ISSN: 2594 - 2905

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https://doi.org/10.61117/ipsumtec.v7i2.346

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Abstract -- Equality of educational opportunities in Mexico was and has been a pending and slow subject the opinion of academics. The study of mathematics as a subject for professional development was influenced mostly by gender stereotypes, this one mostly focused on the development in this field of science, which is considered to be more male dominated.
This article was a brief analysis of the poor participation of women in mathematics and related sciences, taking as a sample, the low percentage of women in the Mexican Mathematical Society over the last 50 years.

Keywords: Gender equity, women in mathematics, Gender equity in mathematics.

Abstract -- Equality of educational opportunities in Mexico was and has been a pending subject and, slow in the opinion of academics. The study of mathematics as a subject of professional development was largely influenced by gender stereotypes, this mostly focused on development in this field of science and which is estimated to have a greater male predominance.
This article was a brief analysis of the poor participation of women in mathematics and related sciences, taking as a sample the low percentage of women in the Mexican Mathematical Society over the last 50 years.

Key words - Gender equity, women in mathematics, Gender equity in mathematics.

INTRODUCTION

Since the time of the conquest with the founding of the Royal University of Mexico, the development of mathematics in Mexico began and later with the establishment of the mathematics degree at the Autonomous University of Mexico (UNAM) in 1937, together with the founding of the Mexican Mathematical Society (SMM) in 1943, historical events that could be considered as the beginning of the establishment of a formalized current of organization of mathematicians with related purpose; in this same year the UNAM granted for the first time a degree in mathematics; three women were awarded degrees at the end of the thirties: Rosa Aguirre Sánchez, Carmen Alburquerque García and Ana María Flores.
Of course, it would be very important to mention what is considered the first advanced mathematics course taught in Mexico, given at the Escuela Nacional de Altos Estudios in 1912. It was a course on analytical functions whose professor was Sotero Prieto (1884-1935). It is important to note at this point, that historically mathematics in our country, as an organized guild, is relatively young, with only 78 years of existence in an activity developed and used since antiquity as demonstrated in 1832 by Constantine Rafinesque (1783-1840) when he interpreted the Dresden codex and found series of recurring lines and points in images and glyphs from the ancient Mayan region of Báak', now Palenque in the state of Chiapas.

Therefore, without a doubt, the initiators of this transcendent event were the milestone for the development of this science in Mexico. All of them were very valuable people, but without a doubt it should be noted, delving deeper into

Received: 09/21/2024 | Acceptance: 11/04/2024| Publication: 12/27/202

the subject of the article, that, of the 131 founding Mexican mathematicians members of the SMM, 5 of them were women: Enriqueta González, Rita López de Llergo, Sara Rodríguez de Ayala, María Guadalupe Lomelí, Patricia Saavedra and Paris Pishmish, the latter the only one not born in , of Turkish origin. They represented only 3.8% of the affiliates, women of great courage and commitment, dedicated to this field at such a difficult time for their era. We will have to wait 70 years to follow their example and in 2013, in a historic event, the Commission for Equity and Gender (CGE) was created in the SMM, established with the purpose of promoting the inclusion of underrepresented groups and mainly, to promote the inclusion of women in the mathematical activities of the country.

At the dawn of the 21st century, concern arises in certain sectors of the community concerned in , by the scarce participation of women in the disciplines of the exact sciences, which causes a broad reflection of the guilds and feminist associations of the social machinery, which envision a competitive lack of women in scientific and technological development and, therefore, a marked gender disadvantage in this area. Several researchers agree that historically mathematics has been typified as a male domain preserve, a situation that limits their participation as students and professionals in mathematics mentions Jiménez, 2016 [6].

In Mexico it is known that as in many other countries, there is a higher number of women enrolled in careers in social sciences and humanities disciplines than in exact sciences and engineering, stated Espinosa. 2010 [5]. Undoubtedly, women prefer traditional disciplines that are geared to certain social statuses, historically as a continuation of assigned roles.

