

# QHS Methodology for Mathematics Teaching in Engineering

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## ABSTRACT

The Fifth Systemic Helix (QHS) methodology represents a systemic tool to develop mathematical competencies in engineering. A key aspect of the QHS Methodology is to promote the integration of theoretical and practical knowledge, which is essential in the training of engineers. This includes the application of mathematical concepts in real engineering problems. Focusing on developing critical thinking skills, problem solving and the ability to argue and communicate mathematical ideas effectively. Collaboration between students, professors, and industry professionals enriches the learning process and prepares students for teamwork in professional environments. The implementation of technological tools and digital resources is an integral part of QHS, facilitating interactive learning and simulation of complex scenarios. The methodology includes continuous assessment mechanisms to monitor student progress and adjust teaching strategies as needed.

**Keywords:** QHS methodology, DCS methodology, ABP methodology, Math, Meaningful learning

## INTRODUCTION

In the vast and complex field of Science and Technology, mathematics stands as the fundamental foundation of countless scientific and technological disciplines, enabling significant advances in areas as diverse as engineering, computer science, medicine, and physics. In the field of economics and finance, mathematics plays a key role in understanding and thoroughly analysing economic data, making accurate financial projections, and making informed and informed decisions. That is why the Intellectual Development of everyone in contemporary society, it is essential to instruct and understand the relevance of mathematics, from the first years of education to the university stage, with the purpose of promoting the capacity for abstraction and creativity, essential skills for the learning process and the generation of innovative ideas. fundamental pillars for the progress, expansion, and transformation of the community towards a state of well-being and constant improvement. Mathematics, with its ability to solve complex problems and its influence on the advancement of diverse cultures throughout history, has

played a pivotal role in the progress of numerous ancient civilizations. The Pre-Socratic philosophers, who dedicated themselves to the study of the nature and origin of the universe, and the Pythagoreans, followers of the teachings of Pythagoras and known for their interest in mathematics and music, are two fundamental philosophical currents in the history of Western thought.

Thales is considered the pioneer of the current of thought known as “pre-Socratic philosophy”, which encompasses a group of thinkers who developed their ideas in ancient Greece before the birth of Socrates, the famous Athenian philosopher who lived between 470 and 399 B.C. Thales, therefore, is recognized as the initiator of the philosophical tradition in Hellenic culture. According to what is narrated in the chronicles of the writers who came after Thales, the scholar began his mathematical studies following the same approach and methodology that was used in ancient Egypt and in ancient Babylon, where mathematics was applied daily to solve practical and concrete problems. It is said, for example, that the ancient scholar meticulously measured the towering height of the majestic pyramids of Giza by accurately calculating the difference between the shadows cast by these colossal structures and the shadow he himself cast on the fiery desert floor.

Moreover, as a skilled engineer and tactical strategist employed by the illustrious King Croesus, whose reign extended from 560 B.C. to 547 B.C., he skilfully applied the most advanced mathematical principles of his day to an intricate logistical problem. Not content with this, he performed an unprecedented feat by masterfully diverting the course of the mighty Halis River to facilitate the crossing of his powerful army, thus demonstrating his genius both on the battlefield and in the field of hydraulic engineering. Some of these ancient civilizations contributed significantly to the development and progress of the complex and fascinating mathematics that we use and study today (Mark, 2023).

## **Mesopotamia**

**Sexagesimal System:** The Sumerians developed a numerical system based on 60, which we still use today in the measurement of time (60 seconds in a minute, 60 minutes in an hour).

**Algebra and Geometry:** The Babylonians solved quadratic and cubic equations and had an advanced knowledge of geometry.

## **Egypt**

**Practical Geometry:** They used geometry to measure land and build monuments such as pyramids.

**Decimal System:** They developed a decimal numbering system and used fractions in their daily calculations.

## **Greece**

**Pythagorean Theorem:** Pythagoras and his followers made important contributions to geometry.

Euclid's Elements: This text is one of the most influential in the history of mathematics, laying the foundations of modern geometry.

### India

Decimal and Zero System: Indian mathematicians developed the decimal system and the concept of zero, which are fundamental in modern mathematics.

Trigonometry: They made significant advances in trigonometry, including the development of trigonometric functions.

### China

Abacus: They invented the abacus, an essential tool for fast and accurate calculations.

Chinese Remainder Theorem: They developed advanced methods to solve congruence systems.

