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Journal of University Policies

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Knowledge Area

The works must be unpublished and refer to topics of University educational planning, philosophy from the university educational point, social participation in the benefit of university education, equity and university educational coverage and other topics related to Social Sciences.

Presentation of the content

In the first article we present, *Software Development Students' Perception of Active Methodologies in Probability and Statistics* by Trejo-Trejo, Gilberto Abelino, Gordillo-Espinoza, Emmanuel and Domínguez-Gutú, Jesús, with adscription in the Universidad Tecnológica de la Selva, in the next article we present *NOM-035 and Burnout in the University Context: Strategies from the teaching perspective* by Martínez-Aguilar, Gloria Mónica, Mendiola Garcia, Yessica, Morales Solis, Lorena and Palos Cerda, Gloria Cristina, with adscription in the Universidad Tecnológica de Torreón, in the next article we present *Teaching Performance Assessment (TPA), Net Promoter Score (NPS), and their relationship with Knowledge Level (KNL) in university students who completed the workshop on applied mathematics in Chemistry* by Figueroa-Ochoa, Edgar Benjamín, Huerta-Chávez, Irma Alicia, Soltero-Sánchez, Jazmín del Rocío and Soltero-Sánchez, Alma Luz Angélica, with adscription in the University of Guadalajara, in the last article we present *Advances in neurodidactics for innovative instructional design in engineering training* by González-Ramírez, Claudia Teresa, Ruiz-Garduño, Jhacer Kharen, Viñas-Alvarez, Samuel Efrén and Serrano-González, Elisa, with adscription in the Tecnológico Nacional de México.

Content

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Article

Software Development Students' Perception of Active Methodologies in Probability and Statistics

Percepción de estudiantes de Desarrollo de Software sobre metodologías activas en Probabilidad y Estadística

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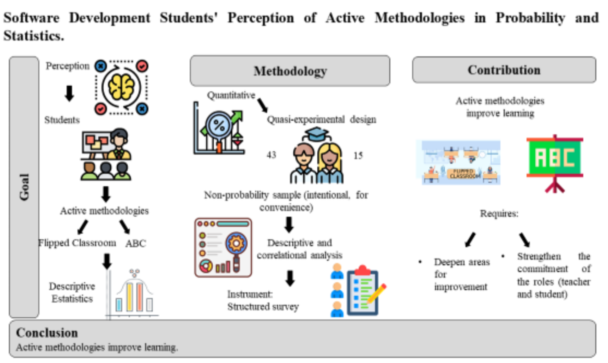
Abstract

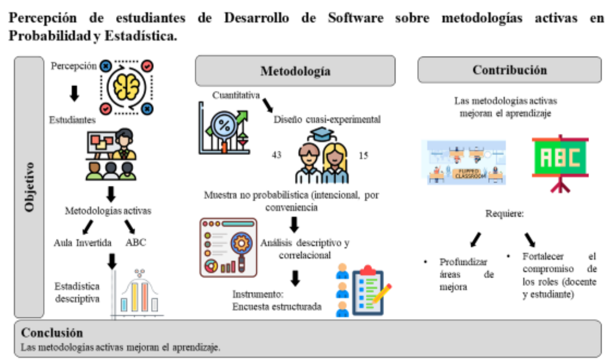
This study presents an analysis of the self-perception of 58 Software Development students regarding active methodologies (Flipped Classroom and Case-Based Learning) in Probability and Statistics, using a quantitative methodology with a quasi-experimental design, a non-probabilistic, intentional, and convenience sample. The analysis was descriptive and correlational in the dimensions of the instruments, based on survey research. The results show that these methodologies improve student satisfaction, motivation, and commitment, with significant relationships between benefits and cognitive and emotional commitments. It is concluded that they are effective for learning, although it is recommended to continue exploring areas for improvement and to promote the commitment of the roles involved.



Flipped classroom; Case-based learning; Active methodologies; Statistics

Resumen

Este estudio presenta un análisis de la autopercepción de 58 estudiantes de Desarrollo de Software, sobre metodologías activas (Aula invertida y Aprendizaje Basado en Casos) en Probabilidad y Estadística, a través de una metodología cuantitativa, con diseño cuasi-experimental, la muestra no probabilística e intencional y por conveniencia, el análisis fue descriptivo y correlacional en las dimensiones de los instrumentos, basado en una investigación por encuestas. Los resultados muestran que estas metodologías mejoran la satisfacción, motivación y compromiso de los estudiantes, con relaciones significativas entre beneficios y compromisos cognitivo y emocional. Se concluye que son efectivas para el aprendizaje, aunque se recomienda seguir explorando áreas de mejora y fomentar el compromiso de los roles involucrados.



Aula invertida; Aprendizaje basado en casos; Metodologías activas; Estadística

Area: Dissemination and universal access to science

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Introduction

In recent years, the use of Information and Communication Technologies (ICT) has been incorporated into education as a complement to traditional classes, having a significant impact on Higher Education. These technologies offer new opportunities and improve the quality of learning by facilitating access to resources and promoting more interactive teaching methods [Bernales, 2023; Jaramillo y Escudero 2024]; this has benefited the implementation of various student-centered active learning methodologies aimed at developing specific disciplinary skills and fostering lifelong learning [Esteve y Gisbert, 2011]; Consequently, these educational strategies conceive learning as a constructive rather than a receptive process [López–Altamirano et al., 2022; Domínguez y Palomares, 2020], enabling a change in roles between students and teachers, where the former take a more active part and the latter guide and facilitate the learning process [Maurel et al., 2021].

Flipped Classroom

The flipped classroom methodology was first described and disseminated by Lage, Platt and Treglia [2000], who implemented it in an Economics course. Two chemistry teachers, Jonathan Bergmann and Aaron Sams, are also frequently recognized as pioneers in applying the flipped classroom model. In 2007, they began recording video lectures so that absent students could catch up; soon they realized that all students benefited from watching the lessons before class, allowing classroom time to be devoted to more interactive and personalized activities [Núñez et al., 2021; Bergmann, 2012]. According to Cervantes et al. [2023] it has become "one of the teaching-learning proposals that, in recent years, has been promoted among upper secondary schools in Mexico" (p. 230).

The flipped classroom emerged as a response to the need to optimize classroom time and enhance student learning. It distributes the learning process by integrating direct instruction in an interactive and dynamic manner through videos, readings, and audiovisual materials prior to class. This allows knowledge acquisition to extend beyond the classroom. Class time is thus used for activities that foster meaningful learning tailored to students' individual needs [López–Altamirano et al., 2022; Maurel et al., 2021].

The rise of digital technologies and the growing availability of online educational resources have had a positive impact on higher education, promoting collaborative learning and knowledge sharing [Bonet et al., 2019].

Today, several studies are related to this topic. For instance, Arráez et al. [2018], evaluated and described students' perceptions after taking a course through this methodology. Using a Likert-scale questionnaire to assess students' satisfaction levels, they found that 68.8% preferred the flipped classroom over traditional classes.

Sanchez-Rivas et al. [2019] focused on examining how university students perceive certain advantages of the flipped classroom model. They used a questionnaire administered to two groups of students enrolled in the same course. Findings revealed that students identified several educational benefits associated with this method.

González y Huerta [2019] implemented this methodology in a Computer Engineering course at a Mexican university to promote the use and production of educational resources. The strategy included teacher-provided materials, student-created resources, and evaluation processes. Results showed that most students approved of the methodology and improved their learning and communication skills. Interaction and collaboration increased, fostering critical thinking and problem-solving while validating the constructivist principle of learning by doing. The authors concluded that active didactic models require learning environments adapted to students' learning styles to develop competencies effectively.

Similarly, Sánchez-Cruzado et al. [2019] analyzed the implementation of the flipped classroom in two courses: Didactics of Measurement and Information and Communication Technologies for Education. Using both qualitative and quantitative approaches through interviews and questionnaires, students reported positive perceptions of the methodology, highlighting greater participation, flexible access to content, adaptation to their learning pace, and better use of classroom time.

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Continuing with higher education studies, González-Zamar y Abad-Segura [2020], provided relevant evidence about the application of this pedagogical strategy in this context. Through a systematic analysis, they examined studies emphasizing the importance of active methodologies that foster autonomy, critical thinking, and digital skills. Their findings indicate that the use of the flipped classroom in university contexts stands out for promoting teamwork and collaboration, with its effectiveness largely attributed to active student participation.

Another study by Maurel et al. [2021] presented results from a survey of teachers and students that explored their perceptions of the flipped classroom and whether its implementation fosters the development of competencies. Findings revealed that both teachers and students were familiar with the methodology, and teachers expressed willingness to receive training on new tools to implement or improve it.

Of course, studies conducted during the COVID-19 pandemic cannot be overlooked. Maldonado et al. [2021] evaluated medical students' perceptions of the flipped classroom using remote synchronous sessions in a Pediatrics course. Results showed a generally favorable perception, with over 70% acceptance in all evaluated aspects. Similarly, Colín [2023] investigated satisfaction and perceived performance among undergraduate business students who used the flipped classroom methodology. Conducted over two semesters in 2021 in Mexico, the study involved 122 students in the first semester and 72 in the second. A quantitative descriptive and experimental methodology was employed using a subjective perception questionnaire. Results indicated that the flipped classroom contributed to greater satisfaction and perceived quality of training, as well as better learning integration.

In more recent research, Alastor et al. [2023] sought to promote student agency in the teaching-learning process through the flipped classroom methodology. Using a mixed method approach including a questionnaire, teacher diary analysis, and observations, the results indicated that, although students had not previously experienced this methodology, they valued it positively for its contribution to learning.

The study also emphasized the benefits of the flipped classroom and the crucial role of teachers in its implementation.

Bañón y Ramón-Dangla [2023] investigated the application of the flipped classroom in an Accounting unit to assess whether this methodology improves learning outcomes and student satisfaction in higher education. The sample included Tourism degree students enrolled in the 2021–22 academic year (Experimental Group), compared with students from the previous year who received traditional lectures (Comparison Group). Implementation occurred in four phases, and student satisfaction was assessed via a questionnaire. Results indicated that the methodology was associated with improved academic performance and high satisfaction levels, regardless of students' sex or age.

Tlalpachicatl et al. [2024] implemented the flipped classroom model and explored student perceptions through quantitative questionnaires and focus group interviews. They reported educational innovation through active methodologies supported by new technologies and provided recommendations for future use of this approach in higher education. Likewise, Mariscal et al. [2024] noted that the use of the flipped classroom at the Instituto Superior Tecnológico Babahoyo in Ecuador has fostered the development of critical thinking and the personalization of the teaching process.

Galvis et al. [2024], also evaluated the impact of the methodology on students through an ad hoc questionnaire, obtaining 73 responses. Results showed widespread positive attitudes toward the implementation of the methodology and its usefulness in addressing course content. Moreover, they found that this approach promotes meaningful learning through authentic and deeper interaction with learning objects.

Rangel et al. [2024] investigated the level of acceptance and knowledge assimilation among Software Engineering students in an analysis course. This quasi-experimental study with a quantitative approach included pre- and post-tests. Results indicated that most students accepted and assimilated the knowledge effectively, highlighting the importance of proper time management and the willingness to engage in preparatory work.

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Case-Based Learning

The case method originated in 1870, when Charles William Eliot, Director of Harvard University, commissioned Langdell to promote its use in law teaching. Langdell proposed that instruction should be based on case discussion rather than academic texts, initially facing resistance. However, by 1895, six law schools had adopted this approach. In 1921, Harvard Business School incorporated it, referring to it as the Socratic method, based on the principle of learning by doing. Harvard's first director grounded this method in observation and experimentation, following the model of the natural sciences [Muñoz, 2024; Estrada y Alfaro, 2015].

The case method is an effective strategy for developing teamwork and collaboration skills. Aramendi et al. [2014] presented the project The Case Study and Cooperative Learning in the University (PIE-2010-2012), funded by the University of the Basque Country, which implemented the case method in Pedagogy and Social Education courses. Two second-year groups—one in Basque and one in Spanish—were selected; one used group dynamics techniques and the other only the case method. Students assessed the experience through a group journal, reporting satisfaction with the activities and adequate competence development. Experimental groups performed better than control groups, underscoring the importance of cooperation and academic and relational support to create a safe and inclusive work environment.

Rondón y López [2017] explored how the European Higher Education Area (EHEA) reform promotes methodological changes to improve learning outcomes. They proposed case-based learning as an innovative and interdisciplinary teaching experience to develop systemic, instrumental, and interpersonal competencies through real-world problem solving. The methodology was evaluated with 130 Social Work students from the Universities of Málaga and Granada using questionnaires and statistical analysis. Results showed that students with higher levels of acquired competencies also reported greater satisfaction with the methodology, thereby enhancing teaching quality.

López [2020] explored the use of case studies in science education to develop critical thinking and problem-solving skills, particularly in plant ecology courses. The study assessed the influence of this method on teaching invasion ecology by integrating interactive teaching strategies such as case-based learning, field education, and the linkage between research and education. Students participated in sessions on various ecological topics and conducted research and case studies on invasive plant species in local environments. Evaluation focused on active participation, effective task execution, brief exercises, and peer collaboration. Results indicated that students demonstrated openness to case-based learning, developing diagnostic and problem-solving skills for real local invasions while connecting more deeply with course content.

Raza et al. [2020] examined the impact of case-based learning on engagement, motivation, and performance among university students in Pakistan. Using structural equation modeling, they found that this method enhances behavioral, emotional, cognitive, and agentic engagement. Case-based learning also improves conceptual understanding and skill development, thereby increasing learning motivation.

Objective

To analyze students' perceptions regarding the implementation of the flipped classroom and case-based learning methodologies in teaching Descriptive Statistics within the Probability and Statistics course.

Methodology

This research study was conducted using a quantitative approach with a quasi-experimental design, employing a non-probabilistic, intentional, and convenience sampling method. Two instruments were used to determine students' self-perception after learning the topic of Descriptive Statistics under the flipped classroom model and case-based learning approach. The sample selected for the study consisted of 58 students, of whom 43 were male, 15 female, and 0 identified as another gender, all enrolled in the second semester of the University Technician in Information and Communication Technologies program at the Universidad Tecnológica de la Selva, located in Ocosingo, Chiapas, Mexico.

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Data collection was carried out immediately after completing the implementation of the flipped classroom and case-based learning methodologies, using two instruments distributed through Google Forms. The first instrument, designed by Cervantes et al. [2023] and adapted for this study, was used to assess students' perceptions of the flipped classroom. It used an anonymous Likert-type scale with five response options: A lot, Quite a bit, Moderate, Little, and Very little. The second instrument, designed by Raza et al. [2020] and adapted for this study, was used to assess perceptions of case-based learning. It also employed an anonymous Likert-type scale with five response options: Strongly agree, Agree, Neutral, Disagree, and Strongly disagree.

From the very first day of class, when the Probability and Statistics course began with the topic of Descriptive Statistics, students were introduced to the use of the flipped classroom methodology combined with case-based learning, as this approach reverses the traditional roles in the teaching–learning process.

In this model, the teacher focuses on the lower taxonomic levels—remembering and understanding—through instructional materials that students review outside the classroom. Subsequently, during in-class sessions, students engage in activities designed to reach higher taxonomic levels through collaborative work and case-based learning. In this way, students assume the primary role in their learning process, while the instructor acts as a facilitator. All students committed to working under these active learning methodologies.

Students were provided, from the first week of class, with all the necessary materials to review and work at home outside of class hours. Class time was reserved for addressing questions and integrating case-based learning within the topic of Descriptive Statistics. This allowed students to access the content anytime and anywhere, thanks to technology, without relying on the teacher as the sole transmitter of information.

The instructor prepared explanatory videos and additional learning materials, and conducted continuous monitoring of student activities to identify possible improvements to the implementation process.

The activities were designed to include case-based learning and promote collaborative work. Data were collected through a survey that students administered to a sample of the university's student community.

The data collection survey was structured into five categories, each representing a "case" to be analyzed by one of the student teams in the classroom. The general survey was structured as follows: Use of Computer Tools, Use of Search Engines and Web Browsing, Use of Social Networks, Collaboration and Videoconferencing Tools, and Use of Artificial Intelligence Tools.

It is worth noting that students carried out various activities such as reading documents, watching videos, conducting independent information searches, and participating in interactive group discussions inside and outside the classroom in order to solve the assigned cases.

From the first week of classes, the topic of Descriptive Statistics was reviewed to verify whether students had engaged with and analyzed the materials previously provided. The instructor asked pre-designed questions to assess this understanding and then continued with active group work in teams of four to five students, which included solving practical cases and group discussions. Students accessed materials via smartphones or personal computers.

