ones who manage their learning in a free and spontaneous way through the use of ICT, which implies a greater degree of responsibility and autonomy in the generation of their learning.

ICTs in the teaching-learning of mathematics

The incorporation of ICT in the teaching of mathematics is relevant for learning processes, there is the possibility of greater motivation on the part of students and also allows diversifying teaching methods by the teacher, Soler et al., 2017 "apud Grisales" (2018), state that teachers should update teaching methods and incorporate new strategies and technologies, to generate motivation in students and invite them to investigate, about the scopes that mathematics has in situations of their professional and practical life. In other words, the incorporation of ICT in the teaching of mathematics is fundamental, because they make it easier to understand some processes and abstract concepts of mathematics.

Also, for Quintero and Jerez (2019) the work with ICT becomes important, because they develop certain key points to talk about the student as the protagonist of their learning, which allows to increase motivation by awakening the interest to learn and understand, they allow the immediacy of transmission and reception of information. In this sense, their use must be oriented to the understanding of mathematical processes and not to the performance of routine activities, i.e., we must seek to achieve meaningful learning of mathematics through the use of ICT. Therefore, they are an ideal tool for teaching mathematics.

Khan Academy in the teaching-learning of mathematics

KA is a freely accessible platform for interactive learning support in science subjects. It offers more than 10,000 online educational videos, each topic includes exercises and problems with real-time solutions. The platform has four main components: data, videos, exercises and a user community that allows users to interact and leave comments on the solution process. On the other hand, Rodriguez, Light and Pierson (2014), mention that, in relation to the teaching of mathematics, positive changes were observed on how students learn and their ability to generate their learning processes in an active way.

This web platform was created in 2006 by Salman Khan and contains lessons in mathematics, art, programming, economics, physics, chemistry, biology, medicine and finance, among others. It is a tool that allows interactivity, promotes student motivation. In addition, it allows the accompaniment of the student, that is, the teacher can simultaneously monitor the process of students virtually and in real time, because KA courses are based on the practice of self-assessment exercises, which are deployed according to the demonstration of previous knowledge, the development of areas of opportunity, and the achievement of mastery of new knowledge.

The courses begin with a diagnostic test that allows recognizing which are the mathematical skills consolidated by the student, then presents exercises to be solved according to a logical mathematical sequence, from lower to higher level of complexity, to form and strengthen different mathematical skills (Ramirez and Vizcarra, 2016).

The self-evaluating exercises allow the teacher to make a diagnosis of the student's academic situation, in a specific mathematics topic and from there a learning path can be designed to strengthen the acquired knowledge.

In this sense, the use of the KA platform increases the motivation of students, because it allows them to learn at their own pace, in addition to having the possibility of reviewing the lessons as many times as necessary, thus consolidating their knowledge while practicing with a variety of exercises, i.e., the activity can be programmed so that they are always different exercises.

Hence, being a flexible platform, it can be used as a support and complement to classroom work, or it also allows anyone to access and work on their own. So it can be an element of support for the teacher and for students who have other ways of learning through visual and interactive activities for the understanding of a lesson.

In addition, the use of KA allows students to acquire meaningful learning and boosts competencies in the area of mathematics, basically it is an innovative strategy to learn and practice based on video tutorials or quizzes with their respective feedback with the objective that the student is able to solve mathematical problems. While the teacher allows him to give a punctualized follow-up to each student and feedback on the topics identified as the most difficult for the students.

Thus, KA is a platform that provides a free digital educational environment easily accessible to develop different activities related to mathematics topics and other areas. It is able to identify pre-knowledge, strengths and weaknesses of each student because it is based on an artificial learning system. It is a platform that allows users to manage their learning.

Methodology

The research was conducted from a quantitative approach, descriptive non-experimental cross-sectional cut, which according to Hernández, Collado and Baptista (2014), seek to specify the properties, characteristics and profiles of people, groups, communities, processes, objects or any other phenomenon that is subjected to an analysis (p. 80). The Instrument to obtain the information was implemented in the first semester of the year 2021.