### Pre-Columbian America

Calendars and Astronomy: Civilizations such as the Mayans used advanced mathematics to develop accurate calendars and make astronomical observations.

These ancient civilizations not only used mathematics to address practical questions, but also laid the foundations for many mathematical concepts that are still relevant today. Mathematics, with its rigorous logic and precision, has played a crucial role in the conception and development of numerous revolutionary inventions, as well as in the progress of science and technology over the centuries (Ferrando, 2020). Some prominent examples worth mentioning are the following:

- The Wheel: Its invention and perfection involved knowledge of geometry and physics.
- The Pyramids of Egypt: The construction of these monumental structures required a deep understanding of geometry and arithmetic.
- The Algorithm: Developed by the Persian mathematician Al-Khwarizmi, algorithms are essential for computer science and complex problem solving.
- The Telescope: Galileo Galilei used mathematical principles to improve the telescope's design, allowing for important astronomical discoveries.
- The Theory of Relativity: Albert Einstein used advanced mathematics to formulate this theory, which has revolutionized our understanding of the universe.

These are just a few examples of how mathematics has been crucial to the development of technologies and discoveries that have changed the world. Throughout the vast history of humanity, there have been countless mathematicians whose contributions have been of extraordinary magnitude to the development and progress of the mathematical discipline, being venerated as authentic "masters" or "sages" of mathematics. Some of the

most outstanding examples so that you can appreciate the diversity and richness of this collection.

- Euclid: Known as the “Father of Geometry”, his work “Elements” is one of the most influential texts in the history of mathematics.
- Isaac Newton: Your contributions to calculus and physics have been fundamental to the development of modern science.
- Carl Friedrich Gauss: Nicknamed the “Prince of Mathematicians”, he made important contributions in number theory, algebra and analysis.
- Leonhard Euler: One of the most prolific mathematicians, known for his work in topology, graph theory, and analysis.
- Srinivasa Ramanujan: A self-taught genius whose contributions to number theory continue to be studied and admired.

Not only have these brilliant mathematicians contributed significantly to the advancement of our understanding of complex mathematical theories, but they have also left an enduring legacy that has served as an inspiration for countless generations of students and professionals in various academic disciplines and fields of work around the globe. Mathematics, with its rigorous analytical approach and ability to model complex phenomena, plays a critical role in generating wealth and fostering economic growth. Some key points to keep in mind about the relevance of mathematics in generating wealth are the following:

- Resource Optimization: Mathematics allows companies to optimize their resources and processes, improving efficiency and reducing costs.
- Data Analysis: In the era of big data, mathematics is essential to analyze large volumes of data and extract valuable information that can guide strategic decisions.
- Financial Models: Mathematical tools such as the Black-Scholes formula have revolutionized the financial markets, allowing the accurate valuation of options and other derivatives.
- Technological Innovation: Mathematics is the basis of many technological innovations, from internet search algorithms to artificial intelligence and cryptography.
- Economic Impact: A study carried out by International Financial Analysts indicates that mathematics represents about 27% of GDP in economic activities and is responsible for 6% of employment.

These educational applications demonstrate concisely how mathematics is not only a fundamental tool in the academic field, but also stands as an indispensable engine for sustainable economic growth and the generation of abundance and prosperity in society. At the university level, it is important to note that some of the countries with the best levels in mathematics at the international level are recognized for the excellence of their academic programs, as well as for their outstanding research in the field of exact sciences. The most outstanding and outstanding in their field:

- Singapore: Recognized for excellence in mathematics education, both at school and university levels.

- Japan: Its universities, such as the University of Tokyo, are leaders in mathematical research and technology.
- South Korea: With institutions such as KAIST and Seoul National University, South Korea is a benchmark in advanced mathematics education<sup>3</sup>.
- Switzerland: Home to the Swiss Federal Institute of Technology in Zurich (ETH Zürich), one of the world's top universities for mathematics and science.
- United States: Universities such as MIT, Stanford, and Harvard are known for their top-notch math programs.