After completing the implementation of the flipped classroom with case-based learning, students responded to the Google Forms survey to measure their self-perception of both teaching strategies, after which the results were analyzed.

To ensure participants' collaboration and willingness, ethical criteria were strictly followed: all participants consented to complete the instruments; participation was voluntary, and they could withdraw at any time; all were informed about the purpose of the study; and all responses remained completely anonymous, as no personal data were requested. Data collection took place immediately after the implementation of both methodologies using two instruments distributed through Google Forms.

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The data obtained from the surveys were analyzed using JASP software, Version 0.18.1. The reliability of the instruments and the pairwise correlations between their dimensions were calculated. The Cronbach's alpha values obtained were 0.85 and 0.87, respectively, which are considered acceptable levels of reliability according to Ruíz [2013]. Additionally, Microsoft Excel was used to perform a descriptive analysis of the results from both instruments, which were presented in tables for better comprehension.

Results

He first instrument is composed of the following dimensions: Benefits, Communication, and Satisfaction. It contains 17 items (see Table 1). The dimensions and the number of items per dimension are briefly described below.

Box 1

Table 1

Dimensions and Questions of the Flipped Classroom Perception Instrument

Dimensions	Questions
Benefits	P1. To what extent was the type of material provided by the teacher sufficient to achieve the learning outcomes of the Descriptive Statistics topics?
	P2. To what extent was the quality of the material provided by the teacher sufficient to achieve the learning outcomes of the Descriptive Statistics topics?
	P3. To what degree did the flipped classroom learning modality support the completion of class activities and/or exercises?
	P4. To what extent did the flipped classroom modality allow for the achievement of the learning outcomes in the Descriptive Statistics topics?
	P5. To what extent do you feel confident about what you learned through the flipped classroom approach when being assessed?
	P6. When carrying out the Descriptive Statistics activities through the flipped classroom approach, to what extent was motivation promoted?
	P7. To what level of satisfaction do you feel motivated to participate in classes that use the flipped classroom approach?
	P8. To what extent do you consider that the flipped classroom learning modality helps you develop skills that will be valuable in your professional development?
	P9. To what extent would you recommend other students to take courses using the flipped classroom approach?
Satisfaction	P10. What is your level of satisfaction regarding the time spent on activities under this learning approach?
	P11. What is your satisfaction regarding the incorporation of innovative methodologies such as the flipped classroom in academic activities?
	P12. Overall, what is your satisfaction after working with the flipped classroom approach?
Communication	P13. To what extent was the support provided by the teacher, according to individual needs, appropriate to resolve questions or doubts about the topics under this learning approach?
	P14. To what extent do you consider that the flipped classroom approach promotes communication between the teacher and the student?
	P15. To what extent do you consider that the traditional teaching method promotes communication between the teacher and the student?
	P16. To what degree does the flipped classroom approach promote communication and collaboration with your classmates?
	P17. To what extent has the flipped classroom approach made it easier for you to express questions and opinions in class?

Source: Adapted from Cervantes et al. [2023]

The results obtained from the first applied instrument are presented below, including their respective dimensions, items, and rating scales, where: ∑ represents frequency and % represents percentage.

Box 2

Table 2

Descriptive Analysis of the Flipped Classroom Instrument

Dimensions	Item	Very much		Quite a lot		Moderate		Little		Very little	
		∑	%	∑	%	∑	%	∑	%	∑	%
	P1	11	19	29	50	18	31	0	0	0	0
	P2	11	19	33	56.9	14	24.1	0	0	0	0
	P3	8	13.8	26	44.8	22	37.9	2	3.4	0	0
	P4	7	12.1	22	37.9	29	50	0	0	0	0
	P5	9	15.5	15	25.9	31	53.4	3	5.2	0	0
	P6	5	8.6	23	39.7	26	44.8	4	6.9	0	0
	P7	4	6.9	14	24.1	26	44.8	14	24.1	0	0
	P8	8	13.8	24	41.4	22	37.9	4	6.9	0	0
	P9	15	25.9	22	37.9	17	29.3	4	6.9	0	0
Satisfaction	P10	3	5.2	17	29.3	33	56.9	5	8.6	0	0
	P11	6	10.3	23	39.7	24	41.4	5	8.6	0	0
	P12	1	1.7	29	50	26	44.8	2	3.4	0	0
Comunication	P13	13	22.4	27	46.6	16	27.6	2	3.4	0	0
	P14	14	24.1	25	43.1	17	29.3	2	3.4	0	0
	P15	5	8.6	27	46.6	22	37.9	4	6.9	0	0
	P16	11	19	29	50	14	24.1	4	6.9	0	0
	P17	6	10.3	23	39.7	27	46.6	2	3.4	0	0

Source: Own elaboration (2025)

According to Table 2, in the Benefits dimension, most participants rated the items as much and quite a lot. As observed in items P1, P2, P3, P4, P8, and P9, between 50% and 75.9% gave a high rating on the defined scale. However, it is also notable that in P5 and P7, many rated them as sufficient, between 44.8% and 53.4%. Additionally, P7 shows more responses of little, representing 24.1%, which indicates areas of opportunity for future studies.

Similarly, the Satisfaction dimension shows a mostly positive perception. As seen in P10, P11, and P12, most participants feel sufficiently satisfied, with percentages ranging from 41.4% to 56.9%. Although P11 shows more balanced results between quite a lot (39.7%) and sufficient (41.4%), both remain favorable.

Regarding the Communication dimension, items P13, P14, P15, and P16 were rated as quite a lot by 43.1% to 50% of participants. Although P17 has a slightly lower proportion (39.7%), the perception remains mostly positive.

The second instrument is composed of the following dimensions: Case-Based Learning, Behavioral Engagement, Cognitive Engagement, Emotional Engagement, Agentic Engagement, Learning Motivation, and Learning Performance. It includes 22 items (see Table 3). The dimensions and the number of items per dimension are briefly described below.

Box 3

Table 3

Dimensions and Questions of the Case-Based Learning Perception Instrument

Dimensions	Questions
Case-Based Learning	P18. Do you think that the case study you developed improves your knowledge of the Descriptive Statistics topics in the Probability and Statistics course?
	P19. Do you think that the instructional materials provided for the Descriptive Statistics topics are relatively important for applying them to the case study you developed?
Behavioral Engagement	P20. During the development of the topics covered in Descriptive Statistics classes, I listened attentively.
	P21. During the development of the topics covered in Descriptive Statistics classes, I paid attention in class.
	P22. I like to work intensively when we start something new in the Probability and Statistics class on Descriptive Statistics topics.
	P23. When I study, I try to connect what I am learning about Descriptive Statistics topics with my own experiences.
Cognitive Engagement	P24. I try to make all my ideas fit together and make sense when I study Descriptive Statistics topics.
	P25. I create my own examples to help me understand the important concepts I study in Descriptive Statistics topics.
	P26. Do you find it difficult to create your own examples to study and understand Descriptive Statistics topics?
Emotional Engagement	P27. When I am in the Probability and Statistics class, I feel curiosity and motivation about what I am learning in the Descriptive Statistics topics.
	P28. I enjoy learning new things about Descriptive Statistics topics in the Probability and Statistics class.
Agentic Engagement	P29. During the development of the Descriptive Statistics topics, I ask the teacher questions.
	P30. I let my Probability and Statistics teacher know what interests me about their class on Descriptive Statistics topics.
	P31. During the development of the Descriptive Statistics topics, I express my preferences or opinions to the teacher.
Learning Motivation	P32. I have devoted time to studying Descriptive Statistics topics.
	P33. The time spent studying the instructional materials for Descriptive Statistics topics is a priority for me.
	P34. I make my best effort to study the instructional materials for Descriptive Statistics topics.
	P35. Overall, my motivation to learn Descriptive Statistics topics is very high.
Learning Performance	P36. I have acquired knowledge from the instructional materials provided on Descriptive Statistics topics to apply them to the case study proposed by the teacher.
	P37. I have developed skills from the instructional materials provided on Descriptive Statistics topics to apply them to the case study proposed by the teacher.
	P38. Overall, I have learned a lot from the Descriptive Statistics topics taught through the application of the case study proposed by the teacher.
	P39. I feel capable of applying the knowledge and skills acquired in the Descriptive Statistics topics through the case study proposed by the teacher.

Source: Adapted from Raza et al. [2020]

The following section presents the results obtained from the second instrument applied:

Box 4

Table 4

Descriptive analysis of the instrument on case-based learning

Dimensions	Item	Strongly agree		Agree		Neutral		Disagree		Strongly disagree	
		Σ	%	Σ	%	Σ	%	Σ	%	Σ	%
Case-Based Learning	P18	11	19	34	58.6	13	22.4	0	0	0	0
	P19	23	39.7	31	53.4	4	6.9	0	0	0	0
Behavioral Engagement	P20	14	24.1	31	53.4	11	19	0	0	2	3.4
	P21	16	27.6	28	48.3	14	24.1	0	0	0	0
	P22	8	13.8	24	41.4	23	39.7	3	5.2	0	0
	P23	12	20.7	23	39.7	20	34.5	3	5.2	0	0
Cognitive Engagement	P24	15	25.9	31	53.4	9	15.5	2	3.4	1	1.7
	P25	8	13.8	13	22.4	23	39.7	11	19	3	5.2
	P25	4	6.9	17	29.3	28	48.3	8	13.8	1	1.7
Emotional Engagement	P27	6	10.3	31	53.4	20	34.5	1	1.7	0	0
	P28	9	15.5	32	55.2	14	24.1	2	3.4	1	1.7
Agentic Engagement	P29	5	8.6	12	20.7	20	34.5	16	27.6	5	8.6
	P30	4	6.9	10	17.2	22	37.9	16	27.6	6	10.3
	P31	4	6.9	10	17.2	27	46.6	9	15.5	8	13.8
Learning Motivation	P32	7	12.1	28	48.3	17	29.3	4	6.9	2	3.4
	P33	9	15.5	23	39.7	20	34.5	4	6.9	2	3.4
	P34	14	24.1	24	41.4	17	29.3	2	3.4	1	1.7
	P35	4	6.9	24	41.4	27	46.6	3	5.2	0	0
Learning Performance	P36	14	24.1	37	63.8	5	8.6	1	1.7	1	1.7
	P37	11	19	32	55.2	13	22.4	1	1.7	1	1.7
	P38	10	17.2	33	56.9	13	22.4	2	3.4	0	0
	P39	8	13.8	23	39.7	24	41.4	2	3.4	1	1.7

Source: Own elaboration

According to Table 4, in the Case-Based Learning dimension, most participants show a positive perception. Items P18 and P19 reached 58.6% and 53.4%, respectively, for the “Agree” scale, while 19% and 39.7% selected “Strongly agree.” Therefore, the data suggest that students positively accepted the case-based learning dimension.

In the Behavioral Engagement dimension, results from P20 and P21 reflect a strong level of commitment, while P22 and P23 show more neutral responses, suggesting the need for additional strategies to strengthen participation or understanding among students.

Cognitive Engagement was not homogeneous across all evaluated items. While P24 shows a clear tendency toward active participation and effort, P25 and P26 reveal uncertainty or lower identification with the statements. This mix of opinions indicates that some participants may not be fully engaged at the intellectual level.

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Regarding Emotional Engagement, results are generally positive: in P27 and P28, most students agreed (53.4% and 55.2%, respectively), with smaller neutral proportions (34.5% and 24.1%). This suggests that students feel emotionally connected to their learning process.

The Agentic Engagement dimension shows a more divided perception; items P29, P30, and P31 have a higher proportion of neutral responses (34.5%, 37.9%, and 46.6%) and disagreement (27.6%, 27.6%, and 15.5%), indicating that many students do not feel fully in control of or responsible for their own learning process.

Moving to Learning Motivation, the overall perception is mostly positive. Items P32–P34 show that the majority of students agreed or strongly agreed (agree: 39.7–48.3%; strongly agree: 12.1–24.1%), although P35 shows a higher neutral proportion (46.6%), suggesting that some students are less motivated.

Finally, the Learning Performance dimension is perceived very positively. Items P36–P38 show that most students agreed (55.2–63.8%) or strongly agreed (17.2–24.1%). However, P39 presents a more balanced distribution (39.7% agree; 41.4% neutral), indicating that not all students are fully confident about their performance.

The following section presents the results of the pairwise correlations among the dimensions of both instruments. The Pearson's r represents the correlation coefficient that measures the relationship between two variables, and the p-value indicates whether the relationship is statistically significant:

Box

Table 5
Correlation analysis between dimensions of both instruments

Dimensions	Pearson's R	P value
Benefits - Satisfaction	0.708***	< .001
Benefits - Communication	0.565***	< .001
Benefits - Case-Based Learning	0.416**	0.001
Benefits - Behavioral Engagement	0.288*	0.028
Benefits - Cognitive Engagement	0.349**	0.007
Benefits - Emotional Engagement	0.253	0.055
Benefits - Agentic Engagement	0.168	0.208
Benefits - Learning Motivation	0.254	0.054
Satisfaction - Communication	0.542***	< .001
Satisfaction - Case-Based Learning	0.288*	0.028
Satisfaction - Behavioral Engagement	0.268*	0.042
Satisfaction - Cognitive Engagement	0.352**	0.007
Satisfaction - Emotional Engagement	0.198	0.136
Satisfaction - Agentic Engagement	0.193	0.147
Satisfaction - Learning Motivation	0.328*	0.012
Communication - Case-Based Learning	0.223	0.092
Communication - Behavioral Engagement	0.218	0.099
Communication - Cognitive Engagement	0.354**	0.006
Communication - Emotional Engagement	0.192	0.149
Communication -Agentic Engagement	-0.018	0.894
Communication - Learning Motivation	0.021	0.878
Case-Based Learning - Behavioral Engagement	0.151	0.258
Case-Based Learning - Cognitive Engagement	0.254	0.055
Case-Based Learning - Emotional Engagement	0.188	0.158
Case-Based Learning - Agentic Engagement	0.156	0.243
Case-Based Learning - Learning Motivation	0.209	0.115
Behavioral Engagement - Cognitive Engagement	0.443***	< .001
Behavioral Engagement - Emotional Engagement	0.425***	< .001
Behavioral Engagement - Agentic Engagement	0.382**	0.003
Behavioral Engagement - Learning Motivation	0.355**	0.006
Cognitive Engagement - Emotional Engagement	0.471***	< .001
Cognitive Engagement - Agentic Engagement	0.460***	< .001
Cognitive Engagement - Learning Motivation	0.411**	0.001
Emotional Engagement - Agentic Engagement	0.270*	0.040
Emotional Engagement - Learning Motivation	0.432***	< .001
Agentic Engagement - Learning Motivation	0.367**	0.005
*p<0.05, **p<0.01, ***p<0.001		

Source: Own elaboration

The analysis in Table 5 reveals significant relationships among several dimensions. The strongest correlation appears between Benefits and Satisfaction (R = 0.708, p < .001), indicating that greater perceived benefits lead to higher satisfaction. Communication also shows a strong correlation with Satisfaction (R = 0.542, p < .001) and a moderate one with Cognitive Engagement (R = 0.354, p = .006).

Different types of engagement (behavioral, cognitive, emotional, agentic) are moderately correlated with one another, suggesting that improving one type can positively influence others. Learning Motivation is significantly correlated with Cognitive (R = 0.411, p = .001) and Emotional Engagement (R = 0.432, p < .001).

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However, some relationships were not significant, such as Benefits–Emotional Engagement (R = 0.253, p = 0.055) or Communication–Case-Based Learning (R = 0.223, p = 0.092), suggesting that these dimensions may not be closely related or that the sample size was insufficient to detect a significant relationship.

Discussion

The results obtained from the two instruments applied in this educational research provide a comprehensive view of students' perceptions regarding active methodologies such as flipped classroom and case-based learning. The following discussion presents the most relevant findings in relation to the evaluated dimensions.

Perception of the Flipped Classroom

Benefits

The "benefits" dimension shows a predominantly positive perception among students. Most items in this category received responses of "A lot" and "Quite a lot," indicating that students consider the flipped classroom methodology to have provided valuable tools for achieving learning objectives in Descriptive Statistics. This finding is consistent with that of Rangel et al. [2024], whose results indicate that most students accepted and assimilated the knowledge, highlighting the importance of proper time management and willingness to work beforehand. Specifically, the materials provided by the instructor and the learning modality itself were perceived as effective for achieving learning outcomes (P1, P2, P4). Furthermore, students feel confident in what they have learned and are motivated to participate in classes under this modality (P5, P7).

