

Proposal for educational intervention in the face of external aspects that prevent the development of mathematical competence in the training of engineers

Propuesta de intervención educativa ante los aspectos externos que impiden el desarrollo de la competencia matemática en la formación de ingenieros

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Abstract

Objectives To establish a proposal to improve the school performance of engineering students. Methodology: The proposed research methodology was qualitative by the controlled trial method. applied to five groups, 3 of first semester and 2 of fifth semester, to identify the existing problems on academic performance considering as variables: bad grades, adaptation, study habits, reading comprehension, mathematical reasoning, emotional problems. With the results obtained in the diagnosis, some improvement strategies were established and throughout the semester the detected students were accompanied, these strategies were modified according to the pre-results that were given. To compare the results obtained, there was a group of first and another of fifth semester to which the improvement strategies were no longer applied. At the middle and end of the semester, evaluations were applied to identify the effectiveness of the measures used. Contribution: This proposal for educational intervention arises as a result of the pilot test carried out, it contains the actions implemented considering the modifications that were made.

Resumen

Objetivos Establecer una propuesta que permita mejorar el rendimiento escolar de los estudiantes de ingeniería Metodología: La metodología de investigación propuesta fue cualitativa por el método de ensayo controlado. aplicándose a cinco grupos, 3 de primer semestre y 2 de quinto semestre, para identificar los problemas existentes sobre rendimiento académico considerando como variables: malas calificaciones, adaptación, hábitos de estudio, comprensión lectora, razonamiento matemático, problemas emocionales. Con los resultados obtenidos en el diagnóstico se establecieron algunas estrategias de mejora y a lo largo del semestre se fue brindando acompañamiento a los estudiantes detectados, estas estrategias fueron modificándose conforme a los pre-resultados que se iban dando. Para comparar los resultados obtenidos se contó con un grupo de primero y otro de quinto semestre a los que ya no se aplicaron las estrategias de mejora. A mitad y a final de semestre, se aplicaron evaluaciones para identificar la eficacia de las medidas utilizadas. Contribución: La presente propuesta de intervención educativa surge como resultado de la prueba piloto realizada, contiene las acciones implementadas considerando las modificaciones que se realizaron.

Intervention, Educational, Mathematics

Intervención, Educativa, Matemáticas

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Introduction

The present work is motivated by the interest of proposing strategies that allow the optimal development of mathematical competence in engineering students, which is necessary because when they enter the labor field they must be able to identify problems, understand them, reason the possible solution alternatives, innovate to solve and interpret the solutions based on theoretical grounds, likewise this process must be done by collaboratively socializing knowledge.

This is the basic profile that companies require from candidates who intend to work with them. In the labor field, the term that describes the above characteristics is *Mentefactura* and refers to the fact that the engineer must innovate and propose solutions to the various problems that arise in different areas.

The country's public universities in the last 30 years have been immersed 30 years have been immersed in constant changes, therefore, they have had to reform the study programs, reconsidering with this the strengthening of the profile of the teachers, in order to change the ways of teaching classes, and that there is not only a transmission of knowledge, but a teaching based on the learning of the students; in addition to this there is a continuous teacher evaluation.

This process has its origins in 1989 when the Education Modernization Program is established by the government of the republic, through which the path of modernization of education is proposed by mentioning as objectives: the renewal of the educational model, professionalize teachers, infrastructure development based on information technologies, depending on the educational field, being this proposal very well accepted by international organizations such as UNESCO (Rodríguez, 2020).

With this reform, various strategies arise through which they try to "motivate" the updating of teachers in higher education institutions, among them, as mentioned by Rodríguez, (2020), are PRODEP, the different scholarships or economic incentives for teaching performance and / or research, the possibility of sabbatical stays, access to competitive funds established by CONAHCYT, RENIECYT, which over the years has led to economic differences in teachers.

For students, various strategies are also implemented to motivate a better performance, with the emergence of scholarships, national and international mobility programs, modifications to the curricula, including the development of reading and writing comprehension skills and collaborative work (Sectorial programs, 1989; 2001-2006; 2007-2012).

