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Gender Disparity in STEM Education: Cracking the Code in Mexico

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Abstract

Despite recent improvements in expanding access to STEM education in the world, many countries, including Mexico, are concerned about gender disparity in STEM studies and career. Gender-based discrimination, social and cultural norms, and other factors prevent Mexican girls and women from having equal opportunities to contribute to, and benefit from, STEM. Equal and high-quality STEM education for these girls and women would equip them with the knowledge, skills, attitudes, and behaviors required to address the 2030 Agenda for Sustainable Development. Using the UNESCO's ecological framework, this article aims to explore the factors that influenced four Mexican female STEM professionals' pathways to STEM studies at the individual, family, school and societal levels."

Keywords: STEM, gender disparity, Mexico, STEM education, higher education

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0. Introduction

Despite continuing global efforts and improvements in the past decades, access to education is not universally available and gender inequality remains a major concern.[1] The gender gap in science, technology, engineering, and mathematical (STEM) education has been extensively researched.[2] [3] [4] Ensuring girls' and women's equal access to STEM education and ultimately STEM careers is imperative to human rights agenda, scientific, and development perspectives.[5] In 2015, the 2030 Agenda for Sustainable Development[6] was adopted by the United Nation's General Assembly and the United Nations Educational, Scientific, and Cultural Organization (UNESCO) and played an integral role in shaping this agenda as well as actively contributing to its implementation ever since.

The 2030 agenda addresses seventeen important worldwide goals referred to as the Sustainable Development Goals or SDGs which demand global action to transform the financial, economic and political systems that govern our societies today to guarantee the human rights of all.[7] In this regard, UNESCO's actions contribute significantly to nine SDGs among which stand ensuring inclusive and equitable quality education at all levels for everyone (SDG4), achieving gender equality and empowering all women and girls (SDG5) as well as highlighting the growing importance of science, technology and innovation for sustainable

[1] UNESCO. *Cracking the Code: Girls' and Women's Education in Science, Technology, Engineering and Mathematics (STEM).* Paris, France: UNESCO. Accessed October 2020. https://unesdoc.unesco.org/ark:/48223/pf0000253479?posInSet=3&queryId=f1d154ad-a328-452f-96fc-36e90940cd91.

[2] Friedman, Lynn. "Mathematics and the Gender Gap: A Meta-Analysis of Recent Studies on Sex Differences in Mathematical Tasks." *Review of Educational Research* 59, no. 2 (1989): 185-213. https://doi.org/10.2307/1170414.

[3] Hyde, J. S., and Fennema, E. and Lamos, S. J. "Gender differences in mathematics: A meta-analysis." *Psychological Bulletin*, no. 2 (1990): 139–155. https://doi.apa.org/doiLanding?doi=10.1037%2F0033-2909.107.2.139.

[4] Becker, B. J. "Gender and science achievement: a reanalysis of studies from two meta-analyses." *Journal of Research in Science Teaching*, no. 2 (1989): 141–169. https://onlinelibrary.wiley.com/doi/abs/10.1002/tea.3660260206.

[5] UNESCO, "Cracking the code" 72.

[6] UN General Assembly, *Transforming our world: the 2030 Agenda for Sustainable Development* , 21 October 2015, A/RES/70/1, available at https://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E.

[7] "The Sustainable Development Goals Report," Zhenmin, Liu, accessed April 15, 2021. https://unstats.un.org/sdgs/report/2020/.

development (SDG 9),[8] all of which highlight the significance of addressing gender disparity in STEM education.

The gender gap in STEM education starts in early childhood and widens as girls lose interest in these fields with age.[9] In higher education, more women study education, arts, health, welfare, humanities, social sciences, journalism, business and law, while STEM-related fields are male-dominated, with male students making up the majority of those enrolled in engineering, manufacturing, construction, information and communication technology studies. (Figure 1)[10]

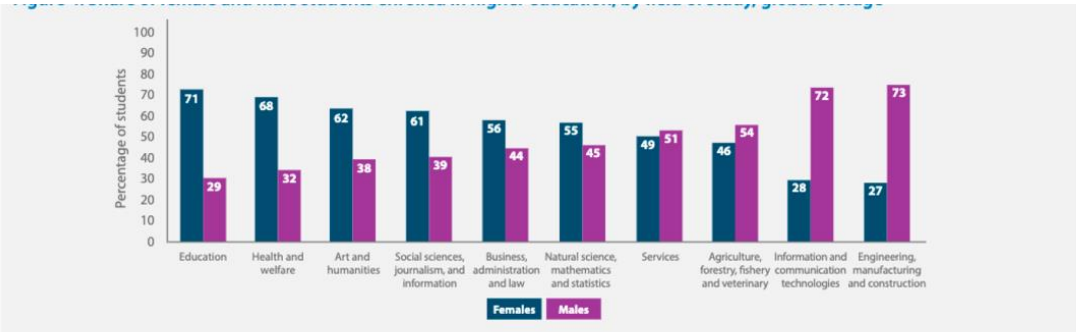

Figure 1: Share of female and male students enrolled in higher education, by field if study, global average.

Only 30% of female university students in the world pursue STEM-related fields, with significantly low enrollment rates in information and communication (3%) as the lowest, followed by natural sciences, mathematics and statistics (5%), engineering, manufacturing and construction (8%), and health and welfare (15%). (Figure 2)[11]

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[8] UNESCO. *UNESCO moving forward the 2030 Agenda for Sustainable Development.* Paris, France: UNESCO. Accessed April 2021. https://en.unesco.org/creativity/sites/creativity/files/247785en.pdf.

[9] Simon Marginson et al., *STEM: Country Comparisons.* Melbourne, Victoria: *Australian Council of Learned Academies (ACOLA)*. Accessed April 2021. https://dro.deakin.edu.au/eserv/DU:30059041/tytler-stemcountry-2013.pdf.

[10] UNESCO, "*Cracking the code,"* 20.

[11] UNESCO, "*Cracking the code,"* 20.

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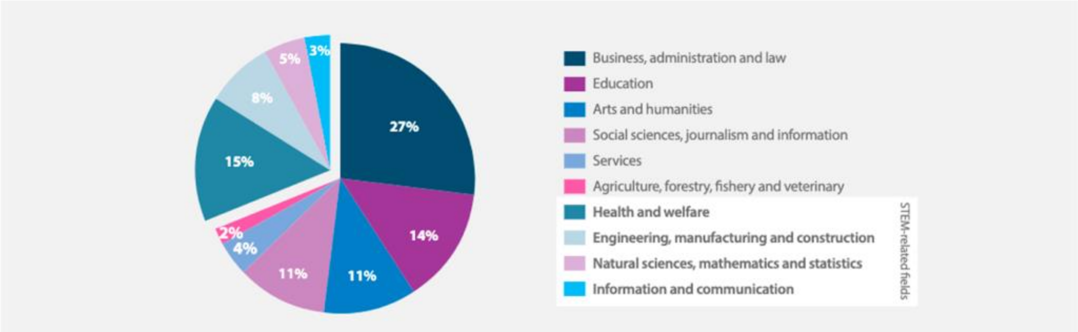

Figure 2: Distribution of female students enrolled in higher education, by field of study, world average.