It was oriented to the knowledge about the use of the KA platform, with the intention of improving its implementation in the teaching of mathematics at the higher level, considering the dimensions of motivation, learning and innovation in the teaching-learning processes, according to the approaches of Jara, Cancino and Casillas (2019).

The fieldwork consisted of collecting data directly with the students, through a survey using a structured questionnaire applying the Likert scale, which according to Matas (2018), is a psychometric instrument in which the interviewee indicates agreement or disagreement on a statement, item or reagent, which is done through an ordered and unidimensional scale, (p.30).

The three dimensions of motivation, learning and innovation are analyzed through a questionnaire that includes five questions in each of them, with response options: always, almost always, sometimes, almost never and never adapted from Brioso (2020), to find out based on the guiding question of the work about the attitude of students in the use of the KA platform, which according to Oskamp and Schultz (2009), "apud Hernández, Collado and Baptista", an attitude is a learned predisposition to respond coherently in a favorable or unfavorable way to an object, living being, activity, concept, person or its symbols, thus attitudes are related to the behavior that is maintained around what is referred to.

With respect to validity according to Hernandez and Mendoza (2018), three types of validity can be used: content, construct and criterion validity. The validity in the use of KA was taken into consideration the content validity, which is established by the judgment of three experts considering pertinence, relevance and clarity.

Reliability is understood as the capacity to replicate congruent results with the same instrument when a measurement is made again in a similar population (Bernal 2010). To determine it, the Cronbach's Alpha coefficient was used, in which it has been defined that a value above 0.80 is acceptable, therefore, a value of 0.962 was obtained, which gives a high reliability to the instrument.

The study group was made up of 40 students from two undergraduate programs at the Centro Universitario del Norte of the University of Guadalajara, as shown in the following table:

Academic programs	Learning units	Population	Sample
Electronics and Computers	Pre-calculus	30 students	12 students
	Integral Calculus		12 students
Education	Mathematical Problem Formulation I	10 students	6 students

Table 1 Study group in the use of KA

Source: Own elaboration

Regarding the sample space, it was formed by the students who answered the instrument voluntarily. A total of 30 of them accepted the invitation and answered the questionnaire, which represents 75% of the population.

The information obtained was processed using Excel for the representation of the data and corresponding graphs. The following table shows the operationalization which, according to Carrasco (2006), consists of describing the form or method of how the variable is measured based on its conceptual definition, indicating the terms in which it should be measured.

Variable	Concept	Operational definition	Measuring level	indicators	
Use of Khan Academy	It is the use of didactic strategy through a digital platform based on b-learning for the study of mathematics and the improvement of their learning (Jara et al., (2019).	The use of Khan Acaemyes evaluated in terms of the dimensions Motiva-tion, Learning and Innovation	Ordinal	Never (1)	Under
				Almost never (2)	
				Sometimes (3)	Medium
				Almost always (4)	High
				Always (5)	

Table 2 Operationalization

Source: Own elaboration

Results

In the implementation of the instrument for the evaluation of the dimensions of motivation, learning and innovation on the use of the platform, the following results were obtained and are reviewed in each of the dimensions, first in a general way (tables) and in a second moment considering each of the questions (graphs).

Motivation Dimension

This dimension according to Manrique (2004), is necessary for the student to overcome difficulties, to be able to learn by developing self-confidence and to be aware of his capabilities and limitations, it is observed, as the interest shown by the student towards learning mathematics through technological and didactic strategies; motivation was measured in three levels: high, medium and low.