Satisfation

Satisfaction levels are also high, similar to the study conducted by Bañón y Ramón-Dangla [2023], whose results indicated that the flipped classroom methodology is associated with improved academic performance and a high degree of satisfaction. Most students express satisfaction with the time devoted to activities and the incorporation of innovative methodologies (P10, P11). Overall satisfaction after working with the flipped classroom approach is notably high (P12).

This finding aligns with that of Arráez et al. [2018], who evaluated students' satisfaction with this methodology and found that 68.8% preferred the flipped class over traditional lessons, and 77.7% believed they assimilated content better through the flipped class than through traditional methods.

Comunication

Communication between teachers and students, as well as among students themselves, is enhanced by the flipped classroom model. Students perceive the teacher's support as appropriate for addressing questions (P13) and believe the modality facilitates communication and collaboration in the classroom (P16, P17). Conversely Sanchez-Rivas et al. [2019] eported no significant impact on participation-related elements such as teacher-student interaction. Interestingly, perceptions of communication in the traditional method were also positive (P15), suggesting that both modalities have their own strengths in this regard.

Perception of Case-Based Learning

Case-Based Learning

Students believe that case studies improve their understanding of Descriptive Statistics topics and that the instructional materials provided are important for applying them to case study development (P18, P19). This suggests that case-based learning is an effective strategy for deepening understanding of course content.

Behavioral and Cognitive Engagement

Students demonstrate high behavioral and cognitive engagement, with most of them listening attentively in class and attempting to connect what they learn to their own experiences (P20, P21, P23). This finding is similar to that reported by Aramendi et al. [2014], where students expressed satisfaction with learning activities, successfully developed competencies, and exhibited effective teamwork. These outcomes were closely related to interpersonal variables such as cooperation, assistance, and supervision among group members, which fostered interaction and a sense of security in students striving to achieve learning objectives.

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Additionally, students attempt to ensure their ideas make sense and create their own examples to better understand key concepts (P24, P25). However, some students report difficulty in generating their own examples (P26), which could be an area for improvement in future educational interventions. This aligns with the findings of López [2020], where students showed an open attitude toward case-based learning, which helped them develop the thinking skills necessary to diagnose and solve real-world problems while connecting them to broader course content. The evaluation methods focused on active participation, effective execution of activities and case studies, peer collaboration, and student involvement in evaluating course sessions, fieldwork, and general content.

Emotional and Agentic Engagement

Emotional engagement is noteworthy, with students expressing curiosity and motivation about what they learn (P27, P28). Although agentic engagement is present, it shows greater variability in responses, suggesting that some students may require additional encouragement to express their preferences and opinions to the teacher (P29, P30, P31). This contrasts with the findings of Raza et al. [2020], where agentic engagement was found to be statistically significant in establishing a connection with students' learning performance.

Learning Motivation

Motivation to learn Descriptive Statistics topics is high, with students dedicating time and effort to studying instructional materials (P32, P33, P34, P35). This indicates that students value learning these topics and are willing to invest time in understanding them. This finding aligns with the main results of Raza et al. [2020], which revealed that case-based learning leads to a deeper understanding of classroom concepts, the development of student skills, and increased motivation for learning.

Learning Performance

Learning performance is perceived as positive, with students acquiring knowledge and skills applicable to the case study (P36, P37, P38). Moreover, students feel capable of applying what they have learned in practical situations (P39).

These findings are consistent with those of Muñoz [2024], who found that case-based learning is an alternative approach for developing problem-solving skills and that implementing the case method in the classroom facilitates the application of concepts to real-world problems.

Conclusions

The results of this research suggest that both the flipped classroom modality and case-based learning are positively perceived by students and contribute to achieving learning objectives in Descriptive Statistics. The high levels of student satisfaction, motivation, and engagement indicate that these methodologies are effective in enhancing the teaching–learning process. However, it is important to continue exploring areas for improvement, such as supporting students in creating their own examples and fostering agentic engagement, to maximize the benefits of these educational strategies.

Although variations exist, it can be noted that most participants have a positive perception of the benefits, satisfaction, and communication dimensions. Areas with lower perceptions, such as items P5 and P7 within the benefits category, may require specific attention to improve the overall educational experience.

Similarly, most participants expressed positive perceptions regarding case-based learning, behavioral engagement, and learning performance. Areas with lower perceptions, such as agentic engagement and certain items within cognitive engagement, may also need specific attention to enhance the overall learning experience.

Finally, the significant relationships observed among benefits, satisfaction, and cognitive and emotional engagement highlight key areas for improving the educational experience. Effective communication and learning motivation also play important roles. Non-significant dimensions may require targeted interventions or further studies to better understand their dynamics.

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Declarations

Conflict of interest

The authors declare no conflict of interest. They have no competing financial interests or known personal relationships that could have influenced the work reported in this article.

Author contribution

Trejo-Trejo, Gilberto Abelino: ontributed to the project concept, methodological approach, design, and writing of the research; reviewed the theoretical framework and literature to define the educational intervention and prepared the final manuscript.

Gordillo-Espinoza, Emmanuel: contributed to reviewing the theoretical framework, the methodological approach, and to writing and revising the manuscript.

Domínguez-Gutú, Jesús: contributed to the literature review and revision of the manuscript.

Availability of data and materials

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Abbreviations

ICT	Information and Communication Technologies
COVID-19	Highly contagious respiratory disease caused by the SARS-cov-2 virus
SARS-cov2	Severe Acute Respiratory Syndrome Coronavirus type 2

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Article

NOM-035 and Burnout in the University Context: Strategies from the teaching perspective

La Norma 035 y el Burnout en el Ámbito Universitario: Estrategias desde la perspectiva docente

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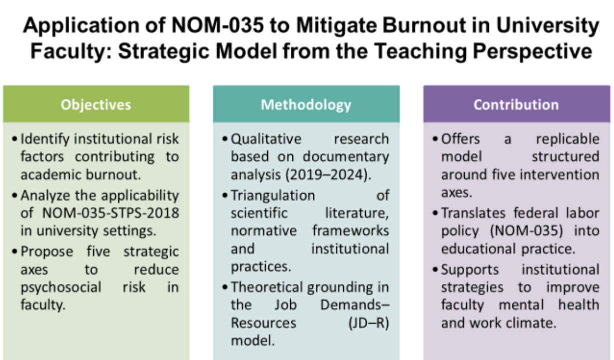
Abstract

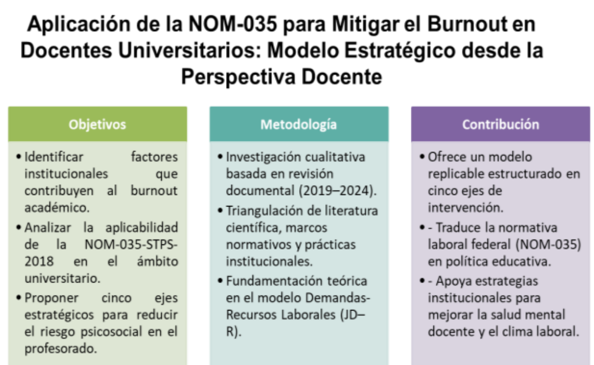
This article analyzes the application of NOM-035-STPS-2018 as a framework for mitigating burnout among university faculty in Mexico. Based on a qualitative review of literature from 2019 to 2024, five key strategies are proposed: ongoing assessment of the work environment, equitable workload distribution, stress management training, internal support networks, and institutional policy updates. Evidence indicates that universities implementing these strategies report improved faculty well-being, reduced psychosocial risk factors, and enhanced academic performance. The findings support the use of NOM-035 as a tool not only for regulatory compliance but as a strategic axis for building healthier educational institutions.



Burnout, NOM-035, University faculty

Resumen

Este artículo analiza la aplicación de la NOM-035-STPS-2018 como marco para mitigar el burnout en el profesorado universitario en México. A partir de una revisión cualitativa de literatura entre 2019 y 2024, se proponen cinco estrategias clave: evaluación continua del clima laboral, distribución equitativa de la carga de trabajo, capacitación en manejo del estrés, redes internas de apoyo y actualización de políticas institucionales. La evidencia indica que las universidades que implementan estas estrategias reportan mejoras en el bienestar del personal académico, reducción de riesgos psicosociales y mejor desempeño educativo. Los hallazgos respaldan el uso de la NOM-035 no solo como una obligación legal, sino como una herramienta estratégica para construir instituciones educativas más saludables.



Burnout, NOM_035, Docentes universitarios

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Introduction

Over the last few decades, burnout syndrome has been widely recognised as a consequence of chronic work-related stress, characterised by emotional exhaustion, depersonalisation and a decrease in perceived professional efficacy (Maslach & Leiter, 2016). This syndrome directly affects the physical and mental health of workers and is associated with a progressive deterioration in performance, organisational climate and quality of service provision. Its impact is not only individual but also collective, affecting the work environment and organisational processes, decreasing productivity, increasing absenteeism and eroding professional commitment.

In the field of education, particularly in higher education, this issue takes on critical relevance due to the multiple and growing demands faced by teachers. In addition to their academic duties, they are assigned administrative, research, and institutional outreach responsibilities, often without the necessary institutional support. This overload, combined with precarious working conditions and limited opportunities for professional development, fosters conditions that promote emotional exhaustion, detachment from work, and deterioration of overall well-being.

Several studies have documented that university teaching staff are particularly exposed to work contexts that favour the development of burnout. Among the most recurrent factors are work overload, pressure to meet academic goals and lack of recognition (Leiter & Maslach, 2017; Schaufeli, Desart & De Witte, 2020). Internationally, it is estimated that between 25% and 45% of university teachers show symptoms of burnout, with an overall estimate of approximately 37%, according to a meta-analysis by Fernández-Suárez et al. (2021), which shows a worrying trend. In Latin America, and particularly in Mexico, these figures tend to be higher due to unfavourable structural conditions such as lack of budget, instability in the academic sphere, technological backwardness and high staff turnover.

In the case of Mexico, data from the Ministry of Labour and Social Welfare (2020) reveal that 75% of workers report high levels of work-related stress, surpassing even countries such as China (73%) and the United States (59%).

This statistic places Mexico among the nations with the highest incidence of work-related stress globally. In particular, the university environment clearly reflects this problem: recent research in Mexico has documented a high incidence of burnout syndrome among university professors. For example, a national study identified that between 30% and 50% of university professors show significant symptoms of work-related exhaustion (Villamar Sánchez-Narváez et al., 2023), while another regional study in the north-west of the country reported 85% (Olivares Fong et al., 2020). These figures reflect a direct impact on the health, professional performance and institutional retention of academic staff.

Against this backdrop, Mexican Official Standard NOM-035-STPS-2018 emerges as a regulatory instrument with high potential for identifying, analysing and preventing psychosocial risk factors in the workplace. Although it was originally designed for the industrial and service sectors, its guidelines are applicable to educational environments by promoting the evaluation of the organisational environment, the early detection of work-related stress and the implementation of continuous improvement measures aimed at staff well-being (Secretariat of Labour and Social Welfare, 2020). Its adoption by universities represents a strategic opportunity to transform the working conditions of academic staff from a comprehensive perspective, based on regulatory compliance, institutional responsibility, and the improvement of organisational health.

Unlike traditional approaches focused exclusively on the individual, this proposal emphasises the structural transformation of higher education institutions through the integration of public policies, legal frameworks, and organisational strategies. The added value lies in articulating regulatory guidelines with specific institutional practices, generating a replicable and empirically based model that solves the palliative approach to stress, building sustainable, healthy and resilient work environments.

The starting point is the hypothesis that the structured application of NOM-035, aligned with specific organisational strategies, can significantly reduce psychosocial risk factors and improve the overall well-being of university teaching staff.

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To this end, this article aims to identify and analyse strategies for mitigating burnout among university teachers in Mexico based on a systematic review of scientific, regulatory and experiential literature published between 2018 and 2024.

The article is structured in the following sections: first, the documentary and regulatory review methodology used is presented; then, the main results and findings are presented; finally, the conclusions and recommendations for its effective implementation in Mexican universities are presented.

Methodology

This study was developed using a qualitative approach, with an exploratory perspective, based on an analytical and interpretative documentary and regulatory review. This methodological choice responds to the need to understand in depth the interaction between two complex dimensions: teacher burnout syndrome and the implementation of Mexican Official Standard NOM-035-STPS-2018 in higher education institutions in Mexico. Both phenomena are multidimensional, as they involve individual (emotional, cognitive, attitudinal), organisational (structures, policies, working conditions) and regulatory (legal frameworks, institutional standards) components, which justifies a holistic and reflective approach.

The research considered that the construction of institutional strategies to mitigate teacher burnout requires not only isolated empirical evidence, but also a critical articulation of scientific literature, regulatory frameworks and documented institutional experiences. Therefore, the methodology used was designed to integrate and triangulate various reliable secondary sources, with the aim of constructing a strategic framework based on evidence, theory and practice.

Information gathering

Information gathering focused on academic, institutional, and legal sources published between 2018 and 2024, a period that encompasses both the enactment and initial implementation of NOM-035-STPS-2018 in the Mexican context.

Priority was given to the analysis of scientific literature indexed in specialised databases such as Scopus, Web of Science, Redalyc, SciELO and Google Scholar, using combinations of keywords such as: teacher burnout, academic work stress, psychosocial risks, higher education, institutional interventions and NOM-035. Official reports issued by national (such as the Ministry of Labour and Social Welfare) and international (such as the International Labour Organisation) bodies were also consulted, as well as doctoral theses, peer-reviewed journal articles, case studies, and technical documents detailing real experiences of regulatory implementation in Mexican universities.

Methodological análisis

The analysis was structured in three sequential and interrelated phases, represented in Figure 1:

1. Systematic mapping of academic literature:

In this stage, relevant works on burnout in university teachers were identified and selected, with special attention to the Mexican and Latin American context. Inclusion criteria were applied, such as: empirical or analytical approach, thematic relevance, current relevance (2018-2024), and academic validation. The key topics analysed were teacher work stress, psychosocial risk factors, the consequences of burnout on educational quality, and institutional prevention strategies. This stage allowed us to construct a broad and up-to-date overview of the phenomenon under study.

2. Normative analysis of NOM-035-STPS-2018:

This phase consisted of a detailed review of the structural components of the Standard, its legal basis, the technical instruments it proposes, and its possibilities for application in educational contexts. Its adaptability to the university sector was evaluated by analysing documented experiences in public and private universities, identifying both barriers and facilitators for its implementation. This analysis also considered the alignment of the Standard with other institutional policies on well-being, occupational health, and risk management.

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3. Triangulation of findings and construction of the strategic model:

In this phase, the results obtained in the two previous phases were integrated in order to construct a strategic framework for intervention adapted to the university context. Based on this synthesis, five priority areas of action were defined for the mitigation of teacher burnout:

a) Periodic evaluation of the working and psychosocial climate
b) Equitable and transparent distribution of teaching load
c) Training and education programmes in stress management and self-care
d) Strengthening of institutional support networks and internal communication
e) Review and updating of labour policies from a preventive approach

Each of these areas was supported by empirical and regulatory evidence demonstrating their viability, relevance and potential impact on organisational health. A strategic formulation was chosen that allows for adaptation in different universities, regardless of their size, budget or level of progress in applying the Standard.

Box 1

Methodological phase

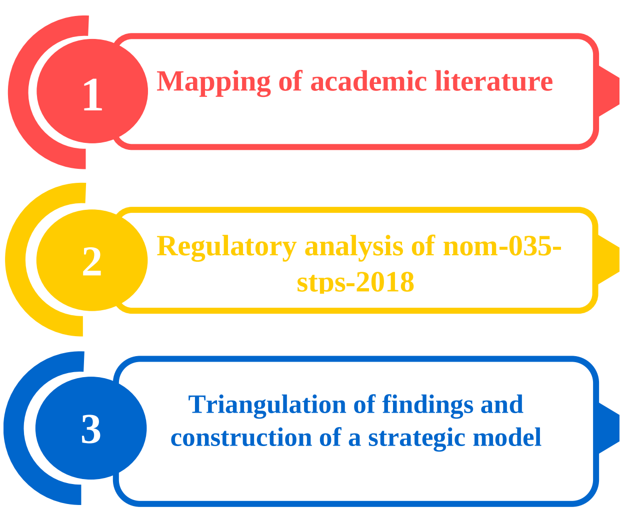

Figure 1
Phases of the methodological process of the study
Source: Own Elaboration

Theoretical support

To guide the interpretation of the findings and give theoretical coherence to the proposed model, the Job Demands–Resources (JD–R) model developed by Bakker and Demerouti (2007) was used. This model posits that burnout arises when there is an imbalance between job demands (physical, emotional, and cognitive demands of the job) and available resources (institutional support, autonomy, training, recognition, among others). The JD–R allows individual and organisational factors to be articulated in the same analysis, making it an ideal framework for understanding the work dynamics of teachers and designing preventive strategies tailored to institutional realities.