Regarding the educational model, it is stated that the mere transmission of knowledge does not allow higher level graduates to optimally apply their knowledge when entering the labor market; this cannot happen magically, during the course of their careers they must develop this ability, so that the way of teaching, what to teach and how to teach is reformulated, international organizations identify it as education for life, modifications are proposed, concepts such as educational quality are implemented, the union of study programs with social needs is established (UNESCO, 1998) (OECD, 2004).

All of the above is at risk of undergoing a new modification due to the so-called republican austerity.

In spite of this, the institutions of higher education IES, improve their study programs to offer students new perspectives of professional and technical training.

The Technological Universities arise with the interest of offering a new option of higher education focused on the analysis, interpretation and good use of information, within its organizational guidelines is to be linked to the productive sector of goods and services.

Among the "novelties" presented by the Technological University of Puebla, is the offer to finish the degree: bachelor's degree and/or engineering in three and a half years, that is, 3 semesters per year and obtaining the degree of "university technician" after two years.

The policies, strategies and lines of action of this university are based on the 1995-2000 national development plan, in which various strategies are proposed in order to lay firm foundations to overcome the imbalances between geographical regions, social groups and productive sectors. It also proposes overcoming the contrasts between individual opportunities for training, employment and income, and substantially expanding the provision of quality services, which are the basis for a dignified life and productive well-being. These services include health, education and housing (DOF, 31/05/1995).

To date, more than 113 technological universities have been created, which have been adapting to regional changes and requirements, as promoted in the institutional mission and vision.

Causes that affect the formation of engineering graduates

The educational models arise with the intention of solving the different "needs" that society has, and have a reduced validity, depending on the mentioned social requirement, which will be determined by the government in turn.

The central part of the educational model of the Technological University of Puebla is to place the student as the main actor, since learning is the central part in the constructivism model, therefore, the student carries out the search for knowledge through a series of contextualized strategies proposed by the teacher, which aim to facilitate understanding by motivating the creation of knowledge (Vielma & Salas, 2000).

Specifically in the division of mechatronics careers, there are agreements with the productive sector with important companies in the automotive industry such as Audi and Volkswagen, which go in two directions, the graduates with the best averages are "captured" by these companies to go to specialize in the period of "stays" which is the "four-month period" eleven, in which students remain only in the company doing their project and depending on their performance may be hired at the end of this period.

In the last year, the dual program with the two aforementioned assemblers was initiated, which consists of the students doing their admission process with them and after a thorough selection process, they begin their preparation, the technical subjects are taken at the plant and the scientific and human development subjects are taken virtually asynchronously with the Universidad Tecnológica de Puebla, Throughout their preparation, which also lasts 3 and a half years, they are accompanied by tutors from both instances, which achieves a complete training for the graduates, having the opportunity to be "trained" based on the specific needs of the assembly plants, as stated in the vision of the institution.

In compliance with the stated mission, the study programs are designed under the competency-based model and are carried out based on the needs of the productive sector of the region, with 70% practical and 20% theory, and two periods of activities in the industry (Rubio, 2006).

Thus, with the aforementioned actions, the Technological University of Puebla complies with both the mission and vision projected in its Institutional Educational Program.

All of the above is important to "bring it down" to the level of our classrooms, where teachers "train" future graduates, this training should be comprehensive so that everything proposed in the institutional program is achieved in real practice, so that they are able to detect problems and propose innovative solutions,

This is what is intended to be achieved as a result of the implementation of any competency-based program. In each subject, the techniques that teachers will put into practice to achieve the particular objectives and thus "contribute" to the achievement of the institutional mission are proposed from their different approaches.

It is worth mentioning that these implemented techniques depend on the development of technology, the socio-cultural and economic needs of the region, as well as the industrial requirements, so that the graduates can be correctly inserted in the labor market.

As mentioned by Diaz, (2006), in competency-based curricula, different teaching and learning strategies are implemented, whose main intention is the integral formation of students so that not only a transmission of knowledge is carried out, but also a real application of the knowledge that students acquire, thus promoting meaningful learning in each subject.

