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PERMA as a positive impact factor in engineering education. A case study in Mexico.

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***Abstract*– Technological innovations should be the foundation for improving the living conditions of societies. Engineers are responsible for this task, and they are trained in institutions that must develop retention mechanisms to prevent student dropout, as a significant number of engineering students abandon their studies for various reasons. One of these reasons, where schools have control and can make a difference, is academic performance. In this case study, the impact of the PERMA model on student achievement in recent years within a competency-based training program has been measured, concluding that there is evidence of improved classroom performance, as measured by the learning assessment process.**

***Keywords*- Engineering education, teaching standards, academic standards, learning processes.**

I. Introduction

It is undeniable that education plays an important role in the analysis of economic growth within a society [1][2]. Higher levels of educational attainment are strongly linked to increased employment rates, a more skilled labor force, higher earnings, and better health.[3]. Higher education fosters more critical, responsible, participatory citizens, motivates innovation, creativity, and technological development that drives increased productivity, and serves as an important driving force for social mobility and equality.

Following the data of OECD [3], in 2024, 22% of people aged 25 to 64 held a tertiary education level in Mexico. Furthermore, adults with a university education are more resilient to long-term unemployment; their employment rate was 9% higher than that of adults with upper secondary education. They also earn higher salaries, although this varies depending on the field of study. Their advantage also increases with age: 25 to 34-year-olds with a university degree earn 38% more than their counterparts with upper secondary education, while those aged 45 to 54 earn 70% more. A study conducted in 181 countries between 1970 and 2020 found a positive correlation between higher average years of schooling and greater economic growth in GDP per capita as an annual percentage, which held in half of the cases studied [4].

According to data from Mexico's National Institute of Statistics and Geography (INEGI), 21.6% of the population aged 15 and over has completed higher education, including bachelor's degrees, engineering degrees, and postgraduate studies. Of the 2.9 million young people who completed upper secondary education, only 34.48% reported being enrolled in higher education. The three main reasons why young people between 18 and 20 years old did not continue their higher education are lack of financial resources (32%), not being accepted into their chosen institution or failing the entrance exam (19.9%), and lack of interest or desire to continue studying (10%). Additionally, only 8% of students who begin undergraduate studies complete their degrees [5].

Supporting student well-being in schools is becoming an increasingly global priority. It is a condition that can help create suitable environments within the school setting and a way to support students' academic activities. However, research and initiatives focus on general well-being rather than experiences related to specific subjects, so it must be adapted to the context of the subject matter, for example, in a mathematics class where there are widespread levels of math anxiety, negative attitudes, and a lack of engagement in mathematics education [6]. In the scientific study of well-being, two aspects are recognized: first, happiness, positive effect, low negative affect, and life satisfaction, which are rooted in the hedonic tradition, with some works by authors such as Bradburn [7], Kahneman, Diener, and Shwartz [8], and Lyubomirsky and Lepper [9]. Secondly, the eudaimonic tradition, which emphasizes positive psychological functioning and human development, with authors such as Diener [10], Michaelson, Abdallah, Steuer, Thompson, and Marks [11], and Stiglitz, Send, and Fitoussi [12].

Closely related to the concept of well-being is the PERMA model. Its creator, Seligman [13], states that it is a means to achieve personal and professional results that contribute to well-being, which can be measured in its development. It also argues that students at basic education levels should develop skills for personal well-being, which should provide support for obtaining adequate professional training when choosing a career [15].

A. Background

Technological training in Mexico is focused on the field of engineering, due to their skills and abilities can contribute to the technological change of the country.

In 2024, the total number of students enrolled in higher education institutions was 4,926,166, of whom 25.61% were studying engineering [17]. The number of engineering students in the country has grown in recent years, with a positive trend until 2017, followed by a slower growth rate from 2018 onward.

Among the institutions offering engineering studies is the National Technological Institute of Mexico (TecNM), which comprises 254 campuses across the country. One of these is the Technological Institute of Higher Studies of Cuautitlán Izcalli (TESCI), located about 30 km northwest of Mexico City. TESCI offers nine engineering programs, a bachelor’s degree in public accounting, and two graduate programs focused on technological research. It is worth noting that seven of the eight engineering programs hold international accreditations, a testament to the high-quality education provided by the institution. The campus was inaugurated in 1998 and had an enrollment of over 6,000 students in 2025. The campus infrastructure includes classroom buildings, laboratories, green spaces, and sports and recreation areas, providing an environment conducive to student learning.

Higher education in Mexico is expanding, but it faces structural challenges related to investment, equity, and job placement. In this context, applying the PERMA model to programs like Industrial Engineering at the National Technological Institute of Mexico could be an innovative way to improve both academic performance and graduate employment.

