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Journal Practical Didactics

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Support the international scientific community in its written production Science, Technology and Innovation in the Field of Social Sciences, in Subdisciplines of psychology of the education of the sociology, conditions of the educational act from the physiology, conditions of the educational act from the sciences of the communication, pedagogical techniques and the science of the methods, the sciences of the evaluation, the didactics and the theory of the programs.

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Knowledge Area

The works must be unpublished and refer to topics of psychology of the education of the sociology, conditions of the educational act from the physiology, conditions of the educational act from the sciences of the communication, pedagogical techniques and the science of the methods, the sciences of the evaluation, the didactics and the theory of the programsand other topics related to Social Sciences.

Presentation of Content

In the first article we present, *Technology transfer in the integrative projects of the new educational model at the Technological University of Jalisco, campus Digital Creative City* by González-Del Castillo, Edgardo Emmanuel, Romo-González, Ana Eugenia, López-Laguna, Ana Bertha and Peña-Montes De Oca, Adriana Isela, with adscription in the Universidad Tecnológica de Jalisco, as the following article we present, *The Academic Bodies in the system of Polytechnic Universities of the State of Hidalgo and their academic production* by Badillo-Maldonado, Martín, Larios-Ferrer, José, Alpízar-Bonilla, Denise, Vega-Ortiz, Carlos and Reyes-García, Juan Carlos., with adscription in the Polytechnic University of Energy, as the following article we present, *ChatGPT: Impact on programming learning among students at the Technological University of Huasteca Hidalguense* by Felipe-Redondo, Ana María, Del Carmen-Morales, Yucels Anaí, Del Carmen Morales, Heidi and Nuñez-Cárdenas, Felipe de Jesús, with adscription in the Universidad Tecnológica de la Huasteca Hidalguense and Universidad Autónoma del Estado de Hidalgo, as the next article we present, *Analysis of the school enviroment in a university of the South of Sonora* by Moncayo-Rodriguez, Lizette Marcela, Herrera-Quijada, Julio Antonio, Sosa-Covarrubias, John and Galván-Corral, Alberto, with adscription in the Instituto Tecnológico de Sonora, Unidad Navojoa, as the next article we present, *School environments and educational performance: Challenges and opportunities in Secondary Education* by Rodríguez-Aguilar Jessica Sabrina, Espericueta-Medina, Marta Nieves, Sanchez-Rivera Lilia and Villareal-Soto, Blanca Margarita, with adscription in the Universidad Autónoma de Coahuila, as the last article we present, *Energy efficiency study of an academic classroom of an educational center under NOM-007-ENER-2014 and NOM-025-STPS-2008* by Rodríguez-Uribe, Juan Carlos, Trejo-Torres, Zaira Betzabeth and Benitez-Alonso, Margarita, with adscription in the Instituto Tecnológico Superior de Huichapan.

Content

Journal Practical Didactics 8[19]1-7: e1819107
Article

Technology transfer in the integrative projects of the new educational model at the Technological University of Jalisco, campus Digital Creative City

La transferencia tecnológica en los proyectos integradores del nuevo modelo educativo en la Universidad Tecnológica de Jalisco sede Ciudad Creativa Digital

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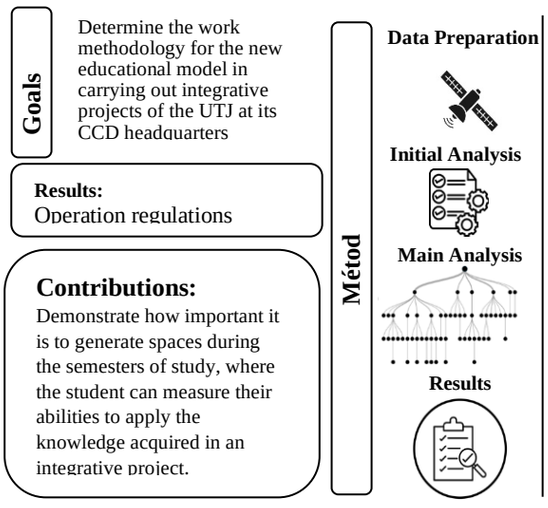
Abstract

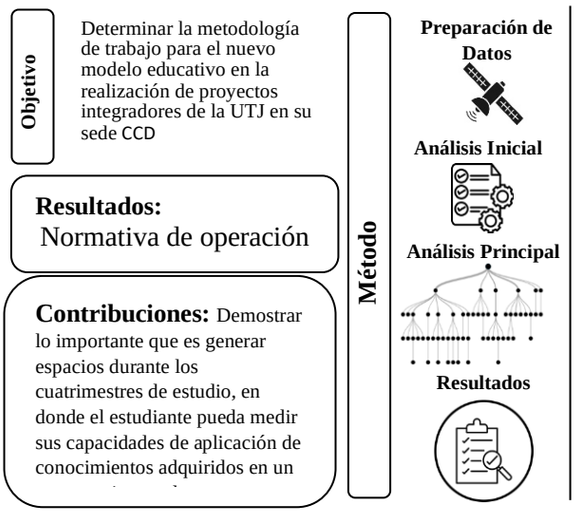
An Integrative Project is a work that is prepared in a specific area of knowledge, through which the student highlights the knowledge acquired throughout a specific period of studies, promoting the understanding, analysis and transformation of the problems of the context, is a collaborative work that aims to develop and integrate the acquired skills. This article shows the process of technological transfer in the integrative projects of the new model of the Technological University of Jalisco campus Digital Creative City, which are presented in a plenary exhibition at the end of each training cycle, through which scientific and technological knowledge is delivered. to develop new applications. The sources of knowledge and development of the technologies to be transferred are of diverse origin and belong to or have some link with the University.



Transformation, Integrative, Technologies

Resumen

Un Proyecto Integrador es un trabajo que se elabora en un área específica del conocimiento, por medio del cual el estudiante pone en evidencia los conocimientos adquiridos en un periodo determinado de estudios, promoviendo la comprensión, análisis y transformación de los problemas del contexto, es un trabajo colaborativo que tiene como objetivo desarrollar e integrar las competencias adquiridas. El presente artículo muestra el proceso de transferencia tecnológica en los proyectos integradores del nuevo modelo de la Universidad Tecnológica de Jalisco sede Ciudad Creativa Digital que son presentados en exposición plenaria al finalizar cada ciclo de formación, a través del cual se entregan los conocimientos científicos y tecnológicos para desarrollar nuevas aplicaciones. Las fuentes de conocimiento y desarrollo de las tecnologías a ser transferidas son de diverso origen y pertenecen o tienen algún vínculo con la Universidad.



Transformación, Integrador, Tecnología

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Introduction

The General Directorate of Technological and Polytechnic Universities (DGUTYP) is the area of the Under secretariat of Higher Education (SES) in charge of promoting quality education that allows the training of competitive and confirmed professionals with regional and national development, and that contributes to the construction of a more just society (DGUTYP, 2024).

Within the training of university students of the new educational model of the DGUTYP in the Information Technology Division (DTI) of the Technological University of Jalisco (UTJ) campus City Creative Digital (CCD), the current study plans and programs are the Higher University Technician (TSU) in Virtual Environments and Digital Business and the TSU in Multiplatform Software Development completing their training in the Bachelor of Engineering in Information Technologies and Digital Innovation (UTJ, 2024) and are divided into three training cycles , carrying out the development and evaluation of Integrative Projects (IP) at the end of each cycle, in which a complete innovative technological application is developed, said application represents the process through which, after making a critical analysis of the object, A problem is identified and addressed by creating a response, which becomes a solution to a technological problem. When we talk about innovation, we talk about creating or modifying a product that has the objective of evolving to provide effective solutions and improve the quality of life of customers and society in general.

Technology can be defined as the set of knowledge and techniques that are applied in an orderly manner in order to achieve an objective or solve a problem. And it emerged as a response to humans' desire to transform the environment and improve their quality of life (Assembler, 2023).

Regarding the first training cycle completed in the third semester, a project belonging to the catalog of projects previously designed as case studies is assigned, allowing students a first approach in the development of these applications that in the company of the institution's teaching staff. . They will provide knowledge and experience in achieving the proposed objective.

Project-Based Learning (PBL) is a learning methodology in which students are guided to look for possible solutions to a certain problem, based on projects (Pimentel, 2021).

For the second training cycle at the end of the fifth semester, the project to be developed is developed in a real company, documenting the project by formulating research questions, reviewing literature, collecting and analyzing data, and presenting results. and at the same time finishing his training as a TSU.

It is a condition for students to be able to study Technical Engineering, which is taken in three semesters plus a stay, to have obtained the TSU professional degree and to have completed and approved their stay; they must previously do their social service.

The third cycle of training of the curricular model allows that after obtaining the TSU degree, students can choose to study Technical Engineering which is taken in three semesters plus a stay, it is highly professional in nature by preparing graduates in areas specific to professional practice for direct insertion into the labor market, developing your integrative project in the ninth semester where you will strengthen presentation and communication skills to transmit innovative results, lead teams effectively and at the same time allow technological transfer within the Academy-Company synergy MySMEs of Mexico.

Technology transfer, or technological transfer, is the process by which organizations transfer technology, skills and knowledge to each other. These transfers occur so that another series of organizations with fewer resources can access scientific advances in an easier and more accessible way. In this way, technological transfers allow the technological development of organizations, as well as the creation of value in their products and services (IPN, 2024).

Operation regulations for integrative projects

On the path towards innovation and excellence, promoted in the UTJ slogan, in 2005 the first formats for records and matrices of project deliverables were implemented in the DTI, carrying out an update of its regulations; Years later, in 2011, an exhaustive review and new proposals for the process to be followed in planning activities were carried out.

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By 2021, its operation and planning were formalized in the current regulations, as well as its evaluation in a plenary session through a rubric of evaluation and the catalog of projects available to be developed by the work teams.

In this phase we want to show and demonstrate to the academic community how important it is to generate spaces during the semesters of study, where the student can measure their abilities to apply the knowledge acquired in an integrative project.

Having as a general objective to determine the guidelines to follow in the planning of integrative projects and allowing the activities of the CCD academic unit to be carried out in a harmonious and disciplined manner, being functional, efficient and productive in the development of the integrative projects carried out. At the end of each training cycle in the DTI of UTJ-CCD and derived from the accreditation process through which the study plans and programs go through in the National Council for Accreditation in Informatics and Computing (CONAIC), it determines in its evaluation criteria the implementation of integrative projects that allow students to demonstrate the skills acquired throughout their university life.

The subjects corresponding to the specialty include projects aimed at developing the student's ability to solve real problems in accordance with the technological needs of the program itself (CONAIC, 2023).

In this sense, the PIs seek to solve the evidence required in the indicators, allowing success in the acquisition of accreditations, for this reason the guidelines described below are established.

Regarding the assignment of teachers

- Only one coordinating teacher per group.
- Teacher rotation must be carried out every quarter.
- Regarding the registration of work equipment
- In alphabetical order by paternal last name on each team.
- With a minimum of four members and a maximum of six.
- As far as possible, maximum six teams per group at the teacher's discretion.
- All teams must have the same number of members with a maximum difference of one person.
- Only repeating students who take a specialization or integrative subject must register in a work team and present an integrative project at the end of the semester.

In relation to the duration of the exposure.

- 20 minutes of exposure.
- Five minutes for teacher feedback.
- Five minutes for the team change.

In relation to the content of the exhibition.

- Only the presentation of the work team and project problems in English.
- Functional demonstration of the technological application.
- Presentation of two reports or diagrams relevant to the project, they must be the same in all teams.
- Specific teacher requests (videos, additional pages, etc.)

In relation to the work equipment on display.

- Formal and uniform attire.
- Collaboration of all members of the exhibition team.
- Punctuality at the beginning of the exhibition.
- Structure of the presentation defined, sequenced and with mastery of the topic.

Box 1

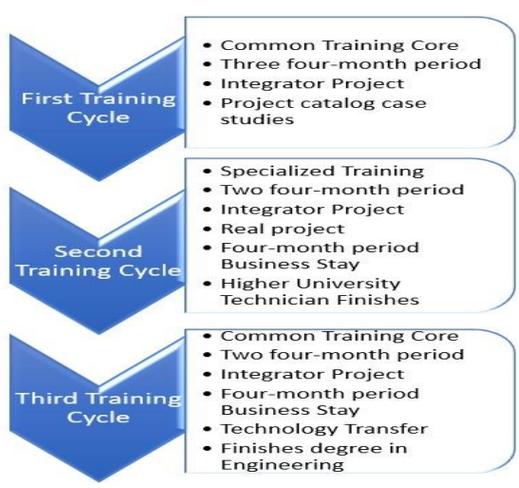

Figure 1
New university model

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First cycle of vocational training

In this first training cycle that covers three semesters, specialized subjects related to computer networks are taught from their fundamentals to advanced topics such as switching and routing, as well as computer programming in its fundamentals, structured programming, object-oriented programming and the first subject of database, which allows determining the following as the objective of the integrative project:

Develop a desktop application in visual mode taking as reference the object-oriented programming paradigm, as well as design and manipulate a relational database from the application and at the same time design the physical and logical topology of the local area network in accordance with the project needs.

For this first cycle of professional training, the integrative projects maintain a common core in their two aspects both for the area of multiplatform software development and for the area of virtual environments and digital businesses and will be assigned from the catalog of projects developed in collaboration with the academia and the coordination of projects, written as case studies, to facilitate a first approach in the development of technological applications, facilitating the student's understanding.

Project catalog

- Control of warehouses, industrial warehouses and storage services.
- System for insurer.
- Administration of soccer fields.
- Preparation, distribution and sale of beer.
- Producer and distributor of packaged fast food.
- Coordination of workshops and laboratories.
- Distributor of Western glasses and bags.
- Distributor of paints and coatings.
- Sweet shop.
- Systems for the control of textile products.
- Control of material and tools in production lines.
- Shoe store.
- Systems for controlling a pharmacy.
- Hardware store control.
- Minisuper control.
- Stationery and maintenance of fountain pens.
- Control of a medical network.
- Control of sales of plastic products.
- Spare parts for heavy vehicles.
- Private security company.
- Automotive service workshop.
- Technological services.
- Information control and technical support.
- Dry cleaning control.
- Tool control in production lines.
- Transportation services company.
- Veterinary.

Second cycle of vocational training

In relation to the second cycle of training, which covers two semesters plus one in business stay, it has two areas, the first is in Multiplatform Software Development and includes subjects focused on the development of web and mobile applications in conjunction with software analysis and design, standards and metrics for development and includes advanced databases in its specialized subjects, allowing the following to be determined as the objective of the integrative project:

Develop a multiplatform mobile and web application based on web development frameworks and database information management in the cloud, providing security to Industry 4.0 processes, applying models, standards and metrics that ensure the quality of the project.