Not only do these countries excel in international assessments of academic achievement, such as the Programme for International Student Assessment (PISA) and the International Trends in Mathematics and Science Study (TIMSS), but they are also home to renowned university institutions that stand out for their leadership in research projects and advances in the field of mathematics. It is curious to note that, despite the relevance of mathematics in scientific and technological development, no award equivalent to the Nobel Prize has been established for this discipline. There are multiple theories and speculations about the reasons that led Alfred Nobel to deliberately omit this area of knowledge in the selection of laureates of his prestigious prizes. One of the most widely disseminated theories, although it has not been officially corroborated, postulates that Alfred Nobel may have been influenced by motivations of a personal nature, possibly linked to a complicated love network. However, it is considerably more likely that Mr. Nobel would have taken into consideration the fact that mathematics already had adequate recognition through other prizes awarded in that historical period. Prestigious awards in mathematics:

- Fields Medal: Awarded every four years to mathematicians under the age of 40, it is one of the most prestigious awards in this field.
- Abel Prize: Considered the “Nobel” of mathematics, this annual prize recognizes exceptional contributions to the discipline.

The level of competence in mathematics in the country of Mexico has presented challenges of great magnitude and complexity over the course of the last few years. According to the data obtained in the PISA 2022 assessment report, it can be observed that approximately 66% of students in Mexico do not manage to reach the minimum level required in mathematics. Mexico ranked 35th out of a total of 37 member countries of the Organization for Economic Cooperation and Development (OECD) that were evaluated, obtaining an average score of 407 points, which is significantly below the OECD general average, which is 4781 points. In addition, according to the data obtained from the PLANEA assessment, it can be observed that in the sixth grade of primary education, a worrying 59% of students are at the lowest level of academic performance in the subject of mathematics. In the secondary education stage, it is observed that a significant percentage, specifically 65% of students, are also at the lowest level of performance.

These results obtained in the study clearly and forcefully reflect the urgent need to implement effective measures that contribute to optimizing and enhancing both the quality and effectiveness of educational processes related to the teaching and learning of mathematics at the national level. In addition, during the prestigious International Mathematics Olympiad held in the beautiful nation of Japan, Mexico reached its most outstanding position in its entire history, ranking fourteenth with a total of six valuable medals. Mathematics plays a fundamental role in various areas of daily life and work. It is crucial to highlight its relevance in the promotion of Critical Thinking, which directly influences the capacity for logical and analytical reasoning (Moreno, 2024).

These skills are essential for effectively addressing and solving a wide range of problems in different contexts. Practical Applications of Mathematics affect a wide variety of situations, from calculating the change in a store to planning a detailed monthly or annual budget. In this sense, mathematics becomes an indispensable tool that accompanies and guides us in multiple aspects of our daily lives, facilitating informed and accurate decision-making. The fundamental areas of mathematics that are the object of study in the various engineering disciplines are exhaustively detailed in Table 1. On the other hand, Table 2 presents in detail the analysis of the diversity of mathematical branches presents in the field of Engineering.

**Table 1.** Types of mathematics by career.

Professional Grade	Math Features
Engineering	They are widely used in calculus, linear algebra, and differential equations to design and analyze systems and structures.
Economy and Finance	Financial mathematics, statistics, and probability theory are essential for modeling markets and making economic decisions.
Computer Science	They include algebra, mathematical logic, and graph theory for the development of algorithms and data structures.
Physics	Calculus and geometry are fundamental for modeling physical phenomena and conducting experiments.
Biology	Biostatistics and mathematical modeling help to understand biological and ecological processes.
Architecture	Geometry and calculation are essential for the design and construction of buildings.

**Table 2.** Type of mathematics for engineering careers.

Math	Description of the type of mathematics
Algebra	It is essential for analyzing physical processes, performing calculations, and creating computer code.
Calculation	It includes differential and integral calculus, and is crucial for understanding and modeling physical and engineering phenomena.
Numerical sets	Important for computing and data analysis.
Logic	Used in circuit construction and machine assembly.
Matrices	Used in various applications, from solving systems of equations to linear programming.

Engineering disciplines that demand a more advanced level of mathematical knowledge are usually those that focus on detailed analysis and effective resolution of highly complex and challenging problems. Engineering that requires a high level of mathematical knowledge (Moreno, 2019).

- **Aerospace Engineering:** Requires a deep knowledge of calculus, linear algebra, and differential equations for the design and analysis of aircraft and spacecraft.
- **Electrical Engineering:** Uses advanced mathematics for the analysis of circuits, control systems, and signal theory.
- **Mechanical Engineering:** Includes the study of fluid mechanics, thermodynamics, and structural analysis, all based on advanced mathematics.
- **Systems Engineering:** Focused on information theory, algorithms, and optimization, it requires a solid knowledge of mathematics.
- **Chemical Engineering:** Uses differential equations and numerical methods to model and optimize chemical processes.
- Not only do these disciplines require a strong mastery of mathematics, but they also apply this knowledge to innovate and solve problems in their respective fields.