Let us establish a starting point and a vision this problem or dilemma that is presented as a mere condition of social survival or as a mere nucleus of acquired interest, since as human beings we are conditioned by the stimuli that seem familiar to us.

Is it that there are no opportunities for women to have access to careers in hard sciences? Or perhaps gender equity is a social precept established under a norm of a social historical nature, or is it just that greater academic development is needed in the country and this can only be achieved when mathematics covers more time in the national historical evolution? Our purpose for the moment is to establish a starting point to set the parameters and lines of work in this problem. In the field of education in Mexico, particularly in higher education, some works by Olga Bustos can be consulted, where she makes a detailed follow-up of what has been done to advocate for gender equity, as mentioned in Bustos, 2003 [20]. In the case of science and technology, where the world lags furthest behind in achieving gender equity, it is important that girls and young women be introduced to these subjects.

As an advance in this lag, we point out that in Mexico in 2014, the SMM organized the first meeting of Mexican mathematics specifically from 23 to 26 January 2014 in the city of Queretaro, Mexico and undoubtedly this congress marked a historic moment in mathematics in our country, because it is the first time that researchers and teachers in the area of mathematics are involved and meet with the common purpose of enhancing and promoting the study of this beautiful branch of pure science with a common precept, to promote social acceptance for research.

DEVELOPMENT

The purpose of this study is mainly historical, hence the method used, it seeks to establish a reliable knowledge of the past by analyzing historical sources to verify their accuracy and reliability.

The study period includes the years 1970-2022, these years were selected as the beginning of each decade, so they were chosen as starting points, also as a representative sample of the current numerical situation of women enrolled in mathematics careers, so we highlight the temporal context with the emergence of new currents in the mathematical field according to their appearance in university careers, such as: statistics, applied mathematics, mathematical engineering, among others.

The historical-statistical intention is to capture the participation of women in mathematics careers in order to construct indicators that show a broad and detailed picture of the representation of women in this science.

In 1965 there were twelve science faculties in the country, of which seven offered a degree in Mathematics (Faculty of Sciences of the UNAM, Higher School Physics and Mathematics of the IPN, School of Higher Studies of the University of Sonora, Technological Institute of Monterrey, Autonomous University of Nuevo Leon, University of Veracruz and Autonomous University of Yucatan). The number of mathematicians in the entire republic amounted to approximately 120 (Arvizu, 1998) [10].

By the year 1970, the total number of mathematics students in the country amounted to 1,226, of which 330 were women, which means that women studying mathematics in that decade was 26%. It should be noted that the increase in the number of students enrolled in mathematics is somehow related to the diversification of the line of studies in the mathematical field, since then, it has specialized and branched out into other fields.

In the eighties, new lines of study were added, mathematics and computing and applied mathematics, adding more lines of research, encouraging young people in general to be attracted to these careers.

In passing, we will mention that one of the last mathematics careers to be incorporated into the development of research is the career of Educational Mathematics, as well as Mathematical Engineering.

Well into the 21st century, in recent decades we have witnessed a notable increase in the use of the words gender and equity in different social spheres. These two words appear frequently in official speeches, in different kinds of political debates, feminist protests, political campaigns, etc. Gender and mathematics studies in our country are little more than two decades and most of them have focused on the social strata, not specifically in the academic area or related to the scientific environment.

The professional presence of men traditionally in a number of professional activities in certain areas such as mathematics, physics and technology, according to Olaz, 1997 [3] and Salomone, 2007 [4]. In the case of mathematics, it has been historically observed that women have been socially denied access to mathematical knowledge and management, as shown by the data in the table in Figure 1. Eradicating gender stereotypes by area of knowledge, mainly in science and mathematics, should be an educational policy at all levels of formal education (González, 2005) [20]. If mathematics is seen in an absolutist, immutable, static, unchangeable and universal way it would have a pessimistic vision for women; knowing the limitations, biases and structure of beliefs regarding mathematics helps to determine how it should be changed, affirms Chavarría, 1994 [1].