In the area of virtual environments and digital businesses, it includes specialized subjects focused on digital modeling and animation, virtual reality applications, in conjunction with the development of web applications, which allows the following project objective to be determined: Develop a virtual reality application with navigation scenarios and interactions and a website with e-commerce and payment gateway that includes a product catalog with visual production of Advertising Spot. In this cycle of professional training, the projects must be in an existing company, which will allow the student a first approach to the real world in which they apply their academic knowledge through the development of a project that responds to the needs of the company and that enhance your skills, attitudes and knowledge within the professional field.

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At the end of this cycle, the aim is to promote the development of creative thinking for the design of methodological proposals that impact the student's professional training and develop their entrepreneurial spirit, to increase their expectations of professional development and promote the use of professional methods and criteria for the resolution of specific problems in the training area, which will allow technology transfer to the companies in which it participates.

Box 2

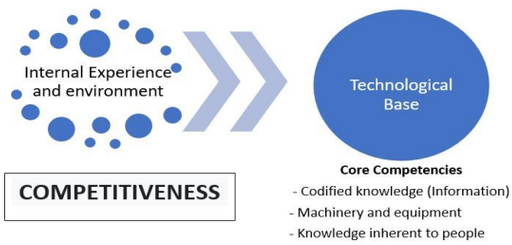

Figure 2
Competitivenes

Third cycle of vocational training

The third cycle of training allows that after obtaining the TSU degree, students can choose to study Technical Engineering which is taken in three semesters plus a business stay, the purpose of which is to complement their training and allow the student to put the skills into practice. related to the work methodology, intellectual and practical, to resolve problematic situations in real conditions through a process of technological transfer, since it requires a research process, this technological transfer occurs gradually, requiring an adaptation and implementation that does not allows immediate effectiveness. For this educational training cycle, technology transfer is classified into eight phases:

Phases of the technology transfer process

- Discovery*:* Process through which a project is developed and an innovation is generated.

- Documentation: It is the phase in which the innovation is identified, as well as its results and advantages in application.

- Evaluation: Phase in which the possible impact of the implementation of said discovery is evaluated, as well as the effects in practice.

- Protection: It is the phase in which the patent is generated. That is, where we develop intellectual or industrial property to guarantee that plagiarism does not occur.

- Marketing: Phase in which the patent is marketed, trying to ensure that it is implemented and developed in a real case.

- License: Phase in which an agreement is reached with interested investors, with the aim of putting innovation and development into practice.

- Article 173 of the Federal Copyright Law states that it is the power to exclusively use and exploit titles, names, denominations, distinctive physical and psychological characteristics, or original operating characteristics applied, in accordance with their nature (Indautor, 2024).

- *Development:* It is the phase in which the company, once it has the license, puts into practice and develops the result extracted from the research.

- *Exploitation*: It is the phase in which the new products or services produced through the implementation of research are commercialized on the market and profits are generated.

Methodology

The research methodology used was qualitative with multiple instrumental case studies, observation and experimentation of an Integrative Project allowing technological transfer. In this way, a well-defined and documented operations strategy was obtained with the pedagogical, technological and design elements to work collaboratively.

In the words of Jesús Ibáñez, the so-called quantitative techniques investigate the meaning produced (the facts). The discussion group technique investigates the process of production of meaning, which is nothing more than the reproduction of the social unit of meaning, and its technical value lies therein.

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Box 3

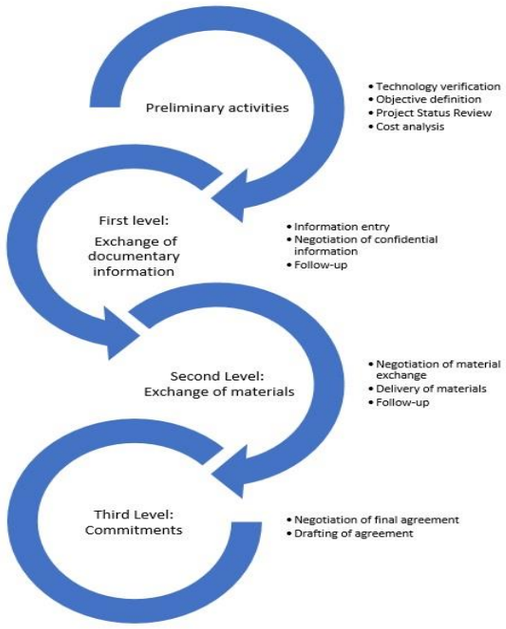

Figure 3

Levels of technological transfer

Box 4

Figure 4

Assistance of Professors in the evaluation of integrative projects

Box 5

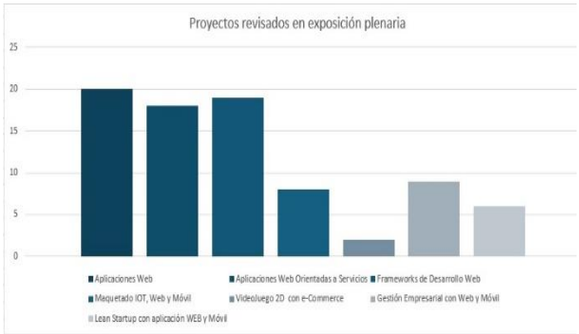

Figure 5

Integrative Projects reviewed in plenary exhibition

Source: Self Made

Results

The result is the work methodology for the new educational model in carrying out integrative projects of the UTJ at its CCD headquarters, having a well-defined and documented operations strategy that makes us affirm that we are better prepared to work more efficiently. and effective, aligning internal resources to create agile and profitable processes, since applying a successful strategy adds added value to our services.

Continuing with the practical application, the management and evaluation tools described in the corresponding sections of this work have been implemented.

It is evident that with the application of everything explained, a more agile, more flexible university is obtained, more adaptable to market variations. Likewise, the process is much easier to understand, as well as to follow its evolution. All elements of management and evaluation of integrative projects contribute to this. Thus, supporting it and identifying deviations, correcting them and applying the idea of continuous improvement is much easier.

If you want to be successful in any activity you must have human capital, trained, involved and committed. In some way it is what underlies all the actions to put this work methodology into practice. Apply techniques focused on helping people and, through information and motivation, achieve a better university thanks to its committed professors.

Conclusions

In today's world and particularly that of productive universities, change is increasingly rapid and forceful.

The environment becomes more competitive every day and more and more universities are entering this competition to be more attractive and better located in a more demanding market.

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We always want to get the most out of resources of any kind, whether material or human, as well as the skills of the staff who work, seeking for each one to magnify their task. The main goal is to help understand operations as a competitive weapon in the global market through good management of the systematic design, direction and control of the processes that transform inputs into products and services to satisfy the needs of students and power. generate a competitive advantage.

Annexes

Declarations

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.

Author contribution

Gonzalez-Del Castillo, Edgardo Emmanuel: Contributed to the project idea, research method and technique and academic coordination with teachers.

Romo-Gonzalez, Ana Eugenia: Contributes to the management of economic resources to carry out research and publication.

López-Laguna, Ana Bertha: Contributes to data analysis and article revision.

Peña-Montes De Oca, Adriana Isela: Contributes to the translation into English of the presentation and the article.

Availability of data and materials

Initially, the information is recorded in the central Drive repository, later in the system developed for the management of integrative projects.

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Own resources in the academic secretary dedicated to research

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Abbreviation

CCD - City Creative Digital
DGUTyP - The General Directorate of Technological and Polytechnic Universities
DTI - Information Technology Division
IP - Integrative Projects
MySMEs - My small and medium-sized company in Mexico
PBL - Project-Based Learning
SES - Secretariat of Higher Education
TSU - Higher University Technician
UTJ - Technological University of Jalisco

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Article

The Academic Bodies in the system of Polytechnic Universities of the State of Hidalgo and their academic production

Los Cuerpos Académicos en el sistema de Universidades Politécnicas del Estado de Hidalgo y su producción académica

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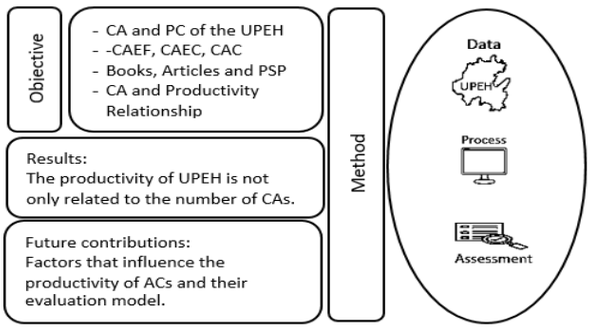
Abstract

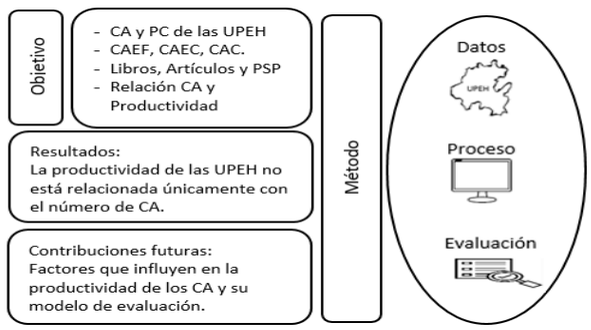
The CAs of the UPs are constituted by PTC around a common object of study, with goals, strategies and academic actions that allow their development and consolidation. Through their LIIADT in their CAs, the PTCs generate and apply new knowledge by providing PCs designated as valid by PRODEP. This work has the purpose of determining the level of productivity of the CAs of the UPEH, according to the number of valid PCs. The results show that the factors that determine the productivity of the ACs of the UPEH are not related only to the number of PCs. It is suggested to reflect on the relevance of the PTC, the integration of their AC, as well as the PC that are generated. As future research, all the factors that influence the productivity of the ACs will be determined to generate a model for evaluating the productivity of the ACs for the UPs.



Productivity, Academic Bodies, Polytechnic Universities

Resumen

Los CA de las UP se constituyen por PTC en torno a un objeto de estudio común, con metas, estrategias y acciones académicas que permiten su desarrollo y consolidación. A través de sus LIIADT en sus CA, los PTC generan y aplican nuevos conocimientos aportando PC señalados como válidos por el PRODEP. Este trabajo tiene la finalidad de determinar el nivel de productividad de los CA de las UPEH, de acuerdo con el número de PC válidos. Los resultados muestran que los factores que determinan la productividad de los CA de las UPEH no están relacionado únicamente con la cantidad de PC. Se sugiere reflexionar sobre la pertinencia de los PTC, la integración de sus CA, así como de los PC que se generan. Como investigaciones futuras se determinarán todos los factores que influyen en la productividad de los CA para generar un modelo de evaluación de la productividad de los CA para las UP.



Productividad, Cuerpos Académicos, Universidades Politécnicas

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Introduction

The mission of Higher Education Institutions (HEI) is to provide significant knowledge in the formation of human capital, as well as to offer support to the productive sector and society as a whole in order to better face the challenges of globalisation in this 21st century. Thus, in 2001 the Polytechnic Universities (UP) were created as an educational project to offer engineering degrees, bachelor's degrees and postgraduate studies at the speciality level. Their programmes are designed based on the competency-based educational model and are oriented towards applied research and technological development.

The UPs are decentralised bodies of the state governments. This type of institution was incorporated into the higher education system in 2002 with the aim of expanding opportunities for access to public higher education and strengthening the relevance of the educational offer in the regions where they are located (Cruz López, Y. & Cruz López, K., 2008).

On the other hand, the Ministry of Public Education (SEP, 2006) states that academic bodies (CA) are made up of a group of full-time professors (PTC); which are associated by disciplinary areas, by professional profiles that share one or several lines of generation and/or application of knowledge (LGAC), as well as by disciplinary or multidisciplinary topics that are supported by academic objectives and goals.

These PTC are organised to carry out collective research among themselves, form networks with external groups and develop management activities, human resources training, academic tutoring and support for educational programmes, among other functions.

The Programme for the Professional Development of Teachers (PRODEP) states that the CAs in the UPs are groups of PTCs that share one or several Innovative Lines of Applied Research and Technological Development (LIIADT), which are mainly oriented towards the assimilation, transfer and improvement of existing technologies, and a set of academic objectives and goals. These ACs work on research projects that meet the specific needs of the productive sector and participate in advisory and consultancy programmes for this sector (Diario Oficial de la Federación, 2023).

According to the above, the UPs' ACs are constituted to contribute to solving problems and satisfying the needs of the productive sector through their LIIADTs, assimilating, transmitting and improving existing technologies (PROMEP, 2024).

Cáceres-Mesa et al., (2023), state that the Programme for the Professional Development of Teachers (PRODEP) classifies the CAs in a scaled manner into: Cuerpos Académicos en Formación (CAEF), Cuerpos Académicos en Consolidación (CAEC) and Cuerpos Académicos Consolidados (CAC). This organisation is based on the academic capacity of its members.

To be promoted in these three levels of CA, HEIs need to maintain the number of professionally trained PTCs, preferably with the highest academic degree, with recognition of the National System of Researchers (SNI) and Desirable Profile, the diversity and quality of their individual and collective scientific production, their participation in teaching and training of human resources, the development of research projects, as well as in collaborative work with academic peers from other HEIs in thematic networks of research and management. In particular, scientific production (SP) is one of the most important indicators for the evaluation of academic staff, academic staff and HEIs.

Candia Luján et al., (2023) point out that CP refers to the number of academic publications that show the results of research in different areas of knowledge. From this point of view, academic production is established as a level of competitiveness; which becomes an evaluation variable that is measured by the level of dissemination of the valid products generated; such as books published in recognised publishers, articles published in refereed or indexed journals, papers, awards, patents or copyrights (Rodríguez-Maya, et al., 2018).

Additionally, for the UPs, projects with the productive sector (PSP), applied basic research reports, didactic-pedagogical innovation, intervention, curricular development, innovation with social commitment and well-founded digital resources are considered as part of CP, or academic production (Diario Oficial de la Federación, 2023).

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To stimulate CP in Mexico, the government implemented different support programmes for CTPs and ACs. The SNI was created in 1984; in order to become a member and receive financial support, researchers must show evidence of scientific publications in journals indexed in high-impact databases (CONACyT, 2024).

In 1996, the Teacher Improvement Programme (PROMEP, 2024) was created under the National Development Plan 1995-2000, which was derived in response to the recommendations of the United Nations Educational, Scientific and Cultural Organisation (UNESCO) in order to improve the professionalisation of teaching staff in Mexico. Subsequently, in 2013, PROMEP became PRODEP. It is worth mentioning that both federal programmes were characterised by issuing calls for proposals to financially support the performance of teaching and research staff, as well as HEIs, through the training and evaluation of the CAs.

In this way, the UPs join the federal programmes to obtain economic benefits and contribute to their mission through the professionalisation of their PTCs, as well as the formation of CAEFs, CAECs and CACs.