Engineering that requires a lower level of mathematical knowledge is usually those disciplines that allow students to focus more on practical and applied aspects, reducing the mathematical load compared to other branches of engineering. This gives them the opportunity to explore in a more detailed and in-depth way the theoretical and practical concepts that underpin their academic and professional training.

- **Software Engineering:** Although it requires basic knowledge of mathematics, the focus is on programming and software development.
- **Industrial Engineering:** It uses applied mathematics, but to a lesser extent compared to other engineering such as civil or mechanical.
- **Environmental Engineering:** Focuses more on the application of scientific and technical principles to improve the environment, with less emphasis on advanced mathematics.

Mathematics, with its complexity and precision, plays a fundamental role in generating wealth and fostering economic growth in modern societies. Mathematics plays a critical role in a nation's economic development, providing analytical and quantitative tools that enable informed and strategic decision-making. In addition, they foster innovation and efficiency in various sectors, which in turn drives growth and competitiveness internationally. Investing in mathematics education is therefore essential to strengthen the population's knowledge base and promote long-term sustainable economic progress (TecNM, 2024).

- **Resource Optimization:** Mathematics allows companies to optimize their resources and processes, improving efficiency and reducing costs.

- **Data Analysis:** In the era of big data, mathematics is essential to analyze large volumes of data and extract valuable information that can guide strategic decisions.
- **Financial Models:** Mathematical tools such as the Black-Scholes formula have revolutionized the financial markets, allowing the accurate valuation of options and other derivatives.
- **Technological Innovation:** Mathematics is the basis of many technological innovations, from internet search algorithms to artificial intelligence and cryptography.
- **Economic Impact:** A study carried out by International Financial Analysts indicates that mathematics represents about 27% of GDP in economic activities and is responsible for 6% of employment.

## **RESEARCH MATERIAL AND METHODS**

The Problem-Based Learning (PBL) methodology is an innovative educational strategy that is based on the use of real problem situations as a starting point for the teaching-learning process. This innovative methodology is exceptionally effective in the educational field of mathematics, since it significantly promotes the development of critical thinking, effective problem solving and the practical application of the various mathematical concepts that are addressed in the learning process.

### **Characteristics of PBL in Mathematics**

- **Real Problems:** Students work on authentic problems that require the application of mathematical concepts to be solved.
- **Active Learning:** Students are the protagonists of their own learning, investigating, and discovering solutions for themselves.
- **Collaborative Work:** Encourages teamwork, where students collaborate to solve problems and share knowledge.
- **Skill Development:** In addition to mathematical knowledge, students develop soft skills such as communication, collaboration, and critical thinking.
- **Stages of PBL:**
  - **Problem Presentation:** A complex and relevant problem is presented that students must solve.
  - **Identification of Prior Knowledge:** Students identify what they already know and what they need to learn to solve the problem.
  - **Research and Learning:** Students investigate, discuss, and apply new knowledge to address the problem.
  - **Problem Solving:** Students develop and present a solution to the problem.

### **Benefits of PBL in Mathematics**

- **Motivation:** Students feel more motivated when working on problems that they consider relevant and meaningful.
- **Deep Understanding:** By applying mathematical concepts to real situations, students develop a deeper and more lasting understanding.



- Preparing for the Future: Develops skills that are essential for success in professional and personal life.

Implementing the Project-Based Learning (PBL) methodology in mathematics teaching can have a significant impact on the way students acquire and use mathematical knowledge, turning it into more meaningful and motivating content.

### **Feature of the QHS Methodology**

The Fifth Systemic Helix (QHS) methodology is an innovative and highly effective approach that integrates diverse perspectives and pedagogical approaches to significantly enhance the quality of mathematics teaching at all educational levels. This innovative model is based on the close collaboration and synergy between a wide diversity of key actors, such as academic institutions, companies from various sectors, government entities, civil society organizations and the protection of the natural environment, with the purpose of establishing a comprehensive, inclusive, and highly effective learning environment (Martinez, 2020, 2024). Principles of the QHS Methodology in Mathematics Teaching:

- **Interdisciplinarity:** Encourages the integration of knowledge from various disciplines to address complex problems more comprehensively.
- **Collaboration:** Promotes joint work between teachers, students, industry professionals and other relevant actors to enrich the teaching-learning process.
- **Innovation:** Encourages the use of new technologies and pedagogical methods to make learning more dynamic and relevant.
- **Sustainability:** Considers the environmental and social impact of educational practices, looking for solutions that are sustainable in the long term.
- **Adaptability:** It allows teaching strategies to be adjusted according to the specific needs and contexts of students and the educational community.