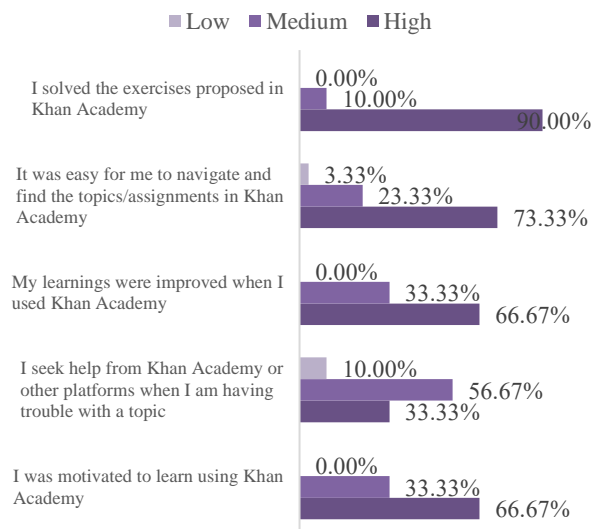
As shown in Table 3, generally considering 30 students, and that each of them would have 5 response options so that the total of responses is 150, taken as a basis for obtaining the percentages in this dimension, we have the levels of motivation in the use of KA. Based on the answers to the five questions, 2.66% have a low level, 31.33% have a medium level and 66% of the respondents have a high level of motivation.

Motivation						
Levels	Questions					%
	1	2	3	4	5	
Under	1	0	0	2	0	2.66
	2	0	1	1	0	
Medium	3	3	7	17	10	31.33
High	4	21	20	9	19	66
	5	6	2	3	1	

Table 3 Results in motivation
Source: Own elaboration

Next, in graphic 1, each of the questions is shown with the results obtained, for example in question one (Did you solve the exercises proposed in Khan Academy?), based on the response of the 30 students in the low level 0%, medium level 10% and high level 90%.

Motivation



Graphic 1 Levels of Motivation in the use of Khan Academy
Source: Own elaboration

Most of the interviewees feel motivated to learn, solve the exercises proposed by the platform and were facilitated to navigate and find the topics and activities on the platform, basically they feel motivated in their learning and with the use of the platform.

Learning dimension

This dimension refers to the learning obtained using the KA platform through a process of knowledge acquisition; learning is measured in three levels: high, medium and low.

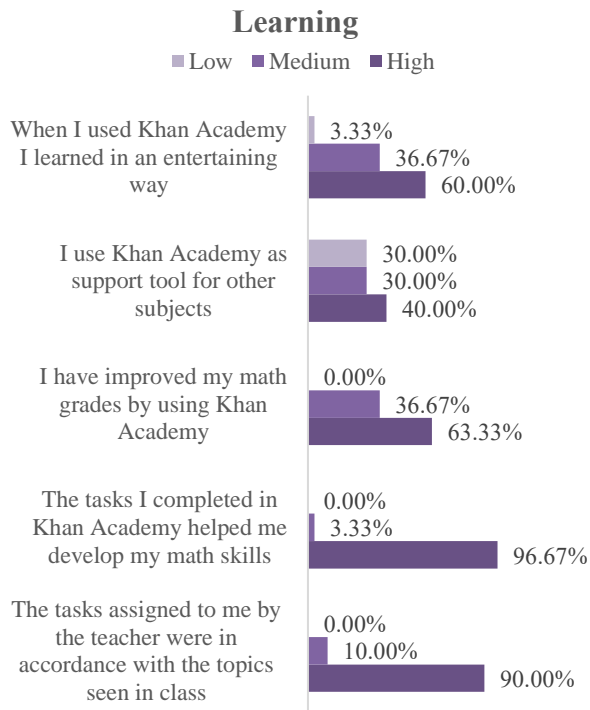
As shown in Table 4, this dimension expresses the levels of learning achieved with the use of KA, which are characterized by a higher proportion of high and medium levels.