In Mexico there are 64 UPs; particularly in the state of Hidalgo there are 6 that form the system of Polytechnic Universities of the State of Hidalgo (UPEH). In this system, CA have been integrated, according to the guidelines of the PROMEP-PRODEP programmes.

A timeline shows the UPs located in the state of Hidalgo, starting from the year of their foundation: Polytechnic University of Tulancingo (UPT) 2002; Polytechnic University of Pachuca (UPP) 2003, Polytechnic University of Francisco I. Madero (UPFIM) 2005; Universidad Politécnica Metropolitana de Hidalgo (UPMH) 2008; Universidad Politécnica de Huejutla (UPH) 2012 and Universidad Politécnica de la Energía (UPE) 2014 (PRODEP, 2024).

However, Negrete Urbano, et al., (2021) state that the UP agenda began to change significantly during the beginning of the new century.

Initially, the agenda showed an insistence on decentralisation, attention to social demand and planning; however, over a period of two decades, it shifted to issues such as accreditation, as well as evaluation to obtain extraordinary resources for quality.

As can be seen, for more than twenty years, CP has not been one of the priority issues on the agendas of the UPs.

Similarly, Velázquez and Ramírez (2023) argue that scientific research in the UPs has lagged behind. In particular, these authors point out that there has been a slow but steady growth; in other words, research work has not ceased, although it is still not enough.

The above shows that there is a gap to be covered by the ACs that make up the UP group in order to generate knowledge and strengthen the productive sector through the application of science, which, today, is the time to create links, not only in the university-business relationship, but also to collaborate to solve the areas of opportunity presented by the productive sector in each region, and thus fulfil the raison d'être for which these institutions were created.

Derived from the above, this work aims to determine the level of productivity generated in books, articles and projects with the productive sector (PSP) by the ACs that are in formation, in consolidation and consolidated by UPEH system. Based on the results obtained, this analysis will allow reflection to generate new work strategies in the UPEHs, their ACs and the form of organisation of the PTCs.

In this work it is proposed that the greater the number of CAEF, CAEC and CAC in the UPEH, the greater the PC in books, articles and PSP will be.

In order to determine the productivity of the CAs of the UPEHs, an investigation was carried out in relation to the number of academic bodies (CAEF, CAEC and CAC) that exist in each of the institutions in question.

It is worth mentioning that the information was obtained from the website accessible to all UPs, through the Ministry of Public Education of Hidalgo (SEPH), particularly in the educational offer for higher education (SEPH, 2024). The results are presented in Table 1.

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Box 1

Table 1

CA in the UPEH.

UPEH	CAEF	CAEC	CAC	Total
UPT	5	3	1	9
UPP	13	6	1	20
UPFIM	5	2	0	7
UPMH	7	2	0	9
UPH	1	0	0	1
UPE	0	0	0	0
Total	31	13	2	46

Source. SEP – Hidalgo, 2024. https://sep.hidalgo.gob.mx/ofertaeducativaES/.

Likewise, PC in relation to books, articles and PSP was obtained from the website of each UPEH, through the SEPH, particularly in the educational offer for higher education (SEPH, 2024). The results are presented in Table 2.

Box 2

Table 2

PC in the UPEH.

UPEH	Scientific production			Total
	Articles	Books	PSP	
UPT	56	8	13	77
UPP	7	0	0	7
UPFIM	24	16	11	51
UPMH	34	0	9	43
UPH	0	0	0	0
UPE	8	0	0	8
Total	129	24	33	186

Source. SEP – Hidalgo, 2024. https://sep.hidalgo.gob.mx/ofertaeducativaES/.

The data analysis was carried out using descriptive statistics. Table 3 shows the relative frequency of the CA (CAEF, CAEC and CAC) in each UPEH, according to the data presented in Table 1. Where for each of the UPEHs the following is calculated:

$$fr = \frac{CA\ number}{total\ number\ of\ CA} * 100 \quad (1)$$

Box 3

Table 3

Relative frequency of CAs in UPEHs

UPEH	CAEF	CAEC	CAC	Total
UPT	16%	23%	50%	20%
UPP	42%	46%	50%	43%
UPFIM	16%	15%	0%	15%
UPMH	23%	15%	0%	20%
UPH	3%	0%	0%	2%
UPE	0%	0%	0%	0%

Source. Own elaboration

Similarly, Table 4 shows the relative frequency of CPs (Articles, books and PSPs) in each UPEH, according to the data presented in Table 2. Where for each of the UPEH the following is calculated:

$$fr = \frac{PC\ number}{total\ number\ of\ PCs} * 100 \quad (2)$$

Box 4

Table 4

Relative frequency of CPs in the UPEHs

UPEH	Scientific production			Total
	Articles	Books	PSP	
UPT	43%	33%	39%	41%
UPP	5%	0%	0%	4%
UPFIM	19%	67%	33%	27%
UPMH	26%	0%	27%	23%
UPH	0%	0%	0%	0%
UPE	6%	0%	0%	4%

Source. Own elaboration

On the other hand, the arithmetic mean, a simple measure of central tendency, was applied to determine the average CA and PC in the UPEH system, where it is calculated:

$$\bar{X} = \frac{X_1+X_2+\cdots+X_n}{n} = \frac{\sum_{i=1}^{n} X_i}{n} \quad (3)$$

The information was calculated from the data presented in Tables 1 and 2. The results are presented in Tables 5 and 6.

Box 5

Table 5

Arithmetic mean of CA in the UPEH System

UPEH	CAEF	CAEC	CAC
Total	31	13	2
$\bar{X}$	5	2	0

Source. Own elaboration

Box 6

Table 6

Arithmetic mean of PCs in the UPEH system

UPEH	Scientific production		
	Articles	Books	PSP
Total	129	24	33
$\bar{X}$	22	4	6

Source. Own elaboration

Finally, to determine the productivity of the PHEUs, it is calculated by considering the production obtained among the total factors employed; and it is represented by the following equation:

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$$PG = \frac{production\ obtained}{total\ factors\ employed} \quad (4)$$

Although there are several factors that concur to obtain scientific products, in the particular case of this study, only the factor of academic bodies in each UP is considered, where:

$$P = \frac{scientific\ production\ (PC)}{academic\ bodies\ (CA)} \quad (5)$$

The results are shown in Table 7.

Box 7

Table 7

Productivity of the UPEH

UPEH	PC	CA	Productivity
UPT	77	9	8.56
UPP	7	20	0.35
UPFIM	51	7	7.29
UPMH	43	9	4.78
UPH	0	1	0.00
UPE	8	0	N/A

Source. Own elaboration

Results

According to the results obtained, it can be seen that, of the total number of CA of the UPEH, the highest frequency (43%) was obtained by the UPP. Of the total number of CAs, the UPP has 50%, 46% are CAECs and 42% are CAEFs. However, of the total number of CPs of the UPEH, the UPP has a frequency of 4%, which only corresponds to 7 articles.

On the other hand, the UPT and the UPMH presented a frequency of 20% each, in relation to the total number of CA of the UPEH. However, the frequency distribution for the UPT is 16% CAEF, 23% CAEC and 50% CAC; in contrast to the UPMH, which has 23% CAEF and 15% CAEC. In relation to the total CP of the UPEH, the UPT has 41%, where 43% are articles, 33% books and 39% PSP.

In a different way, the UPMH has 23% of the total CP of the UPEHs as a whole, where 26% are articles and 27% are PSP. This shows that the productivity of the UPT is 18% higher than that of the UPMH. This difference may be based on the frequency of CAC (50%) and CAEC (23%) that the UPT has, compared to the UPMH, which has no CAC and only 15% of CAEC.

In relation to the total number of CA of the UPEH, UPFIM obtained a frequency of 15%; representing 16% of CAEF and 15% of CAEC. In relation to the total PC of the UPEH, UPFIM has a production of 27%, representing 19% in articles, 67% in books and 33% in PSP. This is interpreted as good productivity. It is observed that, with a lower number of CA, its PC is in articles, books and PSP; despite the fact that there is no CAC. Finally, UPH has only one CAEF, which represents 3% of the total CA of UPEH and 0% of PC. On the other hand, UPE has 0% in CA and 6 articles representing 8% in PC.

In sum, it can be observed that, of the total number of UPEH (6), there are 46 CA; which present a relative frequency of 67% of CAEF, 28% of CAEC and 4% of CAC. In the same sense, the arithmetic mean is 5 CAEF, 2 CAEC and 0 CAC.

With regard to the CP of the UPEHs, out of a total of 186 products, the relative frequency in articles is 69%, in books 13% and in PSP 18%. The arithmetic mean is 22 articles, 4 books and 6 PSPs.

According to the above data (Table 7), it can be seen that the productivity of the UPEH is not only related to the number of CA.

Particularly in the UPT, with the same number of AC (9) as the UPMH, its productivity is almost twice as high as in the UPMH (8.56 and 4.78, respectively).

On the UPP side, productivity is .35; that is, with 20 CA they only have 7 PC. Conversely, UPFIM's productivity is 7.29, which means that with only 7 CA they have managed to develop 51 PCs.

Finally, UPH has zero productivity due to the fact that with one CA there are still no CPs. On the other hand, the UPE has 8 PCs without a single CA.

Conclusions

PRODEP, through the curriculum capture module, offers a means to quantitatively and qualitatively determine the academic productivity of research professors (Rodríguez-Maya, et al., 2018).

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However, the SEP, through the Under-Secretariat of Higher Education (SES) and the General Directorate of University and Intercultural Higher Education (DGESUI, 2024) carries out actions to promote the integration of PTCs in CA. To this end, it issues a call for Public Higher Education Institutions (IPES) attached to PRODEP, so that they can register new CA proposals; or, through the evaluation of existing CAs, they can achieve a higher degree of consolidation. In this sense, to determine the degree of consolidation of an academic body, its members must provide documentary evidence of the collegiate work carried out, show common goals to generate knowledge and carry out applied research, as well as show solidity and maturity in the LIIADT. For all levels of CA consolidation, the academic products that will be considered valid to provide evidence of collegiate work are: books, book chapters, refereed articles, indexed articles, intellectual property, patents, prototypes and technical reports. Likewise, according to the level of the AC, the PTC must have a Doctorate or Master's degree and have the Desirable Profile Recognition.

As can be seen, there are several factors to consider when evaluating the productivity of the ACs. Nevertheless, and in a first approach to the topic of productivity of the ACs of the UPEH, in this work the PC was proposed as the only factor of analysis for the productivity of the ACs. It was argued that the greater the number of CAEFs, CAECs and CACs in the UPEHs, the greater the CP in books, articles and PSP. However, the results obtained showed that the productivity of the UPEHs is not only related to the number of CA.

addition to what the DGESUI points out in order to evaluate the CAs, it is observed that it will be necessary to study other factors such as: 1) time (referred to as the seniority of the UP, as well as of the CAs since their formation and during their escalation), 2) CV of the PTCs (observing age, experience, professional training relevant to the educational programme and with postgraduate studies, recognitions and distinctions, occupation and distribution of time in the performance of their functions, among others) and 3) economic resources obtained by any federal, state or HEI programme for the PTCs and/or CAs.

Therefore, as future research, it is established to study and determine the factors that influence the productivity of CAEF, CAEC and CAC. In this way, it will be possible to build a model that provides an instrument and its methodology to evaluate the productivity of the CAs.

On the other hand, it could be seen at the time of data collection that the information on the websites of each institution is not homologous. In some cases, the professional profile of the PTCs is shown, their academic degree, the line of research in which they work, whether they belong to the SIN or have a desirable profile. However, in other cases there is little or no information regarding the PTCs, their PC and the CAs.

In this sense, it is suggested to standardise the structure and content of the UPEH web pages. But even more important is to invite HEIs to reflect on the relevance of their full-time teaching staff, the integration of their ACs, as well as the PCs generated.

This will allow them to find opportunities for improvement so that they have greater possibilities to carry out collaborative, equitable and quality work; which will contribute to the training of students capable of facing current challenges, favouring the productive sector to solve its areas of opportunity and; particularly for the UPEHs, to show themselves as institutions that contribute wealth to society as a whole.

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.

Availability of data and materials

The availability of the data obtained in this research was through the SEPH website, particularly in the educational offer for higher education (SEPH, 2024).

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However, in each of the UPEH web pages the information is not complete or homologous, particularly in the UPP it is not possible to consult the PCs, in the same way it happened in the UPH. Contact was sought via email and telephone but no response was received.

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There is no funding of any kind. It is carried out with its own income, which limits the collection of data in situ.

Abbreviations

CA	Academic Bodies
CAC	Consolidated Academic Bodies
CAEC	Academic Bodies in Consolidation
CAEF	Academic Bodies in Formation
DGESUI	General Directorate of University and Intercultural Higher Education
IES	Higher Education Institutions
IPES	Public Higher Education Institutions
LGAC	Lines of Generation and/or Application of Knowledge
LIIADT	Innovative Lines of Applied Research and Technological Development
PC	Scientific Production
PSP	Projects with the Productive Sector
PTC	Full-Time Lecturers
PRODEP	Programme for the Professional Development of Teaching Staff
PROMEP	Programme for the Improvement of Teaching Staff
SES	Under-Secretariat for Higher Education
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UP	Polytechnic Universities
UPE	Polytechnic University of Energy
UPFIM	Polytechnic University of Francisco I. Madero
UPH	Polytechnic University of Huejutla
UPMH	Metropolitan Polytechnic University of Hidalgo
UPP	Polytechnic University of Pachuca
UPT	Polytechnic University of Tulancingo
UPEH	Polytechnic Universities of the State of Hidalgo
SEP	Ministry of Public Education
SEPH	Secretariat of Public Education of Hidalgo
SNI	National System of Researchers

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Article

ChatGPT: Impact on programming learning among students at the Technological University of Huasteca Hidalguense

ChatGPT: iImpacto en el aprendizaje de la programación en los estudiantes de la Universidad Tecnológica de la Huasteca Hidalguense

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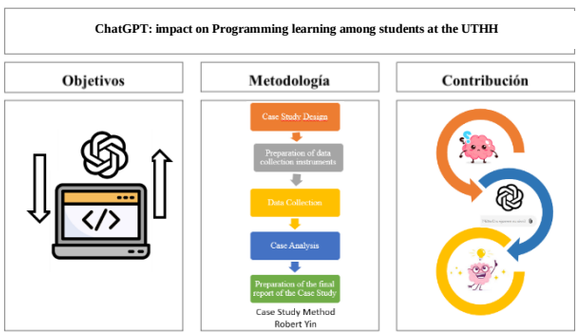
Abstract

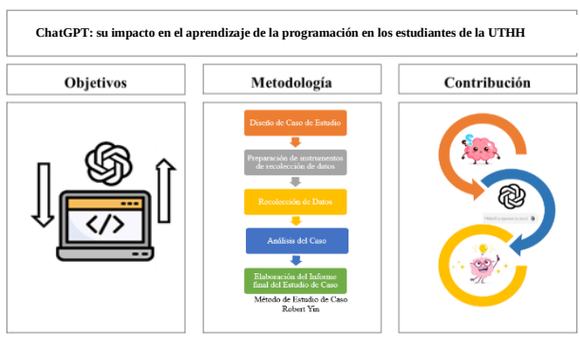
The emergence of generative AI in education has a revolutionary impact, which moves teaching-learning processes to change, thus requiring teachers and students to learn new skills to enhance their use in such a way that it favors meaningful learning. This research focused on knowing the impact of its use on the learning of programming in UTHH students; The Case Study Method proposed by Robert Yin was used. The analysis of the results does not lead to the conclusion that students strengthen the learning process through requesting guidance and correction on errors in the code, detailed explanation of the lines of code to ChatGPT, highlighting the fact that it can be used natural language for communication, which helps them better understand the problems raised.



