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Journal High School

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Support the international scientific community in its written production Science, Technology and Innovation in the Field of Humanities and Behavioral Sciences, in Subdisciplines Higher education curricular standards, higher education training fields, higher education curricular frameworks, higher education curricular parameters.

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Knowledge Area

The works must be unpublished and refer to topics of Higher education curricular standards, higher education training fields, higher education curricular frameworks, higher education curricular parameters and other topics related to Humanities and Behavioral Sciences.

Presentation of Content

In the first article we present *Ecosystem of a Spin-off for the generation of MSMEs at the higher education level* by Méndez-Mendoza, José Nemorio, Cano-Corona, Ariana, Varela-Loyola, José Antonio and Hernández-Zempoaltecatl, Rodrigo, with adscription at the Universidad Politécnica de Tlaxcala, as the next article we present *Innovative approaches in teaching modal analysis: Utilizing additive manufacturing for structural engineering education* by Centeno-Moreno, Alan Ibrahim, Torres-Cedillo, Sergio Guillermo, Cortes-Pérez, Jacinto and Reyes-Solís, Alberto, with adscription at the Centro Tecnológico Aragón, FES- UNAM, as the next article we present *Evaluation of Experience in Higher Education, innovating with artificial intelligence in the implementation of predictive models* by Torres-Gutiérrez, Arturo, Lino-Gamiño, Juan Alfredo, Díaz-Ledezma, José de la Cruz and Enríquez-Cerda, Pablo, with adscription at the Universidad Internacional de la Rioja, Universidad de Colima and CISET, as the next article we present *Application of design thinking in EE Technological Competences in Education* by Guzmán-Coutiño, Héctor, Martínez-Herrera, Brenda Marina, Hernández-Trejo, Lorena and Olivares Ruiz, Nancy Araceli, with adscription at the Universidad Veracruzana, as the next article we present *Student perspective on the contribution of scientific research to society and its importance in university education* by Carrillo–Beltrán, Julio César Cuauhtémoc, Suárez-Flores, Marina, González-Hernández, Maricruz and Aguirre-Bravo, Anna Alessandra, with adscription at the Universidad Autónoma de Nayarit, as the last article we present *Peace building from the classrooms* by Morlett-Villa, Zaida Francisca, Terrazas-Medina, Tamara Isabel, Hernández-Rivera, Diana and Flores-López, Beatriz Adriana, with adscription at the Universidad Autónoma de Coahuila.

Content

Journal High School 8[19]1-7: e1819107
Article

Ecosystem of a Spin-off for the generation of MSMEs at the higher education level

Ecosistema de un Spin-off para la generación de MiPymes en el nivel superior

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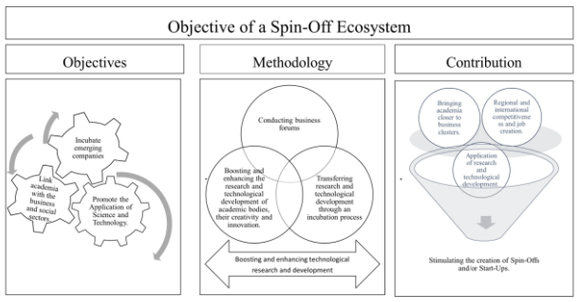
Abstract

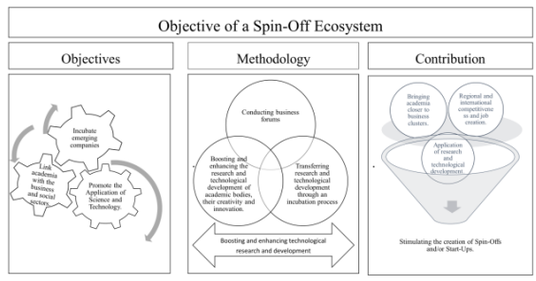
The ecosystem converges within the academy, which offers programs of excellence, holistically integrating science and technology; the state, institutions, and research centers, technological parks, the private sector, and the link with the community, fostering an entrepreneurial identity among students and/or interest groups. Technology transfer manages knowledge and technology directed at providing solutions to manufacturing or control processes required by companies to be competitive and sustainable in a globalized market, promoting innovation and economic development. Business success lies in innovative business proposals that involve the transfer of science and technology required by productive or service companies, fostering the generation of spin-offs and startups. Currently, the University, through Nodess, links the social and private sectors, promoting social and solidarity economy in the southern region of the state of Tlaxcala, Mexico.



Spin off, Technological transfer, Research line

Resumen

El ecosistema converge dentro de la academia, que ofrece programas de excelencia, integrando de manera integral ciencia y tecnología; el estado, las instituciones y centros de investigación, los parques tecnológicos, el sector privado y el vínculo con la comunidad, fomentando una identidad emprendedora entre los estudiantes y/o grupos de interés. La transferencia de tecnología gestiona el conocimiento y la tecnología dirigidos a brindar soluciones a los procesos de fabricación o control que requieren las empresas para ser competitivas y sostenibles en un mercado globalizado, promoviendo la innovación y el desarrollo económico. El éxito empresarial radica en propuestas empresariales innovadoras que impliquen la transferencia de ciencia y tecnología requeridas por empresas productivas o de servicios, fomentando la generación de spin-offs y startups. Actualmente, la Universidad, a través de Nodess, vincula al sector social y privado, impulsando la economía social y solidaria en la región sur del estado de Tlaxcala, México.



Spin off, Transferencia tecnológica, Líneas de investigación

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Introduction

This article is related to the application of science and technology that converge from the research generated by the academic bodies according to the lines of research of the Polytechnic University belonging to the technological subsystem, these lines affect a social and economic benefit; providing consulting services generating and creating Spin-off / Star Up that interact with business clusters focused on students or interest groups.

The declarations in the conference on *the new dynamics of higher education and the pursuit of social change and development mission* (Unesco 2009) in its paragraph nineteen implies for the university to provide strategies to promote ensure society's entrepreneurial development through research, technology transfer and innovation.

According to the subsystem of incorporation of the Programme for the Professional Development of Teachers (PRODEP) by 2020 there were 771 public and state institutions of which 62 were polytechnic universities.

In that period there were 1,169 full-time professors with postgraduate degrees, equivalent to 84.28%, of which 27.33% had a PhD and 42.90% had a PRODEP profile.

With regard to the formation and consolidation of academic bodies recognised by PRODEP, there were 149 in formation (16.23%), 31 in the process of consolidation (16.23%) and 11 consolidated (5.76%).

Spin offs created from a transfer office are associated to the University derived from the transfer of a process of research, development and innovation R+D+I that provide business opportunities, patents, economic, legal and development plans for the impulse and growth of the same based on the application of knowledge and technology.

The Polytechnic University of Tlaxcala creates scenarios that favour a process of academic training linked to students, teachers, academic bodies and society, developing programmes with social responsibility.

The organisation of the University fosters the entrepreneurial spirit through the transfer and promotion of science and technology generated by the academic bodies, converging in innovation, research and development to provide solutions to projects proposed by stakeholders.

Development

The organisational structure of the University promotes and encourages the creation of Spin Offs to provide consultancy services and create MSMEs as functional organisations that achieve and attain the objectives of the stakeholders (see fig. 1).

Box 1

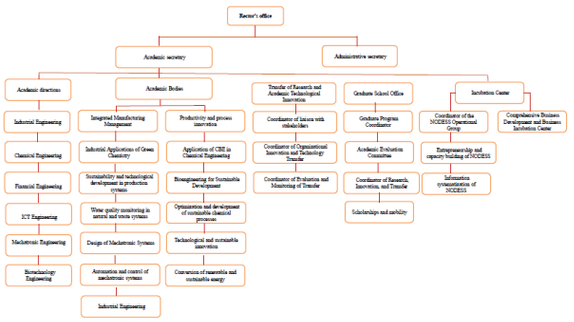

Figure 1

General organization chart Uptx

Source: Uptx

According to the organizational structure of the University, the offer of consultancy and research services is seen as key points of technology transfer that are linked to the professional profile of future engineers, promoting high performance and experience in their work development, guaranteeing the mission of the University.

In correlation to the functionality of the incubation, integral and business centre CIIDEN, see fig. 2, a successful model can be observed, which has allowed to reach and operate significantly the services provided to society through a solidary and economic process

Box 2

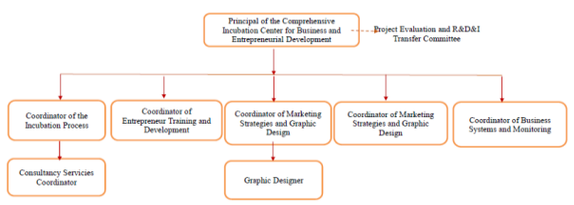

Figure 2

CIIDEN Organigramme

Source: Own elaboration

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The incubation model operated by CIIDEN at the university is based on the technology-based model of the National Polytechnic Institute and Polytechnic Universities and is mainly carried out in a process of pre-incubation, incubation and post-incubation including the transfer of research, development and technological innovation R&D&I for the creation of spin-offs and star-ups, see fig.3

Box 3

Incubation Model		
Phase	Objective	Main functions
Research	Identify and evaluate entrepreneurial projects	Organization of seminars, forums, and workshops for the selection of high-impact innovative projects Approach with researchers and consultants
Acceleration and development	Develop innovative and technological ideas	Engagement with researchers - consultants Legalization of the advisory and transfer process Research and strategic planning of business opportunities
	Business management spin off and/or start up	Mentoring and/or counseling programming. Training in the humanistic area Present a market program and competition cluster Creation of product engineering and production process" Presentation of innovative prototype to a focus group. A product market disruption program is implemented Generation of manuals in administrative and production areas" Legalization of the company and patents Integration of the general business project plan
Growth strategies and continuous innovation	Financial Networking	Advisory for capitalization and search for funding sources
	Market disruption and monitoring of spin-off/startup	Disruption in potential marketing sectors Evaluation of the growth strategy

Figure 3

Incubation model

Source: Own elaboration

Description of Functions

The main functions of the CIIDEN are: directing, planning, programming, controlling and coordinating the general activities for the operation of the incubator, managing resources, agreements and strategic alliances, as well as controlling and improving the operation of the incubator through the establishment of objectives, strategies, operating policies and continuous improvement processes.

To follow up on the application of funding resources and to verify the development of business plans for the various projects. It also participates in the internal project evaluation committee where the following aspects are prioritised:

- Identification and selection of ideas, projects and entrepreneurs.
- Training, advice and specialised consultancy in legal, productive, technological, administrative, quality systems, marketing, sales, accounting and financial areas.
- Individual advice in the preparation of projects and business plans.
- Development of market strategies and business image design.
- Support in the management of sources of initial financing (seed capital), legal incorporation of the company, development and registration of trademarks, trade names and patents.
- Linkage with sources of finance and investment.
- Accompaniment in the training of entrepreneurs, management development, market design, quality systems, business productivity and continuous improvement.

Taking as a reference successful models that have been generated by the Autonomous University of Mexico, the National Polytechnic Institute, the Technological Institute of Monterrey; the Polytechnic University of Tlaxcala developed the generation of an Incubation model called ‘Incubation Model of the Polytechnic Universities’, approved by the Ministry of Economy in 2007 and which was transferred to the network of incubators of the Coordination of Polytechnic Universities.

On the other hand, for the area of research and technological innovation transfer, according to Robert Grosse (1996), it is a process that includes knowledge, as well as skills, technologies, methods and manufacturing samples between legal entities such as private companies, universities and even between governments themselves. Technology transfer models are based on complex systems and must therefore be assessed in order to adapt objectively and close gaps in research, innovation and the application of science and technology for the benefit of society, and which can be scaled up to obtain the solid solutions demanded by the different sectors of society. The gap that exists between the university, society, research, development, innovation and technology transfer is significant, for this reason it is considered to give priority to society and interest groups, to generate competitive entrepreneurs and promote the development of solid companies that remain over time.

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The technology transfer offices are a means that allows an interdisciplinary research process that is generated through lines of research applicable to the solution of problems presented by different productive sectors, likewise the university is immersed in promoting social activities that promote the various sectors of the southern region of the state of Tlaxcala.

Considering the above, a series of opportunities are identified to close the gaps related to funding, so that the academy should contemplate the government sector, non-profit organisations in order to promote and encourage research and thus achieve technology transfer and promote specific areas of research.

In relation to the General Law on Humanities, Science and Technology (2018-2024) it should be considered that a '*Technology and Knowledge Transfer Office is an entity in charge of managing and promoting the transfer of technology and knowledge generated in research and development institutions to the productive sector, with the aim of boosting innovation and technological development in Mexico'*. In the case of the Polytechnic University of Tlaxcala, this office facilitates collaboration between the academic and business sectors and thus encourages the practical application of scientific and technological advances in industry, promoting economic growth and competitiveness in the country.

The strategic transfer of R&D&I activities aimed at the needs and creation of spin-offs and star-ups is structured in key stages such as the identification of innovative projects that demand research in disruptive innovations of medium and high technology, interdisciplinary collaboration of researchers, protection of inventions, registrations, trademarks, design and confidentiality agreements and transfer.

Another key point for technology transfer is the search for licensing and evaluation of new relevant opportunities that enhance the project, a process of technological incubation, follow-up and growth that provides indicators of disruption in the market.

Box 4

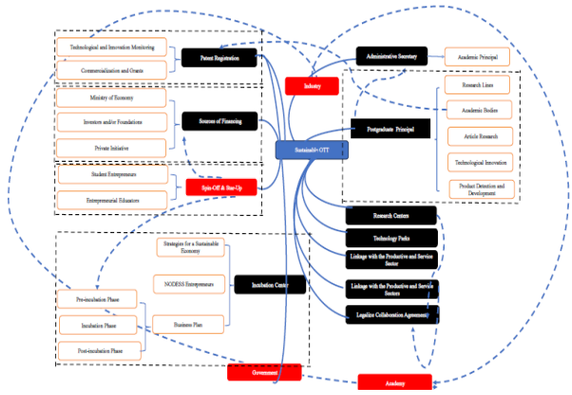

Figure 4

Office of Technology Transfer and Entrepreneurship UPTx

Source: Own elaboration

The ecosystem and entrepreneurship

The R&D&I function is based on standards that promote innovation, technology management and competitiveness that influence the success of technology transfer and create research and academic development networks.

In Mexico, the following standards are considered: Mexican Innovation Standard: NMX_GT_001_IMNC-2008, Technology Management Standard NMX-J_536_ANCE-2027, NMX-GT_002ImNC-2013 and competitiveness standard NMX-CC-9001-IMNC-2015 for technology transfer and research activities.

An ecosystem is considered as a set of individual, organisational, industrial and environmental elements and their leadership mechanisms, dynamic capabilities, culture, capital markets, networks and open-minded customers that combine in complex ways (Guerrero & Urbano, 2017), allowing the university to fulfil its development mission to strengthen the entrepreneurial spirit of students and society in general.

In relation to an entrepreneurship ecosystem, a structure is presented that shows the integral interrelationship of elements of the functioning of a research and technology innovation transfer office at the university and its functionality is of vital importance considering a triple helix engagement involving industry, government and academia.

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The ecosystem operates with key processes linking national research, innovation and entrepreneurship ecosystems that are the product of a synergy of incubation, nodess and technology transfer networks. The university, industry and government (UIG) model, also known as the triple helix Etzkowitz 2000 and Jerome 2011, promotes sectoral collaboration as a key to foster research, knowledge, technology transfer, efficient and innovative technological processes supported by programmes such as conachyt and other sources of funding (see figure 5).

Box 5

Figure 5
Triple Helix
Source: Etzkowitz (2000) and Jerome (2011)

Methodology

The methodology used consisted of a field research within the university, individual contributions of university academic entrepreneurship and literature search with scopus database, using key terms was limited to publications in recent years, as well as an analysis of recent publications, focused on relevant theoretical frameworks.

Results

The results obtained are related to an integration of substantive and adjective functions of the university that include the generation and promotion of entrepreneurs or spin offs through consultancy services, R&D&I and an incubation centre through CIIDEN.

High-impact R&D&I projects are related to the automotive industry where systems have been designed such as: perimeter cutting and window for the sunroof curtain to standardise cutting and improve the finish, epsilon-export curtain by means of a robotic system, rotating mould-holder platform and insulation cube, control system for automatic feeding from warehouses and plastic pellet material dryers to injection machines with intelligent algorithms to eliminate 30% of thermal waste, design of wind power generation systems.

Conclusions

Since the creation of the Polytechnic University of Tlaxcala, Mexico, it fulfils its mission to be competitive; through human talent with a disciplinary profile and with experts, it has infrastructure such as laboratories, information centres, workshops according to industrial needs.

This article summarises the essential functions of the university, focusing on teaching and research, which contribute to the generation of high impact projects.

The university also advises and provides research, innovation and transfer services to the productive sector and society in general. It promotes the creation of micro, small and medium-sized enterprises by creating spin-offs that face various challenges, such as management, legality, identity and commercialisation.

The model presented in Fig. 3 and 4, incorporates a binding process of research, development and technological innovation.

As of July 2023, the university contributes to and promotes the social and solidarity economy through programmes called NODES, strategically integrating in a sustainable way the southern region of the state of Tlaxcala, Mexico with amaranth and walnut producers through the design of automated equipment to increase the production flow of amaranth products; a walnut crusher was also equipped to speed up the process; teachers and researchers were involved in these designs.

In the same sense, the university facilitates spaces for the producers of the clothing industry, technology and other sectors of the southern zone of the state of Tlaxcala to hold exhibitions of their products and services, with the aim of promoting their commercialisation, promoting regional development poles that satisfy social and economic demands.

Conflict of interest

The authors declare that they have no conflict of interest. We have no known competing financial interests or personal relationships that could have influenced the reported article.

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Authors' contribution

Each of the authors was involved in the different sections of the development of the article, as their diverse backgrounds created a synergistic team that contributed to complement the research.

Availability of data and materials

The availability of the information provided in this article is under the protection of the areas of the University, however, being a public institution, it is available to any researcher or person, upon request of the transparency department.