II. THEORETICAL FRAMEWORK

A. PERMA Model

PERMA is a mnemonic device formed from the first letter of each of its phases, written in English: Positive Emotion, Engagement, Relationship, Meaning, and Accomplishment.

This model has led several authors to present studies comparing its statistical effectiveness with others related to well-being, such as the research by Goodman, Disabato, Kashdan, and Kauffman [16], which correlates it with Subjective Well-Being (SWB) at 0.98, leading them to conclude that there is no significant difference between the two models. Nevertheless, the PERMA model is established as a means to improve individuals' performance in their work or study environments, enabling them to enhance their results. To this end, it can be linked to other indicators, such as productivity, to measure its effectiveness.

B. Educational Model of the National Technological Institute of Mexico (TecNM)

The National Technological Institute of Mexico (TecNM) is adopting the New Mexican School model under the approach called Humanism for Social Justice, which seeks to train engineers with solid technical skills, but also with social responsibility, critical thinking, ethics, and the capacity for innovation. The model focuses on the holistic development of students, promoting values of equity, inclusion, and social commitment, and responsibility [18].

In this way, the “Educational Model of the National Technological Institute of Mexico,” which is structured around four key dimensions: philosophical, social-humanistic, technological-scientific, and historical-cultural. These guide the comprehensive education of students, combining values, social commitment, innovation, and historical awareness. It is based on a comprehensive approach that articulates four main dimensions [19]:

1) Philosophical, with a tendency that includes humanism for social justice, including ontological, epistemological, and axiological reference, that leads to critical thinking based on the phrase "I know, I confront, I build, and I contribute".

2) Social-Humanistic. Focused on the integral development of the student as a person and citizen, it promotes training in values, leadership, community commitment, and respect for diversity, seeking equity, social inclusion, and interculturality.

3) Technological-Scientific. It responds to the demands of scientific and technological advancement, promoting innovation, applied research, and knowledge transfer, with a focus on training towards national competitiveness and productivity, linking academia with the productive sector.

4) Historical-Cultural. It recognizes national identity and cultural heritage as an essential part of education by fostering historical awareness and respect for the country's cultural diversity, seeking to integrate tradition with modernity, which allows strengthening social and cultural cohesion.

Taken together, these dimensions ensure that TecNM not only trains technically and scientifically competent professionals but also responsible citizens, aware of their historical and cultural context, and committed to social transformation. The model is based on cross-cutting principles such as social responsibility, equity, inclusion, excellence, and educational innovation.

C. Description of the class model

The professors collaboratively develop a lesson plan for each semester spanning 16 weeks, in accordance with the syllabus approved by TecNM. Each class lasts 4 to 6 hours per week, with the specific hours determined for each subject. The class is designed in three parts: the beginning, which usually starts with an engaging or thought-provoking question; the development of the topic established in the lesson plan; and the closing, which includes the conclusion and considerations related to the topic. The assessment process is continuous and typically consists of three components that assess a product, with a weighted average resulting in a maximum grade of 100 and a minimum passing grade of 70. The final grade is the average of the competency units that each student can review throughout the course.

PERMA is applied within the Competency-Based Learning Model (CBLM), a student-centered educational approach that prioritizes the acquisition and demonstration of skills, knowledge, and practical attitudes over class time or traditional grades. It allows for a personalized pace, progressing as competencies are mastered within the classroom [20]. The adaptations made to CBLM by PERMA were primarily psychological, as the classroom environment was carefully managed to foster positive and motivating aspects among the students [21]. For the application with the improvements obtained in previous studies, they focus on the description of the phases of each stage of PERMA; for example, in the first positivity phase, the class begins with a thought-provoking question to motivate students to start learning. Each stage was adjusted according to its purpose, as shown in Figure 1, being the standard for the development of each session plan.

Positivity	The class begins with a thought-provoking question to motivate students to start learning. Emphasis is placed on the importance of knowledge and how mastering it will benefit them.
Engagement	Students are asked to research the topic using reliable sources and to relate it to their environment or their own experiences.
Relationship	Group interactions are established, both inside and outside the classroom, sharing knowledge and experiences, and incorporating recognition for progress, however small it may be.
Meaning	To understand the importance of knowledge in acquiring competence in your personal life and how it could be used in professional settings.
Accomplishment	Recognize the achievement of acquired knowledge, differentiating between before and after.

Fig. 1 PERMA applied in the case study in class.