ChatGPT, Learning, Programming

Resumen

La irrupción de la IA generativa en la educación tiene un impacto revolucionario, que mueve a cambiar los procesos de enseñanza – aprendizaje, así exige a docentes y estudiantes aprender nuevas habilidades para potencializar su uso de tal forma que favorezca al aprendizaje significativo. Esta investigación se centró en conocer el impacto de su uso, en el aprendizaje de la programación en los estudiantes de la UTHH; se utilizó el Método de Estudio de Caso propuesto por Robert Yin. El análisis de los resultados nos lleva a concluir que los estudiantes fortalecen el proceso de aprendizaje a través de solicitar orientación y corrección sobre los errores en el código, la explicación detallada de las líneas de código al ChatGPT, resaltando el hecho de que se pueda usar el lenguaje natural para la comunicación, que les ayude a una mejor comprensión de los problemas planteados.



ChatGPT, Aprendizaje, Programación

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Introduction

Artificial intelligence (AI) is a branch of computing based on expert systems, meaning that algorithms have "a power of decision", based on millions of established rules. For Turing "... any system capable of imitating human intelligence is considered artificially intelligent..." (Kunjuk, 2024).

This is particularly evident when the design of these AI systems replicates an interactive conversation, matching human behaviour. It was in 1950 when Alan Turing published the article "Computing Machinery and Intelligence", where he proposed the Turing Test to assess the ability of a machine to have human behaviour, in 1956 the term "artificial intelligence" was coined for the first time during the Dartmount conference.

It took seven decades for Turing's ideas to come to life in an accessible and massive way through the proposals of various technology giants, some of these are: chatGPT, ChatSonic, Claude, Copilot, Gemini, JasperChat, Poe AI, YouChat, among others (Expansión, 2024). In this journey of AI integrating into everyday life, several types are identified. Each subset of AI requires a unique combination of hardware, software and security depending on the end goal of the project, a classification is listed below:

- Classical Machine Learning (ML): Uses models or algorithms to analyse data sets, identify patterns and make predictions without human intervention.
- Deep learning: Makes use of models that can recognise complex patterns in images, text, sounds and other data to produce accurate information and predictions. This type of AI is an advance on classical ML.
- Computer vision: Trains computers to understand the overwhelming amount of visual data that is collected to locate, identify and track specific objects or actions.
- Generative AI: Generative AI creates new content based on the massive data sets and machine learning AI algorithms it was trained on. This type of AI is integrated with language AI, also known as natural language processing (NLP), which allows it to process and understand human language (INTEL, 2024).

According to the article "Microsoft Copilot vs. ChatGPT vs. Gemini: Which One is the Best AI Chatbot?" recently conducted by DynaTech Systems (DynaTech Systems, 2024), these are the three most demanded options, and Table 1 highlights some statistics on their use, although the exact number of subscribers is not known for reasons of commercial strategies.

Box 1

Table 1

Statistics at a glance

Copilot	ChatGPT	Gemini
70% of Copilot users indicate that they are more productive, and 68% mention that it impacts the quality of their work. 77% of users once they have used Copilot, they don't want to stop. 64% say that Copilot helps them reduce the time they spend on their activities.	ChatGPT has up to 200 million monthly active users around the world. 77.2 million people are located in the US. The ChatGPT Plus version has around 3.9 million subscribers in the US.	Gemini has around 1 billion users worldwide. Gemini is available in 46 languages, including Chinese, German, Arabic, Spanish, Hindi, etc. Gemini has around 330.9 million monthly visits.

Source: DynaTech (2024)

Table 2 shows a summary of the main features of the three most demanded generative AI proposals, where it can be highlighted that Copilot and Gemini, being subscription products, their use is restricted, on the other hand, ChatGPT offers a free version which favours its use.

Box 2

Table 2

Comparison of Copilot, ChatGPT and Gemini

Criterio	Copilot	ChatGPT	Gemini
Company Year of launch Language model	Microsoft 2023 Based on GPT-4 (from OpenAI)	OpenAI 2022 GPT-3.5 / GPT-4	Google 2023 Gemini (Based on PaLM 2)
Integration	Office 365, GitHub	OpenAI API, various platforms	Google Workspace, Google Assistant
Multilanguage	Yes	Yes	Yes
Year of access to information	Until 2021 (by OpenAI GPT-4)	Until 2021 (GPT-3.5) / 2024 (GPT-4 Turbo)	Until 2023 (upgraded)
Generate images	No	Yes (with DALL-E in GPT-4)	Yes (integrated with Google tools)
Costs	Subscription-based	Subscription based, limited free version	Subscription based, integrated with Google services
Programming support	Extensive, integrated with GitHub and VSCode	Basic	Basic

Source: DynaTech (2024)

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This availability of AI tools for students and teachers generates a new scenario in the teaching-learning process. As they point out in the experimental comparative study of the use of chatGPT and its influence on student learning in the Information Technologies degree programme at the University of Guayaquil, the researchers argue that 'The results suggest that the use of ChatGPT can be an effective didactic strategy to improve the academic performance of students'.

While AI offers opportunities to support teachers in their educational and pedagogical responsibilities, human interaction and collaboration between teachers and learners must remain central to education.

AI has become ubiquitous in education, it can be used by teachers to alter the teaching and learning experience, helping teachers to create instructional content; it can impact the student experience by improving learning outcomes through personalisation.

Advances in AI have generated debates about meaningful learning for students, i.e. building the mental scaffolding Ausubel refers to, 'The most important factor influencing learning is what the learner already knows...', however, the reliance on AI has led to a reliance on the use of AI as a learning tool. However, the dependence on AI to generate answers to students' tasks can cause them to lose important skills and, above all, the construction of their own knowledge and its socialisation.

Universities around the world have the mission to educate and offer students new ways of thinking, of solving problems, of rethinking proposals, and at the same time they must assimilate the knowledge and skills for their insertion in the productive sector.

AI has the potential to revolutionise the teaching-learning process, so students - who will be integrated into an AI-driven workforce and digital economy - cannot be left adrift in their adoption of these academic training alternatives that will allow them to better prepare for an evolving technology-based future.

One potential of AI that should be kept in mind is the fact that personalisation of learning, by giving personalised recommendations on what can be optimally adapted to the speed and level of difficulty required by the learner, can help them improve their academic performance, both in and out of the classroom. UNESCO identifies five areas for AI application:

- In the service of education management and implementation;
- In the service of teacher empowerment and teaching;
- In the service of learning and the assessment of results;
- In the service of developing the values and competencies needed for life and work in the AI era; and
- As a way of providing lifelong learning opportunities for all.

With all these benefits, there are also some challenges, one of the main ones being the lack of training and knowledge of teachers on how to use AI effectively in the classroom; on the students' side they run the risk of minimising critical, reflective and creative knowledge creation processes, which can bring unimaginable consequences in the cognitive process derived from the artificial development of content.

And this is where, from the particular point of view of this team of researchers, the central point of this research is found, the non-production of new knowledge by the students, by leaving to the AI the task of their responsibilities and cognitive effort that represents for each of the learning activities, additionally the decrease of collaborative learning - given the individualisation that is generated with the use of AI - and the socialisation of knowledge, interaction and human relations; privacy and data security, ethics and copyright, whose is it the student or the AI? 'the dangers of digitisation, virtualisation and artificialisation of learning can have negative consequences for the quality of educational assessment'. However, learning to program requires a series of analytical thinking skills, logical and algorithmic reasoning, as well as a high tolerance to frustration, tenacity and constancy to achieve the objectives, the development of these skills positively affects the academic performance of students and their personal development, additionally students also learn how technology works and how they can use it.

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The increase of programming languages and tools has helped students to learn, learning platforms such as Codecademy, Udemy, Platzi, Coursera among others, offer a wide variety of alternative programming courses with different levels of complexity that promote self-learning with 7x24 availability; on the other hand, there are also several programming tools, such as Scratch, Alice, Code, Blockly, Code. org, App Inventor, Micro:bit, Greenfoot, Logo, Codecademy, Thimble, Lightbot, Tynker, Blockly Games, App Lab, Snap! CodeCombat, MakeCode, Swift Playgrounds, Repl.it and Unity among others, these programming tools and environments are designed to help students learn programming concepts in a fun and engaging way.

ChatGPT is completely different from programming tools and environments as it is an AI model and makes use of natural language, allowing even people without programming skills to easily solve programming problems.

During learning programming, students use development environments, which may have AI extensions such as Copilot, ChatGPT - Genie AI, among others, also integrate libraries and / or specific components of the development language in question and requires programming knowledge of the language syntax, ChatGPT does not require knowledge of the syntax or specific knowledge of a programming language, since the interaction is conversational so the learning approach is completely different for both students and teachers.

While there are many advantages for students in terms of learning programming, there are also limitations, this research focuses on examining the opinion of the use of ChatGPT in the learning process of programming in students of the Universidad Tecnológica de la Huasteca Hidalguense, knowing their point of view, will provide teachers with valuable information on how to approach and integrate AI tools in the teaching process of programming. Two research questions were posed:

1. what is the opinion of UTHH programming students on the advantages of using ChatGPT in the programming learning process?
2. What is the students' opinion about the disadvantages of using ChatGPT in the programming learning process?

Methodology

This study examines the opinions of students who use ChatGPT tool for learning programming. It makes use of the case study method proposed by Robert K. Yin, who posits it as a strategy that seeks to understand a complex phenomenon especially when the boundaries between the phenomenon and the context are not clearly defined.

Yin's proposed characteristics:

Focus on context: refers to studying a phenomenon within its context.

Multiple or single case research: Yin proposes that case studies can involve one or several cases.

Variety of data sources: Case studies rely on multiple sources of evidence, such as interviews, surveys, observations, documents among others.

Research design: The design of a case study should consider five main components: Research questions.

- Propositions (or theories) guiding the study.
- Unit of analysis (what or who is the ‘case’).
- Logic linking the data to the propositions.
- Criteria for interpreting the findings.

Data analysis strategies: emphasises the importance of using strategies to analyse the data. Analytical generalisation: reflecting on findings from one case can be applied to a broader theory.

Contextual approach

This study aimed to examine students' opinions regarding the use of ChatGPT in learning programming in the subject Programming Methodology of the first term of TSU in Information Technology at the Universidad Tecnológica de la Huasteca Hidalguense (UTHH) in the course Sep-Dec 2023.

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Both quantitative and qualitative research approaches were used in the study. A questionnaire was designed to collect quantitative data and a form consisting of open-ended questions to obtain qualitative data.

The contextual approach focusing on these features will allow for an in-depth exploration of how a tool such as ChatGPT suits the needs of learners in an early academic programming environment and how it contributes to their learning process.

Sixty-five students from the first semester of Programming Methodology at UTHH participated in the research. The study group included 14 females and 51 males, who voluntarily participated by answering the questionnaire provided.

The ages ranged from 18 to 25 years old. The students who participated in the research have minimal programming experience. As part of the research process ChatGPT was integrated into the course, the course sessions were held for three 2-hour sessions per week, for 14 weeks.

The teaching strategy was oriented to Problem Based Learning (PBL), since it sought to encourage an active role of the student, both in the analysis, the development proposal and the validation of results of the algorithms requested.

The sessions were planned in three moments, the initial moment to activate previous knowledge by explaining the theoretical and practical concepts, also supported by presentations, e-books and of course ChatGPT, this dynamic promoted a directed use of ChatGPT to clarify doubts, compare solutions and reflect on the results obtained by the chat. During the development phase, the problem statement is made, students are asked to make their proposed solution independently and without the help of ChatGPT, the progress is observed and common errors are identified and these are asked to ChatGPT, to provide a solution; On the other hand, students who complete the task correctly, ask ChatGPT to offer alternatives to improve the given solution; for the Closing process, the correct solution of the proposed algorithm is observed and the options and answers given by ChatGPT are reflected upon, students highlight the mistakes they made, or the areas of improvement that can be implemented.

To carry out the data collection process, a questionnaire of closed and open questions was used through a form designed by the research group. The questionnaire and the questions of the form were designed according to a literature review and validated with three experts in the field of educational technology and three experts in the area of programming.

The structure of the questionnaire consisted of the following areas:

- Demographic context: which considered age, gender and level of previous programming experience.
- Focus of ChatGPT use: here a list of possible uses and how it supports learning was given.
- Impact on learning: focused on questions about the appropriation of knowledge and the quality of the knowledge.
- Accuracy of results: this included questions about whether the tool provides correct results.
- In order to get the students' point of view on the use of ChatGPT, three questions were asked:

What positive aspects would you highlight from the use of ChatGPT in your programming learning, what negative aspects or limitations have you found when using ChatGPT in your programming learning, do you have any suggestions for improving the use of ChatGPT in programming learning, and do you have any suggestions for improving the use of ChatGPT in programming learning?

The questionnaire was designed in Google Forms for data collection, they were provided with the link to the form and asked to respond to it.

Quantitative data was obtained from the 65 students, analysis of the data revealed significant patterns in their responses, which were examined in detail by the researchers. This quantitative analysis was complemented by a qualitative analysis of the views expressed by the students, allowing a deeper understanding of their experiences, perspectives and attitudes towards the use of ChatGPT in learning programming.

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Furthermore, the qualitative analysis based on the responses to the open-ended questions provided a framework for identifying commonalities as well as divergences in opinions. The active participation of the researchers ensures validity, reliability and an overview of the study group regarding the impact of ChatGPT on their learning process.

Results

Students' opinions about their use of ChatGPT in the learning process of programming were analysed. Emphasis was given to the use they can make of it with respect to learning, as shown in Table 3, then the perception regarding how it helps in their learning, the practice of copy and paste, as well as the quality part of the answers are documented in percentage form.