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Article

Innovative approaches in teaching modal analysis: Utilizing additive manufacturing for structural engineering education

Enfoques innovadores en la enseñanza del análisis modal: Utilización de la manufactura aditiva en la educación de ingeniería estructural

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Abstract

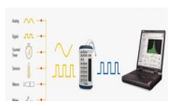
Teaching modal parameters in civil engineering, particularly structural engineering, is essential for understanding structural behavior under mechanical vibrations. As projects grow more complex, the need for rigorous testing increases, making theoretical and practical education crucial. Tools like Matlab, SAP2000, ETABS, and ANSYS are widely used for modal analysis, while practical methods include shake table tests and data collection with accelerometers. Recently, additive manufacturing has gained traction as a cost-effective alternative for creating educational platforms, replacing traditional steel elements with thermoplastics. This innovative approach reduces costs and enhances the practicality of teaching, allowing for visual demonstrations of vibration effects. The article discusses the design of an academic platform using additive manufacturing to teach modal parameters in structural systems, with experimental tests conducted to determine the structure's modal parameters through free vibration analysis.

Objetive

New Alternatives for Teaching Modal Testing Analysis Using Additive Manufacturing

Contributions:
Utilizing Emerging Technologies for Engineering Education

Metodology



Teaching techniques, Modal analysis, 3D printing

Resumen

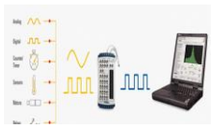
La enseñanza de los parámetros modales en ingeniería civil, particularmente en ingeniería estructural, es esencial para comprender el comportamiento estructural bajo vibraciones mecánicas. A medida que los proyectos se vuelven más complejos, la necesidad de pruebas rigurosas aumenta, lo que hace que la educación teórica y práctica sea crucial. Herramientas como Matlab, SAP2000, ETABS y ANSYS se utilizan ampliamente para el análisis modal, mientras que los métodos prácticos incluyen pruebas en mesas vibrantes y la recopilación de datos con acelerómetros. Recientemente, la manufactura aditiva ha ganado terreno como una alternativa rentable para crear plataformas educativas, reemplazando elementos de acero tradicionales con termoplásticos. Este enfoque permite demostraciones visuales de los efectos de las vibraciones. El artículo discute el diseño de una plataforma académica utilizando manufactura aditiva para enseñar parámetros modales en sistemas estructurales, con pruebas experimentales realizadas para determinar los parámetros modales de la estructura mediante análisis de vibración libre.

Objetivos

Nuevas alternativas de enseñanza del análisis modal experimental empleando manufactura aditiva.

Contribuciones:
Empleo de Tecnologías Emergentes para la Enseñanza en Ingeniería

Metodología



Técnicas de enseñanza, Análisis modal , Impresión 3D

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Introduction

Teaching modal parameters in civil engineering, particularly within the structural domain, is crucial for understanding how structures behave under mechanical vibrations [1]. As engineering projects grow increasingly complex, there is a greater need for rigorous testing before large-scale implementation, making both theoretical and practical education in this area indispensable. Various teaching methodologies exist for modal analysis and the acquisition of modal parameters.

At the University of Mons in France, one effective method involves using Matlab software, which allows for the simulation of Frequency Response Functions (FRF) in structural elements and systems through programming [2]. MATLAB further facilitates the development of reliable damped computational models, offering effective countermeasures for addressing noise and vibration issues [3]. Moreover, it has been utilized to create a new toolbox, “Stabil,” which implements the finite element method specifically for beams, trusses, and plates, enabling comprehensive structural analysis [4].

Another critical example of software application is the Finite Element Method (FEM), which is extensively used to determine dynamic characteristics. [5]. In structural engineering education, programs like SAP2000 and ETABS are commonly employed to identify structure vibration modes through mathematical modeling [6]. ANSYS, specialized software that can be used with MATLAB, provides additional capabilities for vibration simulation and mesh generation [7].

The theoretical instruction for these software tools often includes learning to obtain modal parameters via finite element methods [8]. Complementing these theoretical approaches are practical and visual tests, such as shake table experiments, which typically use scaled-down models [9]. In some institutions, practical exercises in modal analysis involve data collection from steel beams using accelerometers and impact hammers [10]. For example, research conducted at the University of Córdoba and the Higher Technical School of Industrial Engineering involved a modal analysis test compared with shake table results, analyzing a steel frame and threaded rods [11].

In innovative cases, such as at the Oregon Institute of Technology, modal analysis is taught using mobile phones, leveraging an application that enables on-device analysis [12].

The trend indicates a firm reliance on steel elements for laboratory testing and finite element analysis software, primarily due to the associated costs and logistical challenges. However, additive manufacturing technology, which substitutes traditional materials with thermoplastics [13], is emerging as a cost-effective alternative. Based on layer-by-layer material deposition, this technology is increasingly used to create academic platforms that visually demonstrate the effects of vibrations and modal parameters [14].

This article introduces the design of an academic platform for teaching modal parameters in structural systems, utilizing a framework constructed through additive manufacturing. To obtain these parameters, experimental tests will be conducted using numerical and experimental modal analysis. The structure will be subjected to free vibration tests to observe its physical behavior and determine its modal parameters.

Theoretical Framework

Mechanical Vibrations

Mechanical vibrations are oscillatory motions that occur in solid elements over time. For a vibratory system to exist, it must comprise elements that store potential energy, elements that store kinetic energy, and a mechanism through which energy is dissipated. This study focuses on free vibration, which arises when a system oscillates independently following an initial disturbance without the influence of external forces [1]. In such scenarios, the system's vibrations are governed solely by its intrinsic properties, such as mass and stiffness, with no external forces acting.

Studying mechanical vibrations is essential in structural engineering, as it directly impacts the design and safety of built environments. Structures' response to dynamic loads, including those induced by earthquakes, wind, and human occupancy, is a critical consideration in ensuring structural integrity and resilience.

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A thorough understanding of vibrational behavior enables engineers to predict and mitigate potential adverse effects, thereby enhancing structures' safety, comfort, and longevity. This knowledge is vital in designing infrastructure in regions susceptible to seismic activity and other dynamic environmental forces[15].

2.2 Modal Analysis

The modal analysis examines a structure's dynamic properties, including natural frequency, vibration modes, and damping ratio, all of which are governed by its mass and stiffness [16]

The equation that defines the modal analysis of a system with *N* degrees of freedom is derived from equation [1].

$$[M]\{\ddot{x}\} + [C]\{\dot{x}\} + [K]\{x\} = \{f(t)\} \quad [1]$$

The theoretical basis of modal analysis is grounded in formulating the equation of motion, assuming a response form, and ensuring that it satisfies the equation governing the system's motion [17]. In contrast, experimental modal analysis focuses on determining modal parameters through measurements taken directly from the structure, unlike analytical modal analysis, where parameters are derived from finite element models [17]. These analyses typically provide valuable insights into the structure's lifespan, potential damage, existing resonances, and strategies for controlling vibrations through passive, active, or hybrid methods.

Methodology

Study area

The test involved conducting an experimental modal analysis on an academic platform made of PLA using additive manufacturing. The stiffness elements were modified with four different infill densities: 100%, 75%, 50%, and 25%, each identifiable by a color code.

The analysis was performed for each of these infill densities. After collecting the data, it was analyzed using the finite element method to compare the results of the experimental and numerical modal analyses.

To achieve a more accurate analysis that closely represents an actual structure, an academic platform was created based on a frame model (comprising two beam elements and one bar element in 2D) with two levels, two masses m_1 , and m_2 along with eight beam elements, a base plate, four simple joints, and four double joints.

These components connect the plates to the bars, forming a structure that integrates mass and stiffness elements. The setup was designed to demonstrate a structure's behavior under free vibration visually, scaled down, in a manner that is easily transportable and straightforward to fabricate. Figure 1 showcases the academic test rig, which can be produced using Additive Manufacturing. In this figure, the yellow bar joints are highlighted, and these joints can be fabricated with 100% infill, ensuring that all yellow elements are entirely solid.

Box 1

Figure 1

Academic test rig printed in 3D

Source: Own elaboration

The connection between the bar and plate elements, as well as the joints, was achieved using Allen and cross-head screws. Two steel plates were utilized and securely anchored to a high-rigidity table to ensure structural stability and prevent unintended movements due to the surface conditions of its placement.

The models for additive manufacturing were designed using SolidWorks, where the STL files were generated. Subsequently, FlashPrint software was employed for slicing before printing. Each component was fabricated through the Fused Filament Fabrication (FFF) process, which involves melting thermoplastics via an extruder at material-specific temperatures.

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This study chose PLA (polylactic acid) as the thermoplastic due to its ability to produce prints within short timeframes and its minimal post-print deformation. The following table details the printing times and color codes associated with the various elements.

The following points should be considered:

- The bars were printed in pairs, requiring 16 prints to produce 8 bars in 4 different densities.
- The simple joints were printed together.
- The double joints were also printed together.
- The extruder temperature was maintained at 220°C, while the print bed temperature was held at 60°C for all elements.

Box 2

Table 1

3-D Print Time and infill density properties of each printed element

Element	Infill density (%)	3D printing Time (Hrs)	Color
Plate A	100	16	yellow
Plate B	100	16	yellow
Base plate	100	16	yellow
Simple T-joint	100	4	yellow
Double T-joint	100	4	yellow
bars	25	4	white
	50	5	blue
	75	6.5	black
	100	8	yellow

Source: Own elaboration

Stiffness Elements

The platform has eight stiffness elements, distributed as 4 per level, each with 21 x 1 x 0.5 cm dimensions. These elements feature the necessary holes for assembly using single and double T-joints. The specified dimensions and configurations apply consistently across all four densities without requiring modifications.

Mass Elements

The platform includes two mass elements: one for the intermediate level and another for the final section. Both have 21 x 16 x 0.5 cm dimensions and are designed with the necessary features for integration with the stiffness elements.

Base Plate

The base plate, measuring 21 x 16 x 0.5 cm, shares the exact dimensions of the mass elements and is similarly designed for attachment to the stiffness elements. Additionally, 1 cm diameter holes have been added to allow secure anchoring to metal plates, preventing unintended movement during testing.

Experimental Tests with Impact Hammer

Figure 2 depicts experimental tests using the DEWESOFT software and the DAQ system to perform modal analysis of the platform under four different stiffness configurations using an impact hammer. Twenty tests were conducted at nodes 3 and 5 of the structure, with impact forces ranging from 5 to 10 N. The analysis focused on evaluating the interaction between the structure's mass and stiffness elements.

Box 3

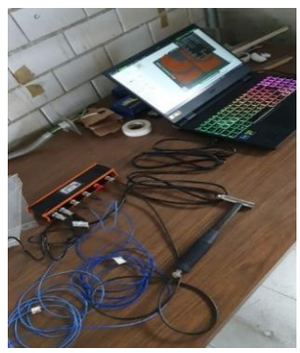

Figure 2

Data Acquisition System

These measurements were conducted using two uniaxial accelerometers, which were placed at each level of the structure, as shown in Figure 3.

Box 4

Figure 3

Placement of Accelerometers

Source: Own elaboration

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After collecting the data, the structure's vibration modes analysis yielded the following results. Figure 4 illustrates the first and second modes using bars with 100% infill, clearly showing the typical mode shapes of a cantilever beam. These results can be qualitatively validated by comparing them with the well-known mode shapes of a simple cantilever beam. Figures 5 and 7, representing 75% and 25% infill, display these mode shapes. However, Figure 6, with 50% infill, exhibits a discrepancy from the previous results, likely due to the reductions in mass and stiffness.

Box 5

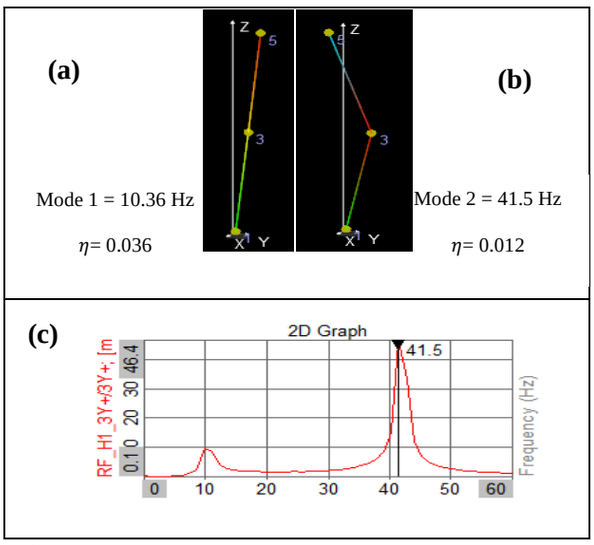

Figure 4

Empirical Modal parameters infill 100%: (a) Mode 1; (b) Mode 2; (c) FRF diagram

Box 6

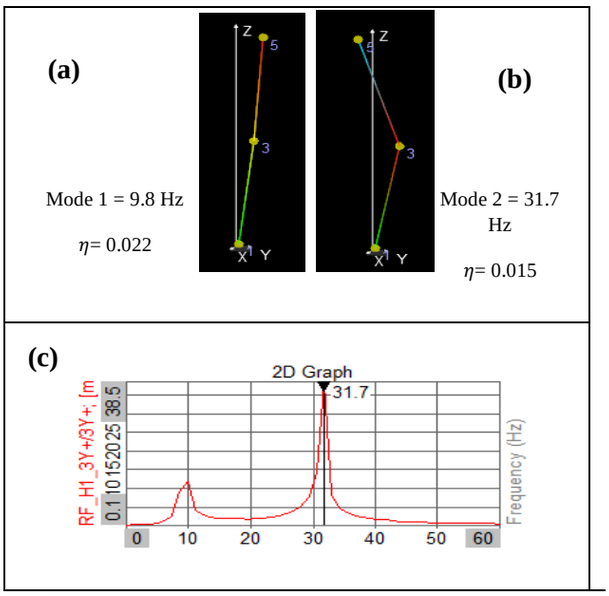

Figure 5

Empirical Modal parameters infill 75%: (a) Mode 1; (b) Mode 2; (c) FRF diagram

Box 7

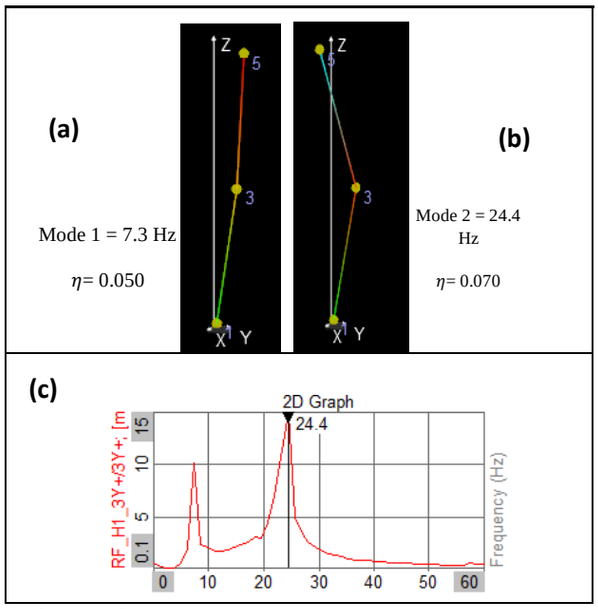

Figure 6

Empirical Modal parameters infill 50%: (a) Mode 1; (b) Mode 2; (c) FRF diagram

Box 8

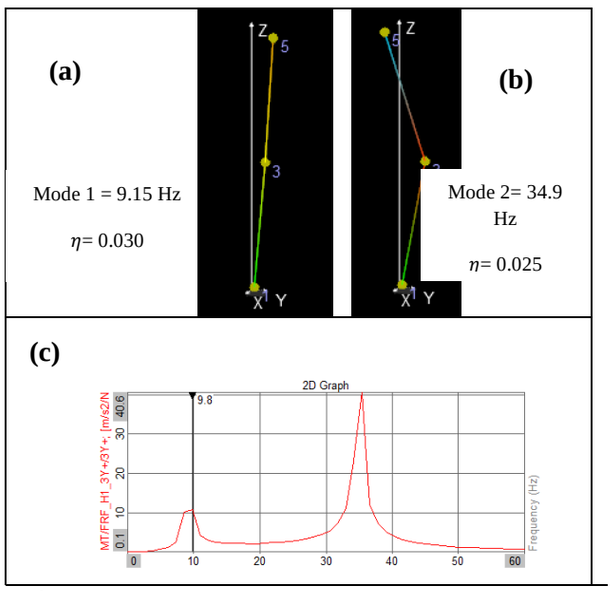

Figure 7

Empirical Modal parameters infill 25%: (a) Mode 1; (b) Mode 2; (c) FRF diagram

Source: Own elaboration

Data Analysis

The preliminary analysis of the experimental modal parameters, as illustrated in Figures 4-7, demonstrates a significant correlation with the well-documented behavior of a cantilever beam.

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In this section, Table 2 is employed to conduct a comprehensive analysis of the average damping loss factor (η) and evaluate the variations in natural frequencies as a function of the infill percentage. This analysis provides critical insights into the influence of infill percentages on the structure's dynamic characteristics, particularly in terms of energy dissipation and the resultant shifts in natural frequencies.

Such an understanding is essential for advancing the knowledge of material distribution effects on structural vibrational performance.

Box 9

Table 2

Natural frequencies and average damping loss factor

Infill density (%)	Mode	Natural frequency (Hz)	Damping loss factor (η)	Average η
100	1	10.36	0.036	0.024
	2	41.5	0.012	
75	1	9.8	0.022	0.018
	2	31.7	0.015	
50	1	7.3	0.050	0.06
	2	24.4	0.070	
25	1	9.15	0.030	0.027
	2	34.9	0.025	

Conclusions

Upon completion of the tests and subsequent analysis of the data obtained, it can be concluded that the application of additive manufacturing in the study of structural dynamics, as an initial exploratory investigation, reveals significant potential as a viable and innovative alternative for teaching modal analysis at the undergraduate level.

This approach not only facilitates access to cutting-edge methodologies but also enhances the depth of understanding of fundamental structural dynamics concepts through direct experimentation and observing vibrational effects in tangible, manipulable models.