Other data from UNESCO's STEM and Gender Advancement (SAGA) project indicates that gender gap is evident in science and grows with students transition from undergraduate to postgraduate levels. UNESCO's 2008 and 2014 data from 226 countries show that the number of female science researchers substantially dropped from about 55% at master's level to around 45% and 30% in doctoral and post-doctoral levels.[12] (figure 3)

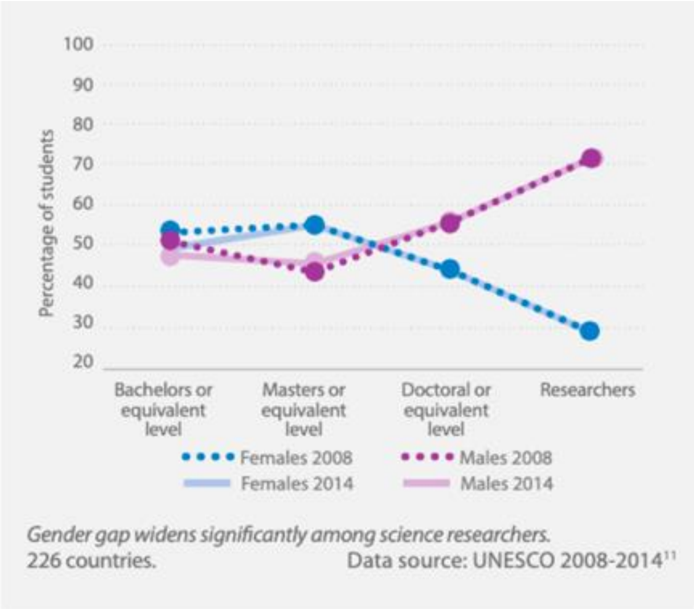

Figure 3: Proportion of women and men in higher education and research, world average

[12] UNESCO. *STEM and Gender Advancement (SAGA).* Accessed October 2020. http://www.unesco.org/new/en/natural-sciences/priority-areas/gender-and-science/improving-measurement-of-gender-equality-in-stem/stem-and-gender-advancement-saga/.

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Gender Disparity in STEM Education in Mexico

Mexico's challenges regarding gender disparity in STEM education start in the first years of mandatory education with students' poor performance in math and science as data from PISA[13] 2018 indicates. According to these results, Mexico's scientific and mathematical performance[14] is below the OECD[15] average. On average, Mexican 15-year-old boys scored higher than girls in both mathematics and science. (Figures 4 &5)[16] [17]

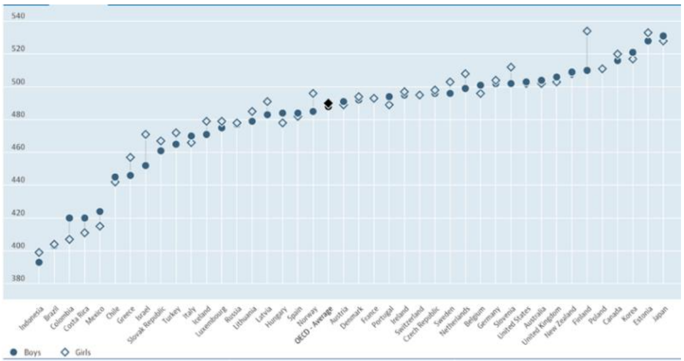

Figure 4: Science Performance (PISA) Boy/Girls, Mean score, 2018

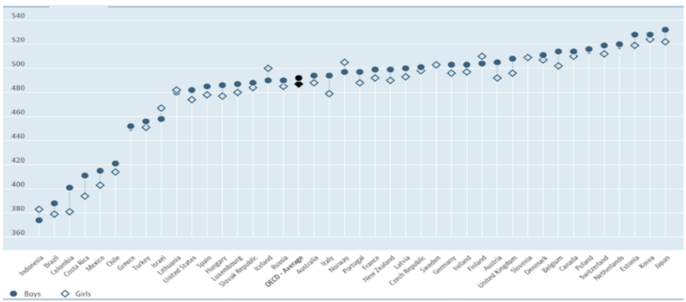

Figure 5: Mathematics performance (PISA), Boys/Girls, Mean Score, 2018

[13] PISA is an international study that was launched by the OECD in 1997, first administered in 2000 and now covers over 80 countries. Every 3 years the PISA survey provides comparative data on 15-year-olds' performance in reading, mathematics, and science. More info: https://www.oecd.org/pisa/aboutpisa/pisa-based-test-for-schools-faq.htm

[14] Scientific performance, for PISA, measures the scientific literacy of a 15-year-old in the use of scientific knowledge to identify questions, acquire new knowledge, explain scientific phenomena, and draw evidence-based conclusions about science-related issues. The mean score is the measure. More info: https://data.oecd.org/pisa/science-performance-pisa.htm

[15] The Organization for Economic Co-operation and Development

[16] "Science performance (PISA)," OECD, accessed October 2020, https://data.oecd.org/pisa/science-performance-pisa.htm.

[17] "Mathematics performance (PISA)," OECD, accessed October 2020, https://data.oecd.org/pisa/mathematics-performance-pisa.htm.

Data suggests that Latin American countries, in general, have not succeeded in effectively integrating STEM education as students tend to opt for studying Social Sciences rather than STEM, and Mexico is no exception to this trend.[18] According to data from National Council of Science and Technology (Conacyt[19]), the majority of university graduates study Social Sciences, Administration, and Law. In contrast, Exact Natural and Computer Sciences together with Engineering, Manufacture and Construction (STEM disciplines) take up a small proportion of Mexico's student population between around 10 to 25%. (Figures 6-9).[20]

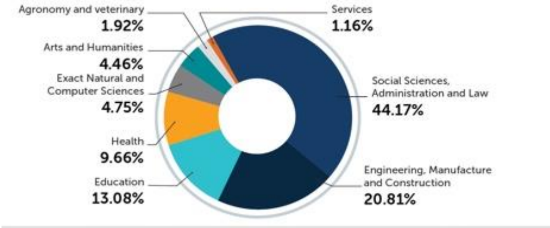

Figure 6: Percentage distribution of graduates divided into fields of science: Bachelor's degree, 2016