### **Applications in Mathematics Teaching**

- **Collaborative Projects:** Involve students in projects that require the application of mathematical concepts to solve real problems in collaboration with industry and the community.
- **Use of Technology:** Implement digital tools and interactive resources that facilitate the understanding of complex mathematical concepts.
- **Problem-Based Learning:** Use real-world problems that require an interdisciplinary approach to solving, encouraging critical thinking and creativity.
- This systemic approach not only improves the quality of mathematics instruction, but also prepares students to face complex challenges in their future careers

## CONCLUSION

These apps show how mathematics is not only an academic tool, but also a key driver for economic growth and wealth creation. Weakness in math can be due to a combination of factors, the most common (Science and Academia, 2024).

1. **Teaching Methods:** Many times, traditional teaching methods focus on memorizing formulas and procedures rather than fostering a deep understanding of concepts.
2. **Genetic and Neurobiological Factors:** Some people may have difficulty due to structural differences in the brain or conditions such as dyscalculia, which specifically affects the ability to understand and work with numbers.
3. **Environment and Context:** Lack of adequate educational resources, insufficient support at home, and quality of teaching can significantly influence math performance.
4. **Math Anxiety:** Fear or anxiety about math can negatively affect performance and willingness to learn.
5. **Lack of Practice:** Math requires constant practice to build skills and confidence. A lack of opportunities to practice can lead to weakness in this area.

These factors clearly and unequivocally demonstrate that the absence of proficient skills in mathematics is not solely restricted to the individual cognitive capacity of each person, but is also significantly influenced and shaped by the surrounding environment in which they grow and by the diverse pedagogical methodologies employed in the educational instruction and acquisition process (Moreno, 2023).

## Recommendations

The STEM (Science, Technology, Engineering and Mathematics) model is an innovative educational methodology that promotes the integration of scientific, technological, engineering and mathematics disciplines in an interdisciplinary and holistic approach. The main objective of this educational model is to promote the development of critical and fundamental skills for academic and professional success, such as analytical thinking, effective problem solving, creativity in the search for innovative solutions, and the ability to adapt to changing and challenging environments.

## Characteristics of the STEM Model

- **Interdisciplinarity:** Combines several disciplines to solve real-world problems.
- **Active Learning:** Promotes active student participation through projects and experiments.
- **Critical Thinking:** Encourages the ability to analyze and evaluate information to make informed decisions. Encourages teamwork and effective communication.
- **Innovation:** It stimulates creativity and the ability to innovate in various areas.

### **Benefits of the STEM Model**

- Future-proofing: Students develop skills that are highly valued in the current and future job market.
- Practical Application: The knowledge acquired is applied to real situations and problems, making learning more relevant and meaningful.
- Integral Development: It not only focuses on technical knowledge, but also on soft skills such as communication and teamwork.

The educational approach known as STEM, which integrates science, technology, engineering, and mathematics, has been widely implemented in various nations around the world thanks to its proven effectiveness in training students to successfully face the challenges and demands of the current era, marked by rapid technological evolution and globalization.

### **Educational Model of the National Technological Institute of Mexico**

At the Technological Institute of Tijuana, belonging to the National Technological Institute of Mexico, an Institution of Technological Higher Education recognized nationally and internationally, with a student population that exceeds 600,000 students distributed throughout the Mexican territory, and an academic body made up of more than 30,000 highly trained professionals, its fundamental role in the training of engineers stands out. being responsible for the preparation of 4 out of 10 professionals in this area, which contributes significantly to the progress and strategic development of various sectors of society. It is important to highlight the excellence and dedication of teachers and students, who day by day demonstrate their commitment to Educational Quality and personal and professional growth (Martinez et al., 2024).

The five brilliant students from the prestigious Tijuana Institute of Technology proved their worth by flying as high as majestic eagles and running at an impressive speed, outpacing even the nimble greyhounds trying to catch up with them. In this way, the outstanding students of the Technological Institute of Tijuana, belonging to the campus of the National Technological Institute of Mexico (TecNM), managed to win the title of champions in the category of Basic Sciences by teams, during the exciting final of the thirtieth edition of the National Student Event of Basic Sciences (ENCB 2023), held at the facilities of the Technological Institute of Morelia, located in the state of Michoacán, on November 23 and 24.