Furthermore, this study has enabled the precise identification of interactions between the two primary modes as frequency increases. This observed behavior is attributable to the specific design of the experimental platform, wherein the joints function as movable supports.

These joints allow for controlled displacements, resulting in response spectra with distinct characteristics and specific data, offering a detailed insight into the dynamic interactions within the system.

However, if the objective is to obtain more precise response spectra or to simulate alternative structural behaviors, modifications to the design of the joints, particularly within the base plate, will be necessary. To replicate the conditions of a fixed structure, it is essential to adjust these joints to restrict displacement, thus generating response spectra that more accurately reflect the dynamics of a fixed system.

These modifications would enhance the collected data's accuracy and broaden the platform’s applicability in teaching various structural types and boundary conditions.

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Article

Evaluation of Experience in Higher Education, innovating with artificial intelligence in the implementation of predictive models

Evaluación de la experiencia en Educación Superior, innovando con inteligencia artificial en la implementación de modelos predictivos

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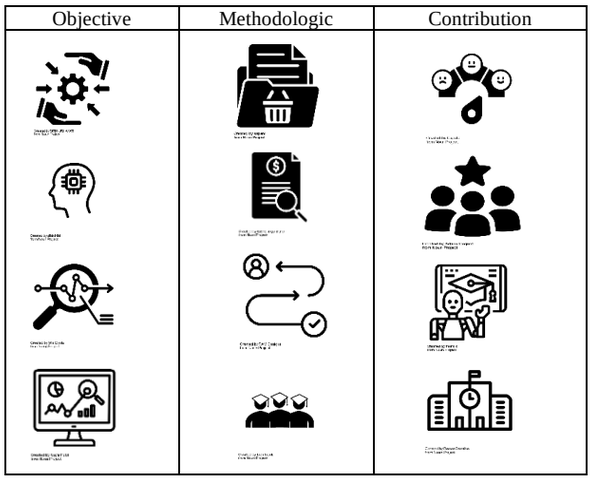
Abstract

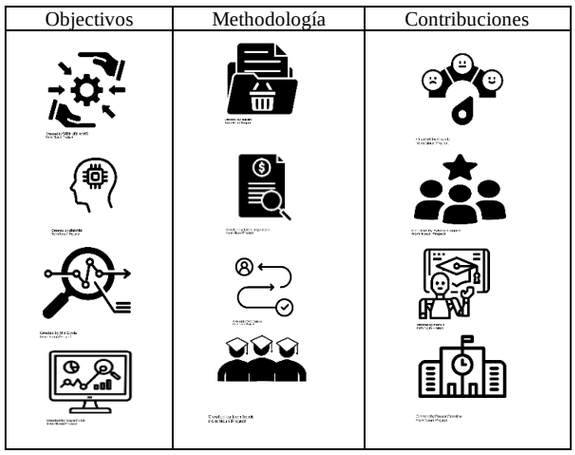
This study explores the impact of artificial intelligence (AI) and predictive models in higher education, focusing on the personalization of learning, student retention, and academic success prediction. In a constantly evolving educational environment, it is crucial for universities to implement innovative curricula that prepare students for the challenges of the current job market. The study's methodology is based on a descriptive approach, using a semi-structured survey administered to 250 higher education students. The survey included questions about academic performance, academic support, guidance, skills, and interests. The collected data were analyzed using regression techniques with SPSS software, allowing for the identification of relationships between predictor variables and student satisfaction. The analysis results revealed that, although the predictor variables explain a small proportion of the variance in student satisfaction, the identified patterns provide valuable insights for improving educational offerings. Personalization of learning and optimization of student retention emerge as key areas where AI can have a significant impact. In conclusion, while the implementation of AI predictive models presents challenges related to accuracy and ethics, these models have the potential to transform the educational experience in higher education. The study suggests that, with proper integration and alignment with educational objectives, AI can enhance the quality of education and meet the individual needs of students, contributing to a more efficient and personalized educational experience.



Higher education, Research institutions, Technological change

Resumen

El presente estudio explora el impacto de la inteligencia artificial (IA) y los modelos predictivos en la educación superior, centrándose en la personalización del aprendizaje, la retención de estudiantes y la previsión del éxito académico. Ante un entorno educativo en constante evolución, es crucial que las universidades implementen planes de estudio innovadores que preparen a los estudiantes para los desafíos del mercado laboral actual. La metodología del estudio se basa en un enfoque descriptivo, utilizando una encuesta semiestructurada aplicada a 250 estudiantes de nivel superior. La encuesta incluyó preguntas sobre rendimiento académico, apoyo académico, orientación, habilidades e intereses. Los datos recopilados fueron analizados mediante técnicas de regresión utilizando el software SPSS, lo que permitió identificar relaciones entre las variables predictoras y la satisfacción de los estudiantes. Los resultados del análisis revelaron que, aunque las variables predictoras explican una pequeña proporción de la varianza en la satisfacción estudiantil, los patrones identificados proporcionan información valiosa para mejorar la oferta educativa. La personalización del aprendizaje y la optimización de la retención estudiantil emergen como áreas clave donde la IA puede tener un impacto significativo. En conclusión, aunque la implementación de modelos predictivos de IA presenta desafíos relacionados con la precisión y la ética, estos modelos tienen el potencial de transformar la experiencia educativa en la educación superior. El estudio sugiere que, con una integración adecuada y alineada a los objetivos educativos, la IA puede mejorar la calidad de la educación y satisfacer las necesidades individuales de los estudiantes, contribuyendo a una experiencia educativa más eficiente y personalizada.



Educación superior, Instituciones de investigación, Cambio tecnológico

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Introduction

Over the last decade, the higher education sector has undergone a number of significant changes driven by rapid technological developments, especially in the area of digitisation.

These changes affect not only the organisational structures of educational institutions, but also the expectations of students and the skills required in the labour market. In this dynamic context, it is imperative that universities implement innovative curricula that prepare students for the challenges of a constantly changing working environment.

Predictive models based on artificial intelligence (AI) emerge as promising tools to revitalise pedagogical methods. These models enable personalisation of learning, improve student retention and predict academic success, thus adapting to the individual needs of students and the demands of the labour market.

According to Arnold and Pistilli (2012), learning analytics can significantly increase student success through early identification of at-risk students and timely intervention.

Despite the remarkable potential of AI in education, its implementation faces several challenges, such as the accuracy of models, the ethical interpretation of data and its alignment with educational goals.

It is crucial to address these issues to ensure that the technology is used effectively and ethically.

Broughan and Prinsloo (2020) highlight the importance of developing robust ethical frameworks for the application of AI in higher education, thereby ensuring fair and transparent use of student data.

This study seeks to explore and analyse the impact of AI on personalising learning, optimising student retention and predicting academic success. In the same vein, it is based on a comprehensive review of existing literature and empirical analysis to provide a robust theoretical and practical framework to guide the implementation of AI in higher education.

Digital transformation in universities seeks not only to improve administrative efficiency, but also to personalise learning, optimise student retention and predict academic success, thus contributing to a more efficient educational experience tailored to the individual needs of students (García-Peñalvo, 2021).

With the aforementioned, there is a need to explore and research deeply in order to apply artificial intelligence (AI) in a way that allows improving the quality of education and AI contributes to improve the performance of teachers in transferring knowledge,

that allows really improving the quality of education and meets the needs of learners without compromising the ethical and cultural principles of the academic objectives of the Universities.

This transformation seeks not only to improve administrative efficiency, but also to personalise learning, optimise student retention and provide for academic success.

Several authors have explored these issues, offering a theoretical and practical framework for understanding and harnessing the potential of AI in the educational environment.

Personalisation of learning: The ability of predictive AI models to analyse large volumes of data and detect patterns has made it possible to personalise education at an unprecedented level.

According to the study by (Broughan & Prinsloo, 2020), the implementation of AI systems in the analysis of student behaviour and performance can help design learning experiences that are more adaptive and focused on the individual needs of learners (Broughan & Prinsloo, 2020) (Arnold & Pistilli, 2012), C., & Prinsloo, P. (2020). Learning Analytics: Ethical Issues and Dilemmas. American Behavioral Scientist, 64(10), (1470-1487).

Optimising student retention: Predictive models also play a crucial role in identifying students at risk of dropping out. A study by (Arnold & Pistilli, 2012) shows that the use of predictive analytics can provide early warnings to academic advisors, allowing them to proactively intervene to improve retention (Arnold & Pistilli, 2012).

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Predicting academic success: In addition to personalising learning and improving retention, predictive AI models are effective in predicting academic success. The work of Xing et al. (2015) demonstrates how data mining and machine learning algorithms can accurately predict students' future academic performance, providing institutions with a (Xing et al., 2015) (Serna et al., 2019) (Fernandez Martinez et al., 2018) (Garcia-Peñalvo, 2021) (Castro Benavides et al., 2021) (Gartner et al., 2020) (Gartner, Top Business Trends Impacting Higher Education in 2021, 2021) (Florez-Nisperuza & Hoyos-Merlano, 2020) (Petruzzellis et al., 2006) (Baumann & Burton, 2010) (Green et al., 2015) (Butt & Rehman, 2010) valuable tool for academic planning and resource allocation (Xing et al., 2015), participation-based student final performance prediction model through interpretable Genetic Programming: Integrating learning analytics, educational data mining and theory. Computers in Human (Behavior, 47, 168-181).

The above premises provide a concrete overview of the impact of AI in higher education and highlight key studies that have contributed to the understanding and application of predictive models in this field as a background for adjusting the scenarios set out here.

Thus, the following is established from the above:

Research Question

How does the implementation of predictive AI models affect the personalisation of learning, the optimisation of student retention and the prediction of academic success in higher education?

Objective

To investigate and analyse the impact of the implementation of predictive artificial intelligence models on the modernisation of the educational experience in higher education, with a specific focus on personalising learning, optimising student retention and predicting academic success, in order to identify best practices and recommendations that can be applied in educational institutions.

The specific objectives of the study are:

1. To develop a predictive machine learning model that integrates AI into the teaching and learning process.
2. To identify patterns that influence student satisfaction and academic performance.
3. To analyse the relationship between the individualisation of teaching and student satisfaction.
4. To evaluate how AI can improve educational outcomes.
5. Encourage research and innovation in the field of AI to develop new solutions to the challenges of the future.
6. To propose guidelines for the effective integration of AI in universities, ensuring that this technology is aligned with the pedagogical plans and strategic objectives of educational institutions.

Hypothesis

The implementation of predictive AI models in higher education significantly improves the personalisation of learning, optimises student retention and enables more accurate prediction of academic success, leading to a more efficient educational experience tailored to the individual needs of students.

Theoretical Framework

In recent decades, artificial intelligence (AI) has transformed various sectors, and higher education is no exception.

The modernisation of the educational experience through the implementation of predictive AI models has become an emerging and promising trend. This transformation seeks not only to improve administrative efficiency, but also to personalise learning, optimise student retention and predict academic success (Arnold & Pistilli, 2012).

Transformation is redefining learning and its impact on education (Serna et al., 2019), Working IT Steering Group Crue - ICT, 2017; (Fernandez Martinez et al., 2018).

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This transformation is presented recently in the incorporation of advanced technologies such as artificial intelligence that promises to change pedagogical methods with it, the academic plans generating a new form of teaching-learning (García-Peñalvo, 2021).

In addition, the author suggests that these technological changes must go hand in hand in the curricula and organisational structure for educational institutions to be effective (Castro Benavides et al., 2021), taking advantage of the human resources themselves and the environment that surrounds them (Serna et al., 2019).

The conceptual foundations and empirical studies underpinning this transformation, covering three main areas: personalisation of learning, optimisation of student retention and prediction of academic success.

Personalisation of learning

Personalisation of learning is one of the most promising aspects of AI in higher education. The ability of predictive models to analyse large volumes of data and detect patterns allows educational institutions to tailor teaching to the individual needs of students. According to (Broughan & Prinsloo, 2020), AI systems can analyse student behaviour and performance to deliver more adaptive and student-centred learning experiences (Broughan & Prinsloo, 2020).

Personalised learning environments use data to adjust educational content, pace and teaching style to the preferences and needs of individual learners. This approach not only improves student motivation and engagement, but also facilitates deeper and more effective learning (Huberman & Miles, 1994).

Optimising Student Retention

Student retention is a critical challenge for higher education institutions. The ability to predict and prevent student attrition through predictive analytics is a significant advance in this area. (Arnold & Pistilli, 2012) demonstrated that predictive models can provide early warnings to academic advisors, allowing them to proactively intervene to improve student retention (Arnold & Pistilli, 2012).

In this sense, these models use historical and current student data, such as grades, participation in academic activities and other indicators, to identify those at risk of dropping out. Early interventions based on these predictions can include additional tutoring, academic counselling and psychological support, which helps to keep students on track for graduation (Broughan & Prinsloo, 2020).

Forecasting Academic Success

Forecasting academic success using predictive AI models allows educational institutions to plan and allocate resources more efficiently. (Xing et al., 2015) demonstrated how data mining and machine learning algorithms can accurately predict students' future academic performance (Xing et al., 2015). These predictions are based on a variety of factors, including academic history, online behaviour and interaction with educational resources.

Challenges and Ethical Considerations

While the benefits of implementing predictive AI models in higher education are significant, there are also challenges and ethical considerations that must be addressed.

Data privacy, equity of access to technologies and responsible use of predictions are crucial issues. (Broughan & Prinsloo, 2020) stress the importance of developing clear ethical frameworks and policies for the use of AI in education, ensuring that technologies are used in a fair and transparent manner (Broughan & Prinsloo, 2020). The ability to predict academic success allows institutions to implement continuous improvement strategies, adjust educational programmes and provide targeted support to students in need. It also facilitates better curriculum planning and optimisation of teaching and administrative resources.

(Gartner et al., Use Gartner Reset Scenarios to Move from Survival to Renewal for Higher Education, 2020) state in their research that a crucial dimension of digital transformation is the ability of universities to leverage data to understand and improve the processes that university students go through, they identify scenarios in which they emerge from digital transformation, such as: New paradigms, consolidation, standardisation and adjustment, and management of disruption, as shown in the table below.

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Box 1

Table 1

Evolutionary scenarios in digital transformation

Transcendent transformation Low Transformation	New paradigms Consolidation Short term	Standardization and adjustment Disorder management Long term

Source:: Adaptado de Gartner (2020). "Use Gartner Reset Scenarios to Move from Survival to Renewal for educación superior"

Each presents profound challenges and opportunities specific to the use and application of artificial intelligence at higher education level.

The short-term consolidation scenario with little transformational impact is characterised by high competition in student recruitment, experience creation and reconstruction. Those institutions with a solid reputation seek a strong face-to-face educational experience that remains attractive to students (Coronado, 2020).

Those with mature online strategies will leverage their experiences during the pandemic to move forward and gain market share.

In this scenario, AI can be used to analyse real-time data on the effectiveness of both online and face-to-face teaching strategies, allowing institutions to quickly adjust their methods to maximise student retention and satisfaction (Florez-Nisperuza & Hoyos-Merlano, 2020).

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AI tools can also help optimise resources, reducing costs and improving educational outcomes, which is crucial at a time when many universities are seeking operational efficiencies.

The disorder management scenario, on the other hand, is characterised by a situation of prolonged uncertainty, where institutions face major challenges in maintaining stability and educational quality. Both teachers and students respect the rules, but are uncomfortable with the experience. The sector will tend to polarise into institutions that are elite, with a strong and renewed research orientation (Vargas, et al., 2022) and attractive to students, but tend to preserve traditional teaching practice.

In this case, AI becomes essential to manage large volumes of information efficiently, helping institutions to understand and control the evolution of educational processes in a dynamic and changing environment.

In this context, universities seek to optimise resources and maximise student satisfaction.

This will allow us to make the necessary adjustments by applying agility mechanisms that favour the improvement of students and educational quality (Florez-Nisperuza & Hoyos-Merlano, 2020).

Student satisfaction emerges as a crucial important aspect that is affected by the scenarios prior to the digital transformation in Higher Education Universities. To this end, in the statements of (Petruzzellis et al., 2006), student satisfaction influences certain factors such as; cognitive, cognitive, affective and attitudinal factors that emerge from evaluations or metrics measuring the service provided.

In that sense (Baumann & Burton, 2012) state that high satisfaction with the service received not only has a positive effect on students, but also leads to an increase in the recommendation rate towards the institution, i.e. a positive multiplier effect, as confirmed by the findings of (Abdelmaaboud et al., 2020).

This allows such satisfaction to provide a satisfactory environment with its discipline, attitude, commitment, as pointed out by the study of (Green et al., 2015).

Which affirm the emotional aspect of when the educational service meets the expectations that the learner expected, even beyond what he (learner) expected in the beginning.

On the other hand, studies by (Butt & Rehman, 2010) identify in their findings a number of factors that impact student satisfaction, such as the faculty experience, facilities, academic content, career offerings, as shown in Figure 2 below.

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Box 2

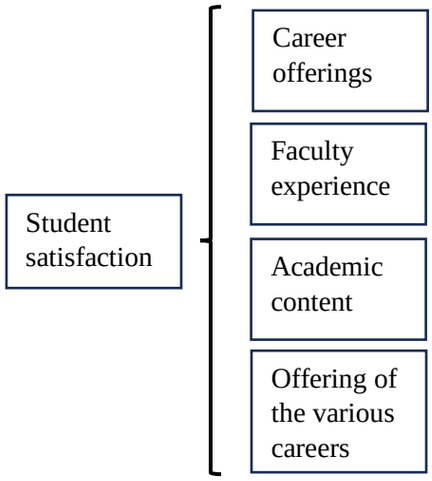

Figure 1

Factors impacting students.

Source: Butt and Rehman (2010). "Study examining student satisfaction at the tertiary level.".

Education value chain

This value chain is carried out throughout the student's entire journey from the beginning stage within the University to the alumni stage, highlighting each stage in their educational experience throughout their career.

It will focus on stages of a conversion funnel in which we will focus on the learning stage belonging to the Customer Journey phases of the student in this subprocess is intended to go through the various experiences of the student, starting at the beginning measuring in each of them their experience, thereby allowing them to universities of higher education to focus their efforts on strategies aligned with the objectives.