Each topic is adapted to this session plan framework, prioritizing in the assessment system the learning observed by the teacher through the work students do in the classroom, whether individually or in groups. A defined product provides the evidence that supports a grade for each session.

III. Methodology

The research has a quantitative approach, with a correlational scope and experimental design. It uses a methodology based on the scientific method, which consists of the following steps:

- Formulation of the test hypothesis.
- Design of Experiment.
- Data Collection of the Experiment.
- Data analysis.
- Discussion of results.
- Conclusions and recommendations.

IV. Application of Methodology

A. Formulation of the test hypothesis.

This study aims to determine whether there is a significant difference in academic performance when the PERMA model is applied to competency-based education within the Industrial Engineering program at the National Technological Institute of Mexico/TES Cuautitlán Izcalli.

Thus, the null hypothesis states that there is no significant difference between the mean semester grades in the two study periods: sample A from 2019 and sample B from 2023 to 2025. Mathematically, this is observed in Equation (1).

$$H_o\colon \mu_A = \mu_B \tag{1}$$

On the other hand, if the null hypothesis is rejected or not accepted, it would be concluded that there is a significant difference between samples A and B, demonstrating that one would be better than the other.

B. Design of Experiment

Since the PERMA Model began to be partially used in the training of engineers from 2023 onwards, doubts have arisen as to whether it has had a positive impact on the grades of the groups where it was applied or how it has been performed to date.

For this purpose, professors who meet the requirements of having competency-based teaching training, experience teaching the selected subjects, and who implement the PERMA model in their classes are selected. A pilot program was launched in 2023.

C. Data Collection of the Experiment

Within the Industrial Engineering program, the following subjects were considered for this study: Maintenance Management (MM), Operations Research (OR), Project Formulation and Evaluation (PF&E), Economics, and Economic Engineering (EE). The minutes of 10 courses taught from 2023 to the first semester of 2025 were consulted, and a sample of 326 records was obtained, distributed in group sizes as they appear in said minutes. This information, along with the group averages, is summarized by semester in Table 1.

TABLE I
INDIVIDUAL GRADES BY COURSE (SAMPLE B)

Subjet	MM	OR	PF&E	E	PF&E	EE	PF&E	OR	EE	EE
Item	2023-1	2023-2	2023-2	2024-1	2024-1	2024-2	2024-2	2025-1	2025-1	2025-1
1	92	82	89	100	78	89	82	93	98	96
2	79	73	43	98	85	78	78	91	84	92
3	86	82	78	100	64	91	80	93	92	93
4	92	74	85	100	52	96	35	91	94	99
5	97	80	92	100	98	93	94	94	87	98
6	98	70	86	94	82	87	78	89	85	92
7	94	22	83	99	75	97	28	92	98	98
8	98	71	82	100	76	78	85	93	92	81
9	83	87	87	77	85	87	84	85	98	83
10	86	71	90	98	79	94	89	88	79	91
11	97	86	74	75	91	83	77	77	95	100
12	81	58	96	97	91	87	84	88	94	85
13	93	74	57	92	85	93	75	87	98	99
14	89	87	81	86	85	74	84	74	86	82
15	94	74	81	100	81	91	70	93	95	79
16	97	90	93	90	96	82	82	79	77	89
17	97	76	85	97	89	75	85	82	79	96
18	86	87	78	97	73	97	73	91	93	80
19	97	71	93	100	77	88		86	83	83
20	91	81	88	100	81	79		92	98	90
21	97	84	77	93	84	96		86	90	100
22	95	79	94	100		84		93	91	75
23	98	81	83	99		70		93	97	100
24	91	81	95	87		74		87	83	99
25	93	81	84	100		74		92	86	99
26	90	74	82	98		94		93	88	88
27	99	91	89	84		71		94	84	86
28	96	83	86	100		91			81	99
29	89	76	73			85			86	87
30	82	71	75			81			79	89
31	93		88			97			97	83
32	85		82			79			78	88
33	95		76			76			92	93
34	94		81			84			46	98
35	96		73						86	97
36	79		76						98	98
37	97		77						80	100
38			88						85	95
39			79						99	97
40			87						72	100
41			92						92	98
42			86						77	99
43			79						89	91
44									99	88

For reference purposes, six subjects taught in 2019, before the application of this Model, are considered: Operations Research (OR), Simulation Systems (SS), Economic Engineering (EE), and Logistics and Supply Chain (L&SC), with their respective averages, which can be seen in Table 2. For this study, the years 2020, 2021, and 2022 are not taken into account due to the pandemic conditions that may bias the results.