Methodological considerations

The main limitation of this research is that it did not include primary data collection (such as interviews, questionnaires or focus groups), which limits the possibility of empirically validating the proposed strategic model in a specific environment. Nevertheless, the systematic review of secondary sources, the triangulation of approaches, and the theoretical integration are considered to provide a robust and replicable starting point for future empirical research.

As a line of continuity, we suggest the development of longitudinal studies in Mexican universities to evaluate the effectiveness of the model, as well as participatory research that actively involves teachers, management personnel, and those responsible for workplace well-being policies.

Results

The documentary analysis carried out identified a coherent set of strategies that have proven effective in mitigating teacher burnout in the university setting, especially when aligned with the principles and guidelines of NOM-035-STPS-2018. These strategies are grouped into five fundamental areas, which integrate both regulatory elements and practical recommendations based on empirical evidence. Each of these is presented and analysed below:

a) Periodic assessment of the working environment

The implementation of continuous workplace climate assessment mechanisms allows for the early identification of psychosocial risk factors that contribute to burnout. Recent studies have confirmed that institutions that apply systematic diagnostics—such as the Burnout Assessment Tool (BAT)—have lower levels of emotional exhaustion among teachers (Schaufeli, Desart & De Witte, 2020). This empirical evidence is in line with the postulates of the Job Demands–Resources (JD–R) model, which argues that an adequate balance between job demands and available resources significantly reduces professional burnout (Bakker, Demerouti & Sanz-Vergel, 2014).

NOM-035 requires all workplaces, including universities, to conduct periodic assessments covering both quantitative and qualitative aspects of the work environment. The integration of technological tools—such as online survey platforms, continuous feedback systems, and institutional analysis—has proven effective in reducing indicators related to chronic teaching stress by improving control and perceptions of organisational justice (García-Arroyo, Osca & Peiró, 2019).

Studies conducted in Latin American universities confirm this relationship; for example, in Peru, it was found that a more favourable work climate is significantly associated with lower levels of burnout among university professors (Yslado, Ramírez-Asís, García-Figueroa & Arquero, 2021). Furthermore, these evaluations strengthen strategic decision-making, as they provide objective evidence for implementing specific interventions, adjusting workloads, improving physical working conditions or modifying internal communication processes. They also promote the active participation of teaching staff by making their perceptions and needs visible, generating greater commitment to institutional strengthening.

b) Equitable distribution of teaching load

One of the most common causes of burnout in higher education is the unequal distribution of academic tasks.

Work overload, combined with pressure to meet productivity indicators, has a negative impact on faculty well-being and limits their capacity for innovation, class preparation, and professional development.

Numerous studies have shown that universities and educational centres that apply clear and fair criteria for the distribution of academic tasks—such as course assignments, tutorials, and administrative duties—significantly reduce work-related stress and increase teaching staff satisfaction. For example, a longitudinal study found that a positive perception of the school context is associated with lower levels of burnout and greater satisfaction among teachers (Skaalvik & Skaalvik, 2021), while another analysis confirmed that clarity in roles and workloads reduces stress and decreases teachers' intention to leave (Harmsen et al., 2018).

NOM-035 identifies excessive workload as a risk factor that must be monitored and regulated. Some institutions have begun to implement academic workload review committees, job rotation, and transparent platforms for recording assigned hours.

These measures have shown a decrease in professional exhaustion and an improvement in the perception of organisational justice, as documented by Hakanen, Bakker, and Schaufeli (2006) from the JD-R model approach. More recently, Saloviita and Pakarinen (2021) found that adequate workload management, combined with institutional support and clarity of roles, is significantly associated with lower levels of teacher burnout, reinforcing the need for coherent organisational interventions.

This approach is particularly relevant in Latin American educational contexts, where studies such as that by Puga (2021) indicate that the disproportionate distribution of academic tasks increases the risk of professional burnout, affecting both the health of teachers and the quality of educational services. Along these lines, UNESCO (2024) has emphasised the urgency for higher education institutions to adopt internal policies that guarantee equitable workloads as part of an organisational culture focused on well-being.

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c) Training and development in stress management

Strengthening individual stress management skills is an essential strategy for preventing burnout. Empirical evidence has shown that training programmes in mindfulness, emotional intelligence, self-care, relaxation techniques and organisational resilience contribute to significantly reducing emotional fatigue and improving work-life balance (Leiter & Maslach, 2017).

More recently, a meta-analysis identified that mindfulness-based interventions, together with cognitive and emotional approaches, are highly effective in mitigating emotional exhaustion in university teachers (Li, Xue & He, 2023).

These initiatives also generate institutional benefits: they reduce absenteeism, improve the work environment, increase teaching productivity, and strengthen an organisational culture focused on well-being.

d) Strengthening support networks and internal communication

Building collaborative and emotionally safe environments is a key pillar in preventing burnout. Factors such as teacher motivation, organisational support, and perceived belonging are directly related to lower levels of emotional exhaustion. A recent meta-analysis confirms that social and work support is significantly associated with reduced levels of burnout among teachers (Wang et al., 2023). In Latin America, a systematic review found that institutional support, peer mentoring, and active listening spaces are essential for reducing the incidence of burnout among university teachers (Rojas-Solís, Totolhua-Reyes & Rodríguez-Vásquez, 2021).

Effective internal communication, which allows for the expression of concerns and needs, is vital for establishing healthy working relationships. Universities that have implemented teacher mentoring, dialogue groups, psychological counselling services, and emotional support spaces have reported positive effects in reducing burnout and improving the perception of institutional support (Beames et al., 2023; Rautenbach & Rothmann, 2017).

This axis also aligns directly with the principles of NOM-035, which promotes organisational environments with structured social support.

e) Updating and adapting institutional policies

The sustainability of anti-burnout strategies depends on the institutional willingness to review and adapt its internal policies. NOM-035 should not be seen only as a legal obligation, but as an opportunity to reformulate organisational practices that impact mental health.

Universities that have adopted flexible protocols, continuous feedback, and periodic evaluation mechanisms for their policies have shown significant improvements in emotional regulation and academic staff retention. Aldrup, Carstensen, and Klusmann (2023) reported that teacher emotional regulation—fostered by feedback systems and autonomy—is associated with greater well-being and job retention. Similarly, Heenan et al. (2023) found that transformational institutional leadership, together with communication practices and constant support, strengthens organisational culture and helps retain faculty.

Having clear policies on equity, occupational health, hybrid work, and emotional management allows for the anticipation of risks and adaptation to changing contexts such as those experienced during the pandemic. Normative-institutional alignment consolidates an organisational culture oriented towards well-being, resilience and educational excellence.

The five strategic axes described are summarised in Table 1, which summarises the main risks addressed, recommended actions and expected impacts for each, based on the evidence reviewed.

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Box 2

Table 1

Strategic approaches to mitigating teacher burnout through the application of NOM-035

Strategic focus	Risk addressed	Proposed action	Expected impact
Workplace climate assessment	Chronic stress, organisational ambiguity	Regular application of psychosocial assessments, internal surveys, feedback boxes	Up to 25% reduction in teacher burnout indicators
Equitable distribution of teaching load	Work overload, internal inequality	Clear criteria for workload allocation, job rotation, monitoring of actual hours	22% increase in perception of organisational justice
Training in stress management	Emotional fatigue, poor coping skills	Ongoing training programmes in mindfulness, self-care, emotional intelligence	30% decrease in symptoms of emotional exhaustion
Support networks and internal communication	Isolation, demotivation, conflicts	Mentoring, spaces for dialogue, psychological support services	40% improvement in perception of institutional support
Adaptation of institutional policies	Regulatory rigidity, structural stress	Annual review of internal regulations, inclusion of mental health criteria	Sustained reduction in job burnout and increased staff retention

Source: Prepared internally based on reviewed literature. (2018–2024

The strategies summarised here are not only theoretically and normatively sound, but also highly applicable at the institutional level. Universities can use these five pillars as a basis for designing internal occupational health programmes, developing psychosocial risk prevention manuals, and generating monitoring indicators to measure faculty well-being. These results may also be useful for educational authorities and accrediting bodies seeking objective criteria for evaluating institutional commitment to workplace well-being in higher education.

In this sense, consolidating sustainable, resilient, and healthy work environments must be assumed as an essential condition for guaranteeing educational quality, the retention of academic talent, and organisational transformation in Mexican universities.

Conclusions

The analysis confirms that burnout syndrome in university faculty is a complex and multidimensional phenomenon that requires a comprehensive, structured, and sustained institutional response over time. Based on a review of scientific, regulatory and applied literature, five strategic areas of intervention were identified that allow psychosocial risk factors to be addressed in a manner consistent with the guidelines established by NOM-035-STPS-2018.

First, periodic evaluation of the work environment is a fundamental tool for diagnosing, anticipating and redirecting organisational problems that generate stress. The use of continuous monitoring methodologies, accompanied by institutional data analysis and participatory feedback mechanisms, provides a solid basis for managing the well-being of teaching staff.

Secondly, the equitable distribution of the teaching load substantially improves the working conditions of academic staff and promotes teaching-learning processes by facilitating more efficient planning, greater educational innovation and better conditions for professional development. This axis requires the implementation of clear criteria, monitoring platforms, and committees for the continuous review of academic assignments.

The third axis, training and development in stress management, highlights the need to provide teaching staff with psychological and emotional tools to cope with work demands.

The implementation of programmes in mindfulness, emotional intelligence, self-care and institutional resilience has proven effective in reducing professional burnout and promoting a culture of well-being. Fourth, strengthening support networks and internal communication is an essential component in combating workplace isolation and promoting a sense of belonging.

Strategies such as dialogue groups, mentoring, psychological support services, and horizontal communication channels allow for the construction of collaborative, safe, and emotionally sustainable environments.

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Finally, updating and adapting institutional policies represents the most cross-cutting and strategic axis. Periodically reviewing internal regulations, incorporating mental health criteria, and generating inclusive policies for psychosocial risk prevention consolidates organisational transformation. Under this approach, NOM-035 transcends its regulatory function to become a tool for institutional change.

The evidence reviewed shows that universities that take a proactive stance in implementing this regulation report significant improvements in faculty well-being, academic talent retention, institutional performance, and educational reputation. In addition, documented experiences at the international level confirm the viability and effectiveness of this intervention model in diverse contexts.

Proposal for gradual implementation in Mexican universities

Based on the strategic axes identified, a three-stage implementation route is proposed for universities seeking to integrate NOM-035 as a tool for managing faculty well-being:

– **Phase 1 (Diagnosis):** application of instruments to assess the organisational climate and map prevalent psychosocial risks.

– **Phase 2 (Strategic planning):** prioritisation of lines of action, definition of institutional goals, allocation of resources, and staff awareness-raising.

– **Phase 3 (Implementation and follow-up):** formation of wellbeing committees, application of interventions, and continuous monitoring through institutional reports and indicators.

This model allows the intervention to be adapted to organisational particularities, promoting sustainable, realistic implementation in line with the capacities and culture of each university.

Declarations

Conflict of interest

The authors declare that there is no financial, professional or personal conflict of interest that could have influenced the preparation or publication of this article.

Author contribution

All authors contributed equally to the conceptualisation, document review, analysis, writing and final revision of the manuscript. Each author approves the final version of the document for publication.

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Data availability

The data used in this article come from public, academic, and regulatory sources available in databases such as Scopus, Redalyc, Web of Science, Google Scholar, and institutional websites. No confidential data were used, nor were any primary data collection instruments applied.

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Abbreviations

NOM: Official Mexican Standard
STPS: Ministry of Labour and Social Welfare
JD–R: Job Demands–Resources (Model of Job Demands and Resources) References

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Article

Teaching Performance Assessment (TPA), Net Promoter Score (NPS), and their relationship with Knowledge Level (KNL) in university students who completed the workshop on applied mathematics in Chemistry

Evaluación del Desempeño Docente (TPA), del Índice de Promotores Neto (NPS) y su relación con el Nivel del Conocimiento (KNL) en estudiantes universitarios que cursaron el taller de matemáticas aplicadas a la Química

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Abstract

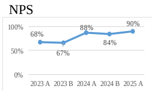
Teaching performance is essential both for university students' learning and as a benchmark for educational quality, reflecting the institution's competitiveness. The goal of this research is to assess teaching performance, the Net Promoter Score, and the level of knowledge during the initial, final, and applied phases of undergraduate studies. The study is descriptive and correlational, quantitative, and longitudinal. Convenience sampling was used with 98 students. The instrument includes 26 items validated by expert judgment and Cronbach's Alpha. Data analysis involved descriptive statistics and hypothesis testing using Pearson's correlation. Results confirm that teaching performance significantly correlates with the Net Promoter Score, and both variables are significantly related to the level of knowledge in applied math in the academic setting.

Teaching Performance Assessment (TPA), the Net Promoter Score (NPS), and its relationship with knowledge level (KNL) in university students who completed the mathematics workshop

Goals
– Assess teacher performance (TPA).
– Determine the Net Promoter Score (NPS).
– Measure the knowledge level (KNL), with its initial (IKL), final (FKL) and applied (AKL) dimensions.

Method
Research type
– Quantitative
– Descriptive and correlational
– Longitudinal study
Measure instrument
Likert Scale of 26 items that assess TPA, NPS and KNL variables
Expert judgment
Cronbach´s Alpha
Population
n = 98 university students
Data analysis
Descriptive statistics with SPSS 25
Hypotheses testing

Findings
– α´s Cronbach
TPA 0.909
KNL 0.920
IKL 0.841
FKL 0.822
AKL 0.839
– NPS



– Pearson´s correlation
TPA-NPS 0.747
IKL-FKL 0.748
FKL-AKL 0.732
TPA-KNL 0.527
NPS-KNL 0.355
Sig. bilateral 0.000

Teaching quality, educational satisfaction, mathematical knowledge

Resumen

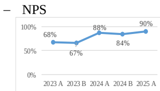
El desempeño docente es fundamental tanto en el aprendizaje de los estudiantes universitarios como al ser referente de la calidad de la enseñanza educativa, reflejando la competitividad de la Universidad. El objetivo de esta investigación es evaluar el desempeño docente, el índice de promotores neto y el nivel de conocimientos en las fases inicial, final y de aplicabilidad académica en estudiantes de pregrado. La investigación es descriptiva y correlacional, cuantitativa, y longitudinal. El muestreo fue por conveniencia con 98 estudiantes. El instrumento consta de 26 ítems, validado por jueceo de expertos y Alpha de Cronbach. El análisis de datos fue mediante estadística descriptiva y la prueba de hipótesis con la correlación de Pearson. Los hallazgos corroboran que el desempeño docente tiene una relación significativa con el índice de promotores neto, y ambas variables tienen una relación significativa con el nivel de conocimientos en matemáticas aplicadas en el ámbito académico.

Evaluación del desempeño docente (TPA), del índice de promotores neto (NPS) y su relación con el nivel del conocimiento (KNL) en estudiantes universitarios que cursaron el taller de matemáticas

Objetivos
– Evaluar el desempeño docente (TPA).
– Determinar el índice de promotores neto (NPS).
– Medir el nivel del conocimiento (KNL), con sus dimensiones inicial (IKL), final (FKL) y aplicado (AKL).

Método
Tipo de investigación
– Cuantitativa
– Descriptiva y correlacional
– Estudio longitudinal
Instrumento de medición
– Escala Likert de 26 ítems que evalúa las variables TPA, NPS y KNL
– Jueceo por expertos
– Alfa de Cronbach
Población
– **n** = 98 estudiantes universitarios
Análisis de datos
– Estadística descriptiva con SPSS 25
Prueba de hipótesis
– Correlación de Pearson

Resultados
– α Cronbach
TPA 0.909
KNL 0.920
IKL 0.841
FKL 0.822
AKL 0.839
– NPS



– Correlación Pearson
TPA-NPS 0.747
IKL-FKL 0.748
FKL-AKL 0.732
TPA-KNL 0.527
NPS-KNL 0.355
Sig. bilateral 0.000

Calidad de la enseñanza, satisfacción educativa, conocimiento matemático

Area: Dissemination of and universal access to science

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Introduction

Teaching performance plays a fundamental role both in the learning of university students and as a benchmark for the quality of education, reflecting the competitiveness of the institution. For this reason, it encompasses different actions and behaviors that teachers develop during the delivery of their courses, from the planning and execution to the implementation of pedagogical activities. Added to this is the development of various teaching-learning strategies that, during this process, strengthen the positive evaluation of teaching performance, which is evaluated directly by the university student, according to their perception in line with expectations regarding the content of the workshop, teaching skills, and treatment, to name a few.