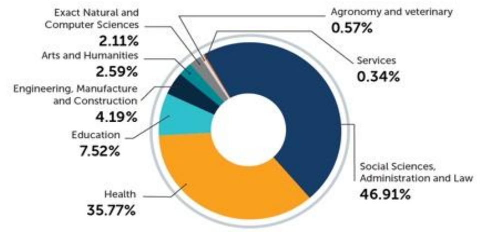

Figure 7: Percentage distribution of graduates divided into fields of science: Specialization, 2016

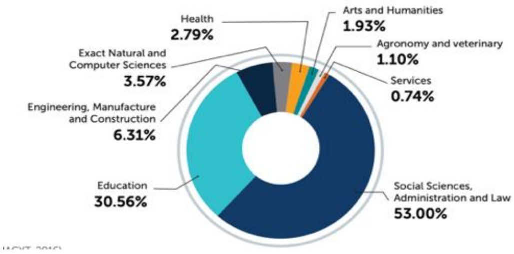

Figure 8: Percentage distribution of graduates divided into fields of science: Master's degree, 2016

[18] "STEM Vision for Mexico," Movimiento STEM. https://blog.movimientosteam.org/wp-content/uploads/2021/01/STEM-Vision-for-Mexico.pdf.

[19] Consejo Nacional de Ciencia y Tecnología

[20] Consejo Nacional de Ciencia y Tecnología (Conacyt), *Informe general del estado de la ciencia, la tecnología y la innovación* (Ciudad de México, México: Conacyt, 2017), 57-60, accessed October 2020, https://www.siicyt.gob.mx/index.php/transparencia/informes-conacyt/informe-general-del-estado-de-la-ciencia-tecnologia-e-innovacion/informe-general-2016/3835-informe-general-2016/file.

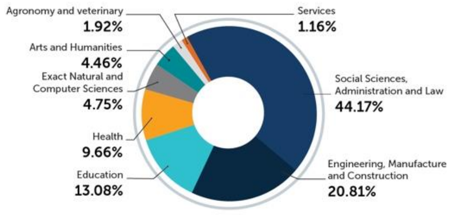

Figure 9: Percentage distribution of graduates divided into fields of science: Doctoral degree, 2016

Women's share in STEM education and careers in Mexico is even less significant than that of their male counterparts. According to INEGI's data for the 2017/18 academic year, only 28.6% of engineering, manufacture, and engineering and 24.1% of IT and communication students enrolled at undergraduate level were women.[21] (figure 10)

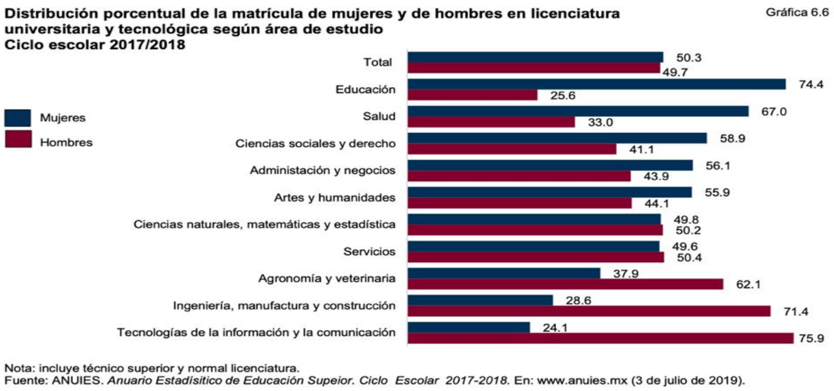

Figure 10: Percentage distribution of men and women enrolled in undergraduate level according to field of study

Mexican researchers' academic merits are evaluated based on their level (I, II, and III) on the National System of Research (initial in Spanish: SNI),[22] and in accordance with global

[21] Instituto Nacional de Estadística y Geografía, *Mujeres y hombres en México 2019* (Aguascalientes, México: Instituto Nacional de Estadística y Geografía), 84, accessed November 2020, https://www.inegi.org.mx/contenido/productos/prod_serv/contenidos/espanol/bvinegi/productos/nueva_estruc/702825189990.pdf.

[22] The Mexican National Research System is responsible for the quantitative and qualitative control of research in Mexico. To join the system, applicants must have a doctorate degree, demonstrate the ability to conduct original research in their field of study, and have completed their bachelor's degree less than 15 years prior to the date of application. Researchers are placed and promoted to three levels (I, II, & III) based on a

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trends, the number of Mexican female STEM researchers at doctoral and postdoctoral levels decreases. Figure 11 shows that the majority of the Mexican Academy of Sciences' members continue to be men, with women's lowest presence in physics, engineering and mathematics.[23] (Figure 11)

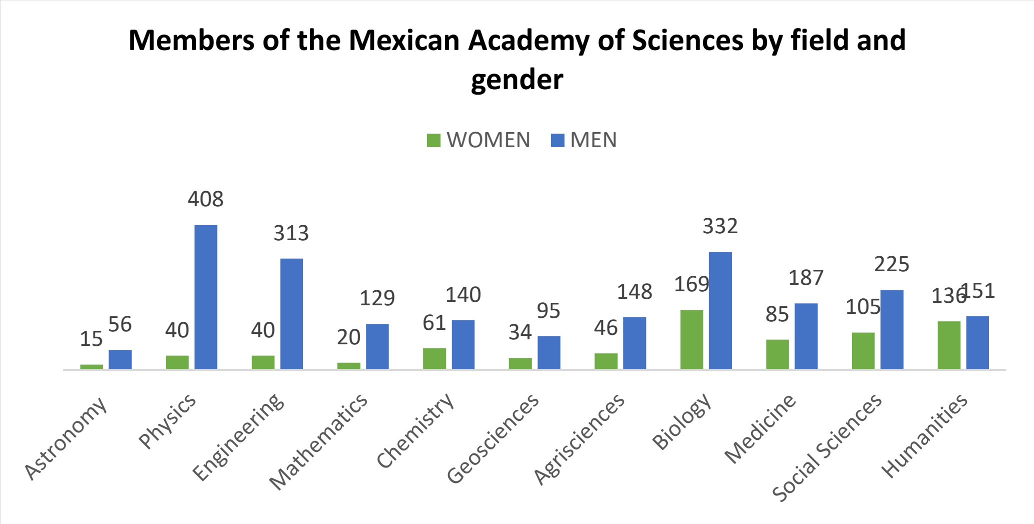

Figure 11: Number of Members of the Mexican Academy of Sciences

The purpose of this paper is to analyze the hindering or facilitating factors in girls' and women's engagement in and pursuit of STEM education, using data from interviews with four renowned Mexican female STEM professionals. This analysis is driven by two research questions:

- What factors hindered or facilitated these Mexican STEM women's decisions to pursue studies and careers in STEM?
- What are the commonalities between these women's narratives and the factors studied in UNESCO's ecological framework?