TABLE 2
INDIVIDUAL GRADES BY COURSE WITHOUT PERMA (SAMPLE A)

Subjet	OR	SS	OR	EE	L&SC	L&SC
Item	2019-1	2019-1	2019-2	2019-2	2019-2	2019-2
1	80	84	74	72	86	92
2	62	82	78	88	87	87
3	75	83	79	71	74	90
4	67	87	79	71	81	86
5	83	83	83	81	86	84
6	55	83	78	81	82	80
7	70	84	84	72	86	81
8	80	84	80	75	87	88
9	73	85	73	77	89	90
10	80	73	79	72	86	86
11	80	89	82	70	87	89
12	66	91	81	75	87	93
13	78	90	79	73	83	89
14	82	83	78	74	94	95
15	73	77	79	77	89	90
16	86	90	77	73	80	88
17	69	79	78	78	90	88
18	76	92	80	71	83	87
19	66	81	83	75	81	95
20	78	89	80	74	80	93
21	80	84	71	72	91	84
22	69	95	85	74	95	88
23	58	86	81	74	95	91
24	77	85	73	72	89	93
25	73	88	84	77	88	83
26	76	92		72	80	84
27	76	82		77	88	81
28	64	71		75	82	85
29	81	91		72	89	85
30		89		72	87	84
31		84		70		92
32				71		
33				72		
34				72		
35				75		
36				76		

D. Data analysis

The averages of the group grades are obtained for each semester to identify any trends. Table 3 shows the averages for each semester. The graph in Figure 2 shows a positive slope, resulting in a linear function, as shown in Equation (2):

$$y = 1.15x + 80.73 \quad (2)$$

The first derivative indicates the rate of change in each semester, which in this case is positive, and it shows that the grade increased throughout the study period, as shown in Equation (3).

$$y' = \frac{\partial}{\partial x}(1.15x + 80.73) = 1.15 \quad (3)$$

This is an initial indication that the level of grades has indeed improved, suggesting that this increase is due to the improvement achieved with the implementation of PERMA. However, it is not conclusive unless there is a significant difference between the two periods being compared.

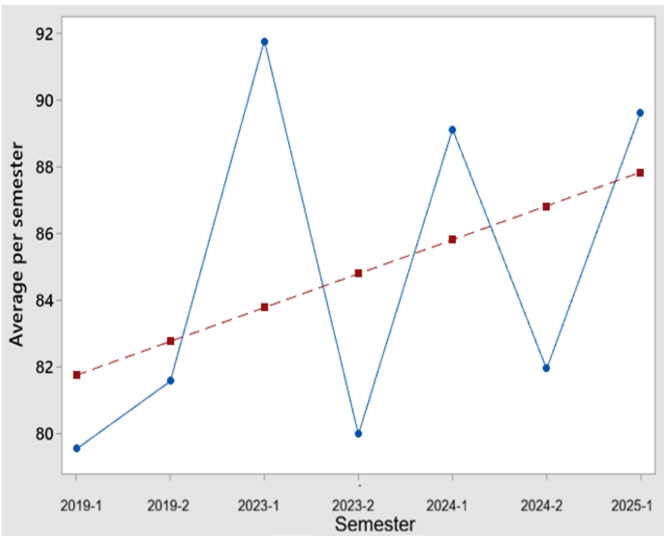

Fig. 2 Mean of courses per semester.

C. Discussion of results

Considering the hypothesis that there is no significant change in the means of the two periods considered, that is, there is no difference between the traditional method of competency-based training, which is called sample A, and the new model that uses PERMA, which is called sample B; the statistical results of both samples are shown in Table 3.

TABLE 3
DESCRIPTIVE STATISTICS OF THE SAMPLES.

	Sample A	Sample B
Mean	80.89	86.407
StDev	7.634	10.863
Variance	58.271	118.01
A^2	0.64	5.69
p- value	0.091	<0.005
n	182	326

Based on this data, it can be concluded that sample A comes from a normal population, since the A^2 statistic, which measures the deviation of the data, is low, and the p-value is 0.091 using a significance level of $\alpha = 0.05$. The graph of its distribution is shown in Figure 3.