Table 1. Percentage female student population in mathematics majors.
No data were found for 1960.

Año	Carrera	Número de estudiantes	Número de mujeres	Porcentaje representativo de mujeres
1970	Matemáticas Estadística	1226	330	26%
1980	Matemáticas Estadística Fisicomatemática	2017	483	24%
1990	Matemáticas Matemáticas Aplicadas Fisicomatemática Estadística Matemáticas y Computación	5706	1789	31.35%
2000	Matemáticas Matemáticas Aplicadas Fisicomatemática Matemáticas y Computación Matemática Educativa Ingeniería Matemática Estadística	6578	2246	34.14%
2010	Matemáticas Matemáticas Aplicadas Fisicomatemática Matemáticas y Computación Matemática Educativa Ingeniería Matemática Estadística	8759	3457	39.46%
2020	Matemáticas Fisicomatemática Matemáticas Aplicadas Estadística Matemáticas y Computación Matemática Educativa Ingeniería Matemática	11237	3661	32.57%

The data recorded in the table above show their flow of female presence in mathematics-related careers.

Table 2 shows the stratified behavior of students enrolled in mathematics programs during the last 50 years. In 1970 there were only two mathematics majors, bachelor's degree in mathematics and bachelor's degree in statistics, of which a total of 1266 students, 1197 belonged to the mathematics major and 69 to the statistics major, correspondingly, 303 (25.3%) women in mathematics and 27 (39.1%) in statistics; for the year 2000 the students registered by major: mathematics 3,062, statistics 321, mathematics and computer science 2,344 and engineering in mathematics 321.

Student population in mathematics majors 1970-2020 and the percentage of female participants. Data from the ANUIES statistical yearbook.

Año	Carrera	Número total de estudiantes	Número de mujeres	Porcentaje de mujeres
1970	Matemáticas	1197	303	25.3%
	Estadística	69	27	39.1%
1980	Matemáticas	1154	376	32.5%
	Estadística	491	196	39.9%
	Matemáticas Aplicadas	88	45	51.1%
1990	Matemáticas	3110	748	24%
	Matemáticas Aplicadas	336	121	36%
2000	Matemáticas	3062	1151	37.5%
	Ingeniería Matemática	321	144	44.8%
2010	Matemáticas	5787	2345	40.5%
	Matemáticas Aplicadas	457	158	34.5%
	Matemática Educativa	348	169	48.5%
2020	Matemáticas	6759	1724	25.5%
	Matemática Educativa	298	125	41.9%
	Ingeniería Matemática	1054	378	35.8%
	Matemáticas Aplicadas	2896	925	31.9%

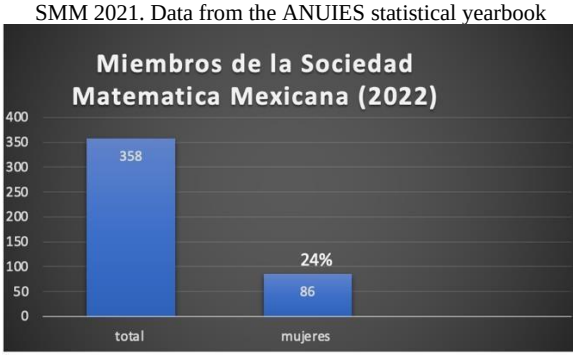
It is important to mention at this point that the career of mathematical engineering is only offered in the country in two institutions which are: the Autonomous University of Chihuahua and the National Polytechnic Institute , the career of Educational Mathematics is only offered by the Autonomous University of Guerrero and the Autonomous University of San Luis Potosi, educational mathematics with a percentage of female students that hovered around 42% and in 2010 amounted to 48.This is why it can be considered as the career that achieves equity between men and women who study it, but not the Mathematics career that does not exceed one third of the total enrollment that year, since only 1 out of 4 students is a woman.

The University of Colima, the University of Montemorelos and the Autonomous University of Yucatan have a degree in mathematics teaching, and the Autonomous University of Baja California is the only university in the country that has a degree in mathematics teaching.