In order to identify the factors influencing the participants' journey to STEM education and careers, I used the ecological framework suggested by UNESCO (figure 12), which

variety of factors including the number and quality of scientific production, teaching activities, and training new scientists. Once they enter the SNI, these researchers receive economic stimuli whose amount varies according to the level reached (CONACYT, 2017)

[23] Academia Mexicana de Ciencias, 2020

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compiles and presents the factors at individual, family and peer, school-level, and societal level.[24]

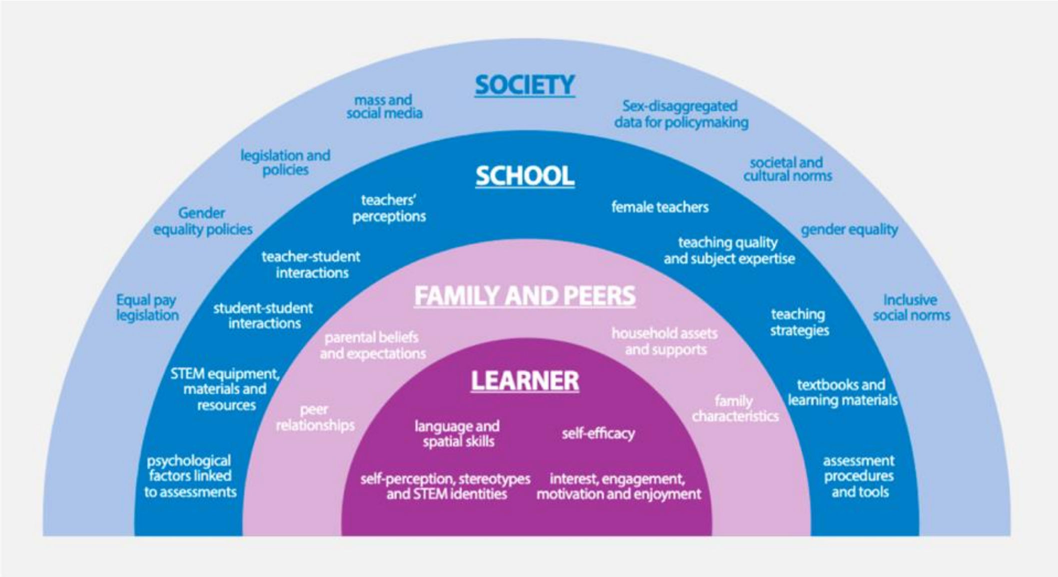

Figure 10: Ecological framework of factors influencing girls' and women's participation, achievement and progression in STEM studies

This framework which is amalgamated from several studies aims to better understand not only the influencing factors but the correlation between them through a plethora of research, which will be presented as follows.

1. Individual-level factors: In this level both biological and psychological factors are studied. The first address the individual's learning, cognitive ability and behavior as well as genetics and hormones, while the latter evaluates the role of self-perception, self-efficacy, and STEM gender stereotypes.

Studies show that despite some differences in brain structure and functions between men and women, learners' academic ability is not or is hardly influenced by these biological

[24] UNESCO, "Cracking the code" 40.

factors.[25] [26] [27] Research on girls' and boys' cognitive abilities, communication and personality variables has found no or only small differences between the sexes.[28] [29] [30] [31] Research also highlight the significance of neuroplasticity, especially during childhood, as the foundation of any kind of learning.[32] Findings suggest that younger students' performance in STEM improves once they are taught about brain's malleability.[33] While stronger written language and spatial skills are associated with higher competence in mathematics,[34] research indicates that these can be significantly improved, particularly in early childhood.[35] [36] [37] Studies have found a correlation between an individual's genetic factors and their education performance,[38]

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[25] Amber N. V. Ruigrok et al., "A Meta-analysis of Sex Differences in Human Brain Structure," *Neuroscience & Behavioral Reviews,* Vol. 39 (February 2014): 34-50, https://doi.org/10.1016/j.neubiorev.2013.12.004.

[26] Lise Elliot, "Single-sex Education and the Brain," *Sex Roles: A Journal of Research*, no. 7-8 (August 2011): 1-19, https://doi.org/10.1007/s11199-011-0037-y.

[27] Spearman, "Perception shapes experience" 217-238.

[28] Catherine Riegle-Crumb et al., "The More Things Change, the More They Stay the Same? Prior Achievement Fails to Explain Gender Inequality in Entry into STEM College Majors Over Time," *American Educational Research Journal,* no. 6 (December 2012): 1048-1073, https://doi.org/10.3102/0002831211435229.

[29] Ming-Te Wang, Jacquelynne S Eccles, and Sarah Kenny, "Not Lack of Ability but More Choice: Individual and Gender Differences in Choice of Careers in Science, Technology, Engineering, and Mathematics," *Psychological Science*, no. 5 (March 2013): 770-775, https://doi.org/10.1177/0956797612458937.

[30] Janet Shibley Hyde, "The Gender Similarities Hypothesis," *American Psychologist,* no.6 (September 2005): 581-592, https://doi.org/10.1037/0003-066X.60.6.581.

[31] Hyde, Janet, "The gender similarities hypothesis," *American Psychologist,* no. 6 (September 2005): 581-592, https://doi.org/10.1037/0003-066X.60.6.581.

[32] Knudsen, Eric, "Sensitive periods in the development of the brain and behavior," *Journal of Cognitive Neuroscience,* no. 8 (October 2004): 1412-1425, DOI: 10.1162/0898929042304796.

[33] Elliot, "Single-sex Education," 1-19.

[34] Xiano Zhang et al., "Linguistic and spatial skills predict early arithmetic development via counting sequence knowledge," *Child Development,* no. 3 (May-June 2014): 1091-1107, DOI: 10.1111/cdev.12173.

[35] Zhang, "Linguistic and spatial," 1091-1107.

[36] Jonathan Wai, David Lubinski, and Camila P. Benbow, "Spatial ability for STEM domains: Aligning over 50 years of cumulative psychological knowledge solidifies its importance," *Journal of Educational Psychology,* no. 4 (2009): 817-835. https://doi.org/10.1037/a0016127.

[37] Moshe Hoffman, Uri Gneezy, and John A. List, "Nature affects gender differences in spatial abilities," *Proceedings of the National Academy of Science of the United States of America,* no. 36 (September 6): 14786-14788, https://doi.org/10.1073/pnas.1015182108.

[38] Yulias Kovas et al., "The generic and environmental origins of learning abilities and disabilities in the early school years," *Monographs of the Society for Research in Child Development,* no. 3 (2007): 1-144, DOI: 10.1111/j.1540-5834.2007.00439.x.