Box 3

Table 3

Student use of ChatGPT

Use	Number of students	Porcentage
Ask questions about theoretical concepts	39	60.0
Get detailed explanations of code	49	75.3
Ask for help debugging code	22	33.8
Generate code samples to study	24	36.9
Ask for suggestions on best programming practices	29	44.6
Solve concrete algorithm problems	20	30.7
Learn new technologies and programming languages	27	41.5
Ask for explanation in natural language to help understanding of the subject, prior information needed for the coding process	45	69.2
Ask for clarification and correction when there are errors in the code or the results are not as expected.	52	80.0

Source: Own elaboration

This data gives a picture that while students are clear about how the learning process can be aided by asking for guidance and correction of errors in the code, the detailed explanation of the lines of code and highlights the fact that natural language can be used to achieve understanding of the topic - i.e. analysis of the problem - before coding.

These practices have an impact on the learning of programming, so the following results are observed in the quantitative analysis:

Box 4

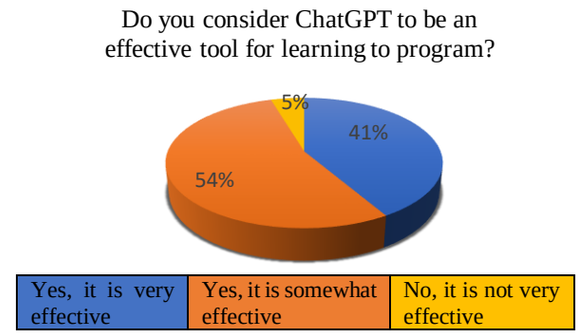

Figure 1

Distribution of usage for learning to program.

Source: Own elaboration

It can be seen that 54%, i.e. just over half of the students consider ChatGPT to be a moderately effective tool for learning to program.

Box 5

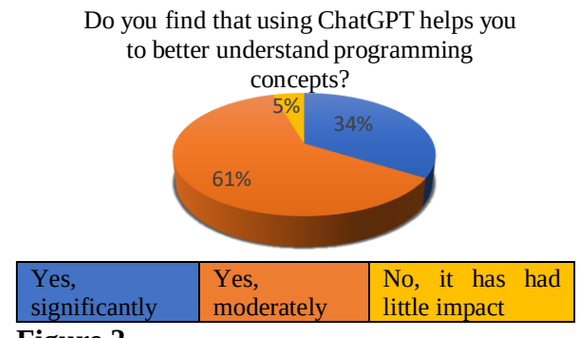

Figure 2

Distribution of impact on understanding.

Source: Own elaboration

61% of the students agree that the tool helps them to better understand programming concepts.

Box 6

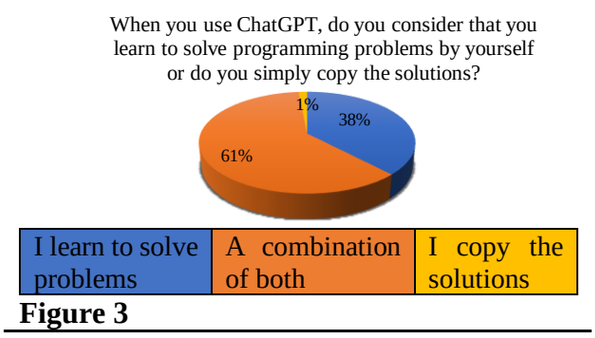

Figure 3

Distribution of impact on skill development

Source: Own elaboration

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61% mention that they do a combination of their own learning and the practice of copying solutions.

Box 7

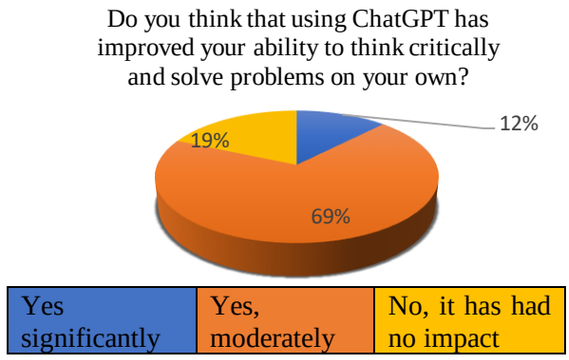

Figure 4

Distribution of usage for learning to program

Source: Own elaboration

Students consider that the use of ChatGPT has improved their ability to think critically and solve problems on their own,

Regarding the advantages of using ChatGPT to promote learning programming to students, there were 4 main advantages, shown in Table 4.

Box 8

Table 4

Coincident Benefits Concentrate

Coinciding Advantages	# Students
Explanation of the code	18
Minimise time for bug fixes	22
Learning new programming languages or frameworks	12
Optimise code or suggestions on best programming practices	13
Total	65

Source: Own elaboration

Some of the students' opinions are:

"Sometimes I understand the codes better with the explanation you provide".

"It helps to explain in detail if you indicate it".

"It has helped me to solve problems quickly, this is summarised in a significant time saving and allows me to move forward with greater speed in my work".

"That you don't just give code for the sake of giving it, but that there is a reason, an explanation as to why that code."

"Decrease in learning time by not having to search in different sources, plus it gives you current solutions and not the articles or videos from years ago, plus it helps to better understand the documentation in some aspects that become complicated."

"It offers useful and fresh alternatives when I can no longer find solutions in traditional places like Stack Overflow or in the official documentation"

"Time saving and better understanding, as you can explain the code step by step and get to know how everything works."

"The way of explanation can be in such a basic way that one manages to understand it."

"Many students are able to ask questions that they don't ask in class, because they are afraid or embarrassed to talk".

With respect to the disadvantages of using ChatGPT to promote the learning of programming to students, 4 fundamental disadvantages were agreed upon, as well as there were students who stated that they did not find any disadvantage in its use.

The results are summarised in Table 5.

Box 9

Table 5

Concentration of Coincident Disadvantages

Disadvantages Coincident	# Students
Dependence on use to carry out activities	14
Copy paste	9
Incorrect or out-of-context answers	17
Solutions deviate from a logic of their own	14
I find no disadvantages	11
Total	65

Source: Own elaboration

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Some of the students' opinions are:

"I don't think so much at the moment, but a few months ago I realised that I was relying on it a lot for development".

"It provides code without the need for research, which doesn't help a programmer to develop their skills."

"That it doesn't allow autonomous learning, it doesn't make me think about problem solving at all."

"That I don't have the confidence to think that my code is OK"

"If you don't learn the basics of programming and above all logic, chatting is useless, because you yourself will have no idea what you want to do and you will just copy for the sake of copying".

"Irresponsible use, just getting information to copy and paste into a paper".

"It limits us as learners to face challenges, understanding of programming and relying on it for problem solving without understanding."

"Sometimes chatgpt does not fully understand the context or the question, which gives inaccurate answers."

"It prevents us from looking for solutions based on our own logic."

"That if you don't know what you want or are unclear, it gives ambiguous and mostly wrong answers."

"The negative thing would be that you lose the habit of researching elsewhere on the internet or even the official documentation of a framework is no longer read so thoroughly because you solve your doubts with the AI."

Conclusions

The purpose of this research was to find out the impact of the use of ChatGPT on students who are learning programming. Most of the students agree that ChatGPT offers them advantages, they also recognise the limitations or risk of its use and the impact on their learning process.

The use of ChatGPT is oriented to the explanation of the code that helps them to understand it better, to solve problems or errors, to optimise the code already generated or to learn a new development technology.

One aspect to highlight is the fact that the students value the quick answers, but they also point out as a disadvantage the effectiveness of the answer, although this fact can be related to the approach, the description of the context or the structure of the question, they also highlight the lack of updated information or questions to data sources not available in the free version.

What is most striking to the group of researchers is the recognition of the dependence that can be generated among students to solve their assignments and abuse of copy paste.

While most of the participants in the study acknowledged that they use ChatGPT to better understand the process of programming logic and to apply this logic and sequence of thought in the actual posing of questions to make the solutions effective, on the contrary, those who perceive that ChatGPT affects their thinking skills because a correctly posed question is enough and the solution is given, no longer carry out this process.

To minimise this impact, which can have serious consequences on the natural process of analysis for solving algorithms, it is essential that as teachers we rethink the use of ChatGPT by moving towards projects that promote thinking skills (computational thinking, creativity, algorithmic thinking, socialisation of learning, critical thinking and problem solving), critical thinking and problem solving), understanding that the chat is only an ‘auxiliary in the learning process of concepts and practices related to the PC, allowing the generation of virtuous cycles, through which the learner of this subject can use this type of tool to increase the pace and quality of acquisition of new skills’.

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.

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Authors' contribution

Felipe-Redondo, Ana María: Contributed to the research idea, the design of the data collection instrument and data analysis, as well as teaching the study groups.

Del Carmen-Morales, Yucels Anaí: Contributed to the design of the data collection instrument and data analysis.

Del Carmen-Morales, Heidi: Contributed to the design of the data collection instrument and data analysis.

Núñez-Cárdenas, Felipe de Jesús: Contributed to the design of the data collection instrument and its analysis. As an external teacher, but a specialist in programming, his opinions strengthened the objectivity of the analysis.

Availability of data and materials

The data collected are available for consultation, upon request to the author of the correspondence.

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Abbreviations

ABP	Problem Based Learning
IA	Artificial Intelligence
ML	Classical Machine Learning
PNL	Natural Language Processing
UTHH	Technological University of Huasteca Hidalguense

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Article

Analysis of the school enviroment in a university of the South of Sonora

Análisis del clima escolar en una universidad del Sur de Sonora

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Abstract

The purpose of this proposal is to evaluate the level of school climate in students at a university in Southern Sonora to formulate recommendations aimed at improving or strengthening it. A self-administered instrument adapted from Gutiérrez (s/f) was applied, originally composed of 35 items, the final version applied was composed of 39 items grouped into two dimensions, general coexistence climate and satisfaction and fulfillment of expectations. In the analysis of the results, means were formulated by item, dimension and general school climate, the variables that summarize the characteristics of the participants were considered as categorical variables and were used to analyze whether or not they influence the evaluation of the school climate, at a general level. and by dimensions, an analysis was carried out through the Statistical Package for Social Sciences (SPSS) program. The levels of school climate, general coexistence climate, as well as satisfaction and fulfillment of expectations turned out to be high.

Analysis of the school enviroment in a university of the South of Sonora		
Objetives	Metodology	Contribution
Evaluate the level of school climate in the students of the Bachelor's Degree in Tourism Business Administration of the Technological Institute of Sonora (ITSON) Navojoa to formulate recommendations aimed at its improvement or strengthening.	Using a quantitative methodology, the level of school climate in students of Bachelor of Tourism Business Administration (LAET) from a university located in the south of the state of Sonora.	This analysis evaluates the level of school climate in students at a university in Southern Sonora and generates recommendations aimed at improving or strengthening it.

Students, School enviroment, University

Resumen

La presente propuesta tiene por objeto evaluar el nivel de clima escolar en los estudiantes de una universidad del Sur de Sonora para formular recomendaciones tendientes a su mejora o fortalecimiento. Se aplicó un instrumento auto administrado adaptado de Gutiérrez (s/f), originalmente integrado por 35 reactivos, la versión final aplicada estuvo compuesta por 39 reactivos agrupados en dos dimensiones, clima de convivencia general y satisfacción y cumplimiento de expectativas. El análisis de los resultados se formuló medias por reactivo, dimensión y clima escolar general, las variables que resumen las características de los participantes fueron consideradas como variables categóricas y se emplearon para analizar si influyen o no en la evaluación del clima escolar, a nivel general y por dimensiones, se hizo un análisis a través del programa Statistical Package for Social Sciences (SPSS). Los niveles del clima escolar, del clima de convivencia general, así como la satisfacción y cumplimiento de expectativas resultaron ser altos.

Análisis del clima escolar en una universidad del Sur de Sonora		
Objetivos	Metodología	Contribución
Evaluar el nivel de clima escolar en los estudiantes de Licenciado en Administración de Empresas Turísticas del Instituto Tecnológico de Sonora (ITSON) Unidad Navojoa para formular recomendaciones tendientes a su mejora o fortalecimiento.	Empleando una metodología cuantitativa, se determinará el nivel de clima escolar en estudiantes de Licenciado en Administración de Empresas Turísticas (LAET) de una universidad ubicada en el sur del estado de Sonora.	Este análisis evalúa el nivel de clima escolar en los estudiantes de una universidad del Sur de Sonora y genera recomendaciones tendientes a su mejora o fortalecimiento.

Estudiantes, Clima escolar, Universidad

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Introduction

The value of school climate as a regulating element of the environment where learning and teaching take place is clearly unquestionable, and it is related to it as one of the determinants of the quality of educational institutions, regardless of their educational level.

The Organisation for Economic Co-operation and Development (OECD, 2017), states that school climate has been associated with important school outcomes. Growing evidence suggests that school climate can affect students' learning levels and academic performance, altering their perception of the environment around them and the interpersonal relationships they have (Gomes and Morais, 2019).

The research by Retamal and González (2019), brings together some dimensions involved in school climate: fair rules, good treatment, teacher support, student participation, sense of belonging and connectedness, learning orientation and school safety.

The assessment of school climate in an educational institution enables it to recognise the likely causes of problems that hinder the achievement of its institutional goals.

Likewise, it is recognised that an adequate climate is one in which the dynamics of relations between the different actors converge in which communication and collaboration are favoured; there are appropriate means of communication, as well as distinctions and encouragement for the different actors based on their performance.

In addition, there is a high level of satisfaction of the actors with regard to the performance of the educational institution, their own and the rest of the educational actors; high expectations are formed and fulfilled on the basis of the achievements obtained; also the degree of motivation and commitment to work of all actors is high.

School climate is also assessed as a multidimensional construct, which is integrated by safety, relationships, commitment to teaching and learning, organisational structure and functions, and institutional improvement actions.

Climate includes students' perceptions of their competence and school, relationships with teachers and peers; the way school life is experienced, which enables academic, social, ethical and emotional development.

The objective of this research is to evaluate the level of school climate in the students of the Bachelor's Degree in Tourism Business Administration at the Instituto Tecnológico de Sonora (ITSON) Navojoa Unit in order to formulate recommendations for its improvement or strengthening.

Methodology

Using a quantitative methodology, we will determine the level of school climate in students of the Bachelor's Degree in Tourism Business Administration (LAET) at a university located in the south of the state of Sonora.

Participants

The sample consisted of 67 students who, voluntarily and anonymously, decided to participate in the present study. It should be noted that 100 percent of the students were invited to participate, so it is considered that the application was to 100 percent of the universe of LAET students.

Since the sample is the population, it is expected to be sufficiently heterogeneous to formulate psychometric analyses based on the responses of the population.

Instrument

A self-administered instrument adapted from Gutiérrez (n.d.), originally composed of 35 items, will be applied; the final version applied was composed of 39 items grouped in two dimensions, general climate of coexistence and satisfaction and fulfilment of expectations. Table

1 shows the dimensions, factors and items included in each aspect of the instrument.

A five-point Likert-type scale was used to answer it: 5=strongly agree, 4=agree, 3=disagree, 2=strongly disagree and 1=no items to answer; all participants should have items to answer all items.