Box 3

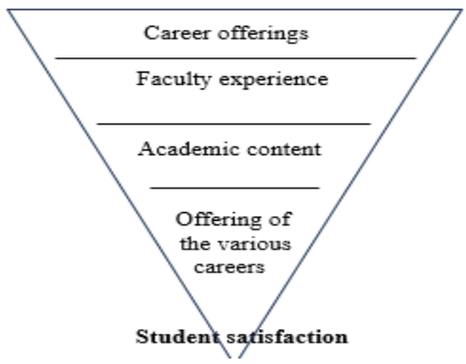

Figure 2

Value chain funnel

Source: Own elaboration with data from Butt and Rehman (2010)

Once learner satisfaction has been established in the value chain funnel, the next step is the development of automatic learning.

Methodology

We started with the collection and analysis of detailed student data (250 student testimonials), including 8 questions related to their academic performance, academic support, orientation, skills, interests, among others.

These questions are related as described in table 1 below.

Definition of the research approach, design and type of research

The methodology is the analysis of how the research will be carried out as stated by (Braikie, 2007) as well as the description of the data collection and analysis techniques as expressed by (Saunders, 2009).

The type of study used was descriptive, which allowed for a detailed description of the value chain funnel processes and the existing evaluation methodologies at the University, without intervening in them or establishing casual relationships.

This descriptive approach enabled a comprehensive understanding of the characteristics, behaviours and phenomena related to student satisfaction processes and the evaluation methodologies used.

By not intervening in the satisfaction processes of higher education students or establishing casual relationships, the descriptive study could have provided an objective view of the existing situation, allowing for an accurate characterisation of the student satisfaction processes and the assessment methodologies used.

Application of the semi-structured survey

A semi-structured survey was designed and applied to the selected participants. This survey included questions related to the objectives of the study, allowing for the collection of relevant information on student satisfaction and the assessment methodologies applied.

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Data analysis

Once the survey data had been collected, the data was analysed. This included reviewing the responses provided by the participants, identifying patterns, trends and relationships between the variables studied, and drawing meaningful conclusions.

Evaluation model

It will be measured by means of a structured questionnaire consisting of 8 items. The questionnaire will assess satisfaction with the innovation experience of the students related to their academic performance, academic support, orientation, skills, interests, among others.

These questions are related as described in table 1 below.

Box 4

Table 2

Description of open questions

Código Constructor	variable	Objetivo de la variable	Objetivo de la pregunta	Pregunta
P1	Motivación	Evalúa nivel de motivación de los alumnos con relación a su carrera/Universidad	La motivación es un factor clave para el compromiso y el éxito académico de los alumnos.	¿Qué tan motivado te sientes al estudiar está carrera/universidad? (escala de 1 a 5, donde 1 es "nada motivado" y 5 es "muy motivado").
P2	Calidad de enseñanza	Evaluar la percepción de los alumnos sobre la efectividad de los profesores en transmisión de contenidos académicos.	La calidad de enseñanza tiene un impacto directo en el aprendizaje y la comprensión de los alumnos.	¿Consideras que los profesores transmiten de manera efectiva los contenidos académicos? (Opciones de respuesta: SI/NO/Tal vez).
P3	Aplicabilidad de los Conocimientos	Determinar si los alumnos perciben que los conocimientos adquiridos en sus estudiantes son aplicables en su futuro profesional.	La aplicabilidad de los conocimientos es fundamental para la preparación de los alumnos para su futuro profesional.	¿Crees que los conocimientos adquiridos en tus estudios tienen una aplicación práctica en tu futuro profesional? (Opciones de respuesta SI/NO/No estoy seguro).
P4	Participación	Evaluar el nivel de participación de los alumnos en actividades académicas extracurriculares relacionadas con su campo de estudio.	La participación en actividades académicas complementarias puede enriquecer la experiencia de aprendizaje y fomentar el desarrollo de habilidades adicionales.	¿En qué medidas participas en actividades académicas extracurriculares relacionadas con tu campo de estudio? (Escala de 1 a 5, donde 1 es "nunca participo" y 5 "participo siempre").
P5	Plan de estudios y variedad	Evaluar si los alumnos perciben que el plan de estudios ofrece una variedad de asignaturas y oportunidades de especialización acorde a sus objetivos.	Un plan de estudios estructurado y variado brinda opciones de aprendizaje adaptadas a los intereses y objetivos individuales de los alumnos	¿Consideras que el plan de estudios ofrece una variedad de asignaturas y oportunidades de especialización de acuerdo con sus objetivos? (Opciones de respuesta: SI/NO/Tal vez).
P6	Acceso a recursos y tecnologías	Evaluar la percepción de los alumnos sobre la accesibilidad y disponibilidad de los recursos académicos como bibliotecas, herramientas, tecnológicas, laboratorios y plataformas de aprendizaje en línea.	El acceso a recursos y tecnología adecuados facilita el proceso de aprendizaje y el desarrollo de habilidades necesarias en la educación actual.	¿Qué tan accesible y disponible consideras los recursos académicos como, bibliotecas, herramientas, tecnologías, laboratorios y plataformas de aprendizaje en línea? (Escala de 1 a 5, donde 1 es "poco accesible" y 5 es "muy accesible").
P7	Apoyo y orientación académica	Evaluar la percepción de los alumnos sobre el respaldo y la orientación académica blindados por el personal de la Universidad (tutores, asesores, profesores, etc), para tomar decisiones informadas sobre su trayectoria académica.	El apoyo y la orientación académica son fundamentales para que los alumnos tomen decisiones informadas y se sientan respaldados en su trayectoria académica.	¿Sientes que recibes un adecuado respaldo y orientación académica por parte del personal de la Universidad, (tutores, asesores, profesores, etc) para tomar decisiones informadas sobre tu trayectoria académica? (opciones de respuesta SI/NO/ Tal vez).
P8	Satisfacción general	Evaluar el nivel de satisfacción general de los alumnos con sus estudios Universitarios hasta el momento.	La satisfacción general refleja la experiencia global de los alumnos en sus estudios Universitarios.	En general, ¿Qué tan satisfecho(a) estas con tus estudios Universitarios hasta ahora? (escala de 1 a 5, donde 1 es "nada satisfecho(a)" y 5 es "muy satisfecho(a)"

Using SPSS software to perform data capture and analysis to create tables and graphs with complex data. It meticulously coded qualitative transcript data to ensure that each case was treated as a unique entity (Eisenhardt, 1989) while maintaining the context of the testimonies in which key words, sentences, phrases or complex paragraphs were coded (Huberman & Miles, 1994). Subsequently, after this coding, a cross-analysis is carried out (Yin, 1994).

All of the above allows us to understand the replication and variability in this type of study, which allows us to enrich it. The patterns identified in the analyses allow us to know anticipated or future behaviours of university students and thus improve the educational offer.

The above allows us to draw conclusions backed by real or raw data that are crucial for making decisions and improving education in real time, allowing us to respond quickly and proactively to the needs of university students before they may be upset or disappointed in their choice of career and university.

Results

Model Summary

The following table presents a summary of the regression model that analyses the predictors of students' level of satisfaction with the answers to their questions. The components and results of the model are detailed below.:

Box 5

Table 3

Summary of the regression model

Modelo	R	R cuadrado	R cuadrado corregido	Error Tip. de la estimación	Estadísticos de cambio					Durbin-Watson
					Cambio en R cuadrado	Cambio en F	gl 1	gl 2	Sig. Cambio en F	
1	.249*	.062	.028	1.13998	.062	1.807	7	192	.088	1.635

Source: Own elaboration using SPSS

Components of the Model

1. R (Multiple Correlation Coefficient): Indicates the quality of the model's prediction and the strength of the direction of the relationship between the independent variables and the dependent variable. A value of 0.249 suggests a moderate or low positive correlation between the predictor variables and the dependent variable.

2. R-squared (Coefficient of determination): Represents the proportion of the variance in the dependent variable that is explained by the independent variables. In this model, R-squared is 0.062, which indicates or suggests that only 6.2% of the variance or variability in response satisfaction can be explained by the predictor variables included in the model.

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3. Adjusted R-squared: Adjusts the R-squared value for the number of predictors in the model. Here, the value is 0.028, suggesting that, after adjusting for the number of predictors, the model explains only 2.8% of the variance in satisfaction. This standard error represents a measure of the part of the variability of the dependent variable that is not explained by the regression line. In general, the better the fit, the smaller this standard error.

4. Standard error of the estimate: This is a measure of the precision of the model's predictions. It measures the standard dispersion of the observed values around the regression line. A value of 1.13998 indicates the standard deviation of the prediction errors, i.e. there is considerable variability in the estimates produced by the model.

Change statistic

1. Change in R-squared: This indicates how much the model improves with the addition of predictor variables, i.e. the change in the R-squared value if a variable is added or removed from the model. In this case, the change is 0.062, suggesting that the added predictor variables additionally explain 6.2% of the variance in satisfaction.

2. Change in F: This is the F-test statistic comparing the models with and without the most recently added variable. The value of 1.807 is the F-statistic for the change in R-squared, i.e. the magnitude of the change in the new variable. This value is used to determine whether the change in R-squared is significant.

3. gl1 and gl2: These represent the degrees of freedom of the model, associated with the numerator and denominator of the F-test, respectively. Here, gl1 is 7 (the number of predictors) indicating 7 degrees of freedom and gl2 is 192 (the sample size minus the number of predictors minus 1) indicating 192 degrees of freedom in the denominator.

4. Sig. change in F: This is the significance value associated with the change in the F-statistic. A value of 0.088 indicates that there is an 8.8% probability that the change in R-squared is statistically significant, suggesting that the predictor variables together are significant in predicting satisfaction with the responses, i.e. the F-statistic is due to chance.

Box 6

Table 4

Shows whether or not there is a relationship between the variables

Anova[a]

Modelo		Suma de cuadrados	gl	Media cuadrática	F	Sig.
1	Regresión	5.285	7	.755	1.047	.399[b]
	Residual	138.395	192	.721		
	Total	143.680	199			

Source: Own elaboration using SPSS

The F statistic allows us to test the hypothesis that the population value of R is zero, which in the simple regression model allows us to test the hypothesis that the slope of the regression line is zero.

The critical level of (sig) indicates that, if we assume that the population value of R is zero, it is impobable (probability 0.0399) that R, in this sample, takes the value 0.249. This implies that Res is greater than zero and that, consequently, both variables are linearly related. That is to say; as p=0.088<

Table No. 3. Shows the coefficients of the regression line.

Box 7

Table 5

Shows the coefficients of the regression line

Coefficientsa

Modelo	Coeficientes no estandarizados		Coeficientes tipificados		
	B	Error tip.	Beta	T	Sig.
1. Constante	2.625	.665		3.949	.000
¿Qué tan motivado te sientes al estudiar esta carrera/universidad?	.154	.096	.113	1.597	.112
¿Consideras que los profesores transmiten de manera efectiva los contenidos académicos?	-.143	.100	-.101	-1.425	.156
¿Crees que los conocimientos adquiridos en tus estudios tienen una aplicación práctica en tu futuro profesional?	.002	.104	.001	.019	.985
¿En qué medidas participas en actividades académicas extracurriculares relacionadas con tu campo de estudio?	-.022	.074	-.021	-.298	.766
¿Consideras que el plan de estudios ofrece una variedad de asignaturas y oportunidades de especialización de acuerdo con sus objetivos?	.020	.102	.014	.192	.848
¿Sientes que recibes un adecuado respaldo y orientación académica por parte del personal de la universidad (tutores, asesores, profesores, etc)?	.004	.069	.005	.065	.948
¿Qué tan accesible y disponible consideras los recursos académicos como, bibliotecas, herramientas tecnológicas, laboratorios y plataformas de aprendizaje en línea?	.278	.103	.192	2.701	.008

Source: Own elaboration using SPSS

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The coefficient corresponding to constant is the origin of the regression line a = 2.625. The coefficient corresponding to the predictor variables is the slope of the regression line b = 0.154. For each of the values of the predictor variables (b=-0.143, 0.002, -0.022, 0.020, 0.004, 0.278) indicates the average change corresponding to the dependent variable (Satisfaction Level) for each unit of change in the independent predictor variables.

Predictors

Accessibility and availability of academic resources: libraries, technological tools, laboratories, and online learning platforms.

- Motivation to study the degree/university.
- Variety and opportunities for specialization of the curriculum.
- Effectiveness of professors in transmitting academic content.
- Academic support and guidance from university staff (tutors, advisors, professors, etc.).
- Participation in extracurricular academic activities related to the field of study.
- Practical application of the knowledge acquired in the studies in the future professional life.

The regression analysis revealed that the predictor variables explain only a small proportion of the variance in student satisfaction.

However, the patterns identified in the analyses allow for future behaviours of university students and improved educational provision.

Conclusion

The regression model shows that the variables mentioned have a low significant impact on student satisfaction with respect to the responses received. Although the R-squared is relatively low, indicating that there are other factors not included in the model that also affect satisfaction, the significant change in F (p = 0.088) suggests that the variables included are relevant.

This analysis can serve as a basis for improving the areas identified as influencing student satisfaction. The analysis of the correlation table shows that there are low significant relationships between several variables that affect students' satisfaction and perception of their academic experience.

Especially, accessibility of resources and academic support received seem to be important factors influencing students' overall satisfaction and motivation.

Therefore, the Hypothesis with the title: The implementation of predictive artificial intelligence models in higher education significantly improves the personalisation of learning, optimises student retention and allows for more accurate prediction of academic success, leading to a more efficient educational experience tailored to the individual needs of students.

With the results obtained above we can conclude that the hypothesis is not fulfilled by having such low significance values, that is, with these results the hypothesis does not have much support so that the implementation of predictive models in higher education does not significantly improve the personalisation of learning, due to other factors that were not taken into account in this article, which may be subjective student which reflects lack of subjective situations of personal motivation one of the predictor variables with respect to the variable level of satisfaction.

Research suggests that predictive AI models have the potential to improve the educational experience in higher education. However, challenges are faced related to model accuracy, ethical interpretation of data and alignment with educational goals.

It is concluded that AI can contribute to improving the quality of education without compromising the ethical and cultural principles of institutions.

Declarations

Conflict of interest

The authors declare that they have no conflicts of interest. They have no known competing financial interests or personal relationships that might have appeared to influence the article reported in this paper.

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Authors' contributions

Torres-Gutiérrez, Arturo: Contributed to the project idea and research development.

Lino-Gamiño, Juan Alfredo: Contributed to research development, data analysis, review and editing.

Díaz-Ledezma, José de la Cruz: Contributed with review and editing.

Enríquez-Cerda, Pablo: Contributed with research method, data analysis.

Availability of data and materials

Data sets used or analyzed during the current study are available upon request from the corresponding author.

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Abbreviations

R (Multiple correlation coefficient).
R square (Coefficient of determination).
Sig Significance.
AI Artificial Intelligence.

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Article

Application of design thinking in EE Technological Competences in Education

Aplicación de design thinking en la EE Competencias Tecnológicas en la Educación

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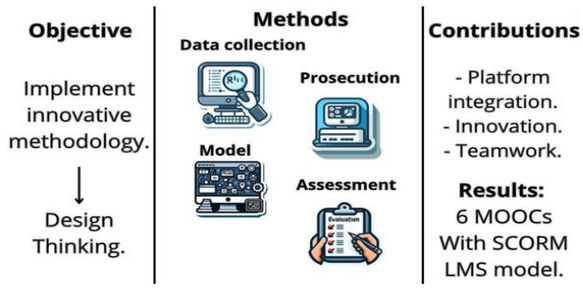
Abstract

The present research refers to the implementation of an innovative learning methodology called Design Thinking with the students of the Bachelor's Degree in Administrative Computing Systems at the Universidad Veracruzana, Xalapa area, specifically in the Educational Experience Technological Competencies in Education. The Design Thinking model is a methodology for solving problems that is based on five stages and focuses attention on people. Applying this methodology in the development of the aforementioned educational experience generated, as a result, the development of 6 Massive Online Open Course (MOOC), using a Shareable Content Object Reference Model (SCORM) or Learning Management System (LMS) in any of the free platforms available and integrating educational technologies to create it, promoting teamwork, innovation, empathy and self-regulation in students.



Innovation, Design Thinking, Learning, Education

Resumen

La presente investigación se refiere a la implementación de una metodología innovadora de aprendizaje denominada Design Thinking con los estudiantes de la Licenciatura en Sistemas Computacionales Administrativos de la Universidad Veracruzana zona Xalapa específicamente en la Experiencia Educativa Competencias Tecnológicas en la Educación. El modelo Design Thinking es una metodología para resolver problemas que se basa en cinco etapas y centra su atención en las personas. Aplicar esta metodología en el desarrollo de la experiencia educativa mencionada generó como resultado, el desarrollo de 6 Massive Online Open Course (MOOC), usando un Modelo de Referencia para Objetos de Contenido Compartible (SCORM) o Sistema de gestión del aprendizaje (LMS) en alguna de las plataformas gratuitas disponibles e integrando las tecnologías educativas para crearlo, favoreciendo el trabajo en equipo, la innovación, la empatía y la autorregulación en los estudiantes.

Innovación, Design Thinking, Aprendizaje, Educacion

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Introduction

The main objective of the Bachelor's Degree in Administrative Computer Systems is to train professionals with solid knowledge in information technologies in organisations to provide them with technological solutions that allow them to produce quality information, improving decision-making processes and generating competitive advantages (UV, 2024). (UV, 2024).

Education has been transformed in recent times, especially higher education, as technology is always within reach to influence student learning in a meaningful way.

Taking into account the behaviour of the graduates of the Bachelor's Degree and the talks with employers, the intervention of the Bachelor in Administrative Computer Systems in the educational field is important, so that in the Curriculum of the Bachelor's Degree has considered as an optional educational experience the educational experience Technological Competences in Education, constituted as a course-workshop distributed in two theoretical hours, two practical hours and six credits. The aim of this educational experience is for the student to learn about existing concepts and methodologies for the development of new technologies applied to education from the perspective of a teacher and possible researcher.