In this sense, public universities are focused on providing quality educational services, with teaching-learning processes that influence the acquisition and application of knowledge by undergraduate students within the academic sphere, starting with an initial diagnosis, which consists of the teacher identifying the knowledge with which undergraduate students begin their courses, translated into a diagnostic assessment that, in addition to identifying the initial level of knowledge, involves the development of teaching-learning strategies to achieve success in education. Subsequently, this initial level of knowledge is transformed into final knowledge and applied in the academic sphere, which becomes meaningful learning.

This research also highlights the importance of the Net Promoter Score (NPS), which measures student satisfaction with educational quality. Students are asked to answer a specific question based on their perception of how likely they are to recommend the mathematics workshop to another university student, taking into account the performance of the teacher. To this end, students become either promoters, passives, or detractors, according to the rating given, and the NPS is then determined to identify areas for improvement in educational quality based on teacher performance, as mentioned above.

This research was conducted using a quantitative, longitudinal, descriptive, correlational, and non-experimental approach.

This type of research was chosen because of the benefits it offers, mainly in relation to the qualitative approach, since it allows for the objective analysis of numerical data to describe, explain, and predict the behavior of the variables under study, using statistical methods and avoiding biases with value judgments. This helps to generalize the results based on the responses obtained from the sample, making it possible to have a clearer explanation of the issue under study. It also allows the revised theory to be corroborated based on the data obtained.

This research addresses the issue of teacher performance and student satisfaction with educational quality based on teacher performance, which is evaluated using the Net Promoter Score (NPS). It also integrates the initial, final, and applied levels of knowledge in mathematics in the academic field, as well as the relationship between the aforementioned variables. To this end, the main research question is: What is the relationship between teacher performance assessment, the net promoter score, and the level of knowledge among university students in the mathematics workshop? The hypotheses to be tested are:

- $H1_0$: Teacher performance assessment (TPA) has no significant relationship with the net promoter score (NPS).
- $H1_a$: Teacher performance assessment (TPA) has a significant relationship with the net promoter score (NPS).
- $H2_0$: Initial knowledge level (IKL) in mathematics does not have a significant relationship with final knowledge level (FKL) in mathematics.
- $H2_a$: Initial knowledge level (IKL) in mathematics has a significant relationship with final knowledge level (FKL) in mathematics.
- $H3_0$: Final knowledge level (FKL) in mathematics does not have a significant relationship with the applied knowledge level (AKL) in mathematics.
- $H3_a$: Final knowledge level (FKL) in mathematics has a significant relationship with the applied knowledge level (AKL) in mathematics.
- $H4_0$: Teacher performance assessment (TPA) has no significant relationship with the knowledge level (KNL) in mathematics.

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– $H4_a$: Teacher performance assessment (TPA) has a significant relationship with the knowledge level (KNL) in mathematics.
– $H5_0$: Net promoter score (NPS) does not have a significant relationship with knowledge level (KNL) in mathematics.
– $H5_a$: Net promoter score (NPS) has a significant relationship with knowledge level (KNL) in mathematics.

This article is divided into nine sections, which are described below to detail and explain the general content of each one. The first section presents an introduction to the research topic, a general explanation of the topic and its importance, highlighting the problem to be solved, the working hypotheses developed as null and alternative, and explains the added value of the technique used for this research and other generalities to clarify the topic studied. Next, the second section provides an overview of the state of the art by reviewing the current knowledge on the topics covered in this article from a literature-based perspective, emphasizing university teaching performance, the net promoter score, and the level of knowledge of undergraduate students in mathematics.

The third section details the method used, the type and design of the research, the description of the variables, the measurement instrument, the participants, the procedure, and the techniques for data analysis. The fourth section includes the results and discussion, with descriptive statistics, as well as the discussion in light of the supporting theory described in the state-of-the-art review according to the scientific method. The fifth section details the conclusions reached in this research and the recommendations, and also presents the main results, limitations, and future work to be done to continue the research. The sixth section includes the appendices, which show the instrument used, with the items applied for the development of the research.

Section seven of the declarations includes conflicts of interest, authors' contributions, availability of data and materials, funding for the research work, and acknowledgments to the participants, undergraduate students who evaluated the teachers, and also to the professors who allowed the evaluations to be carried out for this research.

Likewise, the eighth section shows the abbreviations used in this article. Finally, the ninth section lists the references of the authors who have directly contributed to this study according to the literature review: background, rationale, support, differences, and discussions.

2. Theoretical background

2.1 Teaching performance

Since the 1990s, Mexico has implemented systematic assessment of teaching performance measures with financial compensation programs to minimize the drastic drop in teachers' salaries due to the economic crisis (Rueda, 2008). One example is the Program for Teacher Professional Development (PRODEP) established by the Ministry of Public Education (SEP), which focuses on the professional development of full-time teachers and the generation of knowledge in public higher education institutions in Mexico.

Before referring to teaching performance, it is important to consider that the activity of university teachers is complex, since it incorporates personal elements related to empathy, such as teacher-student interaction, values associated with the teacher-student relationship, promotion of student learning, and willingness to teach. As well as disciplinary elements, i.e., the teacher's relationship with knowledge of their discipline, and pedagogical elements, which have to do with the teacher's role as the main transmitter of knowledge, initiator and motivator for students to acquire knowledge autonomously, tutor, innovator, and questioner of existing knowledge. Likewise, university teachers must consider the context and appropriation of learning by students, and contemplate the curricular approach from the perspective of planning, program organization, content selection, teaching strategies, clarity of presentation by the teacher, technical or material support, and finally, the evaluation strategy (Francis, 2006).

Over the last two decades, higher education institutions in Mexico have prioritized research over teaching, with the education sector focusing on salary compensation, increasing the academic qualifications of teachers, expanding the structure of full-time teaching positions, and developing the infrastructure for academic bodies.

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Evaluations consider aspects of teacher behavior, subject mastery, group performance, use of teaching techniques, student assessment methods, course objectives, course content, teaching and assessment methods, knowledge, group management, self-assessment, and teaching situations such as theoretical courses, workshops, laboratory or field practices (Rueda, 2008).

The main purpose of university professors is to educate students in their discipline. To do so, professors must have sufficient knowledge both in the discipline they teach and in how to teach knowledge and skills to future professionals. That is why professors who excel in the assessment of teaching performance transcend teaching, formal research work, and teaching outreach, being rated with criteria such as excellent, good professor, efficient teacher, or best-rated professor (Francis, 2006).

This means that teachers have to carry out more activities than just classroom work, including administrative and planning tasks, due to constant demands, decision-making, innovations, as well as keeping up to date with technological advances and developments in the subject they teach. In addition to teaching classes, they must train in various teaching strategies and adapt to the existing competency-based educational model, which involves designing, evaluating, and implementing different educational programs.

The assessment of teaching performance takes into account both teaching activity and advising, tutoring, the dissemination of culture, the development of teaching materials, and research (Cárdenas et al., 2014). This implies disciplinary mastery, teaching mastery, classroom management, and student motivation and self-efficacy (Rodríguez, 2020).

Consequently, teaching performance refers to the role of the university professor in relation to the teaching-learning process in the classroom and involves the following categories: teaching planning; learning mediation; learning assessment; integration of theory and practice; communication skills; attitudes and values: responsibility and teaching ethics; respect and tolerance (Flores, 2010).

Assessment of teaching performance is defined as a systematic process of obtaining valid and reliable data in order to assess the real and significant educational impact of the teacher's professional work on students in terms of their teaching skills, work responsibility, mastery of the subject content, and the nature of their interpersonal relationships with their students (Estrada, 2013). The four main models of assessment of teaching performance are shown below (Cárdenas et al., 2014):

1) The teacher profile-centered model, which evaluates teachers according to a previously established ideal profile.
2) The results-based model evaluates teachers according to the results obtained by their students.
3) The model focused on teacher behavior in the classroom. With this model, teachers are evaluated according to their ability to create a favorable environment for students to learn in the classroom, and they are evaluated according to student achievement.
4) The reflective practice model, which involves evaluating teaching practice together with teachers through supervised reflection.

On the other hand, they emphasize the pedagogical beliefs of university teachers, highlighting that there are different forms, styles, and strategies of teaching that result from training activities, the imitation of other teachers who are considered good teachers, and, of course, the self-correction of teachers' own mistakes (Tapia & Tipula, 2017).

Therefore, university teaching performance is necessary for improving the quality of the educational system, as well as being useful as feedback on teaching practice, serving as a mechanism for both individual and institutional improvement (Romero & Martínez, 2017). Additionally, when teachers are motivated, they consider classroom teaching and learning control techniques to be useful, and they also attach importance to continuous assessment and tutoring, as well as the use of innovative teaching tools in the classroom. It is essential that they recognize their work and are evaluated through student surveys (Jiménez & San-Martín, 2019).

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Emotional intelligence can also be incorporated into teachers' teaching skills to improve their performance, with the aim of helping teachers identify, regulate, and control their emotions (Ramirez-Asis et al., 2020).

Assessment of teaching performance is also understood as the issuance of a value judgment regarding the fulfillment of responsibilities in the teaching-learning process, which leads to the obtaining of valid, objective, and reliable information. This evaluation measures whether the teacher knows how to plan, communicate effectively, use cutting-edge technologies, apply methodologies appropriate to the context in which they work, interact assertively, provide relevant tutoring, and encourage teamwork and individual work. This evaluation helps to correct errors in the teaching-learning process (Rodriguez et al., 2021). In this sense, teacher performance becomes a key indicator as a decisive element in providing quality education regardless of the curriculum design and even the available budget (Gonzales, 2022). It also highlights the work of tutoring as essential to achieving a comprehensive education for students (Alegre, 2025) and that this should also be considered in the evaluation issued by students.

From another perspective, the change brought about by the COVID-19 pandemic is revisited, causing classes to not only be face-to-face, but to migrate to virtual or hybrid formats, which significantly affects teacher performance, as they do not possess all the technical skills necessary to carry them out properly (Piñón et al., 2022). In this same vein, teachers' soft skills are of utmost importance, because the more they develop them, the better their evaluation will be.

Among the soft skills, the following stand out: a) responsibility, b) adaptability, c) information management, d) communication skills, and e) development of others. Responsibility is described as the fulfillment of commitments and objectives; communication refers to active listening and conveying convincing messages; adaptability is described as flexible thinking; development of others refers to identifying students' talents and enhancing them; access to information refers to having reliable sources (Rodríguez, 2020).

Also, it highlights the importance of the correlation between teaching performance and academic achievement (Gómez, 2020), as well as work-related stress that affects teaching performance, specifically in terms of pedagogical competence, which is the core function that all teachers must fulfill in the context of higher education (Benítez-Abarca et al., 2025). Another factor that affects teaching performance is assertive communication with students, as there are factors such as emotional changes in students due to their stage of life, lack of respect from students, anxiety, stress, and rebelliousness, situations that undermine educational work with good teaching performance (Mesia, 2025). On the other hand, collaborative work and project-based learning improve teaching performance by allowing students to generate meaningful learning in accordance with the subject being taught, as it is a methodological teaching-learning strategy that transforms the interaction between teacher and student and the achievement of learning objectives (Irujo, 2025).

However, with rapid technological development, changes are occurring in the teaching-learning process that affect both teachers and students. Therefore, in order to optimally improve this process, information technologies must be implemented in educational preparation, execution, and evaluation (Jácome-Mármol et al., 2025). For this reason, school administrators must demonstrate empathy, flexibility, transparency, and innovation with the educational community, as well as innovation to improve the quality of education (Arana, 2025). Also, with the new Mexican school system, the figure of the technical pedagogical advisor has emerged, who must accompany teachers with a humanistic approach (Paredes, 2025).

2.2 Net Promoter Score (NPS)

The Net Promoter Score (NPS) is a metric of customer loyalty or fidelity that is analyzed through word-of-mouth recommendations based on satisfaction with the products or services of an institution. This measurement is based on the belief that customers are promoters, i.e., extremely satisfied customers who act as brand ambassadors.

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There are also detractors, i.e., extremely dissatisfied customers who will undermine the brand's growth through unfavorable testimonials about their experience with the product or service received. To determine the net promoter score, simply calculate the net difference between the percentages obtained from promoters minus the percentages from detractors. In this calculation, neutral or passive values are discarded (Reichheld, 2003).

The results obtained can range from -100 to 100, so an NPS greater than 0 is considered good, while scores above 50 are considered exceptional. On the other hand, if negative scores are obtained, it is believed that there are more unfavorable comments, which will affect the acquisition of potential customers, including the retention of current customers (Reichheld, 2003). That is why attention must be paid to detractors because, being dissatisfied, they will tend to speak unfavorably about the company (Castillo et al., 2024). In this same vein, the four types of zones into which the results obtained from the NPS calculation are classified are shown below (Montás, 2023), bearing in mind that the net promoter score is determined by the difference between the percentage of promoters and detractors:

– From 75% to 100% means that the brand conveys positive and relevant experiences to customers, has very few detractors, and has high value for the customer.
– From 50% to 74% means that the institution has some areas for improvement. It should be attentive to opportunities, minimizing gaps to deliver new value to the customer.
– From 0% to 49% means that customers are dissatisfied.
– From -100% to -1% means that customers are highly likely to speak ill of the brand, so attention must be paid to reversing what the company is doing.

In the case of a higher education institution, the customer is the university student and the product or service refers to the educational service they receive. Therefore, loyalty is determined by the degree of commitment of the student to the institution after receiving a service. They become promoters and are not even affected by other universities offering them other promotions.

In fact, the intention to continue and complete their university studies prevails. Undergraduate students' loyalty factors include motivation, institutional pride, sense of belonging, brand identity, and satisfaction with university services, highlighting the quality of the teaching-learning process (De la Cruz & Álvarez, 2017). In order to grow, an organization only needs to seek one result, which refers to the level of recommendation.

Under this vision, perceived quality is measured exclusively with a question about the likelihood of recommending the product or service to a friend or family member (Rodríguez-Fernández, 2018). The reputation of the organization, whether public or private, has an economic impact in terms of monetary losses. Therefore, it is important to create value for the customer through positive experiences and achieve customer satisfaction with the quality of service (Soltero-Sánchez et al., 2024; Trejo et al., 2023).

The NPS is also known as a tool used to measure improvements in university management from the perspective of both internal and external consumers in higher education institutions. By identifying a problem, this tool evaluates the quality of customer service (Montás, 2023). In addition, it is an internationally recognized index because it evaluates recommendations and even applies to the university environment (Yamagoshi & Darahuge, 2023) and is effective in facilitating the development of other skills in students for career success (Mina & Villegas, 2024).

In public higher education institutions, student satisfaction with the quality of education in academic aspects and the quality of teaching plays a special role, as these institutions have the task of training professionals who contribute to social and economic development (Montero et al., 2025). In this regard, it is noteworthy that student satisfaction is key to student well-being and the prestige of the institution. That is why NPS as a metric helps universities make decisions for continuous improvement by identifying promoters, passives, and detractors (Bejarano-Heredia & Castillo-Núñez, 2025).

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2.3 Knowledge of mathematics

In Mexico, learning mathematics is considered a major problem, as demonstrated by the poor performance of students in various standardized tests, both nationally and internationally (Encinas et al., 2016). This represents a major challenge for students, especially when transitioning from high school to university, where a solid knowledge of mathematics is required (Castillo et al., 2025). Added to this is the prevalence of high percentages of students entering university with misconceptions in mathematics, which affect the construction of new knowledge and also their academic performance.

Among the main errors due to procedure or origin, the following were detected: mathematical language, spatial information, incorrect inferences or associations, recovery of a previous scheme, incorrect or accidental calculations, deficiencies in construction, or absence of prior knowledge. Likewise, students reflect errors such as: mathematical content such as identifying the priority of operations, use of parentheses, concept of absolute value, operations with polynomials, notable formulas, laws of powers, factorization, among others (Gamboa et al., 2019).