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Box 1

Table 1

School climate dimensions, factors and items

DIMENSION	REAGENT
General climate of coexistence	
Level of conflict in the school	1
Form of conflict resolution	2, 3
Dynamics of the relationship between actors	4 al 12
Existence of communication channels	13 al 21
Existence of a climate of trust	22 al 26
Satisfaction and fulfilment of expectations	
Degree of satisfaction of the actors with the general functioning of the school and with the performance of the other actors and themselves.	27 al 29
Comparison between initial expectations and achievement	30 al 32
Recognition and incentives for the different actors	33 al 37
Level of motivation and commitment to school work	38, 39

Source: Adapted from Gutiérrez (s/f).

Sociodemographic information was collected on the participants: sex, semester, marital status, employment status, age, whether or not they have a scholarship and whether or not they have dependents.

For the analysis of the results, means were formulated by item, dimension and general school climate. The variables that summarise the characteristics of the participants were considered as categorical variables and were used to analyse whether or not they influence the evaluation of school climate, at a general level and by dimensions, by means of analysis of variance models.

Additionally, three levels of School Climate were determined: high, medium and low, and the colours of a traffic light were assigned to help in the visualisation of the level, as follows (table 2):

Box 2

Table 2

Levels of school climate

Level	Lower value	Higher value	Traffic lights
Low	1.00	2.33	
Medium	2.34	3.66	
High	3.67	5.00	

Source: Own elaboration (2024)

Results

This section describes the school climate results, based on the participation of 67 students (total enrolment), so the sample represents 100.0 per cent of the population. The results are presented in general terms and then according to student characteristics, represented by categorical variables as shown in Table 3.

Box 3

Table 3

Overall school climate results

Item	Media	Level	Traffic lights
School Climate (general)	4.18	High	
General Climate of Coexistence	4.22	High	
Satisfaction and Fulfilment of Expectations	4.20	High	

Source: Own elaboration (2024)

The average value for school climate was 4.18, which places it at the high level within the classification. The same is true for the two dimensions of climate, given that they present values above the reference value for the high level (3.67), since the average values obtained were 4.22 and 4.20 respectively for the general climate of coexistence and satisfaction and fulfilment of expectations. The characteristics of the participants are grouped as shown in table 4:

Box 4

Table 4

Characteristics of the participants

Variables	Participation	Porcentage
Sex		
Male	15	22.4%
Female	49	73.1%
Other	3	4.5%
Semester		
Second	23	34.3%
Fourth	9	13.4%
Sixth	11	16.4%
Eighth	16	23.9%
More than eight	8	11.9%
Marital status		
Single	62	92.5%
Married	3	4.5%
Unmarried	2	3.0%
Employment status		
Study only	34	50.7%
Study and piecework	12	17.9%
Part-time work and study	11	16.4%
Full-time study and work	10	14.9%
Scholarship		
Without scholarship	50	74.6%
With scholarship	17	25.4%
Age grouped		
18-19 years old	25	37.3%
20-21 years old	17	25.4%
22 years old	11	16.4%
Over 22 years old	14	20.9%

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As mentioned above, we worked with 100 per cent of the LAET students at the Navojoa Unit. Based on the responses to the instrument, a posteriori validity and reliability tests were carried out. In relation to the validity of the instrument, the concurrent validity test was applied, through contrasted groups, by means of the Chi-Square test, with values whose bilateral asymptotic significance was less than 0.05, where the 39 items met the requirement of frequency distribution, formulated according to the suggestions of Sierra (2001), Kerlinger and Lee (2008) and Anastasi and Urbina (2009).

This allows us to determine that the instrument has a high level of construct validity.

Regarding the validity of the instrument, the most common definition refers to the degree to which it measures what it is believed to be measuring, that is, the ability to express or symbolise the reality to which it alludes (Argibay, 2006; Campo-Arias and Oviedo, 2008; Kerlinger and Lee, 2008; Anastasi and Urbina, 2009; Quero, 2010; Sánchez, et al, 2011; Hernández, Fernández & Baptista, 2014); Prieto and Delgado (2010) define it as the 'degree to which empirical evidence and theory support the interpretation of test scores related to a specific use' (p. 71), which essentially mirrors the most common definition; they also point out that validity is the most important psychometric property referring to the quality of test inference. Additionally, Argibay (2006) points out that testing the validity of a questionnaire is more complex than determining its reliability, since the former involves theoretical elements, while the latter is an empirical aspect.

With regard to the construct validity of a questionnaire, it is defined as the level at which it can be stated to measure a construct, variable or theoretical trait (Creswell, 2003; Anastasi and Urbina, 2009; Hernández, Fernández and Baptista, 2014). Argibay (2006), for his part, states that it consists of attempting to demonstrate that the behaviours measured by the questionnaire can be qualified as valid indicators of the construct to which they refer. Moreover, construct validity is recognised as the most important form of validity and as one of the most representative scientific advances in modern measurement theory and praxis (Argibay, 2006; Kerlinger and Lee, 2008; Hernández, Fernández and Baptista, 2014). It is also the most difficult to test (Argibay, 2006).

Construct reliability

To determine reliability, a procedure was applied that obtains internal consistency coefficients, specifically MacDonald's Omega. Reliability refers to the level at which the measurement agrees with itself, that is, it refers to the accuracy with which an instrument measures what is desired (Kerlinger and Lee, 2008; Campo-Arias and Oviedo, 2008; Quero, 2010; Prieto and Delgado, 2010; Hernández, Fernández and Baptista, 2014).

Regarding the value of reliability, Kerlinger and Lee (2008) state that some authors have assumed the value of 0.7 as the limit between acceptable and unacceptable reliabilities; however, they also point out that there is no evidence to favour this criterion, which they consider arbitrary; citing Nunally (1978), the authors argue that a satisfactory level of reliability will depend on how the measure is used. On the other hand, they recognise that in some cases values of 0.5 or 0.6 are acceptable, while in other cases values of 0.9 are barely acceptable.

For their part, Anastasi and Urbina (2009) do not suggest a reference value for reliability; while Hernández, Fernández and Baptista (2014) agree with Kerlinger and Lee in stating that there is no value from which to determine the reliability or unreliability of the instrument; therefore, the researcher reports the value and leaves it to the examination and judgment of the users of the study or other researchers, also mentioning the method used; however, they do point out some values that other authors consider, which range between 0.6 and 0.9.

In sum, a low reliability value may be acceptable if the measurement instrument has high validity. Furthermore, considerations for determining a reference value focus on the type of decision to be made when using the measurement instrument: if the decision is made at an early age, is reversible, concerns groups (not individuals) or has temporal effects, a low reliability value is acceptable (Kerlinger and Lee, 2008).

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For the purposes of the present research, 0.8 will be considered as a reliability reference value, taking into account that the instrument has high construct validity (determined by means of the test of contrasted groups); at the same time, the decisions that will be taken derived from the use of the instrument can be considered as diagnostic or early-age according to Kerlinger and Lee (2008). On the other hand, Prieto and Delgado (2010) state that reliability and validity should be understood as a matter of degree and not as a characteristic that instruments have or do not have.

Some authors suggest that when the instrument is multidimensional, it is necessary to report the McDonald Omega coefficient, which estimates internal consistency better in these cases, compared to Cronbach's alpha coefficient (Campo-Arias, 2013), also when the items consider a Likert-type scale, since the alpha coefficient considers that the variables are continuous, which is not the case when a Likert-type scale is used.

The reliability of the instrument was determined through the internal consistency of the scale, by means of MacDonald's Omega coefficient, obtaining an overall value of 0.979 (considering the 39 items). Additionally, the coefficient was calculated for the dimension of general coexistence climate (only items 1 to 26 were included) and satisfaction and fulfilment of expectations (considering items 27 to 39), obtaining values of 0.973 and 0.952, respectively.

Based on the tests formulated in the previous and current sections, it can be affirmed that the school climate results have a high degree of validity and reliability.

Conclusions

It is important to mention that the levels of school climate, the general climate of coexistence, as well as the satisfaction and fulfilment of expectations in the students of the educational programme are high, that is to say, the total of the 39 items present high average values, for this reason the level of school climate can be specified as a healthy, equitable and fair climate.

Gender had a partial influence on the perception of the school climate, since women observe a higher level in the climate in general and in the dimension and fulfilment of expectations, this is attributed to the fact that women maintain a greater optimism in relation to the climate and environment at the university than the rest, it is not assumed that this is due to issues of preferential treatment based on gender, it is also important to mention that fourth semester students perceive lower levels except in the dimension of satisfaction and fulfilment of expectations which are located at a medium level.

As part of the recommendations that can be formulated, it is recommended to implement actions aimed at maintaining and eventually improving the current level of school climate perceived by the students of LAET, Navojoa Unit.

It is necessary to regularly evaluate the school climate to gather feedback not only from students, but also to evaluate the convenience of including teachers from the educational programme and use this information to implement improvements, it is essential to promote open and transparent communication, to establish effective communication channels between students, teachers and administrators as it can help to address problems and resolve conflicts in a constructive manner and to foster an inclusive environment, implementing programmes and activities that promote diversity and inclusion, where all students feel valued and respected regardless of their ethnic, cultural, religious, gender or sexual orientation background, celebrating achievement and success through recognition based on academic performance, participation in extracurricular activities (sports and cultural, leadership, community service or other outstanding student achievements).

Organise special award ceremonies or recognition events where awards are presented and students' achievements are celebrated in front of the school community.

In general terms, the objective of the study was met, as the level of school climate among students at LAET Navojoa Unit was evaluated and recommendations were made to contribute to its eventual improvement or strengthening.

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The relevance of structuring research on the subject from an interdisciplinary, multidimensional approach, with a rigorous contextual and theoretical framework, and with the participation of the different actors of the academic community, is highlighted.

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.

Authors' contribution

Moncayo-Rodríguez, Lizette Marcela: Main idea of the article.

Herrera-Quijada, Julio Antonio: Application of instrument.

Sosa-Covarrubias, John: Design of results.

Galván-Corral, Alberto: Methodological design, author recognised by the SIN level I CONAHCYT.

Availability of data and materials

The information was obtained from various sources and previous research at the Instituto Tecnológico de Sonora Unidad Navojoa, where the school climate was evaluated in some of its undergraduate educational programmes.

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Abbreviations

ITSON	Sonora Institute of Technology
LAET	Degree in Tourism Business Administration
OCDE	Organisation for Economic Co-operation and Development

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Article

School environments and educational performance: Challenges and opportunities in Secondary Education

Entornos escolares y desempeño educativo: Desafíos y oportunidades en la Educación Secundaria

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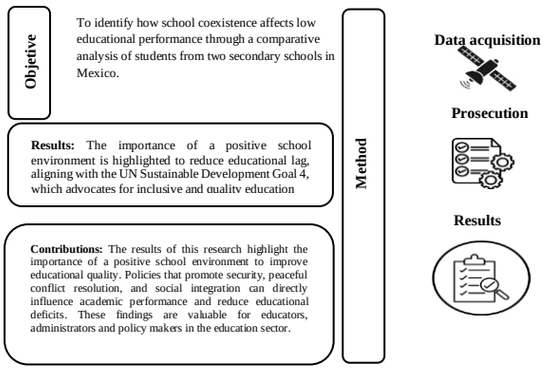
Abstract

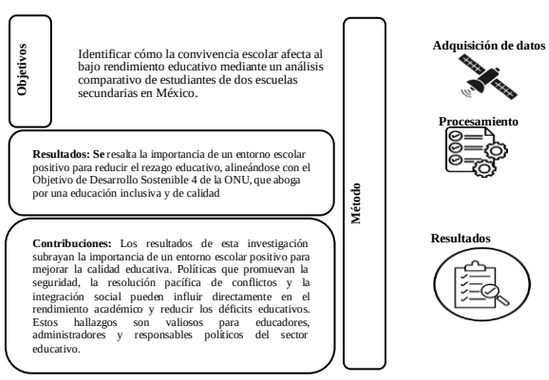
This research analyzes how school coexistence influences low educational performance in two secondary education institutions in a post-pandemic context. The importance of a constructive school environment to mitigate educational lag is highlighted, in line with the UN's Sustainable Development Goal 4, which promotes inclusive and high-quality education. Its main objective is to investigate how school coexistence affects low educational performance through a comparative analysis of students from two secondary schools in Mexico. The methodology implemented is that of a research approach with comparative and correlational designs. A sample of 150 students was used. A specific research instrument was carried out and as for the statistical analysis, it was characterization, correlations and comparisons of means. The main conclusions indicate that school coexistence is crucial for quality education. Constructive environments facilitate integration and academic performance, while hostility and insecurity contribute to poor performance. It is recommended to develop initiatives to improve school coexistence and comply with SDG 4.



Education, educational lag, school coexistence

Resumen

Esta investigación analiza cómo la convivencia escolar influye en el bajo rendimiento educativo en dos instituciones de educación secundaria en un contexto pospandémico. Se destaca la importancia de un entorno escolar constructivo para mitigar el rezago educativo, en línea con el Objetivo de Desarrollo Sostenible 4 de la ONU, que promueve una educación inclusiva y de alta calidad. Su objetivo principal es indagar cómo la convivencia escolar afecta al bajo rendimiento educativo mediante un análisis comparativo de estudiantes de dos escuelas secundarias en México. La Metodología implementada es el de un enfoque de investigación con diseños comparativos y correlacionales. Se utilizo una muestra de 150 estudiantes. Se realizo un instrumento de investigación específico y en cuanto al análisis estadístico este fue de caracterización, correlaciones y comparaciones de medias. Las principales conclusiones indican que la convivencia escolar es crucial para una educación de calidad. Entornos constructivos facilitan la integración y el rendimiento académico, mientras que la hostilidad y la inseguridad contribuyen al bajo rendimiento. Se recomienda desarrollar iniciativas para mejorar la convivencia escolar y cumplir con el ODS 4.



Educación de calidad, rezago educativo, convivencia escolar

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Introduction

Educational quality is a key academic and policy concern on a global scale, particularly in a post-pandemic environment, where the dynamics of educational institutions have undergone considerable transformations. In this context, the concept of school coexistence has become a key determinant of students' academic achievement.

As postulated by UNESCO (2018), a conducive school environment not only facilitates the learning process, but also improves the overall well-being of students, thus contributing to the achievement of Sustainable Development Goal 4 (SDG 4), which promotes inclusive and equitable quality education.

The quality of education systems is a topic of global discussion, crucial for the development of policies and programmes that seek to improve the educational experience. Bianchetti (2017) highlights the importance of understanding 'quality' as a multifaceted and central concept in education, emphasising that its relative definition does not diminish its relevance in the implementation of educational actions.

Manriquez and Vazquez (2019) address specific challenges in Mexico, such as dropout and failure, and highlight the motivational role of teacher-tutors in supporting students with diverse difficulties.