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however, evidence does not support genetic differences affecting boys' or girl's cognitive ability.[39] [40] Other studies dismantle the stereotype that 'girls are good in reading and boys are good at math' by showing that 'generalist genes' affect different abilities simultaneously. This means that learning abilities such as mathematics and reading can be associated to the same gene.[41] Research on the role of a learner's hormones in the pursuit of STEM is still limited, but some studies suggest that girls' pre-natal exposure to testosterone can affect their post-natal behavior, causing girls to show a preference for moving objects in space or become more physically aggressive.[42] [43] However, testosterone exposure is not found to influence mathematical or spatial abilities. [44] Other research indicates girls may choose careers that require taking risks or are considered male domains as a result of testosterone exposure.[45]

Psychological factors, too, are crucial to girls' and women's decision to pursue studies and careers in STEM. According to PISA 2015, two factors determine learners' engagement in science – the way that girls and boys perceive themselves and their attitudes towards science.[46] Therefore, much research has focused on the need to develop girls' science, mathematical identities and self-perceptions of their potentials in studying STEM and professions in this

39 Kovas, "The generic and environmental," 1-144.

[40] Michael S. C. Thomas et al., "What can the study of genetics offer to educators?," *International Mind, Brain, and Education Society and Wiley Periodicals*, no. 2 (May 2015): 72-80, https://doi.org/10.1111/mbe.12077.

[41] Kovas, "The generic and environmental," 1-144.

- [42] Hines, Melissa, "Parental testosterone and gender-related behavior," *European Journal of Endocrinology,* vol. 155 (2006): 115-121, DOI: 10.1530/eje.1.02236.

[43] Hines, Melissa, "Sex-related variation in human behavior and the brain," *Trends in Cognitive Science,* no. 10 (September 2010): 448-456, doi: 10.1016/j.tics.2010.07.005.

[44] Hines, "Parental testosterone," 115-121.

[45] Paola Sapienza, Luigi Zingales, and Dario Maestripieri, "Gender differences in financial risk aversion and career choices are affected by testosterone," *Proceedings of the National Academy of Science, USA,* no. 36 (September 2009): 15268-15273, https://doi.org/10.1073/pnas.0907352106.

[46] OECD (2016), *PISA 2015 Results (Volume I): Excellence and Equity in Education*, PISA, OECD Publishing, Paris, https://doi.org/10.1787/9789264266490-en.

field,[47] [48] [49] since the major reason that makes girls opt out of STEM is their self-selection bias, which means girls do not consider that STEM professions are compatible with the female gender.[50] The reasons behind this could be found in gender stereotypes about STEM that are prevalent in families and throughout the socialization process developed from an early age Research,[51] when girls and boys are exposed to two main stereotypes: "boys are better at mathematics and science than girls' and 'science and engineering careers are masculine domain'.[52] Building STEM identities is more challenging for females as they find it difficult to sense a belonging with these field, while some do not find their gender identity compatible with their academic identity.[53] Female students are encouraged by their families or faculty to enter programs where the academic climate is more supportive to females.[54] [55] Additionally, reports show a relationship between self-efficacy and learners' performance and career aspirations in STEM,[56] [57] Girls are reported to generally have lower self-efficacy in science

[47] Zahra Hazari, Philip M. Sadler, and Gerhard Sonnert, "The science identity of college students: Exploring the intersection of gender, race, and ethnicity," *Journal of College Science Teaching,* no. 5 (May/June2013): 82-91, http://www.jstor.org/stable/43631586.

[48] Zahra Hazari et al., "Connecting high school and physics experiences, outcome expectations, physics identity, and physics career choice: A gender study," *Journal of Research in Science Teaching,* no. 8 (February 2010): 978-1003, https://doi.org/10.1002/tea.20363.

[49] Herrera et al., "A model for redefining STEM identity for talented STEM graduate students." Paper presented at *the American Educational Research Association Annual Conference, Vancouver, Canada, 2012.* https://www.heri.ucla.edu/nih/downloads/AERA2012HerreraGraduateSTEMIdentity.pdf

[50] Lecia J. Barker and William Aspray, "The state of research on girls and IT," *Women and Information Technology: Research on Underrepresentation,* (February 2006): 3-54, DOI:10.7551/mitpress/9780262033459.003.0001.

[51] Richard A. Lippa, *Gender, Nature, and Nurture (*Mahwa, NJ: Lawrence Erlbaum Associates, 2005).

[52] Catherine A. Hill, Christiane Corbett, and Andresse St. Rose, *Why So Few Women in Science Technology Engineering and Mathematics* (Washington DC: AAUW, 2010).

[53] Stout et al., "STEMing the tide", 255.

[54] Jill M. Bystydzienski, Margaret Eisenhart, and Monica Bruning, "High school is not too late: Developing girls' interest and engagement in engineering careers," *The Career Development Quarterly,* no. 1 (March 2015): 88-95, https://doi.org/10.1002/j.2161-0045.2015.00097.x.

[55] Soko S. Starobin and Frankie S. Laanan, "Broadening female participation in science, technology, engineering, and mathematics: Experiences at community colleges," *New Directions for Community Colleges,* no. 142 (June 2008): 37-46, https://doi.org/10.1002/cc.323.

[56] Omolola A. Adedokun et al., "Research skills and STEM undergraduate research students' aspirations for research careers: Mediating effects of research self-efficacy," *Journal of Research in Science Teaching,* no. 8 (August 2013): 940-951, https://doi.org/10.1002/tea.21102.

[57] Sian L. Beilock et al., "Female tecahers' math anxiety affects girls' math achievement," *Proceedings of the National Academy of Sciences of the United States of America,* no. 5 (February 2010): 1860-1863, https://doi.org/10.1073/pnas.0910967107.

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and mathematics than boys[58] and females who assimilate stereotypes related to gender and STEM tend to have lower levels of self-confidence in their abilities in studying STEM [59] [60] However, once girls overcome anxiety and misconceptions about sex-based abilities in STEM, they can outperform boys as a study in Viet Nam on ICT female students with low self-efficacy shows.[61] Furthermore, research emphasizes the importance of building girls' interest in STEM during early childhood as they appear to lose interest in STEM subjects with age, heavily influenced by their social context,[62] female peers at school[63], overall learning experience at school, gender stereotypes,[64] and the media.[65]

2. Family- and Peer- level Factors: UNESCO's report assesses the role of family and peers as well as household environment and assets in shaping girls' attitudes towards, and interest in, STEM studies in this level of the framework. Studies show that parents' traditional beliefs about gender roles, and parents' unequal treatment of male and female children can reinforce gendered behaviors and attitudes in their children, and ultimately deter girls from approaching STEM fields.[66] Moreover, parents strongly influence their children's, particularly girls' career choices through the home environment, experience and support they provide,

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[58] OECD (2016), *PISA 2015 Results (Volume I): Excellence and Equity in Education*, PISA, OECD Publishing, Paris, https://doi.org/10.1787/9789264266490-en.