Learning						
Levels	Questions					%
	1	2	3	4	5	
Under	1	0	4	0	0	6.66
	2	1	5	0	0	
Medium	3	11	9	11	3	23.33
High	4	7	8	13	6	70
	5	11	4	6	21	

Table 4 Learning results
Source: Own elaboration

With respect to learning, in general, 6.66 presented a low level, 23.33 a medium level and 70% a high level, which shows the relevance in the use of the platform that allows the development of skills in mathematics, improving their grades and learning in an entertaining way. In other words, in general, the respondents were able to improve their learning.

Following the mechanics established in the motivation dimension, Graph 2 shows each of the questions with the results obtained in terms of learning.



Graphic 2 Learning levels in the use of Khan Academy
Source: Own elaboration

Innovation Ddimension

This dimension is based on the use of ICT and didactic strategies with Open Educational Resources offering the opportunity to learn mathematics in a different way; innovation is measured in three levels: high, medium and low.

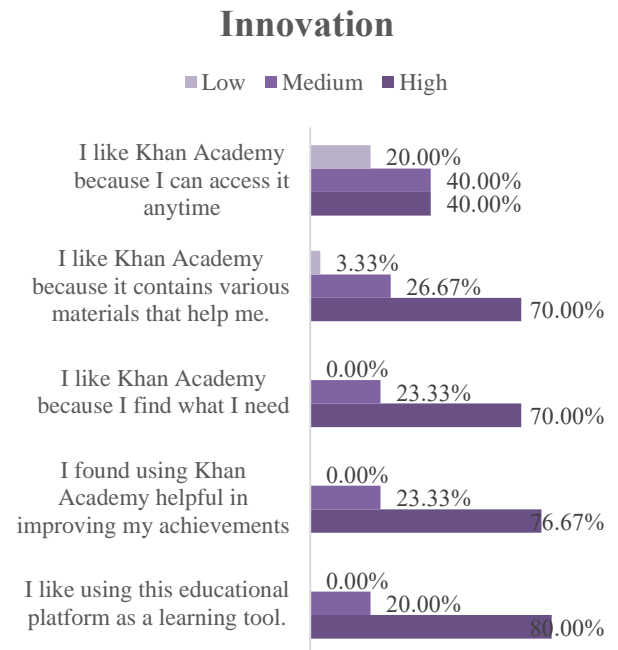
As shown in Table 5, this dimension shows the three levels of innovation in the use of KA.

Innovation						
Levels	Questions					%
	1	2	3	4	5	
Under	1	0	0	0	0	0.66
	2	0	1	0	0	
Medium	3	6	8	9	7	24
High	4	12	13	11	9	75.33
	5	12	8	10	14	

Table 5 Results in innovation
Source: Own elaboration

As can be seen in the table, 0.66% of the respondents show a low level of innovation, 24% show a medium level and 75.33% consider a high level of innovation. In general, most of the respondents have a high or medium level in this dimension, basically here the interviewee made use of ICT to learn mathematics in a different way, the respondents liked the platform, they found it useful because they found a wide diversity of resources and with easy access.

The following graph shows each of the innovation questions with their respective results.



Graphic 3 Levels of innovation in the use of Khan Academy
Source: Own elaboration

Discussion

With respect to the results of the research, it is identified that the use of KA in the area of Mathematics allowed learning in an innovative way, that is, the use of the platform represented an alternative for the student to learn in a different way, and to complement or reinforce what was seen in class, the platform has a great variety of resources and activities, allowing the development of capabilities, competencies and skills in students. The findings coincide with some research on the subject:

In the study by Ramirez and Vizcarra (2016) showed that the use of KA in the elementary mathematics course contributed significantly in the learning of the participants, its use allowed them to remember basic knowledge, reinforce their knowledge and learn new things.

According to Ruiz (2018), regarding the use of KA states that the interaction of the students with the TICS was energized, which allowed greater understanding, they went from being passive participants in the classroom to being active agents of their own learning. While in the findings of Chávez (2018) states that the use of learning strategies in obtaining final grades in the subject of mathematics is influenced and improved by the use of Khan Academy.