In 2020, the situation continues to show a very marked disproportion between genders; however, it is important to note that in 2010 the mathematics program has the highest percentage of women studying it.

The graph in Figure 2 shows the SMM registry data for the year 2022, which reveals that it has 358 registered members (consulted in 2022) of which 86 are women, representing 24%, a representative percentage very close to the years studied in this article.

Figure 1. Graph of the percentage of women affiliated to the SMM 2021. Data from the ANUIES statistical yearbook



DISCUSSION AND ANALYSIS OF RESULTS

This study is limited to analysis of the participation that women have had in the area of mathematics from past to present decades. The contribution of Sanchez Guevara, Irene, 2019 [17] mentions that "The scientific work of women in mathematics generated remarkable results in the discipline. To get there, the transcendental thing was their struggle and the strategies developed to realize the passion of their lives".

Seeking to emphasize the percentage below that represented by men, Gamboa Araya Ronny [18] states that, "Since mathematics began to be professionalized, around the eighteenth century, the ability of women to devote themselves to it was questioned".

In contribution of Mizael Salces, Salces, A. M. 2018 [19], "recent research shows that much of observed differences can be attributed to sociocultural differences and situations of discrimination of women in society".

It can be observed that, over time, this participation has been increasing as shown in Figure 2, a strength that is worthy of praise. Following this analysis, the aim is to continue collecting and analyzing data and information on women's participation in this area since the last date investigated.

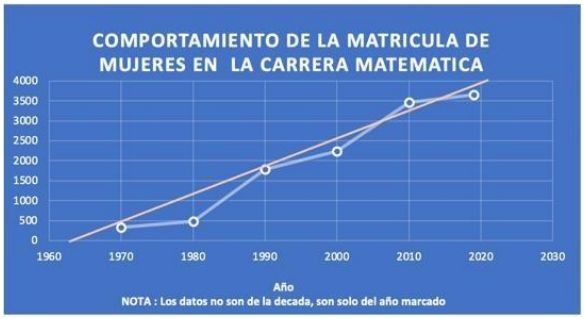


Figure 2. Graph of the behavior of the female population in mathematics careers. Data from the ANUIES statistical yearbook

CONCLUSIONS

Undoubtedly, since the seventies, the percentage of women in mathematics has remained well below the average, this makes us assume that there is a male dominance in this career, however, with modernity, there is an opening for the participation of women in science, from the beginning we know that the development of an inclusive society enables the dimension without gender distinction in universities, the search for gender equity is a central element of a globalizing vision of education, in addition, higher education has as its objective the formation of capacities and attitudes of individuals for their insertion into society as beings capable of regulating the status quo and at the same time transformers of social reality in pursuit of the values in force at a given historical moment. G., Resendiz, M., & Faro, T. (2012) (Barrios, 2012 [2].

The XXI century is a century of re-evolution of the social roles of men and women in their communities to carry out public policies and actions aimed at the benefit and common welfare, from an early age it is important to encourage girls to be interested in science as a means of liberation from prejudices and social vices and for the development of themselves in a changing and revolutionary society of the game of pre-established roles. If we assume for the moment that gender inequality constitutes obstacle to integral human development in our society.

Although considering that the statistical results shown in this research are promising, it would be important to emphasize and be attentive to an analysis of subsequent years in order to make an analytical contrast of the behavior of this past decade and to establish, as far as possible, parameters for statistical measurement of the behavior of enrollment in the different universities in the country that have in their educational offerings a mathematics degree program, It is also necessary to observe the number of women with membership in SMM, and thus take these data as a sign of approach to the behavior of the number of women enrolled in this last decade.

Therefore, we leave the door open to researchers interested in this sociocultural phenomenon of women's vocation to pursue the different mathematics careers offered in the different institutions of higher education in Mexico. The search for gender equality is the neuralgic point for the achievement of the objectives of the digital era and a clear proof that there is still a long way to go to achieve it is precisely a greater participation of women in mathematics careers and related areas, that this is a central element in the vision of educational systems and not only in the field of mathematics but in most science careers in which they are still stigmatized by women themselves.