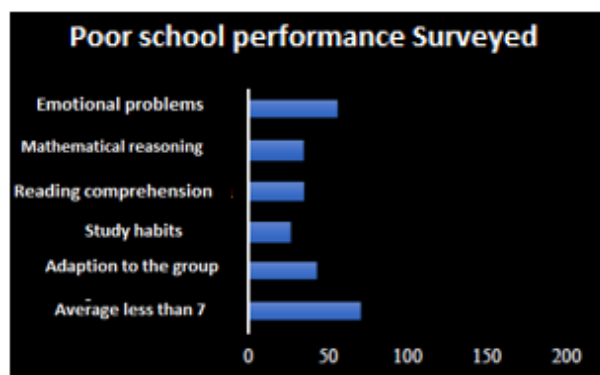
The integral formation of students is not only a matter of acquiring knowledge, it is also necessary as established by the OECD, (2019), to develop civic skills in students so that they have a direct participation in public affairs.

Methodology

As described above this proposal arises as a result of a preliminary implementation where the feasibility of each of the strategies mentioned here was analyzed.

Results

The results obtained in the diagnostic evaluation were:

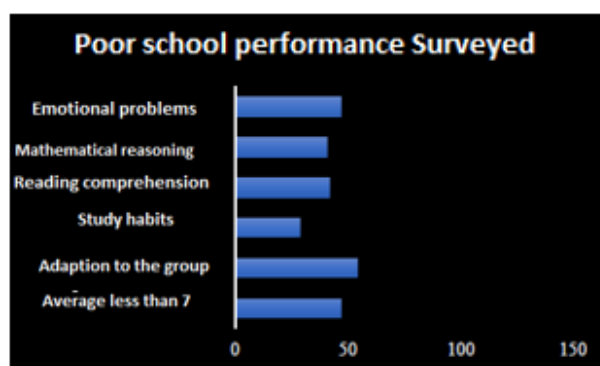


Graphic 1 Diagnostic analysis results

Source: Own elaboration

As can be seen in Graph 1, the 6 variables to be studied have very high values, which shows that they are the causes of the low performance of the students.

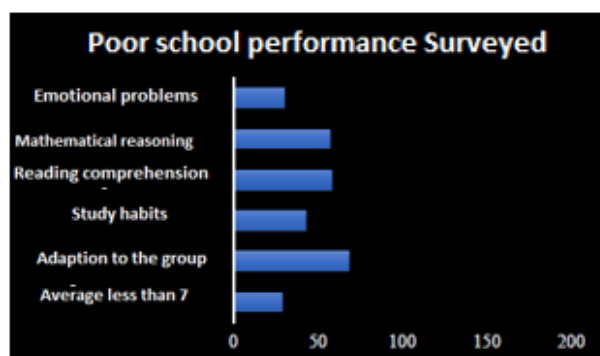
After applying the strategies proposed, the progress achieved was evaluated, obtaining, as shown in Graph 2, an improvement in almost all the items.



Graphic 2 Intermediate evaluation

Source: Own elaboration

At the end of the four-month period, progress was again evaluated and, as shown in Graph 3, improved results in all areas.



Graphic 3 Final evaluation

Source: Own elaboration

From the three evaluations it was seen that by improving reading comprehension, students also improved their mathematical reasoning, which motivates us to continue implementing strategies so that these items continue to increase and thus achieve the development of mathematical competence.

With the results obtained and the modifications that were made along the way, the following educational intervention proposal was developed.

Strategies to implement

As mentioned by Raventós, (2005), the educational crisis we are going through must be fought by using new pedagogical models, new experiences and ideas for the future.

The need to involve the above arises from the requirements of all the educational actors involved, including institutions and society, to carry out an educational transformation through different strategies.

The present proposal is directed in general for the higher level and in particular for the Technological University of Puebla in the division of mechatronics, the areas invited to join this are:

- Address.
- School services.
- Academics: academy of basic sciences, civic-cultural training.
- Students
- Psychopedagogical department.
- External agents.

Work planning

To select the groups to work with in the first stage of the activity, which will be called sample groups.