[59] Tabetha A. Rebenberg, "Middle school girls' STEM Education: Using teacher influences, parent encouragement, peer influences, and self-efficacy to predict confidence and interest in math and science," PhD diss., (Drake University, 2013), https://escholarshare.drake.edu/bitstream/handle/2092/2020/2013TARdd.pdf?sequence=1&isAllowed=y (Accessed February 2021)

[60] Racheael D. Robnett, "Gender bias in STEM fields: Variation in prevalence and links to STEM self-concept," *Psychology of Women Quarterly,* no. 1 (July 2015): 65-79, DOI:10.1177/0361684315596162.

[61] Anna Shillabeer and Kevin Jackson, "Gender imbalance in undergraduate IT programs – A Vietnamese perspective," *Innovation in Teaching and Learning in Information and Computer Sciences,* no. 1 (December 2015): 70-83, https://doi.org/10.11120/ital.2013.00005.

[62] OECD (2016), *PISA 2015 Results (Volume I): Excellence and Equity in Education*, PISA, OECD Publishing, Paris, https://doi.org/10.1787/9789264266490-en.

[63] Rebenberg, "Middle school girls' STEM Education,".

[64] Hill, *Why So Few Women.*

[65] Sapna Cheryan et al., "The stereotypical computer scientist: Gendered media representations as a barrier to inclusion for women," *Sex Roles: A Journal of Research,* no. 1 (June 2013): 58-71, https://doi.org/10.1007/s11199-013-0296-x.

[66] Ming-Te Wang and Jessica Degol, "Motivational pathways to STEM career choices: Using expectancy-value perspective to understand individual and gender differences in STEM fields," *Developmental Review,* no. 4 (December 2013): 304-340, https://doi.org/10.1016/j.dr.2013.08.001.

whereas boys' own interests determine their careers.[67] [68] Mothers' beliefs and expectations are found to play a more vital role in influencing girls' beliefs about their STEM abilities and higher education and career choices.[69] [70]

Family members, particularly parents, with STEM careers can steer girls to STEM studies by familiarizing girls with STEM careers and debunk the perception that STEM occupations are difficult to combine with family life.[71] [72] [73] Likewise, children of more highly educated parents tend to take more mathematics and science courses in upper secondary education and have a better performance as well.[74] [75] [76] Moreover, students' performance in STEM can improve as a result of household assets and support, such as additional learning support and learning materials, which usually correlate with parents' higher socio-economic status who place higher academic expectations and express less conventional beliefs about

[67] Janet S. Hyde et al., "Mathematics in the home: Homework practices and mother-to-child interactions doing mathematics," *Journal of Mathematical Behavior,* no. 2 (2006): 136-152, https://doi.org/10.1016/j.jmathb.2006.02.003.

[68] OECD (2016), *PISA 2015 Results (Volume I): Excellence and Equity in Education*, PISA, OECD Publishing, Paris, https://doi.org/10.1787/9789264266490-en.

[69] Elizabeth A. Gunderson et al., "The role of parents and teachers in the development of gender-related math attitudes," *Sex Roles: A Research Journal,* no. 3-4 (May 2011): 153-166, https://doi.org/10.1007/s11199-011-9996-2.

[70] OECD (2016), *PISA 2015 Results (Volume I): Excellence and Equity in Education*, PISA, OECD Publishing, Paris, https://doi.org/10.1787/9789264266490-en.

[71] Edna Tan et al., "Desiring a career in STEM-related fields: How middle school girls articulate and negotiate identities-in-practice in science," *Journal of Research in Science Teaching,* no. 10 (October 2013): 1143-1179, https://doi.org/10.1002/tea.21123.

[72] OECD (2016), "Skills for a Digital World: 2016 Ministerial Meeting on the Digital Economy Background Report", *OECD Digital Economy Papers*, No. 250, OECD Publishing, Paris, https://doi.org/10.1787/5jlwz83z3wnw-en.

[73] UNESCO, Women's and Girls' Access to and Participation in Science and Technology (Background paper). Paris, France: UNESCO and DAW, October 2010. Available at: https://www.un.org/womenwatch/daw/egm/gst_2010/UNESCO-BP.2-EGM-ST.pdf

[74] OECD (2016), *PISA 2015 Results (Volume I): Excellence and Equity in Education*, PISA, OECD Publishing, Paris, https://doi.org/10.1787/9789264266490-en.

[75] Kathleen M. Jodl et al., "Parents' roles in shaping early adolescents' occupational aspirations," *Child Development,* no. 4 (2001): 1247-1265, http://www.jstor.org/stable/1132440.

[76] Edward Melhuish et al., "Pre-school influence on mathematics achievement," *Science,* no. 5893 (August 2008): 1161-1162, DOI: 10.1126/science.1158808.

gender roles and career paths.[77] [78] [79] [80] [81] Additionally, family socio-cultural factors such as ethnicity, the language used at home, immigrant status and family structure influence girls' experience in STEM.[82]

Peer relationships affect young people's beliefs, behaviours, academic achievement, and motivation to study STEM.[83] and those with friends that value academic achievement has a more positive attitude towards science and math.[84] While peers' gender biases about STEM subjects might discourage girls from choosing STEM subjects, female peers can instill interest and confidence in girls' attitude to mathematics and science.[85]

3. School-related factors: This level assesses the role of the environment within which STEM education takes place, teachers, teaching strategies, the curriculum, learning materials, and assessments. To start, qualified teachers with specialization in science and mathematics can positively impact girls' participation, achievement and persistence in STEM education and

[77] OECD (2016), *PISA 2015 Results (Volume I): Excellence and Equity in Education*, PISA, OECD Publishing, Paris, https://doi.org/10.1787/9789264266490-en.

[78] Harriet R. Tenenbaum and Campbell Leaper, "Parent-child conversations about science: The socialization of gender inequalities?," *Developmental Psychology,* no. 1 (January 2003): 34-47, DOI: 10.1037//0012-1649.39.1.34

[79] Ina V.S. Mullis et al., *TIMSS 2011 International Results in Mathematics.* Chestnut Hill, MA: TIMSS and PIRILS International Study Center, Boston College, 2012.

[80] Kara Sammet and Linda Kekelis, *Changing the Game for Girls in STEM: Findings on High Impact Programs and System-Building Strategies*. Techbridge and Chevron, 2016. https://www.itu.int/en/ITU-D/Digital-Inclusion/Women-and-Girls/Girls-in-ICT-Portal/Documents/changing-the-game-for-girls-in-stem-white-paper.pdf

[81] OECD, *The ABC of Gender Equality in Education: Aptitude, Behaviour, Confidence.* Paris, France: Organization for Economic Co-operation and Development, 2015. Available at: https://www.oecd.org/pisa/keyfindings/pisa-2012-results-gender-eng.pdf

[82] Sandra D. Simpkins, Chara D. Price, and Krystal Garcia, "Parental support and high school students' motivation in biology, chemistry, and physics: Understanding differences among Latino and Caucasian boys and girls," *Journal of Research in Science Teaching,* no. 10 (2015): 1386-1407, https://doi.org/10.1002/tea.21246.