It is expected that the Bachelor in Administrative Computer Systems will be a professional with solid knowledge in Information Technologies in organisations in order to provide them with technological solutions that allow them a competitive advantage.

Delimitation of the problem and importance

The Graduate in Administrative Computer Systems must provide technological solutions, which are completely adapted to the needs of the different organisations or users. 'Through Design Thinking and User Experience Design, we approach our clients in a more empathetic way, as this implies understanding their real needs and being really interested in the details of their lives. Generating empathy with our customers means putting their problems, rather than our solutions, first' (Vargas, 2021).

We must equip students with the innovation, creativity and communication skills that today's world demands. Some of the problems detected in the learning processes of computer administrative systems students are the lack of motivation and self-regulation in their academic activities, as well as the lack of digital competences with the use of ICTs to propose solutions to real cases.

Effective integration of ICT in schools and classrooms can transform pedagogy and empower learners. In this context, teachers' competences are crucial to integrate ICT into their professional practice, to ensure equity and quality of learning. Teachers must also be able to use ICT to guide learners in acquiring knowledge society-related competences such as critical and innovative thinking, complex problem solving, collaborative skills and socio-emotional skills.

Higher Education Institutions (HEIs) have a social responsibility that permeates all their constituent areas. We know that the link with society gives relevance to educational programmes, since society expects solutions to the different problems it faces through knowledge. This is where the University endorses the important role of research.

Problem solving can take place in different areas, but society values the contributions of universities highly and their credibility is very strong.

Thus, HEIs commit the student and academic community to redouble their efforts in the search for and solution of problems.

This has led teachers to incorporate into the classroom agile methodologies for problem solving, full of creativity and innovation, such as (Asunción, 2019): Case Analysis, Role Playing, Problem-Based Learning, Learning in Simulated Environments, Project-Based Learning, Cooperative Learning, among others.

In particular, the Design Thinking methodology has been chosen, which addresses problem solving with a focus on innovation and creativity.

In order to achieve meaningful learning, students need to learn to learn through individual processes, specifically adapted to their needs.

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In view of this, it is expected that by applying the active design thinking methodology as a teaching strategy, benefits such as learning to work in a team, fostering creativity, developing interest in learning more and strengthening problem solving will be achieved.

The students became more sensitive and empathetic to the needs of other users of their systems. It also seeks to strengthen the following digital competences and innovations:

Open Educational Resources (OER)

Open educational resources are all resources that are available to educators and learners without paying royalties or licensing fees.

Social networking

Social networks are websites or applications that provide online connections with people who are part of networks built around common interests or activities. Social networking activity includes the posting of profiles that provide information about individuals. Facebook, Twitter, Instagram and LinkedIn are examples of social networking applications that can offer possibilities for connection and exchange for educators and learners, at classroom, school and global level.
Mobile technologies

Mobile device ownership is growing worldwide. Learners are increasingly using mobile technologies, such as smartphones and tablets, to access information on the Internet for learning purposes. Creative use of these devices can support educational equity, improve efficiency and productivity in the classroom, and facilitate personalised learning.

The Internet of Things

The Internet of Things is the network of computing devices embedded in everyday objects other than computers and smartphones, enabling them to send and receive data over the Internet. The Internet of Things is transforming many areas of everyday life.

Artificial intelligence (AI)

AI applications include expert systems, speech recognition and natural language processing, computer vision and image capturing technologies.

Virtual Reality (VR) and Augmented Reality (AR)

Virtual reality (VR) is a computer-generated simulation of an environment with which a person can interact.

The person is immersed in this simulated environment and can manipulate objects or perform various actions. Augmented reality (AR) is a visualisation of a real environment to which elements are added virtual synthetic images, which are superimposed on the physical environment in real time. AR modifies a person's perception of a real environment, while VR replaces the real environment with a simulated one.

Macrodata

As online connections between people and devices increase, society generates digital data traces at an extraordinary rate, unprecedented in all of human history. Social computing, networked devices, electronic transactions, mobile computing, wearable sensors, environmental scanners, generate billions of events per second, many of which are stored for later analysis or can be analysed as a real-time data stream.

Model Implementation (Methodology)

The design thinking methodology is defined as ‘an analytical and creative process that engages a person in opportunities for innovative idea generation and takes the end-users’ perspective as the focus for experimenting, modelling and prototyping, gathering feedback and redesigning. In this way, problems and needs can be identified and effective solutions, and in many cases alternatives, can be offered for each of them’ (Arias, 2019).

Design thinking stands out as an active methodology with an effective educational and innovation approach that places the student as the protagonist and highlights collaboration to solve challenges.

Unlike other project-centred methodologies, it is distinguished by its comprehensive focus on the development of soft skills such as empathy, creativity, learning autonomy and positive thinking.

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Phases of design thinking:

- *Empathise*: This initial phase has to do with understanding what the users' needs are; it seeks to deeply analyse the students, to know their needs in relation to technological competences. To carry out this phase, interviews, surveys and other tools to gather information are recommended.

In this stage, the aim is to deeply analyse the learners, to know their needs in relation to technological competences. The framework of competences for teachers in Information and Communication Technologies (ICT) developed by UNESCO is presented.

This document responds to recent technological and pedagogical developments in the field of ICT and education, and incorporates in its structure inclusive principles of non-discrimination, open and equitable access to information, and gender equality in the delivery of technology-supported education. It addresses the implications of recent technological developments in education and learning, such as artificial intelligence (AI), mobile technologies, the Internet of Things and open educational resources, in support of the creation of inclusive knowledge societies. (UNESCO, 2024)

The Framework consists of 18 competences organised around the six aspects of teachers' professional practice, at three levels of pedagogical use of ICT by teachers. The underlying idea is that teachers who have the competencies to use ICT in their professional practice will deliver quality education and ultimately be able to effectively guide the development of students' ICT skills. (UNESCO, 2024)

Of the 18 competences, 1 was assigned to each student and an individual presentation of each competence is prepared, mentioning what it consists of, its characteristics and its impact on education.

- *Defining the problem:* This consists of clearly establishing the technological skills that students should develop. This ranges from basic skills such as the use of computer tools to more advanced skills such as programming or interface design.

In this phase, it is necessary to clearly establish the technological skills that the students must develop.

The working teams are created and the projects to be carried out per team are established as follows:

- Team 1, course / tutorial on learning basic level algorithms.
- Team 2, course / tutorial on introduction to Javascript.
- Team 3, course / tutorial on Introduction to AI.
- Team 4, course / tutorial introduction to digital marketing.
- Team 5, course / tutorial introduction to information cybersecurity.
- Team 6, HTML basic course

Investigate the infrastructure necessary for the implementation of technological competences in the organisation. Identify an example of an organisation offering MOOCs (Massive Online Open Courses).

An individual presentation of each organisation, the course, the infrastructure, characteristics and components is elaborated.

- *Ideate*: During this phase, the team has to think creatively, brainstorming possible solutions. During this phase, the team must think creatively, brainstorming possible solutions.

Taking into account the problem to be solved by each team with the proposal for each project to be carried out, the teams prepare a presentation with the following information: Introduction, Characteristics, Type of platform, Components, Advantages, Disadvantages, Costs, Demonstration of a real case.

- *Prototyping*: Once the best ideas have been selected, this phase basically consists of materialising the ideas, the prototype can be digital or physical.

Once the best ideas have been selected, this phase basically consists of materialising the ideas, creating a prototype of the online course using available tools and platforms (e.g. prototypes of content, module structure, first lessons).

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Each team presents its prototype on the technological platform where the course will be developed, the structure, content, activities and exercises to be carried out in the course are shown; as well as the presentation of the different technological resources to be used.

- *Testing*: In this stage, students test and evaluate the prototypes. It is a phase that serves for feedback and validation to discover errors.

Conduct usability testing of the course with the pilot group, gathering feedback on user experience, clarity of content and effectiveness of learning.Delivery of the integrative project based on the application of new technologies applied to learning in a real case.

By applying Design Thinking to the development of technological competencies in education, a collaborative, creative and user-centred approach is encouraged, which can lead to better learning outcomes and more effective preparation of students to meet the technological challenges of the future.

Results

As part of the implementation of the innovative methodology, a census was conducted targeting students through a digital form. Seventeen students responded.

Box 1

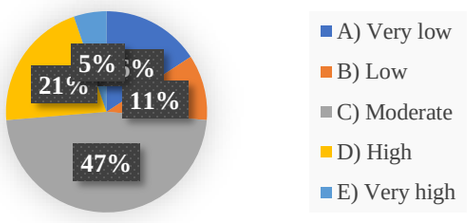

Figure 1

How would you describe your understanding of the Design Thinking model before starting the course?

Source: Own elaboration

A model of educational innovation is not fully understood by learners from the outset. Considering moving away from traditional learning represents a big challenge for all involved. We can see from the graph that, for the most part, students were aware of the model, however, only a small percentage understood it in its entirety.

Box 2

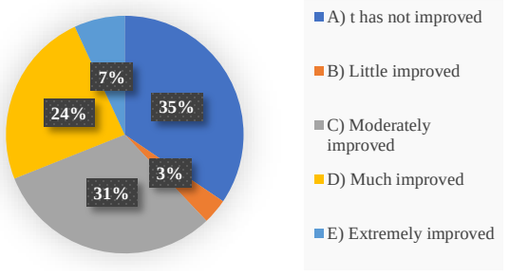

Figure 2

To what extent do you consider that the Design Thinking model has improved your ability to identify and define problems in the context of MOOC development?

Source: Own elaboration

As can be seen in the graph, one of the objectives of the model is achieved for most of the students. In the students' graduation profile, problem solving is identified, so we contribute in this sense, understanding that it is a valuable competence in the labour field.

Box 3

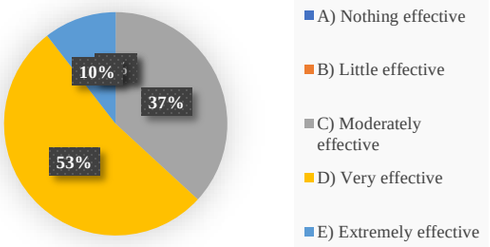

Figure 3

How effective has the Design Thinking model been in fostering creativity in the generation of ideas for the MOOC?

Source: Own elaboration

In this graph we can see that all students were able to develop their creativity, which is highly beneficial for their education.

Box 4

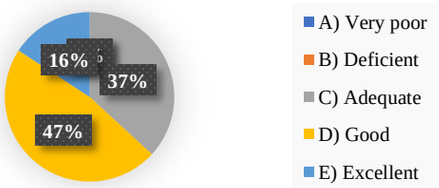

Figure 4

How would you evaluate the collaboration and teamwork during the process of applying Design Thinking in the development of the MOOC?

Source: Own elaboration

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The participation of the members in the development of the MOOC is mostly identified as good. We know that the world of work demands teamwork as organisations carry out various projects that must be developed in a timely manner, which is why strategies involving collaborative work are formulated.

This is an area that needs to be strengthened in students. During the development of the work, the students faced different challenges related to the distribution of work, adequate time management, hierarchy, etc.

Box 5

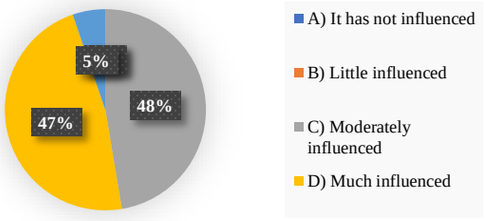

Figure 5

How has the empathy process of Design Thinking influenced the design of the MOOC, considering the needs and expectations of the end users (MOOC learners)?

Source: Own elaboration

In this graph we can see that the objective of identifying user needs was achieved. To achieve this, the students conducted interviews, detected needs and involved the user at all times.

Box 6

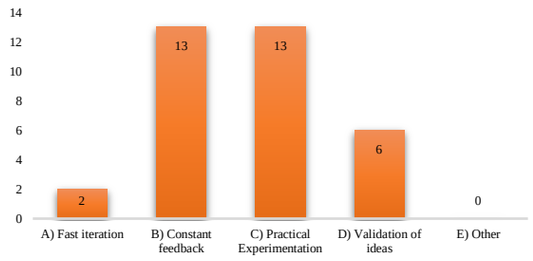

Figure 6

What aspects of the prototyping and testing process in Design Thinking do you think were most useful for the creation of the MOOC?

Source: Own elaboration

Students rated constant feedback and practical experimentation, two aspects that the model encourages, as useful with thirteen favourable responses.

Box 7

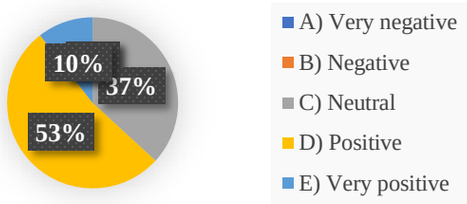

Figure 7

How would you rate the impact of Disign Thinking on the clarity and quality of the content and structure of the MOOC you developed?

Source: Own elaboration

In this section we can see that students generally rate the impact of the methodology used on the final work as positive. It provided clarity and quality of content to the MOOCs conducted.

Box 8

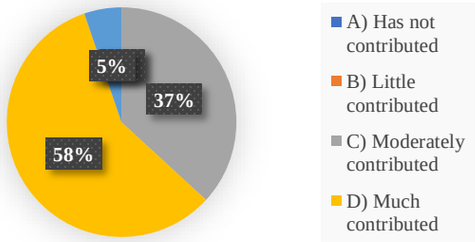

Figure 8

To what extent has the Design Thinking model contributed to improving the learning experience and accessibility of the MOOC for students?

Source: Own elaboration

The majority of students consider that the innovative methodology contributed a lot to improving their learning, i.e. they consider that there was a significant and positive difference compared to the traditional methodology

Box 9

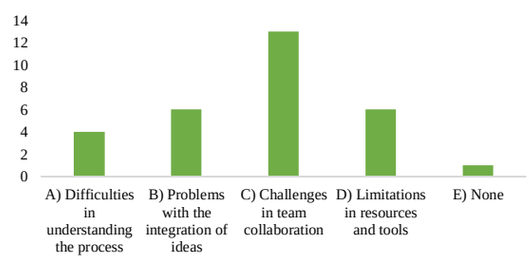

Figure 9

What difficulties did you encounter when applying the Design Thinking model in the development of the MOOC?

Source: Own elaboration

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Among the areas of opportunity identified by the students, the challenges in team collaboration stood out with thirteen responses. On the other hand, with 6 responses, problems with the integration of ideas and limitations in resources and tools were identified.

Box 10

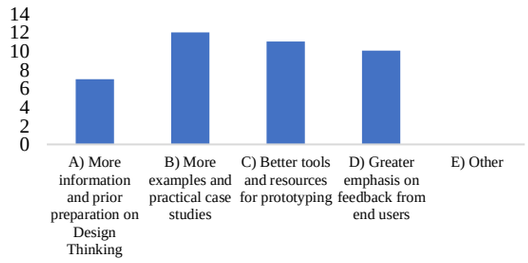

Table 10

What improvements would you suggest for the application of the Design Thinking model in future courses on MOOC development?

Source: Own elaboration

Most students stated that they would like more examples and case studies, better tools and resources for prototyping and more emphasis on user feedback. To a lesser extent, they expressed a need for more information on Design Thinking. As a result of the project 6 MOOCs were developed and are available for use by the university community with the following topics: Course / tutorial on learning algorithms basic level. Introductory course / tutorial on Javascript. Course / tutorial Introduction to AI. Course / tutorial introduction to digital marketing. Course/ tutorial introduction to information cybersecurity.

Basic HTML course

The digital and innovative competences that were strengthened with the development of these projects were:

a) Navigation, search and filtering of information, data and digital content.

Expressing information needs in an organised way, searching for data and information with digital content, finding priority information for teaching activities, choosing educational resources efficiently, creating personal information strategies.

b) Evaluation of information, data and digital content.

Process, collect, understand and evaluate data, information and digital content critically.

c) Storage and retrieval of information, data and digital content.

Store information, manage data and digital content for easy retrieval; organise information, data and digital content.

d) Communication and collaboration

Communicating in digital environments, sharing resources through online tools, connecting and collaborating with others through digital tools, interacting and participating in communities and networks.

e) Interacting through digital technologies

Interacting through a variety of digital devices and applications, understanding how digital communication is distributed, presented and managed, understanding the appropriate use of different forms of communication through digital media, considering different communication formats, adapting communication strategies and modes to specific audiences.

f) Sharing digital information and content

Share the location of information and digital content found, be willing and able to share knowledge, content and resources, act as an intermediary, be proactive in disseminating news, content and resources, be aware of citation and referencing practices and integrate new information into the existing body of knowledge.

Conclusions

Education calls for innovation in learning processes. The student has ceased to be a passive element that receives information, as nowadays he/she is required to be involved in problem solving in an active way.

The academic has ceased to be a transmitter of knowledge and has become the means to build knowledge.

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This project clearly shows the effect on learning when using the Design Thinking methodology, as the students managed to develop the digital, soft and knowledge competences that are reflected in the development of a MOC, using innovation and research at all times.

The innovation applied in this course shows that the effect is very favourable, achieving favourable results for students, academics and society in general.

It is planned to present it to the academy as an integral training activity, seeking to replicate the methodology in other sections. It is also planned to schedule a forum for students to showcase their products and to disseminate them in the institutional media.

Declarations

Conflict of interest

The authors declare that they have no conflict of interest. They have no known competing financial interests or personal relationships that might have appeared to influence the article reported in this paper.

Authors' contribution

Guzmán-Coutiño, Héctor: Contribution to the development of the idea, design and implementation of the Methodology.

Martínez-Herrera, Brenda Marina: Contribution to the design of the Methodology and monitoring of results.

Hernández-Trejo, Lorena: Contribution to the design of the Methodology and monitoring of results.

Olivarez-Ruiz; Nancy Araceli: Contribution to the design of the Methodology and monitoring of results.