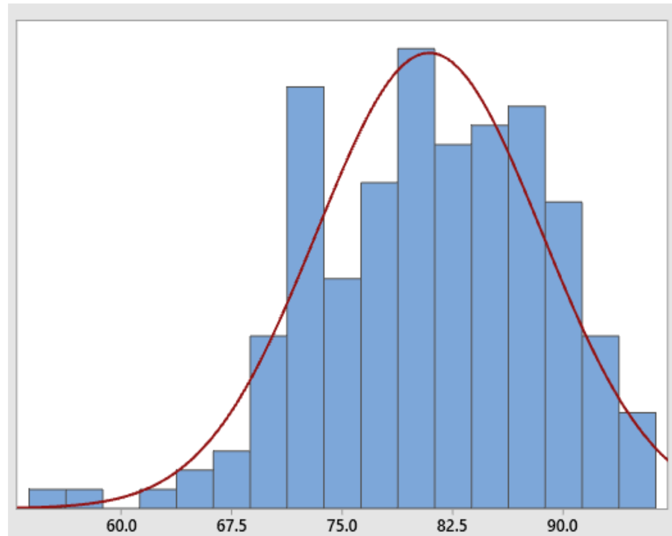

Fig. 3 Graph of the distribution of sample A .

On the other hand, sample B cannot be considered to come from a normally distributed population, since its A^2 statistic is high and the p-value is too low. Figure 4 shows the graph of the sample distribution B. However, because the sample size of B is large (326 observations), by the Central Limit Theorem, it can be assumed that it exhibits a normal distribution. Therefore, inferential statistics for two samples are used in this work to test their significance.

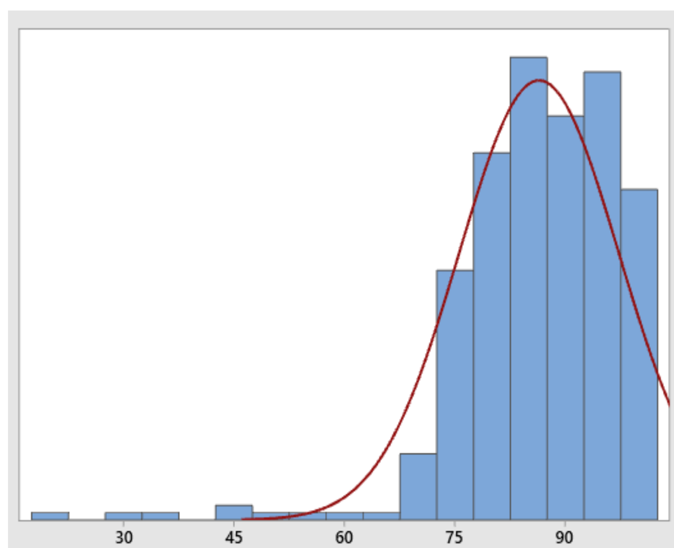

Fig. 4 Graph of the distribution of sample B.

Now, it applied a hypothesis test on the difference in the means of two normal populations. Using the 7-step procedure proposed by Montgomery and Runger [22], it can be concluded that there is a significant difference between the two populations, showing an improvement in the grades of the students to whom the model with PERMA was applied, considering a significance level of 5%, as summarized in Figure 5.

1. To prove that there is an equality of means in the two populations under study.

2. $H_o: \mu_A = \mu_B$

3. $H_1: \mu_A \neq \mu_B$

4. Test statistic $Z_o = \frac{x_A - x_B}{\sqrt{\frac{\sigma_A^2}{n_A} + \frac{\sigma_B^2}{n_B}}}$

5. Reject Ho if the P – value is less than 0.05.

6. Computations: $Z_o = \frac{80.89 - 86.407}{\sqrt{\frac{7.634^2}{182} + \frac{10.863^2}{326}}} = -6.68$

7. Conclusion: Because $Z_o = -6.68$, the P-value is <0.05, so *Ho* must be rejected.

Fig. 5 Hypothesis test on the difference in the means of two normal populations.

V. Conclusions and Recommendations

The positive trend in the function describing the behavior of average grades per semester indicates that student performance in the classroom is improving. Therefore, it can be concluded that there is a significant difference in grades favoring the new competency-based training model supported by PERMA, and thus it can be scaled up for more widespread use by other teachers, school groups, institutionally, and inter-institutionally.

The test of difference of means confirms that there is a significant difference between the means of the two periods under study, so it is concluded that there is an improvement in student performance with a significance level of 5%.

It can be stated that the application of positive psychology techniques, such as the PERMA model, has helped improve student performance, as measured by individual and group grades, and therefore can serve as a suitable reference for improving processes in the training of engineers.

Positivity, engagement, relationships, meaning, and a sense of accomplishment can be seamlessly combined to train engineers who develop critical thinking skills to solve problems in their communities through projects that generate social and sustainable benefits, which is one of the institution's goals.

It is suggested to conduct a nested study with some samples of groups, either with similar or different subjects, taught by teachers not participating in the program, to identify if there is identical behavior, to expand the base of this study, or if there is no gap, to characterize the differences and similarities found in the teaching and learning techniques that were applied with respect to the PERMA model.

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