[83] Barker and Aspray, "The state of," 3-54.

[84] Carrie Furrer and Ellen Skinner, "Sense of relatedness as a factor in children's academic engagement and performance," *Journal of Educational Psychology,* no. 1 (2003): 148-162, https://doi.org/10.1037/0022-0663.95.1.148.

[85] Rebenberg, "Middle school girls' STEM,"

inspire them to pursue careers in these fields.[86] [87] [88] Female STEM teachers, as role models, appear to strongly impact and dispel stereotypes about sex-based, innate abilities in STEM.[89] [90] [91]

Teachers' perceptions, teaching strategies, and interactions with students heavily influence girls'.[92] [93] [94] Teachers' perceptions of sex-based ability, biased treatment of male and female students creates an unequal learning environment and consequently, dissuade girls from pursuing STEM studies.[95] [96] [97] [98] A study in Asia shows that over 60 per cent of student-teacher interactions in math and science classes were with boys.[99] Studies show that teachers might not

[86] OECD, *Teachers Matter: Attracting, developing and Retaining Effective Teachers.* Paris, France: Organization for Economic Co-operation and Development, 2005.

[87] Marginson et al., *STEM: Country Comparisons*.

[88] Rose M. Marra et al., "Leaving Engineering: A multi-year single institution study," *Journal of Engineering Education,* no. 1 (2012): 6-27, https://doi.org/10.1002/j.2168-9830.2012.tb00039.x.

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[90] Scott E. Carrell, Marianne E. Page, James E. West, "Sex and Science: How Professor Gender Perpetuates the Gender Gap," *The Quarterly Journal of Economics,* no. 3 (August 2010): 1101-1144, https://doi.org/10.1162/qjec.2010.125.3.1101.

[91] UNESCO, *Regional Overview: The Arab States. Education for All Global Monitoring Report 2015.* Paris, France: UNESCO, 2015.

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[93] Elstad and Turmo, "The Influence of the," 83-104.

[94] David Sadkar and Karen R. Zittleman, *Still Failing at Fairness: How Gender Bias Cheats Girls and Boys in Schools and What We Can Do about it* (New York, USA: Scribner, 2009).

[95] Donna M. Sayman, "Quinceañeras and Quadratics: Experiences of Latinas in state-supported residential schools of science and math," *Journal of Latinos and Education,* no. 3 (April 2013): 215-230, https://doi.org/10.1080/15348431.2013.765805.

[96] Ernesto Treviño, Cristóbal Villalobos, and Andrea Baeza, *Education Policies: Recommendations in Latin America Based in TERCE.* Paris, France: UNESCO and the Regional Educational Office for Latin America and the Caribbean, 2016. Available at: http://www.unesco.org/new/fileadmin/MULTIMEDIA/FIELD/Santiago/pdf/Education-Policies-Recommendations.pdf

[97] Christine B. Buschor et al., "Majoring in STEM-What accounts for women's decision making A mixed methods study," *The Journal of Educational Research,* no. 3 (December 2013): 167-176, https://doi.org/10.1080/00220671.2013.788989.

[98] Eyvind Elstad and Are Turmo, "The influence of the teacher's sex on high school students' engagement and achievement in science," *International Journal of Gender, Science and Technology,* no. 1 (August 2009): 83-104, http://genderandset.open.ac.uk/index.php/genderandset/article/view/41/30.

[99] Sammet and Kekelis, "*Changing the Game for Girls,*" 2016.

even be aware of communicating gender-biased messages in relation to STEM.[100] Girls' motivation and performance in STEM improves by modifying teaching strategies used in the classroom to more student-centered, inquiry based, participatory ones as well as strategies that aim to boost girls' self-confidence and take account of their specific interest and learning styles.[101] [102]

Curriculum, textbooks and other learning materials, together with access to equipment and recourses also play a crucial role in the learning process and girls' engagement and achievement. Gender biased imagery used in STEM textbooks can communicate and reinforce gender stereotypes and discourage girls from pursuing STEM careers.[103] [104] [105] [106] Additionally, access to equipment, materials and resources can stimulate students' engagement with STEM subjects and improve their learning. Resources like science laboratories, are found to positively impact both sexes' engagement and help to overcome gender biases about girls' abilities in science.[107] Ensuring equal access to materials prevents competition over resources,[108] and decreases the risk of boys monopolizing the material while girls become observers in the learning process.[109]

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[100] "Accenture Finds Girls' Take-up of STEM Subjects in Held Back by Stereotypes, Negative Perceptions and Poor Understanding of Career Option," Accenture, accessed March 2021, https://newsroom.accenture.com/news/accenture-finds-girls-take-up-of-stem-subjects-is-held-back-by-stereotypes-negative-perceptions-and-poor-understanding-of-career-options.htm.

[101] Frank W. Schneider, Jamie A. Gruman, and Larry M. Coutts, *Applied Social Psychology: Understanding and Addressing Social and Practical Problems* (California, USA: Sage Publications, Inc, 2012).

[102] Dale Baker, "What works: Using curriculum and pedagogy to increase girls' and participation in science," *Theory into Practice,* no. 1 (2013): 14-20, http://dx.doi.org/10.1080/07351690.2013.743760.

[103] Eurydic, *Gender Differences in Educational Outcomes: Study on the Measures taken and the Current Situation in Europe* (Brussles, Belguim: Euryduce, 2010).

[104] Aaron Benavot, "Gender Bias is Rife in Textbooks," World Education Blog, a*ccessed Jan 14, 2021,* https://gemreportunesco.wordpress.com/2016/03/08/gender-bias-is-rife-in-textbooks/.

[105] Simpkins, Price, and Garcia, "Parental support," 1386-1407

[106] P Fousiya and Mohameduni A. Musthafa, "Gender bias in school curriculum curbs girls' career aspirations," *IOSR Journal of Humanities and Social Science,* no. 3 (March 2016): 19-22, DOI: 10.9790/0837-2103041922.

[107] Simpkins, Price, and Garcia, "Parental support," 1386-1407

[108] Claudia Costin, Silvia Montoya, and Karen Mundy, "No girl left behind-education in Africa," Global Partnership for Education Blog, accessed December 28, 2020, https://www.globalpartnership.org/blog/no-girl-left-behind-education-africa.

[109] Baker, "Teaching for Gender,".

