

# Student Motivation in STEM Careers at Three Northwest Universities of Mexico

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## Abstract

Mexico hosts a large number of modern firms, notably in the sectors of aerospace, automobiles, foods and beverages, which employ high-skilled and well-educated workers. Therefore, Graduates from Science, Technology, Engineering, and Mathematics (STEM) fields are both in high demand in the labor market and among the most highly paid. Even though, 30.9% of Mexican employers report having faced difficulties finding people with the necessary skills to fill vacancies in STEM areas. Three universities in the northwest region of Mexico conformed a STEM network aiming to promote enrollment, retention and gender equality on STEM careers. An instrument based on Questionnaire ROSE-Q or “Relevance of Science Education” allowed gathering information that allows measuring relevant indicators to support the design of actions and strategies. The project was carried out with funds granted in 2016 from the **National Council on Science and Technology (CONACYT)**. The main indicators impacting the STEM career choice of students are about cultural training, youth identity, and gender equity.

## Keywords

Motivation, Engineering Students, Higher Education

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## 1. Introduction

The low rate of young people enrolled in the areas of Science, Technology, Engineering and Mathematics (STEM) is a major international challenge. In studies of global innovation, mainly tertiary education, the STEM fields have been identified as a critical determinant in the level of innovation (Soumitra, 2011). In the case of Mexico according to the **National Association of Universities and Institutions of Higher Education**

(ANUIES) (2013), only 20% of young people opt for a STEM career, and with a dropout rate of 50%. The objective of this work is to determine data to understand the factors that define the choice of the young people of STEM careers in three public universities: Autonomous University of Baja California, Polytechnic University of Baja California and University of Sonora Estate.

## 2. Theoretical Framework

### 2.1. STEM Model

The STEM model according to the National Science Foundation (NSF, 2014) of the United States is an attempt to capture the spirit of the education, communities, and the workforce, that include, critical thinking, analysis and teamwork in which students integrate the processes and concepts in the real world, for the development of competencies for the university, work, and life.

At present, the impulse of STEM initiatives has turned into one of the fundamental objectives of the educational planning, not only in countries like United States, United Kingdom or Finland, but also for the whole European Union and various international organizations. Even leading companies in diverse sectors, but overall were linked to the technological field, have joined efforts with public administrations to develop programs or initiatives of technical vocations promotions among the young people (Boe, Henriksen, Lyons, & Schreiner, 2011).

### 2.2. Projected Needs for STEM Professionals in the Future Workforce

The STEM participation challenge arises not only from falling enrollments in some disciplines, as described above but also from projected needs for increases in the STEM work-force in the future. Projections from some countries indicate that the demand for STEM-educated labor will increase during the years to come, and there is widespread concern that the supply of people educated within STEM will be too small to meet future demands (Bjørnstad, Fredriksen, Gjelsvik, & Stølen, 2008).

Agree to the report of OECD (2015), Mexico represents the lowest level of the requirements of the labor market with technological activities of high-level. On this data, 30.9% of Mexicans employers report having faced difficulties to find people with the skills needed to fill the vacancies in STEM areas due to the low levels of innovation in the Mexican economy. Among OECD countries, Mexico has a very low score patent and relevant scientific publications. About the gender gap, although boys and girls have similar skills in math and science, their attitude towards learning and aspirations for the future are markedly different, which has a substantial effect on their decision to continue studies of a higher level and with their choice of career (Archer et al., 2012).

According to research among which stand (Hill, Corbett, & St. Rose, 2010) has shown that men and women have similar capabilities to study science and technology. The gender gap in the choice of careers seems to emerge from attitudinal and socialization aspects that are different in men and women. It has been mainly investigated the negative attitude of the women that happens by the absence of models of scientists and

engineers women in education. The didactics and science class environment more appropriate for men are the male vision of science, social and cultural pressure of gender roles on women (Blickenstaff, 2005).

### 2.3. STEM as a Tool to Encourage Studies in Engineering

The OECD, with the purpose to increase the economic development of the country, sets educational policies for Latin America based on the STEM. The model combines a number of different types of content that emphasize educational strategies with the objective of motivate and avoid drop-out of students in engineering. For example, temporary stays in companies for practical application of the knowledge acquired in the university, implementation of experiential workshops, critical reading, debates, panel discussions, critical thinking, fairs and contests of science, clubs, and research networks at the universities, are applied as workshops and talks of successful mentors in the STEM areas. The STEM participation was eliminated.

## 3. Methodology

The applied instrument, Relevance of Science Education Questionnaire (“ROSE-Q”), aims to investigate the intrapersonal and interpersonal factors skills that may influence the choice of STEM courses, consists of open and closed questions (Schreiner & Sjöberg, 2004). Five questions were chosen that investigate: school of origin, gender, the importance of the academic experience for career choice, perception on the importance that had some people for the career selection and opinion on aspects of daily life as a student. The application of the ROSE-Q questionnaires was carried out to first-year students on STEM careers from three universities, undertaken during the period of the month of May-August of the year 2016. The total enrollment of students in engineering area among three universities was 6064 students, of which 1421 responded or sample of 23% of entire population.