In relation to the factors that promote an environment that promotes education, Medina *et al*. (2023) mention school coexistence, understood as the construction of relationships based on respect and solidarity, which are essential for an educational community without violence.

López-Pérez *et al*. (2022) point out the importance of methodological skills as tools for teachers, enabling them to maximise students' potential in the face of learning challenges. Valencia-Aguirre *et al.* (2021) emphasise the promotion of peaceful coexistence as a pillar of educational quality. These studies collectively underline the complexity of educational quality and the need to address it from multiple perspectives in order to foster an effective and enriching learning environment.

Likewise, the Delors Report (1996), widely cited in the educational literature, highlights the relevance of 'learning to live together' as one of the essential foundations of learning. This perspective highlights that educational environments must be endowed with conditions and environments conducive to effective academic development. In this context, Reyes-Jaimes and Velázquez-Reyes (2022) stress the need to create educational climates that enable students not only to acquire knowledge, but also to develop social and emotional skills that are crucial for life in society.

On the other hand, Navarrete-Cazales and Ocaña-Pérez (2022) analyse educational backwardness as a manifestation of social inequality that restricts the personal and professional growth of individuals, limiting their opportunities to achieve a fulfilling life and fairly remunerated employment. This view of educational backwardness as an obstacle to social equity highlights the importance of inclusive and effective educational policies that address the needs of all students.

Finally, Carro-Olvera and Lima-Gutiérrez (2022) offer an interpretation of educational backwardness that goes beyond the mere accumulation of knowledge. They argue that school success should be assessed within a broader framework that considers the diverse realities faced by students, both in the classroom and in their daily lives. This holistic approach suggests that educational success cannot be measured solely by academic outcomes, but must include students' ability to navigate and adapt to the complex social and personal challenges they encounter outside of school.

Likewise, the study by Coque-Méndez *et al*. (2025) highlights the influence of learning styles on the effectiveness of pedagogical strategies in primary and secondary education, highlighting the need to adapt teaching methodologies and the importance of continuous training for teachers.

In summary, these studies converge on the idea that education should be seen as an integral process that not only imparts knowledge, but also fosters human development in all its dimensions. Education, therefore, should be designed to prepare individuals for life in an increasingly interconnected society and to meet the challenges of a changing world.

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The main objective of this study is to examine the interrelationship between school coexistence and educational backwardness in two secondary schools in Mexico. The research seeks to identify how the interactions that occur within educational environments affect students' academic performance and retention, which are vital components for the establishment of quality education.

In a scenario where the pandemic has intensified individual differences, it is imperative to assess the potential of school coexistence as a mechanism to improve academic outcomes and mitigate educational setbacks. School coexistence, defined as the fostering of positive relationships among students and between students and teachers, is fundamental to creating an environment conducive to learning and personal growth. This research responds to the pressing need to adapt educational methodologies to contemporary challenges in order to enable students to participate in quality education that promotes holistic development.

Methodology

This research is comparative and differential, concentrating on correlating the established objectives in order to obtain a comprehensive view of the relationship between school coexistence and educational backwardness. A methodological design was formulated that encompasses a comparative analysis of two populations of secondary schools in the Mexican Educational System.

The study is composed of 100 variables aligned with the research axes, using a centesimal scale ranging from 0 (absence of the attribute) to 100 (maximum presence of the attribute). In addition, 8 variables were incorporated to characterise the study population. These variables facilitated a meticulous comparison between the two educational institutions.

1. Frequencies and percentages: these were used to delineate the distribution of variables and to understand the prevalence of specific phenomena within the populations under study.
2. Characterisation: This analytical level focused on defining the unique characteristics of the two school populations, in terms of the variables examined. Correlation: This technique was used to determine the relationship between several variables, elucidating how certain aspects of school coexistence influence educational delay. Comparison: This method was applied to identify significant disparities between the two institutions, revealing patterns and variations in students' educational experiences.

This methodological approach allowed for a comprehensive and nuanced understanding of how school coexistence affects academic performance and educational delay in various educational contexts, ultimately influencing the quality of education.

Results and Discussion

The comparative analysis between secondary education institutions indicated significant differences in the correlation between school coexistence and educational backwardness. A total of 100 variables related to educational experience were analysed using a centesimal scale, as well as 8 variables characterising the research population.

Frequencies and percentages In the comparison by gender, an almost equal distribution was identified in both educational establishments, with 50.66% of female students and 49.33% of male students. This balance facilitated the exclusion of gender as a possible confounding variable in the evaluation of school coexistence.

Gender Frequency Percentage
Female 76 50.66% Male
Male 74 49.33% Total 150
Total 150 100% Source.

Table 1 Gender
Source: Own elaboration

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Correlation

In the correlational analysis it is observed that the variable tolerance shows a positive correlation with the different opinions of their environment, they have the ability to use emotional tools (r=0.36) to adapt (r=0.38) to the changes that occur every day in the classroom, this leads them to develop a sense of belonging to the institution (r=0.37), which promotes integration between peers (r=0.41) as well as teamwork (r=0.35). However, students who are tolerant do not get upset (r=-0.37) when faced with circumstances that arise with their peers. It is inferred that tolerance is the backbone of educational quality within the spaces in which healthy coexistence permeates the school community, which implies that students who effectively regulate their emotions are more likely to be successfully incorporated into their educational environment.

Variable r-value
Sense of belonging 0.37
Peer integration 0.41
Adaptability 0.38
Teamwork 0.35
Ability not to get upset 0.37
Use of emotional tools 0.36

Table 2 Capacity for Tolerance
Source: Own Elaboration

Comparison

In the comparative analysis of the two educational institutions, it was determined that Technical Secondary School 'A' faces more significant learning impediments, as evidenced by a higher level of perceived insecurity (54.39% compared to 30.16% in General Secondary School 'B') and a higher prevalence of conflict (81.01% compared to 55.01%). These variables correlate with a more significant educational deficit in Technical Secondary School 'A', where students showed reduced participation in extracurricular activities and deteriorated health status.

Variable Sec. Tec. 'A' Sec. Gr. 'B' t-value p-value
Conflicts 81.01 55.01 5.29 0.000000
Perceived insecurity 54.39 30.16 3.99 0.000103
Extracurricular activities 46.13 66.94 -3.17 0.001843
Health Status 62.96 46.54 2.91 0.004212

Table 3 Comparison between institutions
Source: Own Elaboration

Discussion

The results of this research corroborate the fundamental importance of school coexistence in improving educational quality, in line with the principles of the United Nations Sustainable Development Goal 4 (SDG 4), which calls for inclusive and high quality education for all people. Empirical evidence indicates that a safe and affirming school environment is indispensable for students to reach their full academic potential, corroborating the assertions of Manriquez and Vazquez (2019), who clarify that educational quality is susceptible to influences such as dropout rates and academic disapproval, which are shaped by the dynamics of school coexistence.

In the context of the school called Secundaria Técnica 'A', high levels of perceived insecurity and the prevalence of conflict obstruct the holistic development of students, as evidenced by their decreased participation in extracurricular activities and increased educational lag. These observations are consistent with the findings of Navarrete-Cazales and Ocaña-Pérez (2022), who argue that educational backwardness is intrinsically related to social inequality, which manifests itself in conflictive school environments.

The high amount of conflict in this institution indicates the inadequacy of effective methodologies to manage student behaviour and resolve disputes, which negatively affects their academic achievement.

Furthermore, research by Medina *et al.* (2023) on school coexistence as a key element in cultivating respectful and supportive relationships within the educational community underlines the need for an environment conducive to learning. Students in the so-called Secundaria. General 'B' students who are in a safer environment characterised by a lower incidence of conflict show greater integration and participation in extracurricular activities, which fosters their academic and personal growth.

This observation is consistent with the perspective of López-Pérez *et al.* (2022), who assert that methodological competencies allow educators to discern opportunities to foster students' potential, particularly in a positive school environment.

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In contrast, Valencia-Aguirre *et al*. (2021) emphasise that promoting peaceful coexistence within educational institutions involves fostering respect, tolerance and peaceful conflict resolution. As well as the observed evidence that students who cultivate competencies such as tolerance have a greater capacity to adapt to change and contribute to an inclusive school environment, which reinforces the importance of these skills in fostering a healthy school experience. The comparison of the two educational institutions underlines the importance of educational interventions aimed at improving school coexistence as a strategy to mitigate educational backwardness.

Educational policies should prioritise the establishment of a safe and supportive environment in which students can fully cultivate their emotional and social competencies. This view is consistent with the Delors Report (1996), which recognises the need to 'learn to live together' as a fundamental pillar of education, and emphasises that academic success depends on a school climate that promotes mutual respect and collaboration.

Conclusions and Recommendations

This research shows evidence that the dynamics of school coexistence are fundamental to improving educational quality and mitigating educational deficits. A comparative analysis of the so-called General Secondary 'A' school and the Technical Secondary 'B' school shows that a supportive school environment, defined by a minimum of conflict and a greater sense of security, is strongly associated with better academic results and greater participation in extracurricular activities.

The main objective of this work, which was to examine the correlation between school coexistence and educational lag, has been successfully achieved. The data collected and analysed indicated that students in conflictual environments with severe learning barriers, such as those attending the Technical High School 'B', face greater obstacles to academic success. In contrast, students at General Secondary School 'A', who benefit from a safer and more collaborative environment, demonstrate better academic performance and greater integration into the educational community.

The results of this research can contribute to the work of educators, administrators and policy makers in the education sector, as they underline the importance of fostering a positive school environment to raise educational quality; where policies that advocate for safety, peaceful conflict resolution and social integration within educational institutions can have a direct influence on academic performance and the alleviation of educational deficits.

In terms of recommendations, it is important to:

1. Foster school coexistence initiatives with the establishment of programmes that facilitate peaceful school coexistence, such as conflict resolution workshops, emotional intelligence education and activities designed to promote integration and mutual respect among students.

2. Improve school safety: Educational institutions should strive to strengthen safety both on and off campus. This includes the implementation of strategies aimed at decreasing students' perception of insecurity, which can improve their overall well-being and academic performance.

3. Equip teachers with social-emotional competencies through training courses and workshops to identify and address conflict effectively, as well as to cultivate a classroom environment that fosters collaborative and respectful learning.

4. Integrating cross-curricular subjects or topics that foster social and emotional skills into the curriculum such as the inclusion of social-emotional education programmes in the academic curriculum could facilitate the development of essential skills for peaceful and productive coexistence, thus contributing to students' academic and personal success.

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5. Further research on the relationship between school life and academic performance in various contexts and educational levels is advisable. This will enable the formulation of more effective strategies adapted to different school realities.

6. Formulate inclusive education policies that prioritise the establishment of an inclusive environment that accommodates all students, particularly those who face greater barriers to learning, such as those from contexts characterised by significant insecurity or conflict.

In short, improving school coexistence is crucial to reducing educational deficits and achieving quality education aligned with the Sustainable Development Goals (SDGs).

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 could have influenced the article reported in this paper.

Author contribution

Rodríguez-Aguilar, Jessica Sabrinaa: Conceptualisation, research, data curation,

Espericueta-Medina, Marta Nieves: formal analysis. Supervision, methodology,

Sanchez-Rivera, Lilia: project management, validation.

Villareal-Soto, Blanca Margarita: visualisation, drafting, revision and editing

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Availability of data and materials

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Abbreviations

UNESCO United Nations Educational, Scientific and Cultural Organization
SDG 4 Sustainable Development Goal on Education
ONU United Nations United Nations

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Article

Energy efficiency study of an academic classroom of an educational center under NOM-007-ENER-2014 and NOM-025-STPS-2008

Estudio de eficiencia energética del aula académica de un centro educativo bajo la norma NOM-007-ENER-2014 y NOM-025-STPS-2008

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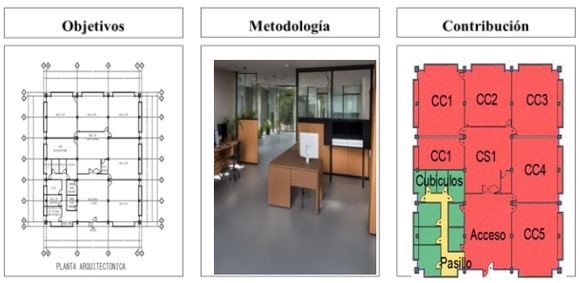
Abstract

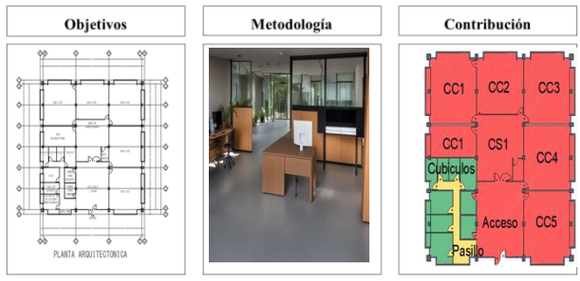
The energy efficiency of an academic classroom is presented as an important alternative to avoid the excessive use of artificial air conditioning systems, thus reducing energy consumption and the environmental, social and economic impacts derived from said consumption. Currently, the official Mexican standards NOM-007-ENER-2014 and NOM-025-STPS-2008 are used, efficiency and lighting conditions in buildings. The official Mexican standard NOM-0076-ENER-2014 establishes the levels of energy efficiency in terms of electrical power density for lighting with which lighting systems for general use of new non-residential buildings, extensions and modifications of existing ones must comply existing. While the official standard NOM-025-STPS-2008 establishes the minimum lighting conditions that every workplace must comply with. With the above, it turned out that based on the materials that currently make up the classroom envelope, it does not meet the standards established by the norm, which directly requires establishing a new design of the envelope that leads to reducing heat gains towards the interior of space.



Efficiency, reducing, environmental

Resumen

La eficiencia energética de un aula académica se presenta como una importante alternativa para evitar el uso excesivo de sistemas de climatización artificial, reduciendo así, el consumo energético y los impactos ambientales, sociales y económicos derivados de dicho consumo. En la actualidad se emplean las normas oficiales mexicanas NOM-007-ENER-2014 y NOM-025-STPS-2008, eficiencia y condiciones de iluminación en edificaciones. La norma oficial mexicana NOM-0076-ENER-2014 establece los niveles de eficiencia energética en términos de densidad de potencia eléctrica para alumbrado con los que deben cumplir los sistemas de alumbrado para uso general de edificios no residenciales nuevos, ampliaciones y modificaciones de los ya existentes. mientras que la norma oficial NOM-025-STPS-2008 establece las condiciones mínimas de iluminación que todo centro laboral debe cumplir. Con lo anterior resultó que con base a los materiales que actualmente conforma a la envolvente del aula no cumple con los estándares que establece la norma lo que en forma directa se debe de establecer un nuevo diseño de la envolvente que conlleve a disminuir las ganancias de calor hacia el interior del espacio.