Abbreviations

MOOC: Massive Online Open Courses.
SCORM: Shareable Content Object Reference Model.
LMS: Learning Management System.
ICT: Information and Communication Technologies.
HEI: Higher Education Institutions
OER: Open Educational Resources
AI: Artificial Intelligence
VR: Virtual Reality
AR: Augmented Reality
HTML: HyperText Markup Language

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Article

Student perspective on the contribution of scientific research to society and its importance in university education

Visión estudiantil sobre la contribución de la investigación científica a la sociedad y su importancia en la formación universitaria

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Abstract

This article presents an exploratory study conducted with 177 students from the Academic Unit of Accounting and Administration (UACyA) at the Autonomous University of Nayarit. The study aimed to analyze students' perceptions of scientific research and its importance in university education. A descriptive quantitative approach was employed, using an online survey through Google Forms to gather data from a sample of students in their first, third, fifth, and seventh semesters of the bachelor's degrees in marketing, Administration, Accounting, and International Business. The sample selection was conducted randomly, including students from both morning and afternoon shifts. The research focused on understanding students' views on the integration of research into the university curriculum, opportunities for participation in research projects, the impact of research on their professional and personal development, and their perception of the contribution of scientific research to society. The results revealed a significant gap between the importance given to scientific research in academia and students' perception of its value. The study highlights the need to implement strategies to foster a culture of research at UACyA, including the integration of research into study plans, the development of scientific literacy programs that clearly and accessibly explain the value of scientific research, and the creation of opportunities for student participation in research projects.

Student perspective on the contribution of scientific research to society and its importance in university education.

Objectives	Methodology	Contribution
The main objective of the research is to analyze the perception of UACyA students regarding scientific research and its importance in university education, assessing their understanding of the role of research in their professional and personal development, as well as their perception of the contribution of scientific research to society.	This study used a quantitative approach,utilizing an online survey through Google Forms. The study sample included 177 students from the first, third, fifth, and seventh semesters of the Marketing, Administration, Accounting, and International Business programs at UACyA. The sample selection was conducted randomly, including students from both morning and afternoon shifts.	This study highlights the need to integrate scientific research into higher education, fostering an understanding of the value of research and promoting active student participation in research projects. Greater integration of research into study plans is required so that students can explore its impact.

Perception, Research, Students, University

Resumen

El presente artículo presenta un estudio exploratorio realizado con 177 estudiantes de la Unidad Académica de Contaduría y Administración (UACyA) de la Universidad Autónoma de Nayarit, con el objetivo de analizar la percepción de los estudiantes sobre la investigación científica y su importancia en la formación universitaria. Se empleó un enfoque cuantitativo descriptivo, a través de Google Forms para recopilar datos de una muestra de estudiantes de primer, tercer, quinto y séptimo semestre de las licenciaturas en Mercadotecnia, Administración, Contabilidad y Negocios Internacionales. La selección de la muestra se realizó de forma aleatoria, incluyendo estudiantes de ambos turnos (matutino y vespertino). La investigación se centró en comprender la visión de los estudiantes sobre la integración de la investigación en el currículo universitario, las oportunidades de participación en proyectos de investigación, el impacto de la investigación en su desarrollo profesional y personal, y su percepción sobre la contribución de la investigación científica a la sociedad. Los resultados revelaron una brecha significativa entre la importancia que se le otorga a la investigación científica en el ámbito académico y la percepción de los estudiantes sobre su valor. El estudio destaca la necesidad de implementar estrategias que fomenten una cultura de investigación en la UACyA, incluyendo la integración de la investigación en los planes de estudio, el desarrollo de programas de alfabetización científica que expliquen de manera clara y accesible el valor de la investigación científica, y la creación de oportunidades para la participación de los estudiantes en proyectos de investigación.

Visión estudiantil sobre la contribución de la investigación científica a la sociedad y su importancia en la formación universitaria.

Objetivos	Metodología	Contribución
El objetivo principal es analizar la percepción de los estudiantes de la UACyA sobre la investigación científica y su importancia en la formación universitaria, evaluando su comprensión del rol de la investigación en su desarrollo profesional y personal, así como su percepción sobre la contribución de la investigación científica a la sociedad.	Este estudio empleó un enfoque cuantitativo, empleando una encuesta de Google Forms. La muestra del estudio incluyó 177 estudiantes de primer, tercer, quinto y séptimo semestre de las carreras de Mercadotecnia, Administración, Contabilidad y Negocios Internacionales en la UACyA. La selección de la muestra se realizó de manera aleatoria, incluyendo estudiantes de ambos turnos (matutino vespertino).	Este estudio destaca la necesidad de integrar la investigación científica en la educación superior, fomentando la comprensión del valor de la investigación y promoviendo la participación de los estudiantes en proyectos de investigación. Se requiere una mayor integración de la investigación en los planes de estudio para que los estudiantes exploren su impacto.

Estudiantes, Investigación, Percepción, Universidad

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Introduction

Scientific research is a systematic and methodical search for knowledge, guided by curiosity and logic. It is based on observation, experimentation and rigorous analysis of data to obtain objective and validated conclusions. Its main objective is to advance our understanding of the world, discover new knowledge and develop innovative solutions to complex problems. Scientific research helps us understand natural, social, technological and cultural phenomena, driving human progress in a variety of areas.

Its impact extends from the creation of vaccines to understanding the universe, contributing to building a more sustainable and prosperous future. According to Rosenberg and McIntyre (1970), scientific research refers to the systematic process of inquiring into and exploring phenomena by asking questions, collecting data and applying analytical methods. This process seeks to generate new knowledge and verify existing theories through observation and experimentation. Scientific research is therefore an organised process that involves systematically examining and studying phenomena.

It involves asking questions, collecting information and using analytical methods to discover new knowledge and validate established theories through observation and experimentation. Scientific research is a dynamic process that goes beyond mere observation and description of the phenomena around us. It is a profound search for knowledge that seeks to interpret the world through the construction and analysis of theories. This process is not static; it involves a constant cycle of verification, correction and formulation of new ideas, with the aim of generating solid and reliable knowledge, capable of standing the test of time and criticism.

Scientific research becomes an essential tool for problem solving. By stimulating cognitive changes, it invites us to think critically, analytically and creatively, enabling us to find innovative and valuable solutions to the challenges we face. This ability to find answers to the questions that trouble us is what makes scientific research an engine of progress and development.

Since the time of Galileo, scientific research has been guided by the scientific method, a rigorous process that has proven its effectiveness throughout history. This method, essential in academic training, becomes an indispensable companion from the earliest stages of education to the completion of professional studies, and even beyond. Scientific research is integrated into everyday life, encouraging curiosity, critical thinking and the search for solutions to the challenges we face. It is a tool that enables us to better understand the world, ask questions, generate ideas and build a more prosperous and sustainable future. Shavelson and Towne (2002) emphasise the importance of scientific research in the field of education.

They state that the use of rigorous scientific methods is fundamental to generating sound and reliable knowledge that can be used to improve educational practices and policies. They emphasise the need to use both quantitative and qualitative approaches to address the complexities of the education system, recognising that each of these methods brings a unique and invaluable perspective to the research process.

Collaboration between researchers and educators is fundamental to the advancement of educational research. This synergy not only enriches the research process, but also ensures that findings are relevant and applicable in real contexts. Educational research must transcend the walls of the academy to have a tangible impact on teaching practice and the lives of students.

Researchers use their knowledge to design and conduct methodical studies, applying scientific methods that ensure the validity and reliability of the results. In turn, educators, with their classroom experience, provide valuable insights into the needs and challenges of the education system. By collaborating, both can establish an enriching dialogue that facilitates the transformation of research findings into innovative and effective pedagogical strategies.

The capacity of scientific research to contribute significantly to the advancement and improvement of the education system is indisputable.

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By fostering informed decision-making and the implementation of evidence-based practices, educational research becomes an essential tool for the transformation of the education system, contributing to the formation of more competent, critical and prepared citizens to face the challenges of the 21st century.

Background

According to Catling (1992), the history of research has been an evolutionary process that has developed over the centuries, reflecting the growth of human knowledge and the search for answers to fundamental questions. From the earliest efforts in antiquity, where philosophers and scientists sought to understand the natural world, to modern scientific methods, research has been driven by curiosity and the need to improve human life.

Important milestones in research include the systematisation of the scientific method during the Renaissance, which established a more rigorous and empirical approach to the exploration of knowledge. As technologies and scientific disciplines have advanced, so have research methodologies, adapting to new questions and contexts.

The development of agricultural research, as mentioned in the context of deep-sea rice, shows how research can focus on solving specific problems and improving practices in vital sectors. In short, the history of research is a testimony to the human effort to understand and transform the environment, contributing to social and scientific progress. According to Deb, Dey and Balas (2018), research is defined as a systematic, objective and well-defined method for seeking knowledge or formulating theories.

This process is driven by curiosity and the desire to make original contributions that expand the existing knowledge base. Research involves the formulation of hypotheses, analysis of data and verification of whether the findings conform to those hypotheses, constituting an effort to create knowledge that does not yet exist. Scientific research, with its goal of expanding knowledge and solving problems, takes place in a complex and multifaceted context. It is not only a set of methods and techniques, but also a culture and a set of strategies that are influenced by a variety of factors.

The institutional environment plays a key role in shaping research culture. Institutional policies, resource allocation, evaluation systems and incentives for scientific publication all shape research priorities and practices. An institutional environment that prioritises quality, ethics and innovation will be crucial for fostering a strong research culture.

Individual motivations also influence research strategies. Personal interest in a topic, ambition for academic recognition, the search for funding or the need to solve specific problems all drive researchers to focus on certain research areas and use certain methodologies. It is important that institutions foster a culture that allows for the exploration of different motivations and promotes collaboration between researchers with different interests.

The balance between tradition and innovation is another key factor. On the one hand, research is based on the accumulation of knowledge over time, which means that traditions and established methods are valuable. On the other hand, innovation is essential for advancing knowledge and addressing emerging challenges. Fostering a balance between preserving traditions and promoting innovation is critical to maintaining a vibrant and dynamic research environment.

Mayank Baranwal (2022) states that ‘research is based on curiosity and the search for answers to unsolved questions, and is a continuous process involving the collection and analysis of data to generate new knowledge’. Thus, research is based on the desire to understand and solve unanswered questions. It is an ongoing process that requires the collection and analysis of information, with the aim of creating new knowledge. This systematic approach allows us to delve deeper into unknown topics and advance our understanding of various areas of knowledge.

Understanding these influences is crucial to fostering an environment that promotes high-quality, ethical scientific work.

A research environment that values integrity, transparency, collaboration, openness to debate and constructive criticism will foster the production of reliable and relevant knowledge for the development of society.

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Relevance in Education

According to Deb, Dey and Balas (2019), research is a systematic process that involves literature review and technical reading to identify problems, formulate questions and apply appropriate methods. This process seeks to generate new knowledge and contribute to the understanding of phenomena in a specific field, ensuring that the research is relevant, rigorous and evidence-based.

Research not only involves collecting data, but also analysing and contextualising it within existing theoretical frameworks, thus enabling the advancement of knowledge and professional practice. The culture of scientific research is a set of values, norms and practices that shape the environment in which science takes place. This cultural framework influences the behaviour of researchers, the way knowledge is approached and the quality of the results obtained. A healthy research culture fosters collaboration, creativity and transparency, which are essential for the advancement of knowledge. Samarajeewa (2022) considers that 'research is a lifelong activity that generates new knowledge for the benefit of humanity' and stresses the importance of collaboration between young researchers and experienced teachers to achieve success in this field.

Research is presented as a constant effort to create knowledge for the benefit of humanity. It also highlights the importance of cooperation between junior researchers and experienced academics, which is fundamental to the successful development and application of new ideas.

In a context where competition for resources and recognition is high, scientific culture can be affected by external pressures that prioritise quick results over integrity and depth of work. This can lead to unethical practices and a lack of innovation, which in turn can compromise public confidence in science. On the other hand, a culture that values lifelong learning, exchange of ideas and ethics in research can enhance the professional development of scientists and contribute to a positive impact on society.

Thus, research culture not only defines the behaviour of researchers, but also determines the quality and relevance of science to contemporary needs and challenges. Kitwood (1976) is of the opinion that 'educational research should be regarded as a form of science, since it uses the scientific method to address educational problems and seeks to generate knowledge that can improve educational practice'. Thus, educational research should be seen as a scientific discipline, since it uses the scientific method to examine and solve educational questions.

Its aim is to produce knowledge that contributes to the improvement of practices in the educational field, thus facilitating the advancement and effectiveness of teaching and learning. According to Feuer, M., Towne, L., and Shavelson, R. (2002), 'a scientific culture of educational research, supported by individual researchers and professional associations, is crucial for stimulating more and better quality scientific research in education'.

This sets the tone for a globalised society and educational institutions to foster a scientific culture in educational research, supported by individual researchers and professional organisations, is crucial to promote a greater quantity and quality of scientific research in education. Such collaboration and collective support are essential to achieve significant and effective advances in educational practice and knowledge generation.

The culture of scientific research encompasses the principles, norms and activities that affect how researchers operate. These elements are fundamental to understanding the environment in which research is conducted and how they impact on the professional conduct of those engaged in research (Joynson & Leyser, 2015). The culture of scientific research is defined by a set of principles and norms that guide the actions of researchers. These aspects are fundamental to understanding the environment in which research takes place and how they influence the professional practice of those involved.

Methodology

This exploratory study, carried out with 177 students from the Academic Unit of Accounting and Administration (UACyA) of the Autonomous

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University of Nayarit, aimed to analyse the students' perception of scientific research and its importance in university education. The main objective was to determine the students' perception of scientific research and its importance in university education, evaluating their understanding of the role of research in their professional and personal development, as well as their perception of the contribution of scientific research to society. To achieve this objective, a quantitative descriptive approach was employed, using an online survey via Google Forms. The study sample included 177 students from the first, third, fifth and seventh semesters of the Marketing, Management, Accounting and International Business degrees at UACyA.

The sample was selected randomly, including students from both morning and afternoon shifts, in order to ensure a diverse representation of the student population.

The methodology of the study was based on the application of an online survey, which was designed to collect quantitative data on students' perceptions of scientific research. The survey was carefully designed to address specific aspects such as their understanding of the role of scientific research in their personal and professional development, their perception of its importance in society, as well as their opinion on the integration of research in the university curriculum.

The results of the study revealed a key finding: there is a significant gap between the importance given to scientific research in academia and students' perception of its value. While students recognised the contribution of scientific research to society, a considerable proportion do not perceive it as an integral component of their university education or as a contributing factor to their personal and professional development.

This finding suggests that there is a lack of understanding of the importance of scientific research in real life and its relevance for students' careers. This lack of understanding may be due to various factors, such as a lack of exposure to scientific research during their training, the perception that research is a complex process and distant from their reality, or the lack of concrete examples of how research has a positive impact on society.

Given this situation, the study highlights the need to implement strategies that foster a research culture at the UACyA. It is essential to integrate research as a fundamental component in the curricula of all degree programmes, allowing students to experience and learn through research.

This integration would allow students to become familiar with the research process from an early stage of their education, developing research skills and fostering scientific curiosity.

It is also important to implement programmes that explain in a clear and accessible way the value of scientific research, its impact on society and its relevance for students' careers. These programmes could include workshops, lectures and hands-on activities that allow students to understand how scientific research contributes to solving real problems and advancing knowledge.

Finally, it is crucial to encourage students to participate in research projects, giving them the opportunity to develop research skills, work in collaboration with research professors and contribute to the generation of new knowledge. Participation in research projects allows students to apply theoretical knowledge, develop practical skills, and experience the satisfaction of contributing to the creation of new knowledge.

This research approach is based on a holistic perspective, combining quantitative and qualitative data collection and analysis. This strategy allows for a deeper understanding of the topic under study by integrating different perspectives and generating more complete inferences from the information gathered.

Student survey

The present research, carried out with a random sample of 177 students from the UACyA of the Universidad Autónoma de Nayarit, focuses on the students' perception of Student Vision on the contribution of scientific research to society and its importance in university education. The sample, composed of students from different semesters (first, third, fifth and seventh semester) of the degrees of Administration, Accounting, Marketing and International Business, with an average age of 18 to 21 years, was randomly selected.

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As mentioned above, the aim of this article is to analyse the students' perception of scientific research and its importance in university education. A descriptive quantitative approach using Google Forms was used to collect data from a random sample of first, third, fifth and seventh semester students in Marketing, Management, Accounting and International Business, covering both morning and afternoon shifts.

The research focused on exploring how students view research within the university curriculum, the opportunities to engage in research projects, and the impact it has on their professional and personal development. The findings showed a notable discrepancy between the relevance given to scientific research in academia and students' perceptions of its true value. This study underlines the need to implement strategies to strengthen a research culture at UACyA. This includes integrating research into curricula, developing science literacy programmes that clearly communicate the value of research, and creating opportunities for students to participate in research projects. This research approach is based on a holistic perspective, combining quantitative and qualitative data collection and analysis to gain a deeper understanding of the topic.

Results

The study found that the present research yielded interesting data that students Analysis and interpretation of the surveys to determine the perception of students in the above-mentioned degree programmes.

The results of the surveys of 177 students were analysed. The detailed information is shown below:

Box 1

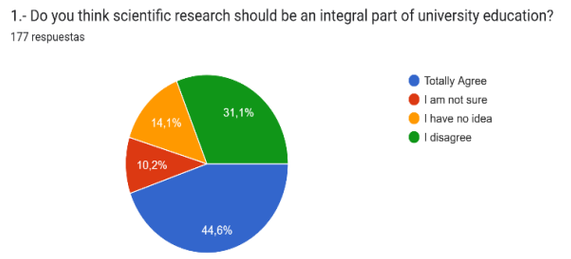

Figure 1

1.- Do you think scientific research should be an integral part of university education?

Figure 1 shows the results of a survey of 177 students on whether scientific research should be an integral part of university education. The results are divided:

31.1% of students believe that scientific research is fundamental to university education, valuing it as an essential tool for learning and professional development. 14.1% of the students express uncertainty, possibly due to a lack of understanding about the importance and benefits of scientific research. 10.2% of students do not have a clear opinion, indicating a lack of knowledge or interest in the subject.