The key feature of ROSE is to gather and analyses information from the learners about several factors that have a bearing in their attitudes to Science and Technology and their motivation to learn. The purpose of rose is not testing of achievement studies as Trends in International Mathematics and Science Study (TIMMS) or Program for international student assessment (PISA), but rather to address attitudinal and motivational aspects. ROSE is not a procedure for measuring a construct. However, items clusters in this study may emerge from the data analysis, and not from a clear explication of the instrument (Henriksen, Dillon, & Ryder, 2015).

## 4. Results and Discussion

The results show that the profile of the career choice through the responses of the women students to some of the items of ROSE-Q, which analyzes intrapersonal and interpersonal elements of students of the three participating institutions.

- Average student participation in all universities was 23.4%. UABC with the highest enrolment showed the smallest sample size with 15.2%. On the other side, UES

- sample size went up to 65.4% as engineering enrolment is the smallest (see **Table 1**).
- It is important to highlight that only 26.6% of the students surveyed are women enrolled in the STEM areas, so we can observe that there is a gender underrepresentation (see **Table 2**).
  - An 84.4% of students feel motivated only if they have an interest in the subject, continuing with knowing with certainty that they obtained the correct answer 76.9%. And finally, with 74.2% the students value classes that include a practical applications of the subject (see **Table 3**).

**Table 1.** Breakdown of participation of each institution involved in the study.

Institution	Table Column Head			
	Total enrollment at the moment of study	Engineering enrollment	Participating STEM students	Participation (%)
UABC	65,323	4,314	659	15.2
UPBC	1,472	1,342	495	36.8
UES	2,021	408	267	65.4
Total	68,816	6,064	1,421	23.4

**Table 2.** Students by gender.

Gender	N	%
Female	378	26.6
Male	1043	73.4
Total	1421	100

Students surveyed enrolled in the STEM areas.

**Table 3.** Perception on the importance of the school experience for the career choice.

Aspects to be value	Value scale (%)				
	Not important	Slightly important	Neutral	Important	Very important
Interest in related topics	0.7	1.1	13.8	34.1	50.3
Previous performance in related topics	2.1	3.8	24.6	42.0	27.5
Experiments and laboratory works	5.5	10.1	24.1	32.7	27.5
Fieldwork or excursions	8.4	13.2	25.9	26.0	26.5
Classes that show importance of topic to society	4.9	9.1	24.3	35.1	26.6
Classes that show practical application	1.9	5.1	18.8	37.5	36.7
The use of mathematics in classes	3.5	5.8	19.3	30.8	40.7
Know with certainty that got the correct answer	2.1	3.4	17.6	33.1	43.8

Aspects related to the importance of the education experience for the career choice.

- In general, students reported with regular and low percentages, the influence that some people had to carry out the election of the career. In the first place, with the highest score, 54.5% the influence to have had good teachers. In the second place, 53.0% said that the mother or stepmother, following in 48.9% the father or stepfather (see **Table 4**).
- High percentages resulted on comments about aspects of everyday life as student, 96.6% value their overall experience as students, 96.3% enjoy the social relationship with classmates, and 84.20% felt that they could go to the pace of the class. Also, students found better than expected in a 49.8% interesting contents of the career and 37.5% the quality of teaching (see **Table 5**).

**Table 4.** Perception on the importance that had some people for the election of the career.

Aspects to be value	Value scale (%)				
	Not important	Slightly important	Neutral	Important	Very important
Mother or stepmother	16.0	10.9	19.1	16.1	37.9
Father of stepfather	22.3	11.2	17.6	15.5	33.4
Good teachers	12.2	9.4	22.9	29.3	26.2
Friends (including boyfriend or girlfriend)	23.8	14.4	23.0	18.8	19.0
Sisters/Brothers and other relatives	24.1	14.6	21.7	17.2	22.3
Guidance counselor at school	27.9	16.3	23.4	17.9	14.4

Aspects related to who support on career choice.

**Table 5.** Opinion on aspects of everyday life as a student.

Aspects to be value	Value scale (%)		
	Worse than expected	As expected	Better than expected
The overall experience of being a student of this career	3.4	64.9	31.7
The social relationship with classmates	3.7	56.3	40.0
The quality of teaching	3.1	59.4	37.5
How interesting is the content of the career	2.3	47.9	49.8
The effort made in the study (worse mean more effort)	15.8	62.8	21.4

Aspects related to the importance of everyday life as student for the career choice.

## 5. Conclusion

As a conclusion, we observed that young people more and more are informed at the time of choosing a career, which is very positive since allowing decreasing the rejection to this type of areas. The aspect of support for the career choice highlights the importance of having good teachers and in the second place, the figure of the mother as the primary support for choosing a career in the STEM area. Regarding their everyday life

as a student, the highest score obtained was to enjoy the company of others and that they felt socially accepted, a valuable data piece to promote the retention, taking into account that they are first-year students.

Finally, the scheme of learning of programs related to the areas of science, technology, engineering, and mathematics. It is recommended to be incorporated into the contents of the study plans to promote them from an early age, to achieve awakening the interest in both sexes. Especially, women have to develop teaching-learning activities under the STEM approach with the purpose of changing their cultural perspective, and try to persuade.

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### Conflict of Interest Declaration

The authors declare that there is no conflict of interests related with this investigation, the authorship and/or the publication of this paper.

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