The annual institutional academic competition, which highlights the importance of the comprehensive training of the student community of the National Technological Institute of Mexico, is divided into various categories, including Basic Sciences and Economic and Administrative Sciences, both individually and in collaborative teams. The group of athletes from the house of the Galgos who achieved the incredible achievement is composed of Octavio Frías Aviña, Fernando Orozco Fabre, José María Mendoza Zapata, Raúl Ferreyra García and Damián Ortiz González, who received valuable guidance from the outstanding teacher Sonia Moreno Cabral. The second position in the competition was awarded to the campus located in Nuevo Laredo, while the third place was won by the city of Tuxtla Gutiérrez

(TecNM, 2023). The New Educational Model of the National Technological Institute of Mexico has a focus on Technological Humanism, for Social Justice in Mexico (TecNM, 2024).

The TecNM has been immortalized in the Congress of the Union, in Mexico City, with Gold letters for its 75th Anniversary (TecNM Celaya, 2024).

## REFERENCES

- Marcelo Ferrando (2020) Historia de las matemáticas, origen y evolución (March 29, 2020). Website: <https://redhistoria.com/historia-de-las-matematicas-origen-y-evolucion/>
- Mark, Joshua (2023) History of mathematics (July 31, 2023). Website: <https://www.worldhistory.org/trans/es/2-606/las-matematicas-griegas/>
- Martinez-Gutierrez, R. (2020). Methodology of Dictionaries of Sector Competences (DCS), to Design Standards of Professional Competences, Research and Labor. In: Nazir, S., Ahram, T., Karwowski, W. (eds) Advances in Human Factors in Training, Education, and Learning Sciences. AHFE 2020. Advances in Intelligent Systems and Computing, vol. 1211. Springer, Cham. [https://doi.org/10.1007/978-3-030-50896-8\\_46](https://doi.org/10.1007/978-3-030-50896-8_46)
- Martinez-Gutierrez R (2024) QHS Methodology Applied to Professional Growth with Impact on Society. Innovation - Research and Development for Human, Economic and Institutional Growth. IntechOpen. Available at: <https://dx.doi.org/10.5772/intechopen.112559>.
- Martinez Gutierrez, R., Lucas Bravo, G., Ernesto Jimenez Bernardino, A., & Daniel Padilla De la Rosa, J. (2024). Perspective Chapter: SDG 4, Educational Strategy and Awareness for Social Innovation in Sustainable Development. IntechOpen. doi: 10.5772/intechopen.1005252.
- Moreno Cabral, Sonia, (2019). Differential Equations for Engineering. Website: <https://www.tijuana.tecnm.mx/presentan-libro-sobre-ecuaciones-diferenciales/>.
- Moreno Cabral, Sonia (2024). Proposals to strengthen the National Education System debated in a discussion. Website: <https://diariotijuana.info/2024/02/debaten-en-conversatorio-propuestas-para-fortalecer-el-sistema-educativo-nacional>.
- Moreno Cabral, Sonia (2023), Scientists and Academics in support of Members of the State Council of Science and Academia of Baja California. (August 14, 2023). Website: <https://www.tijuanainforma.com/2023/08/14/cientificas-y-academicas-en-apoyo-integrantes-del-consejo-estatal-de-ciencia-y-academia-de-baja-california/>.
- Science and Academia (2024). Science and academia forums to submit proposals. (January 29, 2024). Website: <https://notilibretijuana.blogspot.com/2024/01/impulsan-foros-de-ciencia-y-academia.html>.
- TecNM Celaya. The TecNM: Educational Giant Immortalized in Gold. (June 21, 2024) Website: <https://celaya.tecnm.mx/el-tecnm-gigante-educativo-inmortalizado-en-oro/>
- TecNM New Educational Model. Humanism for Social Justice (2024). (August 21, 2024). Website: <https://nuevomodeloeducativo.tecnm.mx/>.
- TecNM Tijuana (2023). Galgo Team Achieves First National Place in Basic Sciences. (December 01, 2023). Website: <https://www.tijuana.tecnm.mx/equipo-galgo-logra-primer-lugar-nacional-en-ciencias-basicas/>.
- Tijuana Institute of Technology (TecNM), Sciences (October 08, 2024). Website: <https://www.tijuana.tecnm.mx/ciencias-basicas/>.