Poor pre-university education in mathematics is a clear indicator of inefficient quantitative training in future professionals, highlighting that mathematical errors are mainly due to concepts and procedures in prior knowledge, which, if not well established, affect the performance of university students. That is why there is a need to return to the basics of pre-university mathematical knowledge when beginning undergraduate training (Arraiz & Valecillos, 2010). In this sense, even when teachers assume that undergraduate students have mastered basic mathematical knowledge, since they studied this content throughout high school, it is not until a diagnostic assessment is applied at the beginning of the course that deficiencies in students' prior knowledge of mathematical content are corroborated and identified (Mota & Valles, 2015). This is a requirement for implementing appropriate remedial measures so that undergraduate students can catch up in mathematics (Castro et al., 2018).

That is why it is necessary to assess prior knowledge as a fundamental task for achieving meaningful learning (Ausubel, 1983), since the acquisition of new knowledge depends directly on the high degree of ideas as part of the cognitive structure. There are three important dimensions: prior knowledge, motivation, and meaningful material. Meaningful learning is achieved precisely when a person relates new learning content to prior knowledge that exists in their cognitive structure.

The importance of meaningful learning is highlighted, as it leads to understanding and, above all, the ability to transfer what has been learned to new situations, greater retention, and the great possibility of relearning what was thought to be forgotten, which differs from rote learning (Encinas et al., 2016). Learning is meaningful as long as it is carried out in a collaborative manner and in conjunction with the teacher, who must enhance students' skills for their professional training (Huaman et al., 2023), emphasizing the creation of new teaching-learning strategies to shift from a traditional approach to a constructive approach where the student is at the center of the process by engaging in the creation of their own knowledge (González-Quezada et al., 2024; Huerta-Chávez et al., 2022; Soltero-Sánchez et al., 2021; Soltero-Sánchez et al., 2023; Soltero-Sánchez et al., 2024).

Here, it is important to highlight that students must have a solid foundation in mathematics in order to successfully learn new concepts. Not only must they have basic mathematical knowledge, but consideration must also be given to how students will be able to relate or anchor this new knowledge to what they already know, that is, achieving meaningful learning so that it remains in their long-term memory and can be applied in a timely manner (Mota & Valles, 2015). In this same vein, the development of mathematical skills in university students is extremely necessary, as it enhances their capacity for analysis, reasoning, synthesis, and application of knowledge. Innovative teaching strategies can be implemented for this purpose, since mathematics teaching in universities should be dynamic and interactive, using playful and interactive resources. However, success in acquiring mathematical knowledge depends not only on the teacher and their teaching strategies, but also on the active participation of students and a positive attitude (Jiménez, 2022).

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In this same vein, collaborative learning stands out as a strategy that allows students to construct new mathematical knowledge and create positive environments for a quality educational process (Morales-Maure et al., 2018). The use of augmented reality as a pedagogical strategy to obtain better results in students' mathematics learning also stands out (Martínez, 2021). Likewise, the strategies implemented by teachers to develop mathematical skills in students are important, such as the development of numerical reasoning operations that involve processes that motivate students to pay attention during classes, allowing them to obtain creative, constructive, and critical knowledge, with greater theoretical and practical learning (Moreira & Pinargote, 2023).

3. Materials and methods

3.1 Type and design of the research

This research was conducted using a quantitative approach, i.e., only numerical data were obtained, which allowed the behavior of the variables to be explained objectively, avoiding bias due to value judgments. The type of research is descriptive and correlational, describing the behavior of the variables and identifying the correlation between them.

Likewise, the research design was non-experimental because none of the study variables were manipulated by the researchers, and it was longitudinal in nature, applying a pre-test to evaluate the knowledge level variable (KNL), specifically the initial knowledge level dimension (IKL) in mathematics, which was a diagnostic evaluation for the implementation of teaching-learning strategies by the teacher, and a post-test test at the end of the course called the mathematics workshop, in which the variables of final knowledge level (FKL) and applied knowledge level (AKL) were evaluated, assessing the three dimensions of the knowledge level variable (KNL) in mathematics. The post-test also evaluated two additional variables: teaching performance (TPA) and the net promoter score (NPS).

3.2 Variables

3.2.1 Teaching Performance Assessment (TPA)

Evaluation carried out by university students of the work of the teacher according to their performance during the course, from planning and execution to the teacher's pedagogical activities, which impact the level of knowledge achieved and applied in the academic field.

3.2.2 Net Promoter Score (NPS)

Net promoter score reflecting the academic satisfaction of university students considering teaching performance and level of mathematical knowledge. This score is measured by the probability that a student would recommend taking the applied mathematics workshop to another undergraduate student enrolled at the higher education institution where the workshop is taught.

3.2.3 Knowledge Level (KNL)

Variable comprising three dimensions: initial knowledge level (IKL), final knowledge level (FKL), and applied knowledge level (AKL) in mathematics. This variable reflects the impact of diagnostic assessment and the implementation of teaching-learning strategies in identifying the level of knowledge in its three dimensions.

3.3 Measuring instrument

The instrument consisted of 26 items on a Likert scale with three variables: teaching performance assessment (TPA), Net Promoter Score (NPS), and level of knowledge (KNL) in mathematics. the latter variable measured three dimensions: initial knowledge level (IKL), final knowledge level (FKL), and applied knowledge level (AKL) in applied mathematics. This instrument was validated by expert judgment and by calculating Cronbach's alpha to ensure the reliability of the instrument, using the following equation 1:

$$\alpha = \frac{\kappa\left(1-\sum_{i=1}^{\kappa} S_i^2/S_t^2\right)}{\kappa-1} \quad [1]$$

Where:
S_i^2 is the variance of the item i
S_t^2 is the variance of all the totals
κ is the number of items

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If the items combine additively and measure the unobservable characteristic in the same direction, then the items are strongly correlated and, therefore, the instrument is reliable. In that case, the α coefficient tends to be 1. This corroborated the reliability of the scale, i.e., that it effectively measures the dimensions of teaching performance and level of knowledge in mathematics, and therefore the results obtained are valid and reliable.

3.4 Participants

The sampling was non-probabilistic (Hernández et al., 2014) for convenience, with the participation of 98 university students who took the mathematics workshop as part of their undergraduate academic training at a public university. The sample included students from five semesters, from 2023A to 2025A, who, in order to be part of the sample, had to attend the course from start to finish, as they participated in the initial diagnostic assessment to identify their initial level of knowledge, as well as at the end of the course, where they participated in the assessment of their final and applied level of knowledge, as well as in the assessment of teaching performance and the net promoter score.

3.6 Procedure

At a public university in Mexico, the assessment of teaching performance (TPA) tool, the Net Promoter Score (NPS), and the Knowledge Level (KNL) in mathematics were applied over five semesters to students enrolled in the mathematics workshop during the 2023A to 2025A school years, who voluntarily agreed to be part of the sample. The instrument was applied in two phases using Google Forms.

The first phase was at the beginning of the course, in which information was collected exclusively from the first section of the course, with the aim of evaluating the dimension referring to the initial knowledge level (IKL) in mathematics, which is part of the knowledge level variable (KNL), as an initial diagnostic evaluation. After the end of the course, the second part of the instrument was applied, completing the assessment of the final knowledge level (FKL) and the applied knowledge level (AKL), which are dimensions of the knowledge level variable (KNL) in mathematics.

The sections on the teaching performance assessment (TPA) and net promoter score (NPS) variables were also applied and evaluated in this second phase, and it was extremely important to apply them until the end of the course.

3.7 Data analysis

Data analysis was performed using SPSS (Statistical Package for the Social Sciences) version 25 statistical software and Microsoft Office Excel spreadsheet software. Reliability and validity tests were performed on the instrument using Cronbach's alpha, as well as descriptive statistics including calculations of data normality tests, graphs, tables, and hypothesis testing with Pearson's correlation.

4. Results and discussion

The Cronbach's alpha obtained from the measurement instrument, which consisted of 26 items and three constructs, was greater than 0.900, which is considered excellent (Hair et al., 1999; Nunnally, 1978). This index is expressed with values between 0 and 1. Therefore, the closer the value is to 1, the greater the internal consistency and reliability of the instrument, confirming that the scale is reliable and that the items are measuring the same construct or variable (see Table 1):

Box 1

Table 1
Reliability index of the measuring instrument.

Variables	Cronbach's Alpha >0.700 (Nunnally, 1978)
TPA	0.909
KNL: IKL, FKL, AKL	0.920

Source: Own Elaboration (2025)

Regarding the frequency distribution of participating students, the results showed that 51% were women and 49% were men. Therefore, there is no significant difference in the number of participants, since in absolute numbers there were 50 women and 48 men in the total conventional sample obtained for this research. This indicates that the gender of the participants does not significantly influence the explanation of the behavior of the variables in the higher education institution studied.

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The participants were classified by age ranges of 18-20 years, 21-23 years, and over 23 years, obtaining a count of 38, 53, and 7 students, equivalent in percentage terms to 39%, 54%, and 7%, respectively, in each established age range (see Table 2).

Box 2

Table 2
Categorical variables

Cycle	Students	Sex		Age		
		Man	Woman	18 - 20 years	21 - 23 years	More than 23 years
2023 A	25	44%	56%	52%	48%	0%
2023 B	18	33%	67%	28%	67%	6%
2024 A	16	69%	31%	31%	69%	0%
2024 B	19	47%	53%	32%	47%	21%
2025 A	20	55%	45%	45%	45%	10%
Totals	98	49%	51%	39%	54%	7%

Source: Own Elaboration (2025)

The number of students per semester was 25 for the 2023A school year, 18 for 2023B, 16 for 2024A, 19 for 2024B, and 20 for 2025A, with a total of 98 participants. It should be noted that this was a convenience sample, in which students participated in this research of their own free will. The frequency distribution in the categorical variable by gender is also shown, where greater participation by women can be observed in three semesters, while men stand out in two (see Figure 2).

Box 3

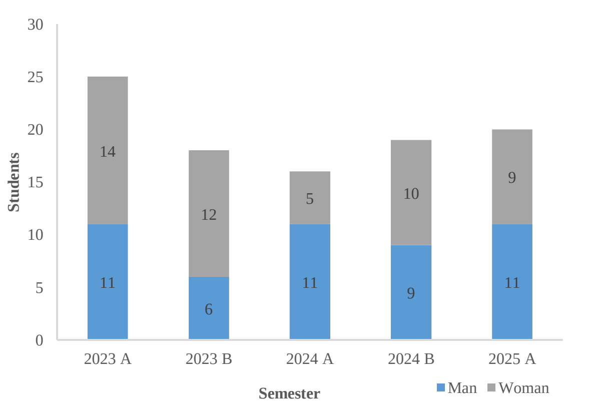

Figure 2
Students participating each semester.
Source: Own elaboration (2025)

Regarding the behavior of each variable in relation to measures of central tendency, it was found that in the construct of knowledge level (KNL) in mathematics, in the dimension of initial knowledge level (IKL) and final knowledge level (FKL),

Items IKL1 and FKL1 obtained the highest mean value in relation to the dimension to which they belong, meaning that students consider themselves to have a level of knowledge in basic operations (addition, subtraction, multiplication, and division with a focus on arithmetic and algebra). Similarly, items IKL6 and FKL6 obtained the lowest mean value, where students considered that they have the lowest level of knowledge in integral calculus (definite and indefinite integrals, double integrals, and higher-order integrals). Regarding the third dimension, called applied knowledge level (AKL) in mathematics, item AKL1 obtained the highest mean, where students were able to apply their knowledge of basic operations (addition, subtraction, multiplication, and division with a focus on arithmetic and algebra) the most. However, the lowest mean value was for item AKL4, which refers to the level of application of knowledge acquired in uncertainty for the study of chemistry (see Table 3).

Of the seven items that make up the assessment of teaching performance (TPA) variable, two items obtained the highest average values: TPA2 and TAP7, with a value of 4.8367. The first refers to whether the program content was covered in its entirety with applications to real problems and situations, and the second refers to whether the attention given to students during the course or workshop is timely, respectful, friendly, inclusive, egalitarian, and non-discriminatory. The lowest average score was obtained in item TPA3, with 4.5714, which refers to the level of mastery of the topics covered, whether it is adequate (theoretical and empirical knowledge, where applicable) (see Table 3).

Finally, the Net Promoter Score (NPS) variable obtained an average value of 4.7857, bearing in mind that, as with the other items, the scale used was a Likert scale with values from 1 to 5. With regard to the minimum values, the IKL dimension mostly reflected values of 1, understanding that this was used to carry out the diagnostic assessment, which identified the prior knowledge that students had before taking the mathematics workshop. The standard deviations for each item were < 1, indicating that the data obtained are very close to the mean.

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Therefore, there is very little dispersion between the values, with greater homogeneity in the data, i.e., the data are quite similar and consistent with each other, which ensures that the variables analyzed behave close to the mean value obtained and that the results can be generalized to explain the variables in the context studied (see Table 3).

Box 4

Table 3

Measures of central tendency for each variable

Variable	Ítem	N	Minimum	Maximun	Mean	Standard deviation
KNL	IKL1	98	1.00	5.00	4.5714	0.67350
	IKL2	98	1.00	5.00	3.9388	0.91737
	IKL3	98	1.00	5.00	3.8571	0.89673
	IKL4	98	2.00	5.00	3.8163	0.95623
	IKL5	98	1.00	5.00	3.8265	0.86185
	IKL6	98	1.00	5.00	3.6122	0.92650
	FKL1	98	3.00	5.00	4.6429	0.57884
	FKL2	98	2.00	5.00	4.1122	0.81079
	FKL3	98	2.00	5.00	3.9388	0.72959
	FKL4	98	2.00	5.00	3.8980	0.85542
	FKL5	98	1.00	5.00	3.8673	0.83280
	FKL6	98	1.00	5.00	3.7041	0.88759
	AKL1	98	2.00	5.00	4.5714	0.64216
	AKL2	98	2.00	5.00	4.3265	0.72901
	AKL3	98	2.00	5.00	4.0306	0.85499
	AKL4	98	2.00	5.00	3.9490	0.92360
	AKL5	98	2.00	5.00	4.2041	0.78595
	AKL6	98	2.00	5.00	4.1531	0.86575
TPA	TPA1	98	2.00	5.00	4.6837	0.61923
	TPA2	98	2.00	5.00	4.8367	0.46957
	TPA3	98	2.00	5.00	4.5714	0.68864
	TPA4	98	2.00	5.00	4.6735	0.60540
	TPA5	98	3.00	5.00	4.6531	0.57620
	TPA6	98	2.00	5.00	4.6939	0.61608
	TPA7	98	3.00	5.00	4.8367	0.44707
NPS	NPS1	98	3.00	5.00	4.7857	0.45972

Source: Own Elaboration (2025)

The Net Promoter Score (NPS) showed favorable results above 50% in the five semesters of this research. In the first two school cycles, 2023A and 2023B, the results obtained were 68% and 67%, respectively, which means that the educational institution has areas for improvement. Therefore, attention should be paid to taking advantage of opportunities and creating new added value for students, with the aim of improving their satisfaction with teaching performance and encouraging them to give positive recommendations.

However, in the last three school cycles, 2024A, 2024B, and 2025A, the results obtained were 88%, 84%, and 90%, respectively. This indicates that the university manages to convey positive and relevant experiences to students, as it has very few detractors, that is, it provides added value backed by teaching performance. Only in the first two academic years, 2023A and 2023B, were there detractors.

Therefore, the diagnostic evaluation that identified the initial knowledge level (IKL) in mathematics helped generate teaching-learning strategies to increase the final knowledge level (FKL) and its application (AKL), improving teaching performance (TPA). This made it possible to significantly eliminate unfavorable comments from students based on teaching performance and to increase the level of promoters (see Figure 3).

Box 5

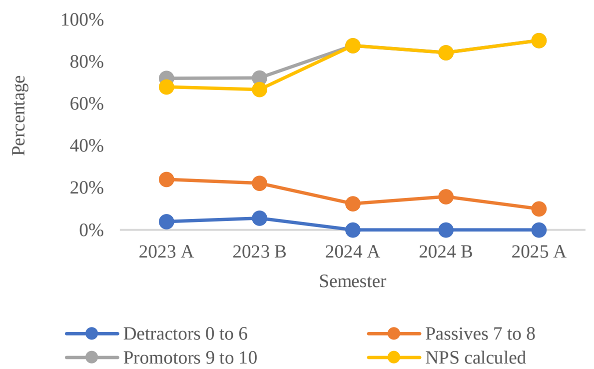

Figure 3

NPS for the 2023A to 2025A school year

Source: Own Elaboration (2025)

Regarding the hypothesis test, the results obtained allow us to reject the first null hypothesis and accept the first alternative hypothesis, which proves that there is a significant relationship between the variable of the teaching performance assessment (TPA) and the Net Promoter Score (NPS) with a value of 0.747. This indicates that there is a strong positive correlation, i.e., both variables move in the same direction; when one variable changes, the other moves in the same direction, which helps to explain both variables because they have a significant relationship (see Table 4).