Analyze the sample groups in order to identify the existing problems on academic performance considering as variables: poor grades, adaptation, study habits, reading comprehension, mathematical reasoning, emotional problems.

The results obtained in the identification of problems are shared with the departments or coordinations involved.

A meeting with the teachers of the group is proposed with the objective of informing about the results of the first identification of variables that impact in our problematic and therefore to establish the strategies that will be carried out in coordination with all the subjects.

The parental tutors of the students with the detected major problems are requested to attend a meeting where the strategies that the institution will implement to support the students will be explained to them.

A meeting is requested with the students with the major problems detected, with the purpose of giving them instructions about the strategies that the institution will implement for their support, emphasizing how their academic improvement will impact their later insertion to the labor field or to the next academic step, given the social, political, cultural and industrial needs of their context, with which it is intended to raise awareness of the need to improve their academic performance.

Considerations to the work planning.

1. The idea of the intervention proposal is presented to the management for the approval of the project.
2. The diagnostic evaluation is carried out by the teachers of the academies of basic sciences and civic and cultural education, considering mathematical reasoning and reading comprehension.
3. A work schedule is presented, specifying the times, progress and actors involved in the reading comprehension intervention proposal for the improvement of mathematical reasoning.

The activities to be carried out by the academic actors:

Analyze the curricula establishing suggestions, activities and/or projects around the topics of reading comprehension and mathematical reasoning.

Establish courses, workshops, and advising in face-to-face, virtual or hybrid mode with the purpose of improving the detected problems.

Develop spaces where the students' progress in the detected problem can be shown, such as a rally or olympiad type contest.

4. Teaching intervention:

Depending on the teaching profile and the different subjects taught, link reading comprehension and mathematical reasoning activities.

Promote student participation during class sessions.

Attention and channeling to the corresponding area when particular problems are detected.

Analysis of formative activities that promote solidarity and collaborative support with students (peer tutoring).

Generation of a reading and reasoning circle that motivates students to learn.

5. Tutorial intervention:

Based on the results obtained on the causes of low academic performance by students and in order to give timely follow-up to the cases, it is proposed: Implement activities of integration, accompaniment and participation of students with the school community, where they can develop both their cognitive skills and their psycho-emotional growth and maturation.

To carry out punctual, continuous and constant accompaniment of the detected students.

Conducting educational events that address issues such as addictions, hygiene, safety, emotional management, family problems.

Promote institutional identity. Promote ethical and moral values.

6. Updating and teacher training.

Promote training within the academic staff in technical, pedagogical and human development areas.

Conclusion

As stated by Elías, (2021), promoting quality education is the commitment of every institution of higher education, whether public or private, to achieve this goal, strategies must be implemented that reflect the concern for addressing the situations that cause conflicts in students and that not only lead to poor school performance but also to a possible dropout, this implies that the strategies must be comprehensive, so that both academic, socioemotional, cultural and physical needs of students and teachers are involved.

The present proposal arises from the need to improve the academic performance of engineering students at the aforementioned university, it is true that the social and health situations that occurred in recent years in Puebla, generated a serious academic delay, which has been dragging level after level, but it is time to implement strategies to remedy the problems that our students have, in the three and a half years they spend preparing in their career should be achieved the development of knowledge, skills, attitudes and aptitudes that they can use to enter the workplace or in the next higher academic degree.

Mathematical competence is more than just solving an exercise in the subject area of mathematics, it is developing critical thinking, it is a way of identifying real problems, modeling them, proposing possible solutions, interpreting the results and proposing improvement strategies, applying mathematical reasoning.

The National Institute for the Evaluation of Education, (2018), stated that the most important part of education is the formation of useful individuals in the labor market, who are able to actively engage as citizens.

Therefore, it is necessary to implement both learning environments and intervention strategies in Universities with the aim of increasing the performance of future graduates and that they are able to achieve metacognition of all the knowledge achieved during their comprehensive training.

Long-term perspectives

It is expected that after the first year of implementing this intervention proposal, the results obtained will be evaluated in order to maintain the actions that worked and correct the strategies that failed.

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