The majority of students (44.6%) disagree, possibly because they do not see research as a relevant component for their professional development or because they perceive it as a complex or inaccessible process.

Box 2

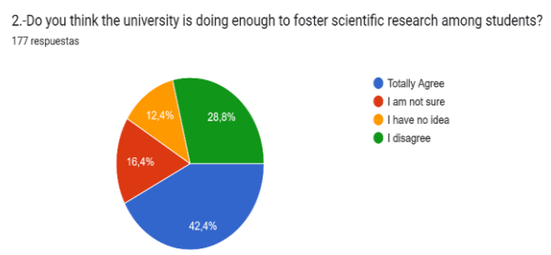

Figure 2

2.- Do you think the university is doing enough to encourage scientific research among students?

Graph 2 reveals a divided perception among students as to whether the university is doing enough to encourage scientific research.

Some 28.8% of the students consider that the university is encouraging scientific research among them. This could indicate that these students have had positive experiences with research, such as participation in projects or the availability of resources.

12.4% of the students are not sure. This suggests that they may have a limited understanding of the university's efforts in this area, or that they have not had the opportunity to experience research first-hand.

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16.4% of students do not have a clear opinion, which could indicate a lack of interest or knowledge about the university's research initiatives.

The majority of students (42.4%) do not believe that the university is doing enough to encourage research. This could be due to a lack of opportunities to participate in research projects, a perception that the university does not provide the necessary resources for research, or a lack of guidance and support to get involved in research.

Overall, the graph suggests that the university needs to strengthen its efforts to encourage scientific research among its students. There is a need to provide more opportunities for students to participate in research projects, adequate resources and support for their development as researchers.

Box 3

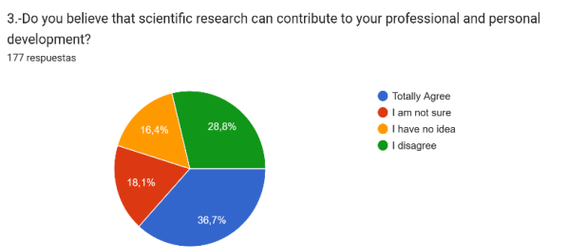

Figure 3

3.- Do you think scientific research can contribute to your professional and personal development?

Figure 3 shows a divided perception among students as to whether scientific research can contribute to their professional and personal development. Some 28.8% of students strongly believe that scientific research can contribute to their professional and personal development. This group probably recognises the potential of research to develop valuable skills such as critical thinking, problem solving, teamwork and communication, skills that are highly valued in today's job market.

16.4% of students are unsure, suggesting a lack of clarity about how scientific research can influence their development. They may not be aware of the skills and knowledge that are developed through research, or they may not see a clear connection between research and their career paths.

18.1% of students do not have an educated opinion, which could indicate a lack of knowledge about scientific research and its impact on personal and professional development, and finally, a significant percentage (36.7%) of students do not believe that scientific research can contribute to their development. This group could be uninformed about the benefits of research or could perceive it as a complex process and alien to their professional needs and aspirations.

The graph highlights the need for the university to help students understand how scientific research can contribute to their professional and personal development. It is essential to connect research with students' career aspirations by showing them how the skills and knowledge acquired through research can be valuable in the labour market.

Box 4

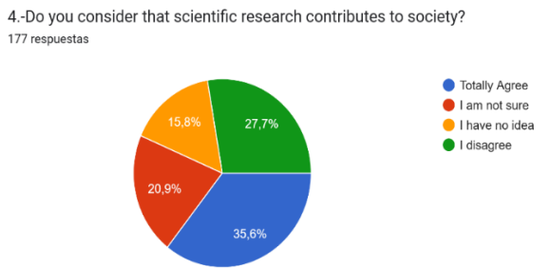

Figure 4

4.- Do you consider that scientific research contributes to society?

Figure 4 shows a divided perception among students about the contribution of scientific research to society. 27.7% of students are convinced that scientific research benefits society. This group recognises the positive impact that research has in areas such as health, technology, economy and environment.

15.8% of students are unsure about the contribution of scientific research. This group might have a limited understanding of the impact of research or be unfamiliar with concrete examples of how research has improved society.

20.9% of students do not have a formed opinion, which could indicate a lack of interest or knowledge on the subject. Finally, 35.6% of the students do not believe that scientific research contributes to society.

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This perception could be influenced by a lack of information about scientific advances that have improved the quality of life, health, technology and the economy. The graph evidences a need to educate students about the positive impact of scientific research on society. It is important to show concrete examples of how research has benefited humanity and how it can contribute to solving global problems.

Box 5

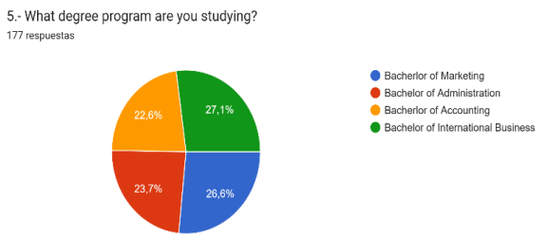

Figure 5

5.- What study programme are you studying?

Figure 5 shows the distribution of the surveyed students by academic programme. Of the 177 students, 47 are studying for a Bachelor's degree in Marketing, representing 27.1% of the sample. 42 students are studying for a Bachelor's degree in Management, equivalent to 22.6% of the total. 40 students are pursuing a Bachelor's Degree in Accounting, representing 23.7% of the respondents.

Finally, 48 students are studying for a Bachelor's degree in International Business, 26.6% of the total sample. This reflects a balanced representation of students from each academic programme within the survey sample, providing an overview of the views and perspectives of students from different fields of study.

Discussion and Conclusions

The present study, conducted with 177 students from the Academic Unit of Accounting and Administration (UACyA) of the Autonomous University of Nayarit, has revealed a divided perception of scientific research and its role in university education. While the majority of students (42.4%) believe that the university is not doing enough to encourage scientific research among its students, a significant proportion (36.7%) believe that research can contribute to their professional and personal development.

The study also highlights the importance of scientific research for society, with 35.6% of students recognising its impact. However, there is a significant group of students (27.7%) who are unsure of its contribution or even question it.

This gap between the understanding of the value of scientific research and its practical implementation in education highlights the need for a cultural change at UACyA. To foster a research culture within the UACyA, it is proposed to integrate research into the curricula, including research projects as part of the curriculum at different levels, giving students the opportunity to actively participate in research.

The implementation of scientific literacy programmes that explain in a clear and accessible way the value of scientific research, its practical applications and its impact on society is also essential.

Opportunities for student participation in research projects should also be created, offering mentoring programmes, workshops, and opportunities for collaboration with research professors so that students can develop their own projects or participate in ongoing projects.

With these actions, the UACyA can promote a greater understanding of the value of scientific research, foster its integration into the learning process, and ultimately prepare students to face the challenges of today's world with a critical vision and a commitment to the generation of knowledge.

Conflict of interest

The authors declare no interest conflict. They have no known competing financial interests or personal relationships that could have appeared to influence the article reported in this article.

Authors' Contribution

Carrillo-Beltrán, Julio César Cuauhtémoc: Contributed with the main idea and realisation of the project, as well as the first draft.

Suárez-Flores, Marina: Contributed with the revision in writing and style, as well as the revision and modification of citations and references, and finally the adaptation to the ECORFAN format.

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Aguirre-Bravo, Anna Alessandra: Contributed to the analysis of the results and the creation of the figures or graphs.

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Article

Peace building from the classrooms

Construcción de la paz desde las aulas

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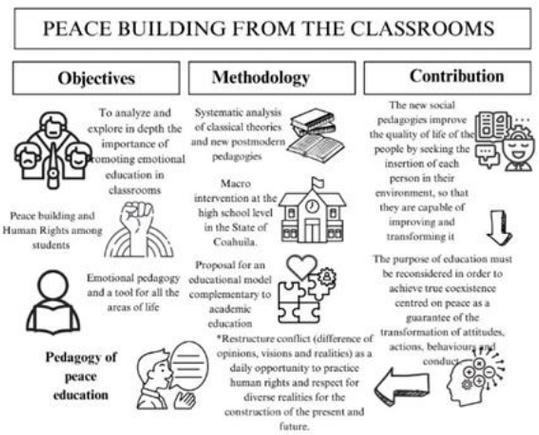
Abstract

This analysis delves into the importance of promoting Emotional Education in classrooms as an important part of socialization and its potential positive impact on building a culture of peace through respect for human rights, as a tool for all areas of life. With the hypothesis that the greater the emotional education, the greater the coexistence and culture of peace; it is established that the new social pedagogies improve the quality of life for everyone. According to this perspective, social education seeks the insertion of each person in their environment, so that they are capable of improving and transforming it; hence the relevance of rethinking the purpose of education to achieve true coexistence centered on peace as a guarantee of the transformation of attitudes, actions, behaviors and conducts, considering conflict as the daily opportunity to practice human rights and respect for diverse realities.



Emotional education, Adolescents, Culture of peace

Resumen

Este análisis profundiza en la importancia de fomentar la Educación Emocional en las aulas como parte importante de socialización y su potencial impacto positivo en la construcción de la cultura de paz a través del respeto a los derechos humanos, como herramienta para todos los ámbitos de la vida. Con la hipótesis de que, a mayor educación emocional, mayor convivencia y cultura de paz; se establece que las nuevas pedagogías sociales mejoran la calidad de vida de todos. Según esta perspectiva, la educación social procura la inserción de cada persona en su entorno, para que sea capaz de mejorarlo y transformarlo; de ahí la relevancia de repensar el fin de la educación para lograr una verdadera convivencia centrada en la paz como garante de la transformación de actitudes, acciones, comportamientos y conductas, considerando al conflicto la oportunidad diaria de practicar los derechos humanos y el respeto a las diversas realidades.

Educación emocional, adolescentes, cultura de paz

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Introduction

According to the OECD (www.gob.mx, 2020), the common factor in most of the risks and/or problems that arise in Mexican schools is violence derived from vulnerability. According to recent statistics from the Organisation for Economic Co-operation and Development (OECD), Mexico is considered the first place internationally in cases of bullying in primary and secondary education, while the National Human Rights Commission states that 7 out of 10 children have been victims of this phenomenon.

School violence is defined as any aggression carried out within the environment of educational institutions, where students live together on a daily basis. This phenomenon can be expressed in different ways by the members of the school community: students, parents, teachers, directors, administrative or support staff, hence the complexity that must be considered when analysing or investigating it. However, in 2020, the COVID-19 contingency forced children to be confined at home, producing other types of violence or negative effects, which have also been investigated and will be referenced in this document.

The Ministry of Public Education (www.gob.mx, 2020), describes that the main expressions of school violence are verbal, physical and psychological, but they are not limited to these, as sexual, cyber, patrimonial, economic and social violence are also observed. In fact, recent reports, news and videos uploaded to different platforms show that bullying has been increasing to the point of reaching extreme violence that includes attacks with knives or firearms, beatings, risky challenges, gang rape, suicide and homicide.

To understand the characteristics of the phenomenon, we must begin by explaining that in most cases, violence in the school environment is the result of an environment that for decades accepted, normalised, tolerated, legitimised and even celebrated violent behaviour due to society's deep-rooted culture of aggression in the resolution of possible conflicts, together with exclusion, discrimination and the lack of a culture of respect for human rights, disabilities, ideological or sexual diversity, ethnic differences or unequal economic conditions of children and adolescents.

According to reports from educational institutions in Mexico, some of the causes associated with school violence and vulnerability are: the prevalence of peer violence due to the lack of knowledge of effective ways to resolve conflicts, insufficient information on the types and effects of violence, absence of effective mechanisms to prevent and eradicate it, lack of bonding, lack of communication, lack of strategies for conflict resolution, personal emotional problems or situations, lack of regulations or policies in this regard or the lack of their application, indifference of the authorities to solve the problem, among many others (SEP. GOB.MX, 2020).

These indicators are already clear evidence that the root cause is not being made visible, much less addressed: the correct management of emotions within students, also known as emotional education, and which only recently entered the 21st century has gained relevance both in research and in practical strategies for interaction in the classroom, after decades of being disconnected from the academic learning that used to receive more attention in the school curriculum.

In order to address this, the Ministry of Public Education and the Ministry of the Interior have implemented actions that engage federal and local authorities in combating bullying and violence in schools, including diploma courses, updates and other strategies. Rojas (2020, p. 32), states that the Federal Government has granted autonomy to state administrations to freely develop according to their local needs the management of coexistence, safety and violence in schools, enacting several local laws appropriate to the different realities.

The legislation includes conceptual considerations and definitions of violence in the school environment, as well as the regulation of the rights and obligations of the actors that are part of the school community (Rojas, 2020, p. 34).

In general terms, every school should have an educational programme aimed at strengthening skills for peaceful coexistence in society, addressing disruptive behaviours, which, although constant and regular, are not healthy for students or for society.

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Several studies support the initiative for schools to reflect on and become aware of the need to implement emotional competence specifically in school curricula (p. 35). Considering that pre-adolescence is a crucial stage between childhood and adolescence, it is necessary to lay a solid foundation of skills necessary for young people to build their own identity, based on a maturity appropriate to their evolutionary development, in addition to providing them with the appropriate resources to deal with conflict situations, to seek help effectively when required, and to be careful in their actions.

Having established the relevance of emotional intelligence both in school coexistence and in the training-learning process, it is now seen as a possible solution to these disruptive behaviours, which is why it is necessary to include it again in academic plans, specifically from primary education onwards. This is a stage in which children begin their emotional maturity, experience psychological and physical changes that they must face with sufficient tools to consolidate their personality, strengthen their character and self-regulate with the aim of deconstructing environments in order to turn them into environments of peace.

Since, as Morlett-Villa (2023, p. 18) points out, vulnerability and its consequences are not just a matter of time. 18), vulnerability and its consequent violence in the adolescent period does not stem from fear and uncertainty about the future, but from the lack of tools or strategies to face it, in addition to the lack of bonds of trust resulting from the phenomenon of individualisation that accelerated during the period of confinement due to the COVID-19 pandemic, This leaves adolescents in a state of greater helplessness and frustration, while parents and teachers have a greater responsibility to act to reduce the risks of reproducing negative effects both now and in the future.

Therefore, school transformation should be understood not as an objective in itself but as a means to achieve a change in society, creating a fairer society after rethinking its function (Hernández, Castilla, 2017, cited in Rojas, 2020). Based on innovation in educational practices and in accordance with current needs, the school becomes the ideal setting for achieving this transformation in learners.

This analysis is part of a macro research conducted at the upper secondary level in the State of Coahuila, which delves into the importance of promoting Emotional Education in the classroom and its potential positive impact on the construction of a culture of peace, as a tool for all areas of a person's life.

The interest in the subject arises from the experience of the group of teacher researchers in interacting with high school students for several years before and after the confinement due to COVID-19.

As the adolescent stage is a specific time of change and vulnerability, it is necessary to train socio-emotional skills through emotional education in order to face phenomena and risks such as school violence, dropout, abuse, stress, anxiety, self-harm or suicide.

The main hypothesis is that the greater the emotional education, the greater the coexistence and culture of peace, therefore, we intend to intervene in various groups of high school students from the three Academic Units of the Autonomous University of Coahuila with the design and implementation of a series of strategies focused on the development of Emotional Intelligence to strengthen school coexistence within the classroom, within the framework of building a culture of peace, which serves as a basis for the creation of an institutional plan for emotional education.

The social function of the school

As a democratising space, it is not surprising that the public school in Mexico had barely begun its activities after the Revolution, with the flamboyant and striking 20th century, the economy, the new industrial system, the modernity that brought with it the demand to know how to follow instructions, to read and write in order to operate the steam engines -boats, ship-owners or trains-, as well as to understand the mathematical operations to count the money that flowed from the shops, leaving far behind the barter, the ‘raya’ or the exchange by ‘montoncitos’ that the rural business in the markets and roads resisted to disappear.

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The Education System is a social institution that arose historically to fulfil a series of functions among which the task of socialising individuals stands out, that is, to train the men and women that societies need to function, developing the personality traits, values, attitudes and basic behaviours required for the social interaction of a specific time and place (Fernández, 2022).

From its inception until a few years ago, one of the main characteristics of the education system in Mexico has been its top-down model, like most of the organisational structures of the last century (NEM, SEP, 2022). According to historians and analysts, the then President Álvaro Obregón created the Secretariat of Public Education, SEP, in 1921 and appointed José Vasconcelos Calderón, a renowned politician, Maderista, revolutionary, philosopher and pedagogue, whose ideas of social improvement and advancement through knowledge and culture were implemented with a macro plan for the promotion of education, which sought to integrate Mexico into the modern world of the 20th century, as its first secretary.

To this end, Vasconcelos requested and promoted the construction of libraries, rural schools, mass publishing of the great works of universal literature and thought, and created an educational exchange programme with other countries so that students and artists could travel to other countries in the Americas, perfect their knowledge and become ambassadors of Mexico to the world.

This global vision was influenced by his constant travels abroad, readings and collaborators; it was also comprehensive, as he considered rural teachers to be ‘apostles of education’, key players in the formation of the people.

The objectives of the nascent Mexican school were to meet the needs of a largely rural population, whose illiteracy rate was close to eighty percent; to disseminate the ideals of the Revolution and the values of humanism, nationalism and patriotism; to encourage projects to improve the country through art and culture; and to integrate Mexican society into the modernity and industrial economy that came from the north by rail with foreign companies.

Two decades and several world armed conflicts later, Jaime Torres Bodet relaunched the national educational project to expand coverage throughout the country. Inspired by Vasconcelos‘ legacy, Torres Bodet again launched a literacy campaign, appealed to young people's vocation for teaching, and created the Instituto Nacional de Capacitación del Magisterio to stimulate teachers’ work in the field and boost their professional development, while also providing support to the poorest families through free textbooks.

After more than a century of being created, with the progress of society, theories, philosophical currents and the influence of technologies such as the internet, it is natural and to be expected that the educational model is no longer compatible with a more educated, plural, democratic and inclusive society, but above all, a global one (SEP, 2022).