Box 6

Table 4

Pearson correlation between TPA and NPS

		TPA	NPS
TPA	Pearson correlation	1	0.747**
	Sig. (bilateral)		0.000
	N	98	98
NPS	Pearson correlation	0.747**	1
	Sig. (bilateral)	0.000	
	N	98	98
**. The correlation is significant at the 0.01 level (bilateral).			

Source: Own Elaboration (2025)

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The second hypothesis was also verified, rejecting the null hypothesis and accepting the alternative hypothesis, which shows that the initial knowledge level (IKL) in mathematics has a significant relationship with the final knowledge level (FKL) in mathematics, representing a correlation of 0.748. Therefore, it is affirmed that there is a strong positive correlation, that is, both variables move in the same direction; when one variable changes, the other also changes (see Table 5).

Box 7

Table 5
Pearson correlation between IKL and FKL

		IKL	FKL
IKL	Pearson correlation	1	0.748**
	Sig. (bilateral)		0.000
	N	98	98
FKL	Pearson correlation	0.748**	1
	Sig. (bilateral)	0.000	
	N	98	98
**. The correlation is significant at the 0.01 level (bilateral).			

Source: Own Elaboration (2025)

In the third hypothesis, based on the results obtained, it is possible to reject the null hypothesis and accept the alternative hypothesis, where there is a significant relationship between the final knowledge level (FKL) in mathematics and the applied knowledge level (AKL) in mathematics, with a correlation of 0.732. This indicates that there is a strong positive correlation; both variables move in the same direction. When one variable changes, the other moves in the same direction, which allows both variables to be explained (see Table 6).

Box 8

Table 6
Pearson correlation between FKL and AKL

		FKL	AKL
FKL	Pearson correlation	1	0.732**
	Sig. (bilateral)		0.000
	N	98	98
AKL	Pearson correlation	0.732**	1
	Sig. (bilateral)	0.000	
	N	98	98
**. The correlation is significant at the 0.01 level (bilateral).			

Source: Own Elaboration (2025)

Regarding the fourth hypothesis, based on the results obtained, it is possible to reject the null hypothesis and accept the alternative hypothesis, whereby teacher performance assessment (TPA) has a significant relationship with the level of knowledge (KNL) in mathematics, with a Pearson correlation of 0.527 (see Table 7).

Box 9

Table 7
Pearson correlation between TPA and KNL

		TPA	KNL
TPA	Pearson correlation	1	0.527**
	Sig. (bilateral)		0.000
	N	98	98
NKL	Pearson correlation	0.527**	1
	Sig. (bilateral)	0.000	
	N	98	98
**. The correlation is significant at the 0.01 level (bilateral).			

Source: Own Elaboration (2025)

In the last hypothesis, which tests the relationship between NPS and KNL, a positive and moderate relationship was found. Although it is not strong enough, it implies that the variables tend to move in the same direction. Therefore, the null hypothesis is rejected and the alternative is accepted, where the Net Promoter Score (NPS) has a significant relationship with the level of knowledge (KNL) in mathematics, with a Pearson correlation of 0.355, which corroborates the relationship between the variables (see Table 8).

Box 10

Table 8
Pearson correlation between NPS and KNL

		NPS	KNL
NPS	Pearson correlation	1	0.355**
	Sig. (bilateral)		0.000
	N	98	98
NKL	Pearson correlation	0.355**	1
	Sig. (bilateral)	0.000	
	N	98	98
**. The correlation is significant at the 0.01 level (bilateral).			

Source: Own Elaboration (2025)

The results obtained confirm the theoretical framework underlying this research, given that teacher performance evaluation, as a systematic evaluation process already carried out by students at universities, brings with it a series of benefits, including economic benefits, prestige, and satisfaction with educational quality.

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This includes aspects such as the personal skills that teachers develop to function in the classroom, their knowledge of the subject they teach, and pedagogical elements and teaching-learning strategies. This leads to the constant training of teachers to keep their knowledge up to date, including the use of new technologies, and thus incorporate the existing competency-based educational model. Consequently, teachers carry out various activities in their academic work, from course planning, program organization, content selection, teaching strategies, clarity of presentation, technical or material support, and finally, assessment strategies (Cárdenas et al., 2014; Flores, 2010; Francis, 2006; Rueda, 2008; Rodríguez, 2020).

Added to this are assertive communication, collaborative work, and the incorporation of information technologies, soft skills, and the support of technical advisors in pedagogy as strategies for improving teaching performance (Arana, 2025; Irujo, 2025; Jácome-Mármol et al., 2025; Mesia, 2025; Paredes, 2025).

Teacher performance evaluations yielded valid and reliable results, highlighting the work that teachers do with undergraduate students in terms of teaching skills, work responsibility, mastery of subject content (Estrada, 2013), and promotion of teamwork and individual work (Rodríguez et al., 2021) as well as various assessment models using a hybrid model that evaluates the teacher's profile, the results obtained, the teacher's behavior in the classroom, and teaching practice as such (Cárdenas et al., 2014), which allows for the improvement of educational quality (Gonzales, 2022), with a view to improving the teaching-learning process of teachers (Benítez-Abarca et al., 2025), the management of emotional intelligence, the reduction of work stress, motivation, the implementation of tutoring (Alegre, 2025), as well as the improvement of technical and soft skills (Jiménez & San-Martín, 2019; Piñón et al., 2022; Ramirez-Asis et al., 2020; Romero & Martínez, 2017; Tapia & Tipula, 2017; Rodríguez, 2020) and their relationship with academic performance (Gómez, 2020).

In this same context, the results obtained from the Net Promoter Score (NPS) were above 50%, which are consistent with the theoretical framework, as they show the level of satisfaction with the quality of educational service, reflecting the commitment that students have to the university by remaining there and recommending, in this specific case, taking the Mathematics Workshop based on teaching performance (De la Cruz & Álvarez, 2017; Mina & Villegas, 2024; Montás, 2023; Reichheld, 2003; Rodríguez-Fernández, 2018; Soltero-Sánchez et al., 2024; Trejo et al., 2023; Yamagoshi & Darahuge, 2023), which considers academic aspects and teaching quality (Montero et al., 2025). Student satisfaction is fundamental to both student well-being and the prestige of the university, highlighting the importance of NPS (Bejarano-Heredia & Castillo-Núñez, 2025).

However, the results of the measurement of the variable of the level of knowledge in mathematics reflected what was stated in the theoretical review, where learning mathematics still prevails as a current problem, posing a challenge for university students, since they still make mathematical errors in their understanding of concepts such as procedures (Arraiz & Valecillos, 2010; Castillo et al., 2025; Encinas et al., 2016; Gamboa et al., 2019), which were detected in the pre-test from the diagnostic evaluation as well as in the post-test evaluation.

This prior knowledge was very helpful in developing teaching-learning strategies from the theoretical perspective of a traditional approach to a constructivist approach for achieving meaningful learning.

This is integrated with collaborative learning, augmented reality, and the development of mathematical reasoning operations, which is related to teaching performance and satisfaction with the quality of service reflected in the NPS (Ausubel, 1983; Encinas et al., 2016; Castro et al., 2018; González-Quezada et al., 2024; Huaman et al., 2023; Huerta-Chávez et al., 2022; Jiménez, 2022; Martínez, 2021; Morales-Maure et al., 2018; Moreira & Pinargote, 2023; Mota & Valles, 2015; Soltero-Sánchez et al., 2021; Soltero-Sánchez et al., 2023).

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5. Conclusions and recommendations

Teacher performance assessment and the net promoter score showed a significant positive and strong relationship, both variables based on undergraduate students' satisfaction with the quality of educational services, supported mainly by the teaching-learning process led by the professor, which allows higher education institutions to be recognized for their work, competitiveness, and, of course, to maintain their prestige in society, especially for public institutions. The level of initial, final, and applied knowledge in mathematics is supported by the theory of meaningful learning, which allows teachers to first identify prior knowledge through a diagnostic assessment and then generate their own teaching strategies and influence the creation of final and applied knowledge during university education.

This research had limitations such as sample selection, as it was limited to non-probabilistic convenience sampling, since this instrument was being used for the first time as a pilot test over five semesters. Likewise, the scope of the population was only applied to one degree program. Therefore, it is recommended that a broader study be conducted in which the sample is probabilistic, preferably stratified, covering more degree programs so that an explanation can be provided in a larger context. It is also suggested that the statistical analysis be expanded from descriptive to inferential and that exploratory and confirmatory factor analysis be applied. It is also suggested that another type of research be conducted to explain the relationship between teacher performance evaluation and variables that affect their performance, such as job satisfaction or work stress.

6. Annexes

The instrument used is detailed below with its 26 items:

1. IKL1 Initial level of knowledge in basic operations (addition, subtraction, multiplication, and division with a focus on arithmetic and algebra).
2. IKL2 Initial level of knowledge in equations (proportions, linear and nonlinear functions, equations with one and more variables).
3. IKL3 Initial level of knowledge in statistical concepts (population, sample, error, mean, mode, median, histograms, asymmetry, kurtosis, dispersion, etc.).
4. IKL4 Initial level of knowledge in determining uncertainty (measurements of concentration, volume, pressure, and temperature).
5. IKL5 Initial level of knowledge in differential calculus (derivatives with one variable, partial derivatives, total derivatives, double derivatives, and higher-order derivatives).
6. IKL6 Initial level of knowledge in integral calculus (definite and indefinite integrals, double integrals, and higher-order integrals).
7. FKL1 Final level of knowledge in basic operations (addition, subtraction, multiplication, and division with a focus on arithmetic and algebra).
8. FKL2 Final level of knowledge in equations (proportions, linear and nonlinear functions, equations with one and more variables)
9. FKL3 Level of knowledge in statistical concepts (population, sample, error, mean, mode, median, histograms, asymmetry, kurtosis, dispersion, etc.).
10. FKL4 Final level of knowledge in determining uncertainty in chemistry (measurements of concentration, volume, pressure, and temperature)?
11. FKL5 Final level of knowledge in differential calculus (derivatives with one variable, partial derivatives, total derivatives, double derivatives, and higher-order derivatives)
12. FKL6 Final level of knowledge in integral calculus (definite and indefinite integrals, double integrals, and higher-order integrals)
13. AKL1 Level of application of knowledge acquired in basic operations for the study of chemistry
14. AKL2 Level of application of knowledge acquired in equations for the study of chemistry
15. AKL3 Level of application of knowledge acquired in statistical concepts for the study of chemistry
16. AKL4 Level of application of knowledge acquired in uncertainty for the study of chemistry
17. AKL5 Level of application of knowledge acquired in differential calculus for the study of chemistry

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18. AKL6 Level of application of knowledge acquired in integral calculus for the study of chemistry
19. TPA1 The content of the thematic program and the evaluation of the course or workshop are clear and precise.
20. TPA2 The content of the program was covered in its entirety with applications to real problems and situations.
21. TPA3 The level of mastery of the topics presented is adequate (theoretical and empirical knowledge where appropriate).
22. TPA4 The skills for conveying the topic are adequate (technical language, clear and precise).
23. TPA5 The teaching strategies used to generate learning are adequate (PowerPoint presentations, supplementary material, article readings, applicability of topics, class participation, individual and group dynamics, research projects).
24. TPA6 The use of technological tools during the course is adequate (computer equipment, software, classroom or Moodle platform, educational digital links, emails).
25. TPA7 The attention you receive during the course or workshop is timely, respectful, friendly, inclusive, egalitarian, and non-discriminatory.
26. NPS1 How likely are you to recommend another student to take the applied mathematics workshop based on the teacher's performance?

7. Declarations

7.1 Conflict of interest

In this research, the authors declare that they have no conflict of interest, that is, they have no financial interests or personal relationships that could influence the results reported in this research paper.

7.2 Authors' contributions

– First author: materials and methods, review of the state of the art, results and discussion; and contribution to the writing of the article.
– Second author: abstract, materials and methods, results and discussion; and contribution to the writing of the article.
– Third author: introduction, review of the state of the art, references, and contribution to the writing of the article.
– Fourth author: conclusions and recommendations, appendices, statements, abbreviations, and contribution to the writing of the article.

7.3 Availability of data and materials

The availability of databases and statistical analyses may be requested by email from the corresponding author of this article.

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8. Abbreviations

AKL (Application Knowledge Level)
FKL (Final Knowledge Level)
IKL (Initial Knowledge Level)
KNL (Knowledge Level)
NPS (Net Promoter Score)
PRODEP (Programa para el Desarrollo Profesional Docente)
SEP (Secretaría de Educación Pública)
SPSS (Statistical Package for the Social Sciences Sciences)
TPA (Teacher Performance Assessment)

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Advances in neurodidactics for innovative instructional design in engineering training

Avances de la neurodidáctica para un diseño instruccional innovador en la formación de ingenieros

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Abstract

Neurodidactics is beginning to consolidate its position as a transdisciplinary field capable of transforming instructional design in higher technological education, particularly in the training of engineers. This study analyzes the application of neuroscientific principles in the university classroom through a systematic and comparative documentary review of research. The observed results provide evidence of a significant impact in three dimensions: academic performance, student motivation, and knowledge transfer to a fully practical context. Neurodidactics helps us optimize cognitive processes and contributes to the training of engineers with the ability to develop social sensitivity, enabling them to face the challenges of the 21st century with commitment and relevance.

Advances in neurodidactics for innovative instructional design in engineering training

Objetives	Methodology	Contributions
To analyze the advances of neurodidactics applied to innovative instructional design in engineering education, highlighting its impact on performance, motivation, and knowledge transfer	Systematic literature review with a comparative approach, analyzing the educational context, neurodidactic criteria, teaching strategies, and observed impacts in higher technological education.	Evidence that neurodidactics enhances critical competencies in engineering, such as logical thinking, applied creativity, and technological innovation. Proposal of a contextualized and humanistic model that integrates active methodologies and digital environments (Moodle) as the foundation for innovative instructional design.

Neurodidactics, Instructional design, Engineering education

Resumen

La neurodidáctica se empieza a consolidar como un campo transdisciplinario capaz de transformar el diseño instruccional en la educación superior tecnológica, particularmente en la formación de ingenieros. Este estudio, analiza la aplicación de principios neurocientíficos en el aula universitaria mediante una revisión documental sistemática y comparativa de investigaciones. Los resultados observados dan una evidencian con impacto significativo en tres dimensiones: el rendimiento académico, la motivación estudiantil y la transferencia de conocimientos hacia un contexto totalmente práctico. La neurodidáctica nos ayuda a optimizar los procesos cognitivos, además de contribuir en la formación de ingenieros con la habilidad de la sensibilidad social, ser capaces de enfrentar los desafíos del siglo XXI con compromiso y pertinencia.

Avances de la neurodidáctica para un diseño instruccional innovador en la formación de ingenieros

Objetivo	Metodología	Contribuciones
Analizar los avances de la neurodidáctica aplicados al diseño instruccional innovador en la formación de ingenieros, destacando su impacto en rendimiento, motivación y transferencia de conocimientos	Revisión documental sistemática, con enfoque comparativo, analizando contexto educativo, criterios neurodidácticos, estrategias didácticas e impactos observados en educación superior tecnológica.	Evidencia de que la neurodidáctica potencia competencias críticas en ingeniería: pensamiento lógico, creatividad aplicada e innovación tecnológica. Propuesta de un modelo contextualizado y humanista que integra metodologías activas y entornos digitales (Moodle) como base para un diseño instruccional innovador.

Neurodidáctica, Diseño instruccional, Educación en ingeniería

Area: Promotion of frontier research and basic science in all fields of knowledge

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Introduction

In recent decades, higher education has undergone a significant transformation, driven by the need to respond to the challenges of the 21st century, such as the globalisation of knowledge, the digitisation of teaching and learning processes, and the growing demand for professionals capable of tackling complex problems in creative and innovative ways (World Economic Forum, 2023). In this higher education scenario, neurodidactics has emerged as an innovative field that integrates findings from neuroscience with pedagogical approaches, with the aim of optimising the way students learn, process and apply knowledge (Pradeep et al., 2023).