On their account, Jara, Cancino and Casillas (2019), showed that the use of KA favored the academic performance of the students and they felt motivated when interacting with the activities in KA.

For their part Lou and Jaeggi, "apud en Salvatierra, Romero y Flores", (2021) state that the implementation of KA for learning shows benefits and allows the activation of prior knowledge. In their study it was shown that KA is a platform that allows to consolidate and consolidate the learning of calculus.

Thus, the analysis in the use of the KA platform in the teaching-learning process, allowed observing the perception of students on three dimensions: Learning, Motivation and Innovation, most of the interviewees felt motivated to learn, they solved the exercises proposed by the platform and it was easier for them to navigate and find the topics and activities on the platform, they considered that the use of the platform favors their learning. They stated that the platform allowed them to learn in an entertaining way, develop math skills and improve their knowledge. They also found that the educational platform offered a wide variety of topics and practice exercises that allowed them to reaffirm their learning.

Funding

This work was developed at the University Center of the University of Guadalajara, and no funding was necessary.

Conclusions

As a teacher, it should be clear that the implementation of ICT in education is not only about integrating technological tools, it is necessary to transform practices and methodologies in the approach to disciplinary content, to enhance its use and allow student participation in the construction of their knowledge, thus facilitating the acquisition of meaningful learning.

In this sense, there are a great number of technological tools that the teacher can use for the teaching-learning process of mathematics, however, a problem is the fear of change, most teachers are wary of innovating using ICT, making proper use of these, it favors the autonomous learning of students, giving them the opportunity to take an active role and teach them to learn how to learn.

The use of KA in the Precalculus, Calculus and Mathematical Problem Formulation courses allowed innovation, giving the student the opportunity to learn in a different way and complement or reinforce what was seen in class.

The use of the platform, which has a great variety of digital resources and activities, appropriate for the development of skills and competencies in the students, allowed them to improve their learning in mathematics.

The study showed that the use of KA improved the teaching-learning process, the interviewees felt motivated to learn using the platform, it inspired them confidence and also some students used the platform to seek help from other subjects. While in the Learning dimension, the topics reviewed were in line with what they had seen in class, allowed them to develop skills, improve their grades and learn in a fun way, and in the Innovation dimension, they were delighted with the content of the material and the easy access to it.

On the other hand, the scope of the study is limited, it analyzed the experience of one teacher with his groups, however, it makes clear the benefits of its use and invites teachers to use it for its flexibility and diversification in the acquisition of learning in mathematics by students in an innovative way.

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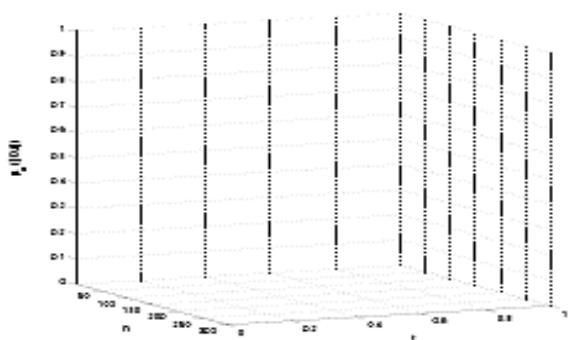
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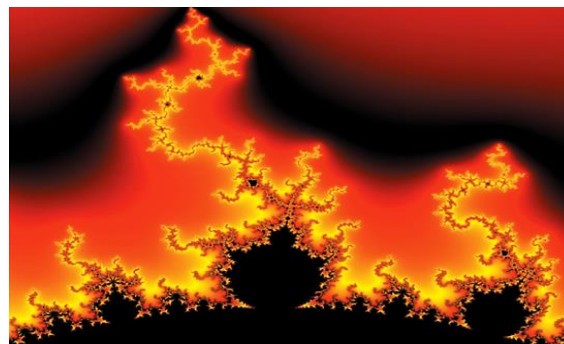


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