Eficiencia, reducción, ambiente

Citation: Rodríguez-Uribe, Juan Carlos, Trejo-Torres, Zaira Betzabeth and Benitez-Alonso, Margarita. Energy efficiency study of an academic classroom of an educational center under NOM-007-ENER-2014 and NOM-025-STPS-2008. Journal Practical Didactics. 8[19]1-7: e6819107.

Introduction

Currently, electrical energy consumption in buildings through luminaires is between 18% and 20% of total consumption, which is why the importance of a correct location and selection of luminaires will have a direct impact on energy consumption in the home or building. That is why it is important to have control over the number of luminaires we need to properly light the work environment, the lack of luminaires would reduce visibility thus affecting the performance of the worker, while an excess of luminaires increases the cost and time in maintenance, in the same way can cause annoying flashes.

In order to have a better efficiency and a saving in the energy consumption that is used in terms of lighting in the facilities of the Instituto Tecnológico Superior de Huichapan (ITESHU), it is proposed to analyse all the facilities of the academic building 'computer systems', this floor has the following architectural spaces: five work laboratories for students, corridor, six cubicles for teachers and a common area.

The work laboratories are the areas that must have a higher number of lux than the other areas of the plant, as this is established by the official Mexican standard for lighting conditions in workplaces. The DiaLux programme will be used to analyse the luminaires that are installed and verify whether they meet the minimum requirements of the official Mexican standard for lighting conditions in workplaces.

If the requirements are not met, a lighting redesign should be carried out, seeking: a good proportion of visibility in order to achieve the required degree of precision and speed in the performance of tasks, lighting levels that reduce the effort required when working, and finally, lighting conditions that provide safety with the furniture and minimum glare and visual impairment.

This article will deal with the architectural survey of a computer laboratory in the 'computer systems' academic building, and its export to the lighting simulation programme in order to carry out the energy simulation of the architectural space.

Theoretical framework

Luxmeter

A luxmeter is an instrument that measures the illumination of a room or a focal point and requires an optical sensor (photodetector) to convert light into an electrical signal in order to measure its intensity. There are several types of photodetectors available on the market, such as phototransistors or LDRs. But the one used by luxmeters is the photodiode due to its linearity and low response time [1].

Box 1

Figure 1

Luxmeter used for illumination measurement

Source: [Own authorship 2024]

DIAlux

Dialux allows you to develop a lighting design for any architectural or architectural project. In addition, use images and web fonts in a variety of formats to develop your lighting plan. It also helps to create all the necessary documentation for the presentation of our lighting projects, making it clear and understandable for both clients and non-advanced users [2].

AutoCAD

AutoCAD is a standard program used by architects to develop sketches, drawings, plans, designs and details that must meet certain parameters in the client's requirements. In addition, AutoCAD is a versatile program that allows you to develop architectural, industrial, mechanical, graphic design and engineering projects. Capable of viewing designs in 2D and 3D [3].

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Methodology

Geographical survey of the building.

The building is located in the municipality of Huichapan in the state of Hidalgo, the area of study is a computer laboratory type building, for its analysis an architectural survey of the construction was carried out. In order to export the survey to the software, it was necessary to draw it in a CAD type software, in which the plans of the three architectural floors were drawn separately. With the measurements obtained in the survey, the electrical plans of these floors were drawn, as well as a plan with the distribution of the objects on each floor.

Climatology

The municipal territory has the following climates with their respective percentages: semi-dry temperate (88.0%), sub-humid temperate with summer rains, lower humidity (10.0%) and sub-humid temperate with summer rains, medium humidity (2.0%).

Box 2

Figure 2 Geolocation of the building
Source: [Own authorship 2024]

Building análisis

The building is a computer laboratory (computer centre) is a building that has 5 spaces of the classroom and computer centre type. We will analyse the amount of power used to light the interiors, as well as the amount of lumens that they manage to contribute to this area in order to achieve an efficient and, above all, safe space.

The facades of the building include a glazed area.

User analysis

The analysed space is used by students from different semesters of the computer systems degree (morning and afternoon shift) as well as by teachers, who give classes. Once the previous stage was completed, the analysis began virtually by means of the NOM-007-ENER-2011 standard [5], which consists of introducing energy efficiency in the installations with respect to the luminaires that are present, and also by means of the NOM-025-STPS-2008 [4], introducing the good use of the luminaires with respect to the luminaires that each area presents.

Architectural Survey

The building is located in the state of Hidalgo in the municipality of Huichapan, the Abundio Martínez computer centre, for its analysis a survey of the structure was carried out using AutoCAD software, which served as a guide to shape the structure in a 2D drawing, with the measurements obtained in the survey the structural plan was drawn up, as well as the distribution of the objects that were inside.

Box 3

Figure 3 Creation of the plan in AutoCAD
Source: [Own authorship 2024]

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Simulation in AutoCAD

Box 4

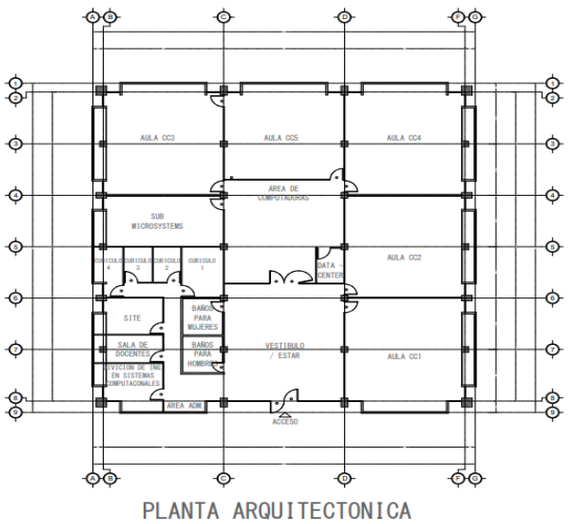

Figure 4

Abundio Martínez computer centre

Source: [Own authorship 2024]

Simulation in Dialux

Dialux Evo software was used as part of the methodology to better visualise the amount of lighting in the academic spaces and corridors, as well as the electrical power consumed by the building.

Box 5

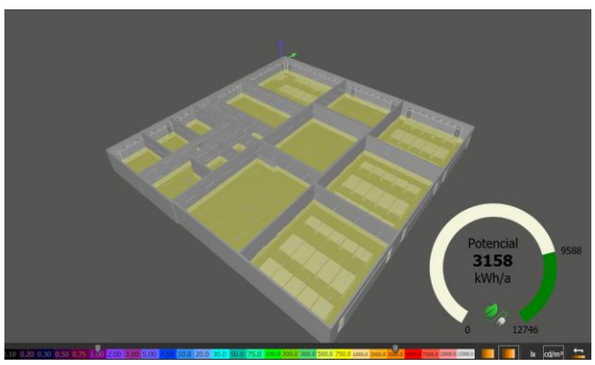

Figure 5

Simulation in DIALux evo 11.0

Source: [Own authorship 2024]

Virtual Model

Renderings of the interiors and façade of the building under analysis were made. The following shows the renderings in different perspectives

Box 6

Figure 6

Façade of the Abundio Martínez Laboratory

Source: [Own authorship 2024]

Box 7

Figure 7

Interior of the laboratory

Source: [Own authorship 2024]

Box 8

Figure 8

Main entrance to the building

Source: [Own authorship 2024]

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Results

The single-level computer laboratory has 130 fluorescent-type luminaires with a total of 106,470 (lm), a total power of 5150 (W) and an electrical power density for lighting of 6.83 W/m^2. lighting of 6.83 W/m^2. The calculation surfaces show that none of the classrooms (CC1, CC2, CC3, CC4, CC5) have the minimum number of lumens, being 500 for the computer room, while all the cubicles manage to exceed the maximum illuminance, and finally, the corridor and the entrance area manage to reach the minimum illuminance. The above can be seen in table 1.

Box 9

Table 1

Number of lumens per zone

Entrance	236 tx	Aula CC1	356 tx
Computer room	265 tx	Aula CC2	264 tx
Data centre	116 tx	Aula CC3	351 tx
Sub-microsystem	211 tx	Aula CC4	344 tx
Toilets	140 tx	Aula CC5	362 tx
Corridors	180 tx	Cubículos	297 tx

Source: [Own authorship 2024]

The table above does not comply with the number of lumens requested by the NOM-025-STPS-2008 standard (table 2), (table 3) DOES NOT COMPLY.

Box 10

Table 2

The number of lumens requested by NOM-025-STPS-2008 is shown

Visual Workplace Task	Work Area	Minimum Illumination Levels (lux))
Outdoor: distinguish traffic area, walking, surveillance, vehicle movement.	General exteriors: courtyards and car parks.	20
Indoors: distinguish traffic area, walking, surveillance, vehicle movement.	General interiors: lightly used warehouses, corridors, stairways, covered parking areas, underground mine workings, emergency lighting.	50
Indoors.	Circulation areas and corridors; waiting rooms; rest rooms; store rooms; platforms; boiler rooms.	100
Simple visual requirement: visual inspection, part counting, bench and machine work.	storage rooms; platforms; boiler rooms.	200
Moderate detail distinction: simple assembly, medium bench and machine work, simple inspection, packaging and clerical work.	Personnel services: rough storage, reception and dispatch, guard houses, compressor rooms, and pailage.	300
Clear distinction of detail: delicate machining and finishing, moderately difficult inspection assembly, data capture and processing, handling of instruments and laboratory equipment.	Workshops: packaging and assembly areas, classrooms and offices.	500
Fine detail distinction: precision machining, assembly and inspection of delicate work, handling precision instruments and equipment, handling small parts.	Precision workshops: computer rooms, drawing areas, laboratories.	750
High accuracy in detail distinction: assembly, processing and inspection of small and complex parts, finishing with fine polishing.	High-precision workshops: painting and surface finishing and quality control laboratories.	1,000
High degree of specialisation in distinguishing details.	Highly accurate process. Execution of visual tasks: - low contrast and very small size for prolonged periods of time; - accurate and very long, and y special tasks of extremely low contrast and small size.	2,000

Source: [Own authorship 2024]

DPEA results according to NOM 007 ENER 2014 standard

The calculation to obtain the total DPEA of the building is shown below.

As requested by the NOM 007 ENER 2014 standard, the calculation is well below the requirements of this standard.

Calculation of DPEA (total concentrated load for lighting total illuminated area))

$$DPEA = \frac{Total\ connected\ load\ for\ lighting}{Total\ illuminated\ area}$$

Total connected load for luminaire: 5,150W

Total illuminated area: 753.77m^2

$$DPEA = \frac{5{,}150\ W}{753.77m2} = 6.83\ W/m2$$

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Box 11

Table 3

The DPEA table by architectural building type is shown

Type of building	DPEA (w/m^2)
Offices	
Offices	12
Schools and other educational institutions	
Schools or educational institutions	14
Libraries	15

Source: [Own authorship 2024]

Box 12

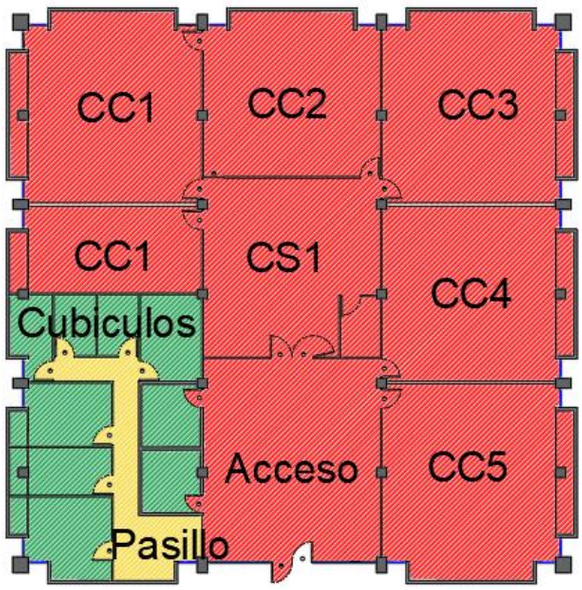

Figure 9

Shown are the spaces that comply with the standard (green) and those that do not (red)

Source: [Own authorship 2024]

Conclusions

We concluded that most of the architectural spaces in the Abundio Martínez laboratory do not comply with the parameters established by the safety and energy efficiency standards NOM-007-ENER-2014 and NOM-025-STPS-2008.

Therefore, a luminaire restructuring could be carried out to avoid possible accidents or damage to health.

Once the analysis had been carried out, negative results were obtained in terms of energy efficiency in accordance with the standard's methodology with the methodology of the standard, according to the standard NOM-007-ENER-2014, the efficiency is very low, because the DPEA, we get very low to the 14 that marks the standard.

Therefore, in terms of the calculation of the standard and energy efficiency must comply with the specifications of the building with respect to the reference building, said the above is determined that the approach around the safety of the standard NOM-025-STPS-2008.

The level of lux is very low, specifically in the areas where students take classes or carry out their academic activities, the amount of lux is less than that required by the standard for buildings or spaces such as computer labs or classrooms.

When carrying out other analyses such as the percentage of solar radiation, these values are disregarded due to the low influence they have on the classrooms because of the opaque glass windows.

Statements

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.

Authors' contribution

JCRU conceptualisation, methodology and software; JCRU and ZBTT validation and writing; MBA review.

Availability of data and materials

All material and data will be made available for consultation on direct request to the corresponding author, subject to applicable ethical restrictions.

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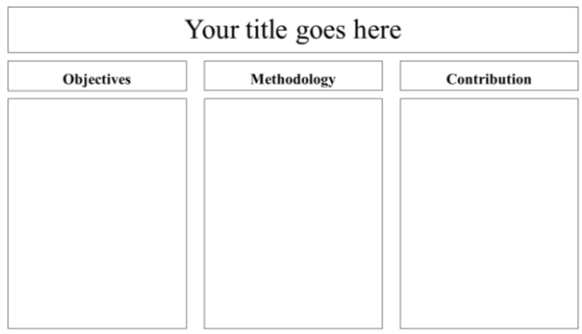

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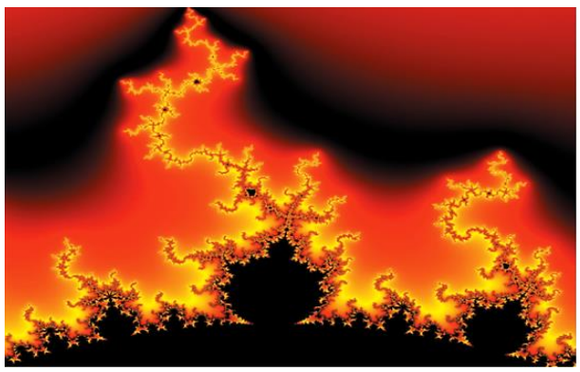

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Table 1

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Results

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Conclusions

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Annexes

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