Scientific evidence confirms that incorporating neurodidactic principles promotes key processes such as attention, memory and motivation, which are decisive for academic performance. Barbosa (2021) showed that a model based on neurodidactics significantly improves communication skills in language teaching. Complementarily, Daugirdiene et al. (2022) demonstrated that active application of neurodidactics as strategies promotes self-regulation and student engagement during learning. Similarly, Zhumabayeva et al. (2020) showed that emphasising content design with a neurodidactic approach improves practical and social intelligence in primary school students, supporting the hypothesis that these approaches are equally applicable and beneficial at higher education levels.

In the university setting, neurodidactics has been linked to technology-mediated strategies. Pérez Sánchez et al. (2022) documented that a collaborative platform based on neurodidactics and learning analytics made it possible to predict student performance and enhance interaction. A pioneer in the application of brain-centred approaches to the field of information, Elsenbaumer (2011) demonstrated that the principles of memory and attention can be successfully incorporated into ICT teaching.

These contributions are crucial for engineering education, where problem-solving skills, creativity, and logical thinking are fundamental competencies. This approach not only improves cognitive processes but also aids in training by taking into account emotions, motivation, and teamwork as crucial components in the creation of knowledge.

Box 1

Table 1

Evolution of approaches in instructional design and relevance of neurodidactics in technological higher education

Approach	Main features	**Limitations**	**Added value in engineering**
Traditional	Masterclasses, content delivery	Low motivation, little interaction	Limited to solving complex problems
Technological	Use of ICT and virtual platforms	Risk of cognitive overload	Improves access and flexibility
Neurodidactic	Attention, emotion, memory, motivation	Requires teacher training and empirical validation	Optimise performance, creativity and innovation in engineering

Own elaboration based on Barbosa (2021)

The following trend graph (2011–2023) shown in Figure 1 illustrates the growth in publications on neurodidactics in higher education.

Box 2

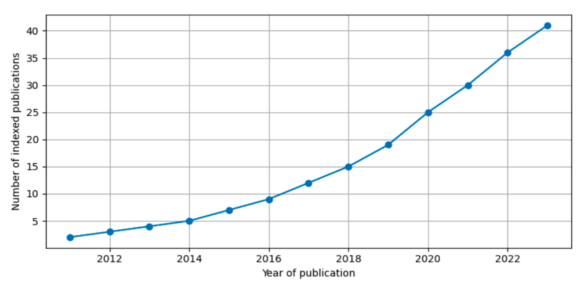

Figure 1

Trend in publications on neurodidactics in secondary schools

Own Elaboration

3. Methodology

The study was based on a systematic documentary review with a comparative approach, focusing primarily on identifying neurodidactic criteria applied to innovative instructional design in engineering education.

3.1 Selection of sources

Academic articles published between 2011 and 2023 were analysed, prioritising research linking neurodidactics, instructional design and active pedagogical strategies in higher technological education.

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3.2 Analysis procedure

The review included three phases: identification, critical evaluation, and comparative synthesis. During the analysis, not only theoretical approaches were considered, but also instructional practices that have proven effective in engineering programmes.

3.3 Analysis variables

The variables were organised into:

– Educational context: studies applied in primary, secondary, higher education and particularly in engineering.

– Neurodidactic criteria: attention, emotion, memory and motivation.

– Teaching strategies: three methodologies with a strong impact on engineering were highlighted here:

– Problem-Based Learning (PBL): promotes the resolution of authentic problems and activates neural networks related to creativity, critical thinking, and decision-making.

– Flipped Classroom: frees up class time for practical activities, while students assimilate theoretical content at home; this reduces cognitive overload and improves consolidation in working memory.

– Moodle as a Virtual Learning Environment: a platform that, being structured with neurodidactic resources (multimedia, immediate feedback, collaborative activities), allows for personalisation of the learning experience and expands opportunities for synchronous and asynchronous interaction.

– Observed impacts: refers to the impact on academic performance, motivation, knowledge transfer, creativity, and reduced dropout rates in engineering programmes.

3.4 University context in engineering

In engineering faculties, these strategies become a complementary pedagogical ecosystem: PBL strengthens multidisciplinary problem solving, the flipped classroom facilitates the efficient use of time in laboratory projects, and Moodle provides the digital infrastructure that articulates both methodologies. From a neurodidactic perspective, this combination enhances sustained attention, working memory, intrinsic motivation, and collaboration, which are key variables for success in cognitively demanding careers.

Box 3

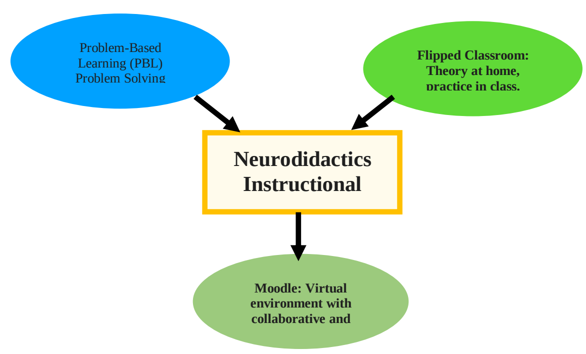

Figure 2

Neurodidactic-based instructional strategies: PBL, flipped classroom, and Moodle in engineering

Source [in italic]

As can be seen in Figure 2, instructional strategies can be used to enhance learning and teaching activities. Figure 4 shows how Moodle, through its various elements (multimedia, quizzes, forums, gamification, and analytics), impacts engineering students by enhancing attention, motivation, memory, collaboration, and academic performance.

Box 4

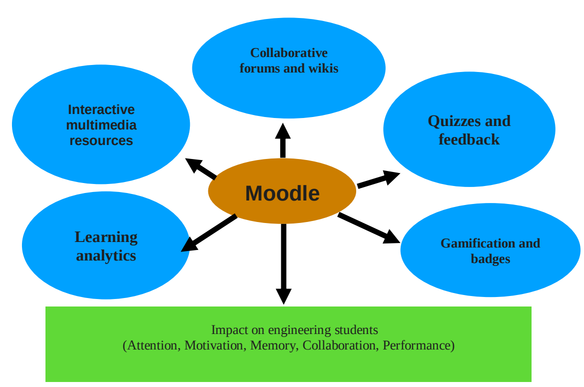

Figure 3

Moodle, through its various elements

Own Elaboration

Moodle, being an open-source learning management system (LMS) platform, offers a flexible and accessible space where teachers and students can create, organise, and develop online courses, promoting more dynamic and interactive teaching and learning processes. Table 1 shows the elements of Moodle and how they interact with neurodidactic variables:

Observed impacts

In the literature reviewed, the results of applying neurodidactic strategies show a consistent impact in three key dimensions:

1. Academic performance

The use of neurodidactic strategies has been shown to increase understanding of complex concepts and improve grades in theoretical and practical assessments.

In the case of engineering, performance is not only measured in exams, but also in the ability to apply formulas, algorithms and principles in real projects, where neurodidactics facilitates consolidation in working memory and information retrieval in highly cognitively demanding situations.

2. Student motivation

The integration of emotions and multisensory stimuli, as well as the use of active methodologies (PBL, Flipped Classroom, gamification in Moodle), increase students' intrinsic motivation.

In engineering, this translates into greater persistence in the face of difficulty, reduced dropout rates, and higher involvement in collaborative activities and laboratory projects.

3. Knowledge transfer

Neurodidactics is not limited to information retention, but promotes transfer to applied contexts. This means that what is learned in the classroom is transferred to practical scenarios, such as prototype design, system programming, or technical problem solving in real environments.

Evidence shows that the combination of neurodidactic strategies and digital platforms such as Moodle enhances this transfer by offering interactive, collaborative, and personalised spaces for learning. Figure 4.

Box 5

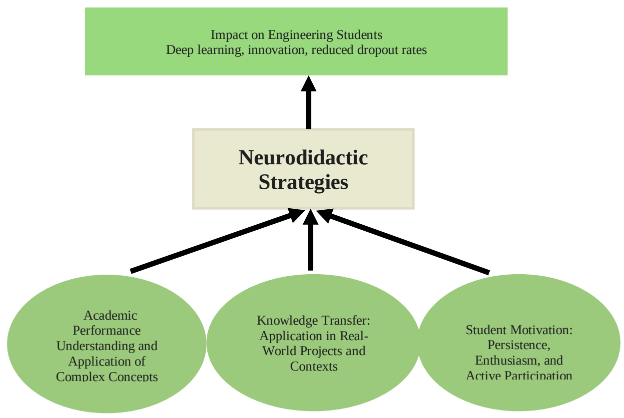

Figure 4
Observed impacts of neurodidactics in higher education in engineering
Own Elaboration

4. Results

The findings derived from the comparative analysis of the literature, together with the theoretical-methodological framework of neurodidactics, show that its application in higher education in engineering has a significant impact in three fundamental dimensions: academic performance, student motivation, and knowledge transfer.

4.1 Academic performance

Academic performance was enhanced in studies where neurodidactic strategies that activate sustained attention and working memory were applied. The use of multisensory resources, spaced repetition, and platforms such as Moodle, with immediate feedback, improved the understanding of abstract content such as mathematics, physics, and programming algorithms.

In the field of engineering, performance was not limited to better grades in assessments, but also to the ability to apply knowledge in real projects, demonstrating deeper and more functional learning.

4.2 Student motivation

Motivation emerged as one of the most consistent results in the application of neurodidactics. Strategies such as Problem-Based Learning (PBL), the flipped classroom, and gamification in Moodle environments promoted emotional activation, a sense of achievement, and self-regulation in the learning process. In the case of engineering training, intrinsic motivation translated into persistence in the face of complex problems, increased participation in collaborative activities, and a decrease in dropout rates, a recurring challenge in cognitively demanding degree programmes.

4.3 Knowledge transfer

One of the most relevant contributions was the finding that neurodidactics facilitates the transfer of learning to practical contexts. Students not only retain information, but also manage to apply it to solving real problems: designing prototypes, developing digital systems, implementing predictive models, and building sustainable technological solutions.

This finding is crucial in engineering, where professional competence is measured by the ability to transfer theory into practice, and confirms that brain-based and technology-mediated strategies enhance this transfer.

The results show a virtuous cycle in which attention and memory strengthen performance; motivation sustains effort and persistence; and transfer ensures that what has been learned is consolidated in professional practice.

Taken together, these elements reinforce the idea that neurodidactics is not just a pedagogical complement, but a transformative model of instructional design in the training of engineers. This can be seen in Table 2.

Box 6

Table 2

Observed impact	Description	Example in engineering
Academic performance	Improved understanding and application of knowledge	Application of mathematical algorithms in software projects
Student motivation	Increased persistence and commitment	Active participation in collaborative projects
Knowledge transfer	Use of learning in real-world contexts	Design of prototypes and technological solutions
Observed impacts of neurodidactics in higher education in engineering		

Figure 7. Main impacts of neurodidactics on engineering students: academic performance, motivation, and knowledge transfer.

Box 7

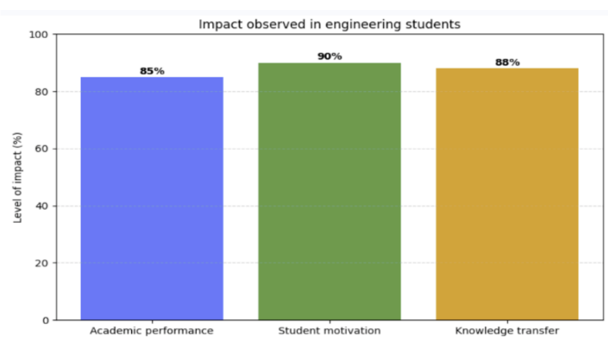

Figure 5

Bar chart showing the main impacts of neurodidactics on engineering students

Own Elaboration

Conclusions

This research confirms that neurodidactics, when integrated into instructional design, offers a solid and innovative framework for transforming teaching in higher technological education. The results reported in the literature, together with the comparative analysis carried out, show that the application of neurodidactic principles has a significant impact on three essential dimensions: academic performance, intrinsic motivation, and the transfer of knowledge to real-life contexts.

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In the case of engineering education, these findings are particularly relevant, as they demonstrate that learning goes beyond the memorisation of formulas or theoretical concepts: it is oriented towards complex problem solving, applied creativity, and technological innovation with social impact. Strategies such as Problem-Based Learning, the flipped classroom, and digital mediation through Moodle are tangible examples of how neurodidactics can be translated into effective teaching practices, enhancing professional skills and encouraging persistence in cognitively demanding programmes.

Neurodidactics not only addresses ‘how’ the brain learns, but also ‘why and with whom we learn,’ promoting a model of education centred on the student as a whole person, with emotions, aspirations, and the ability to transform their environment. This approach to training engineers contributes not only to the development of technical skills but also to the development of critical, creative citizens who are committed to their community.

Finally, the need to expand empirical and longitudinal research that validates these findings in university engineering settings is recognised, as well as the need to strengthen teacher training with a neurodidactic approach. Only in this way will it be possible to consolidate an innovative, humanised and socially relevant instructional design model that prepares future engineers to face the scientific, technological and social challenges of the 21st century.

Declarations

Conflict of interest

The authors Claudia Teresa González Ramírez, Elisa Serrano González, Samuel Efrén Viñas Álvarez and Jhacer Kharen Ruiz Garduño declare that there is no conflict of interest. They also state that they have no financial interests or personal relationships that could have influenced the work presented in this article.

Author contribution

Claudia Teresa González Ramírez: Contributed to the conceptualisation of the project, the literature review and the writing of the manuscript, ensuring the academic and methodological coherence of the document.

Elisa Serrano González: Participated in the collection and analysis of documentary information, as well as in data processing and the preparation of tables and figures for the graphical representation of the findings.

Samuel Efrén Viñas Álvarez: Collaborated in the methodological design and comparison of neurodidactic criteria, as well as contributing to the discussion of results and critical review of the article.

Jhacer Kharen Ruiz Garduño: Responsible for the overall direction of the study structure, as well as the final validation of the manuscript and academic supervision.

Availability of data and materials

The data and materials obtained in this research are available from the corresponding authors upon reasonable request. As the study was based on document review and comparative analysis, no primary databases were generated that could be deposited in public repositories.

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Abbreviations

ABP	Aprendizaje Basado en Problemas / *Problem-Based Learning*
ICT / TIC	*Information and Communication Technologies* / Tecnologías de la Información y la Comunicación

González-Ramírez, Claudia Teresa, Ruiz-Garduño, Jhacer Kharen, Viñas-Alvarez, Samuel Efrén and Serrano-González, Elisa. [2025]. Advances in neurodidactics for innovative instructional design in engineering training. Journal of University Policies. 9[20]1-7: e4920107. https://doi.org/10.35429/JUP.2025.9.20.4.1.

JCR	Journal Citation Reports
LMS	*Learning Management System* / Sistema de Gestión del Aprendizaje
MOOC	*Massive Open Online Course* / Curso en Línea Masivo y Abierto
PBL	*Problem-Based Learning* (equivalente en inglés de ABP)
ROC	*Receiver Operating Characteristic* (Curva ROC, usada en análisis de modelos predictivos)

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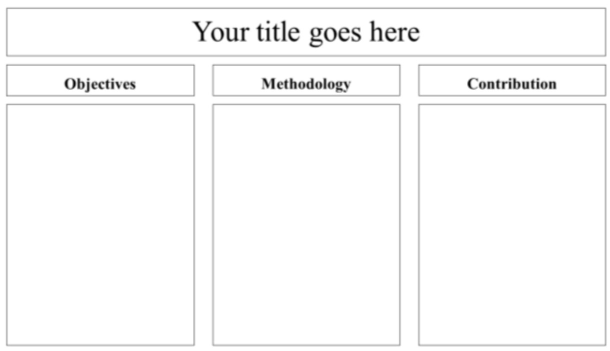

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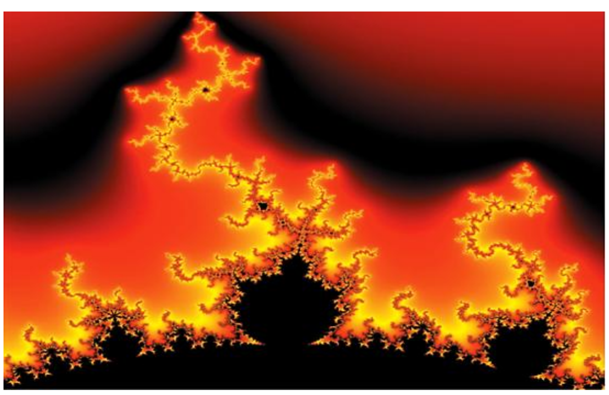

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