According to this premise, despite being a unit, in the country there is a variety of identities, perspectives and cultures that preserve different identities, a reflection of the diversity that characterises us as a nation, which is why we are constantly working so that each person can build a better present and future together with the school, traditions, roots, identity, government and institutions.

According to what has been established and published by UNESCO, education is a basic right of all children and adolescents, which provides them with the skills and knowledge necessary to develop as adults and also gives them the tools to know and exercise their other rights. However, in Mexico, more than 4 million children and adolescents do not attend formal classes in an established school within the education system (UNICEF, 2020, p. 8); while 600,000 more are at risk of dropping out due to various factors such as lack of resources, remoteness from schools, violence and the consequences of the HIV/AIDS pandemic.

In addition, children who do go to school report low achievement in the content of compulsory basic education; likewise, those who live in indigenous communities or speak an indigenous language as their mother tongue, or are members of the Afro-descendant community, are at greater risk of not completing their primary education.

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The National Education System is composed of basic, intermediate and higher education, in school, non-school and mixed modalities (SEP, 2022, p. 35).

Basic education consists of Pre-school, Primary and Secondary levels. Upper secondary education comprises the baccalaureate level, as well as other levels equivalent to it, and vocational education that does not require a baccalaureate or its equivalents.

The main objective of the most recent Education Reform, presented and approved in 2016, is that public Basic and Upper Secondary Education, in addition to being secular and free, should be of quality and inclusive (Education Profiles, 2016). This means not only that the state must guarantee access to school for all children and young people - regardless of their socio-economic background, ethnic origin or gender - but also that the education they receive provides them with meaningful, relevant and useful learning and knowledge for life.

Article 3 of the Mexican Constitution states that the education system shall develop 'harmoniously all the faculties of the human being and shall foster in him/her, at the same time, love of country, respect for human rights and awareness of international solidarity, independence and justice'. According to this document, there are two major considerations for rethinking education in the country: to consider what profile of Mexican is to be formed and to be clear about the results expected from the strategies, resources and tools to be used for this purpose (DOF, 2022).

The purpose of basic and upper secondary education is to contribute to the formation of free, participatory, responsible and informed citizens, capable of exercising and defending their rights, who actively participate in the social, economic and political life of Mexico (Perfiles educativos, 2016). In other words, people who are motivated and capable of achieving personal, professional and family development, willing to improve their social and natural environment, as well as to continue learning throughout their lives in a complex world undergoing dizzying changes.

Vulnerability in the school field

One of the objectives of this macro research-intervention-action work is to delve into the strong impact that confinement has had on the psychological and academic life situation of university students, mainly to rethink the strategies of new pedagogies, as well as the reconsideration of emotional education as a basis for the training of students for school coexistence and peace building.

After a period of confinement due to the pandemic experienced from 2020 to 2022 - which in some parts of the world extended to 2023 - a new reality is imposed both for education in general and for pedagogy in particular; a challenge to the education system itself, to most spaces of interaction, as students who spent almost three years taking online courses, returned to the classrooms with other visions, other skills.

The global pandemic not only damaged the health of the population, but also deteriorated people's economy, generated uncertainty about the future, severely affected the ways of experiencing the world, of connecting with each other, forcing people to create coping strategies (Anglim & Horwood, 2021) that would allow them to adapt to a new reality.

In this sense, it is necessary to develop skills, competences and abilities as part of academic education, rather than mechanically repeating certain content or knowledge. In fact, to rehabilitate basic skills that may have been forgotten during the prolonged stay at home and the lack of social interaction.

A study by Murata (et. al, 2021), developed virtually on a North American sample that included adolescents, adults and health care workers who suffered from the disease, identified several psychiatric/psychological symptoms associated with post-coronavirus such as anxiety, depression, post-traumatic stress, suicidal ideation and sleep disorders, significantly more frequently experienced in adolescents than in the adult population (Baghino and Cortelletti, 2021, p. 339-346).

This environment of generalised uncertainty has led to a systematic reduction in levels of security, happiness and well-being among the general population, and thus in health.

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In this regard, the World Health Organisation (WHO), in accordance with the interpretation of Ryff & Singer (cited in Delfino, Muratori, and Zubieta, 2014), stresses that the health of a subject does not depend purely and exclusively on the absence of a pathology, but that it is also necessary to have a 'positive' aspect in order to be able to speak properly of well-being, i.e. a full state that includes physical, emotional, psychological and spiritual aspects.

Taking into account this post-pandemic context, in the specific case of the baccalaureate level, symbolic violence is taking place. In this sense, Bourdieu mentions that symbolic violence is the acceptance, the internalisation by the dominated of the dominant's schemes of thought and valuation, making the relationship of domination invisible (Terrazas et. al, 2022, p. 185).

Bourdieu (1999) addresses the relationship between power and symbolic violence, from which the following can be inferred: authority, i.e. power, when it imposes ideas already legitimised by that authority or power and does not need to use force (in any of the senses), it is because that authority or power is already legitimised and validated by others, this gives strength to the authority or power in a symbolic form, i.e. it dominates through the relations of force (Terrazas, et. al., 2022, p. 188).

Thus, from the perspective of power and domination, Bourdieu and Passeron (1999) included Social Capital together with other kinds of capitals - especially cultural capital - to understand the role of the school system in the reproduction of an asymmetrical social structure.

The French sociologist defined social space as a 'field', where reproduction is reinforced by 'habitus', which can go hand in hand with conscious, individual and sometimes collective strategies for the achievement of its established purpose (Joignant, 2012). In this theory, agents' practices are the product of learning the social game, a kind of "space of vulnerability" created for a specific purpose.

The school field thus stands out as a reproducer of social inequalities according to Bourdieu and Coleman's observations.

The observable and quantifiable part is the entry statistics compared to the exit statistics. Ramírez & Hernández (2012) explain that there is a generalised idea about why some students progress in their academic education and others stagnate or drop out of school; they consider personal characteristics: their lack of talent, their indiscipline, their rebellious behaviour, their motivation, among others; or institutional ones: poorly prepared teachers, poor infrastructure, overcrowded classes, inequality, economics.

These authors argue that students come to the classroom with unequal resources - normalised inequality - which would allow us to understand the different school performances. Such inequality does not only consist of differences in economic capital, nor in knowledge and skills, but encompasses the different resources in the possession of their social networks and which they can use to their advantage, these resources constituting social capital.

In view of this, if the function of the school is conceived as merely reproductive, this school culture is unquestionable because it responds to the ideals of society (Fernández, 2022).

It represents the legitimate social culture. On the contrary, if the school is conceived as a promoter of social change, it is through it that the promotion of a new culture, the culture of peace, becomes possible.

A school culture that promotes peace develops an attitude of mutual respect, equality of values, tolerance and mutual appreciation, which are decisive in the peaceful resolution of conflicts, as well as in the promotion and development of autonomous thinking.

From this conception, the culture of peace appears not as the absence of conflict - which would be unrealistic, as there is a diversity of opinions and identities, there will always be differences or discussions - but as the daily option to build the principles of a school culture in an inclusive way; to analyse whether or not education could be contributing to the formation of critical, autonomous and supportive students, capable of overcoming the dominant moral vacuum, and who value their commitment to the construction of fairer and more humane societies.

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However, building a culture of peace is a slow and complex process. In this sense, education plays a fundamental role in contributing to the formation of values of future citizens (UNESCO, 2020). However, this is not enough; it is essential that society, from the different spheres involved, supports projects and programmes aimed at promoting peace, thus generating a process of reflection on how to influence the construction of a true culture of peace, from politics, the media, the family, businesses, non-governmental organisations, the economy, values, identities, among others. The aim is to integrate a collective awareness of the need for a culture of peace.

Discussion

Between peace and non-violence, risk management

The concept of peace has different contexts and meanings. From the first descriptions for the use of such a word, one must contemplate the social sense that the Greeks and Romans gave it. For the Romans it represented maintaining order, unity and control, which was later associated with the progress of civilisations and which can be seen in the structures that their buildings still have today, despite the passing of the centuries; while for the Greeks, it represented serenity, harmony and inner tranquillity, as a result of personal and social balance, which is clear in their poems, odes and songs (Cornelius, 2020 p. 15).

Thus, over time, peace began to be described as an environment of tranquillity, security and stillness that is reflected in people's behaviour and assertive emotional response.

Currently, PEACE is a human right, inherent, universal, non-transferable and inalienable for all human beings, it is not inherited or shared, it does not depend on external factors to enjoy it nor is it conditioned, so it cannot and should not be renounced (NEM, SEP, 2022). Despite this, building peace with justice and respect has not been an easy task.

Peace, as a value, contributes to people relating favourably to each other, mainly according to the principles of respect, equality, freedom, inclusion, equity and recognition of diversity. In the world, peace is manifested in non-violence, also in the absence of armed conflicts (wars).

It is important to consider that one of the objectives of the mandate of the United Nations Educational, Scientific and Cultural Organization (UNESCO) is the construction of a culture of peace and sustainable development, a line also followed by the UN with its Agenda 20-30, through the Sustainable Development Goals (UN, 2019), which establish the importance of promoting peaceful, just and inclusive societies that are free from fear and violence. There can be no sustainable development without peace, and no peace without sustainable development.

Therefore, a culture of peace implies:

- Respecting life, promoting the practice of non-violence, through dialogue and cooperation.
- Recognition of gender equality.
- Conflict resolution through negotiation and peacemaking.
- Respect, protection and promotion of human rights and fundamental freedoms.
- Respect for the right of all people to freedom of expression, opinion and information (NEM, SEP, 2022).

Therefore, the culture of peace consists of promoting personal and social actions aimed at collaborating in the construction of favourable environments for the interaction of all, based on the recognition of human rights, respect for life, freedom, personal dignity, equality between women and men, democracy, tolerance, education, respect for the environment and cooperation free of conduct that violates humanity.

Peace is not only the absence of conflict and non-violence, it implies accepting the differences and diversity of human beings, respecting and valuing others; tolerance is not putting up with people, but recognising and accepting them; developing the capacity to listen, dialogue and negotiate; making decisions and resolving conflicts peacefully, but, above all, the unity of peoples and nations is necessary.

This is established in Sustainable Development Goal 16 (UN, 2019), which states that Peace, Justice and strong institutions are a path to the sustainable development of societies. Building a culture of peace implies recognising and making the school an attractive, welcoming and safe space that enables the development of life projects for children and adolescents.

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A space where the role of the empathetic teacher is fundamental, hand in hand with managerial leadership that makes the implementation of an Institutional Educational Project possible. Likewise, the school must work for and guarantee peace, the peace that we want for a society that, like democracy and the model of society, is created in the school (UNESCO, 2020).

Proposal

Building peace from the classroom

In general terms, in order to build a culture of peace, it is essential to strengthen emotional competence and this is achieved through the stimulation and development of emotional intelligence in the classroom. For this reason, the role of the teacher is essential, as he or she is the guide and manager of these educational processes (Rojas, 2020).

According to the United Nations Educational, Scientific and Cultural Organisation (UNESCO, 2020), some principles and values that should underpin the culture of peace are:

- Gender equality. Avoid putting women and men at a disadvantage because of their sex, which leads to fewer opportunities and development.

- Respect for human rights. The existence of equality and equity between people and coexistence based on inclusion.

- Sustainability. Linking social, economic, cultural and environmental development with communities and guaranteeing that needs are met, respecting their lifestyles and ways of life.

- International Security. Collaborate among nations, guaranteeing security and the improvement of living conditions to achieve peace.

- Democracy. Recognise and respect human coexistence, plurality, diversity, multiculturalism, human rights and fundamental freedoms.

- Education. Educate for peace, develop skills and knowledge with the aim of changing attitudes towards valuing, inclusion and respect for all.

- Democratic values. Achieving ethical coexistence between the different groups that make up nations, their inclusion, recognition, sense of belonging and identity (UNESCO, 2020).

The United Nations Children's Fund (UNICEF) defines peace education as a process of promoting the necessary knowledge, skills, attitudes and values that favour a change in the behaviour of children, young people and adults, in order to prevent conflicts or forms of violence, as well as to create conditions for achieving peace in any space or context, personally or socially.

A quality education, inspired by peace, is based on respect for rights, gender differences, origin, health and safety; it strengthens knowledge and favours an adequate preparation for life, activates critical thinking, the ability to make decisions, resolve conflicts and deal with them, communication and negotiation; on the other hand, peace building, violence prevention and care for the environment (SEGOB.MX, 2020).

The culture of peace is a new way of seeing, understanding and living the world. It originates from within and seeks to be able to infect others with this feeling, thinking and acting by forming networks of young people, promoting mutual exchange and overcoming differences.

It starts with the first interactions in the family, then in school, community relations and development spaces, and aims to reach out to local and international society. In order to build and participate in a culture of peace, an education that values the human and seeks social justice, i.e. an education for peace, is necessary.

Peace education and culture of peace have become firmly established in school contexts on an international scale and from a multiplicity of existing approaches: school coexistence, education for citizenship and human rights, conflict management or resolution, participatory strategies, among others (García Vita, et. al., 2020, p. 52).

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This is a sign of the expansion and complexity of educational scenarios and actors, as well as of the social reality, which constitutes an ideal terrain for the strengthening of proposals from social education, based on these principle

Taking as a basis that social pedagogy contemplates the issues inherent to socialisation and maladjustment, it is logical that everything related to social coexistence and the construction of a culture of peace is seen through this approach, in order to improve the quality of life of individuals from a special and fundamentally practical perspective in terms of dignity and values.

According to this perspective, social education seeks the insertion of the individual in his or her environment, so that he or she is able to improve and transform it.

The ultimate goal of peace education pedagogy is to guide the development of individuals towards human dignity and human rights (Cerda, 2013, cited in Esquivel Marín and García Barrera, 2018). Here peace is understood as a guarantor of the transformation of attitudes, actions, behaviour and conduct.

The objectives of this work are: promotion and appropriation of ethical values to avoid violence or abuse; education for citizenship that encourages non-corruption or dishonesty; living together in harmony and regulating conflicts peacefully, resorting to emotional competences to control impulsive responses and thus avoid aggressiveness.

Thus understanding that peace is not a distant thing to be achieved, but a whole way of living together, thinking and acting, for social interaction; peace is built, practised and cemented in safe spaces of dignified, inclusive treatment, respect and solidarity.

The authors of this line of thought recommend that, in order to build peace, we must first rethink the Western concept of peace: peace as the absence of war, to a more dynamic one that includes 'harmony, social justice, well-being, fair relations, inner tranquillity, a well-ordered state of mind' (Lederach, 2000, p. 30, quoted in Pasillas, 2002, p. 5-6).

Furthermore, conflict is not the same as war or violence; on the contrary, 'conflict is an interpersonal or intergroup dynamic that reflects contradictions and controversies that, if well managed, generate constructive processes based on good communication' (Girard and Koch, 1997, cited in Pinilla Quiñonez and Mendieta, 2017, p. 319).

If it is understood that conflict comes from difference, and therefore from the diversity of opinions, beliefs, actions, perspectives, processes, among others, then tools can be created that generate constructive confrontations, favouring the establishment of agreements and collective proposals that favour human relations from the collective, considering conflict as an opportunity and not as something negative that should be avoided.

In this way, the challenge is not to follow a theory or apply an inclusive activity within the school timetable; the real work is to rethink education from its very conception, its aims, even transcending the models and strategies of educating from a structure of the designed from the other that is not in the reality itself where the formative and transformative act of sharing knowledge, ideas of thought and criteria in the ways of seeing life is developed, education as a state policy should be open to the possibilities of a flexible curriculum of the different commitments in the actors of the current educational context (Domínguez, 2019, p. 22). 22).

To close, as part of this process of deconstruction of education, the teacher is a key player; since in the formative evolution of a culture of peace, he/she must rethink his/her forms, methods and methodologies of teaching, as he/she is a determining factor in all social spheres that is built from the existence of the student and the family, in such a way that he/she needs the involvement of the aforementioned agents to attend with responsibility and cohesion of theoretical knowledge in a continuous dialectic.

Conflict of interest

The authors declare that they have no conflicts of interest. They have no known competing financial interests or personal relationships that might have appeared to influence the article reported in this paper.

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Authors' contribution

Morlett-Villa, Zaida Francisca: contributed to the systematic review, text analysis, discussion of ideas, drafting of the paper, article design, intervention proposal and prototype strategies.

Terrazas-Medina, Tamara Isabel: contributed to the systematic review, text analysis, discussion of ideas, drafting of the document, design of the article, intervention proposal and prototype strategies.

Hernández-Rivera, Diana: contributed to the systematic review, text analysis, discussion of ideas, drafting of the document, design of the article, intervention proposal and prototype strategies.

Flores-López, Beatriz Adriana: contributed to the systematic review, text analysis, discussion of ideas, drafting of the document, design of the article, intervention proposal and prototype of strategies.

Availability of data and materials

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Abbreviations

CNDH National Human Rights Commission
COVID-19 Severe Acute Respiratory Syndrome
Severe Acute Respiratory Syndrome Type 2 Coronavirus or SARS-CoV-2.
DOF Diario Oficial de la Federación (Official Journal of the Federation)
NEM New Mexican School
OECD Organisation for Economic Co-operation and Development
SDG Sustainable Development Goals
WHO World Health Organization
UN United Nations United Nations
SEGOB Ministry of the Interior
SEP Secretariat of Public Education
UNESCO United Nations Educational, Scientific and Cultural Organisation
UNICEF United Nations Children's Fund

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Background

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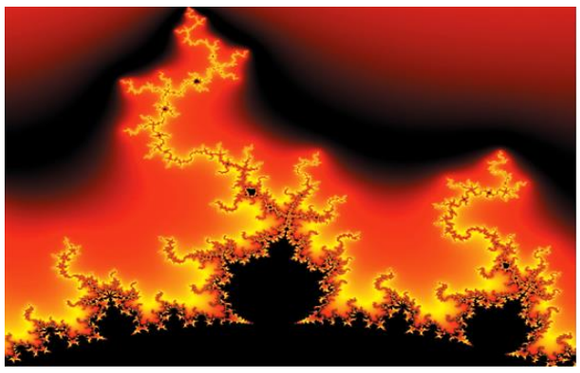

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