The data and reflections presented in this article have the sole purpose of showing the historical presence of women in mathematics careers, in order to create a moment of introjection and reaffirm the importance of gender equity in the enrollment and practice of scientific and technological careers.

BIBLIOGRAPHY .

[1]Chavarría, S. (1994). Gender biased mathematics. Revista de Ciencias Sociales, Mexico. [2]Barrios, J. G., Resendiz, M., & Faro, T. (2012). Brief analysis of the concept of Higher Education. Alternativas en psicología, Mexico.

[3] Olaz, F. (1997). Self-efficacy, gender differences and vocational behavior. Electronic Journal of Motivation and Emotion. Spain.

[4] Salomone, R. (2007, September-December). Equality and difference. The issue of gender equity in education. Revista española de pedagogía, 65(238), 433-.

446. Guía, C. G. E. (2010). Differences between men and women in mathematics education: What happens in Mexico? Investigación y Ciencia, Mexico.

[5] Espinoza, Claudia Gisela (2010). Difference between men and women in mathematics education, what happens in Mexico, Revista investigación y ciencia de la Universidad Autónoma de Aguascalientes # 46 28-35 March 2010, Mexico.

[6] Jiménez, Rosa María (2016). Women mathematicians: analysis of the case of Mexico. Cuestiones de género: de la igualdad y la diferencia, UNAM, Mexico.

[7] Everett, Caleb (2019). The numbers, they made us who we are. Critica, Drakontos. Editorial Planeta. Barcelona. Spain.

[8] Garcia de Leon, (2005), Porfirio, Mujeres pioneras de la sociedad matemática mexicana" in Blazquez, Norma and Flores, Javier (eds.), Ciencia, Tecnología y Género en Iberoamérica. - Plaza y Valdés. CEIICH-UNAM, Mexico.

[9] Barrera, P. S (2012). Academic trajectory of women mathematicians in Mexico. Universidad Autónoma Metropolitana, Iztapalapa, Mexico.

[10] Arvizu, M.A. (1998): Physics and mathematics competitions in search of talent and vocation. Mexico.

[11]Ursini, S., & Ramírez, M. (2017). Equity, gender and mathematics in Mexican schools. Revista Colombiana de Educación, Colombia.

[12] Jiménez, Rosa María (2016). Women mathematicians: analysis of the case of Mexico. Cuestiones de género: de la igualdad y la diferencia, Mexico.

[13] National Association of Universities and Institutions of Higher Education 1977, 1980, 1985),
1990, 1995, 2001): Statistical yearbooks. Undergraduate school population in universities and technological institutes. Mexico: Asociación Nacional de Universidades e Instituciones de Educación Superior.

[14] Galaz Fontes Jesús Francisco and Gil Antón Manuel (2009), La profesión académica en México: un oficio en

reconfiguration process. Electronic Journal of Educational Research. México.
[15] ANUIES, (2000), Statistical Yearbook 1980, 1990, 2000. Mexico.
[16] ANUIES, Anuario Estadístico de educación superior ciclo escolar: 2010-2011, 2019-2020. Mexico
[17] Guevara, I. S. (2019). The legacy and struggle of twelve western women mathematicians. Politics and Culture, (51), 172-193.
[18] Araya, R. G. (2012). gender equity in mathematics education? Educare Electronic Journal, 16(1), 63-78.
[19] Salces, A. M. (2018, September). Gender, culture and performance in mathematics. In Anales de la Universidad de Chile (No. 14, pp. 125-150).
[20] Bustos, O. (2003), "Mujeres y educación superior en México. Recomposition of university enrollment in favor of women. Educational, economic and social repercussions". Mexico.
[20] González, R. M. (April, 2005). An explanatory model of interest in mathematics among high school students. Educación Matemática, 17(1), 107-128.

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