Finally, assessment procedures and tools that are gender-biased or include gender stereotypes may negatively affect girls' performance. Type of tests, as well as the way

assessments are administered influence both genders. For example, boys are reported to get better results in multiple-choice mathematics assessments, while girls have been found to perform better in classroom tests, and course work and 'essay-type' assessments.[110] Teachers can be biased in grading girls and boys in STEM subjects, leading some countries to conceal the student's name and sex during the marking process.[111] [112]

4. Societal-level factors: Cultural and social norms affect individuals' decisions about what fields of study or employment are viewed as possible or appropriate for men and women. In particular, these norms influence girls' perceptions about their abilities, role in society and career and life aspirations. Moreover, girls' participation, achievement and persistence in STEM education is affected by countries' measures of gender equality, policies and legislation aiming to improve girls' and women's engagement in these fields. Data from PISA and other research indicated that in more gender-equal societies, where access to education and decent work is more gender equal and women are more represented in political and economic decision-making processes, the gender gap in STEM is smaller,[113] and girls' attitude towards, confidence about, and achievement in, mathematics are more positive.[114] Girls are more motivated to study math and science after endorsing gender equality which researchers believe could be due to their resistance to gender stereotypes in STEM.[115]

Studies indicate that mass media plays a significant role in shaping children and adults', particularly girls' view of themselves as well as others through the depiction of gender

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110 Howard Wainer and Linda S. Steinberg, "Sex differences in performance on mathematics section of the scholastic aptitude test: A bidirectional validity study," *Harvard Educational Review,* no. 3 (1992): 323-336, https://doi.org/10.1002/j.2333-8504.1991.tb01412.x.

111 Eurydic, *Gender Differences in Educational Outcomes: Study on the Measures taken and the Current Situation in Europe.*

112 Victor Lavy and Edith Sand, "On the Origins of Gender Human Capital Gaps: Short- and Long-Term Consequences of Teachers' Stereotypical Biases," *Journal od Public Economics,* vol. 167 (2018): 263-279, https://doi.org/10.1016/j.jpubeco.2018.09.007.

113 Luigi Guiso et al., "Culture, gender and math," *Science,* vol. 320 (May 2008): 1164-1165, DOI: 10.1126/science.1154094.

114 McDaniel, "The role of cultural," 122-133.

115 Stout et al., "STEMing the tide," 255.

stereotypes.[116] [117] [118] Teenage girls' career choices and professional identities are strongly influenced by the image of STEM professionals in mass media.[119] Women are reported to be less enthusiastic about majoring in or pursuing careers involving technical or quantitative skills after watching TV ads that are gender biased about abilities in mathematics.[120] A 2017 study of Latin American social media users found that women themselves played a more harmful role in dissuading girls and women from studying STEM subjects. According to this study, 75% of all self-mocking mathematics messages were posted by girls, while one-third of students' social media shares about women and girls in STEM were sexist.[121]

Policies and legislations that promote gender equality and equal treatment play an important role as wee. Prioritizing and institutionalizing girls' and women's participation in STEM education and careers, for instance through Quotas and financial incentives, help change social norms and practices resulting in girls' study and career choices[122] In recent years, countries like Malaysia, Germany and France have enacted STEM-related policies and legislation to specifically address gender disparity in STEM education and careers.[123]

Methods

The data was collected from the participants' answers to a number of open-ended questions respecting their background, experiences and perspectives on gender disparity in STEM education in Mexico, followed by Zoom interviews of approximately 2 hours. Initially, ten Mexican female

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[116] Jocelyn Steinke, "Adolescent girls' STEM identity formation and media images of STEM professionals: Considering the influence of contextual cues," *Frontier Psychology,* no. 8 (May 2017), *doi:* 10.3389/fpsyg.2017.00716.

[117] UNESCO, "Cracking the code" 57-58.

[118] UNESCO, "Women's and Girls' Access," 2010.

[119] Jocelyn Steinke, "Cultural representations of gender and science. Portrayal of female scientists and engineers in popular film," *Science Communication,* no. 1 (September 2016): 27-63, DOI:10.1177/1075547005278610.

[120] Paul G. Davies, Steven J. Spencer, Diane M. Quinn, "Consuming images: How television commercials that elicit stereotype threat can restrain women academically and professionally," *Personality and Social Psychology Bulletin,* no. 12 (December 2002): 1615-1628, https://doi.org/10.1177/014616702237644.

[121] Emma Naslund-Hadley, "I'm not Perfect. I'm Pretty," Inter-American Development Bank Blog, accessed February 21, 2021, https://blogs.iadb.org/educacion/es/im-not-perfect-im-pretty/.

[122] UNESCO, "Cracking the code" 57-58.

[123] UNESCO. *Sharing Malaysian Experience in Participation of Girls in STEM Education.* Geneva, Switzerland: UNESCO International Bureau of Education, 2016.

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STEM professionals were picked, but selective sampling technique was used, narrowing down the pool of participants to only four UNAM professors and graduates in Mexico City. In order to cross check these women's narratives, the four were selected from two age groups. Two of the participants, aged over 60, are currently engaged as full-time faculty and were among the first women of their generations to ever step in science departments in the country. Of the other two younger participants, one recently finished her doctorate and the other is building her career outside the academia. All these women are considered highly well-known, public STEM figures in Mexico and three out of four are science communicators. The questions were collected based on a quick review of the literature regarding gender disparity in STEM in the world and in Mexico, in addition to a number of previous interviews with the participants on the NEWS or their own social media. Prior to the conduct of the interviews, participants' answers on a shared Google document would be reviewed in case the need for further questions or elaboration arose. Sue to the semi-formal dynamic of the interviews, new questions and ideas would be discussed as the interview unfolded. In one case, a participant refused to respond to most questions in the document writing only "I do not have hard data!" This was due to the harassment that she and her family members residing in the US have faced as a result of her public narratives of the history of violence and abuse in her family, among other personal experiences. Due to the sensitive nature of the data collected from these interviews, after consulting with the interviewees, I decided to keep these women's identities anonymous.

Results

In a thematic analysis of the interviews, some factors were recurrent in the participants' description of facilitating factors or obstacles in their participation, achievements and persistence in STEM studies and careers. Below appears a brief summary of these factors and parts of the participants' narratives in order of frequency.

Facilitating Factors: The majority of participants benefited from growing up in families, or wider family environments, that supported gender equality, and thus, encouraged, financed and reinforced these women's interest and achievement in STEM studies as well as their decisions to pursue careers in these fields. Parents' role in building their confidence from an early age to study STEM was central "I was never told by my parents that I was not *able* to do anything", "When I was a little girl, my father used to call me a shark! I believed it all my

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life, and nothing could ever scare me!" and "I knew I wanted to become a scientist when my mother gave me a biology book on Christmas," said the participants.

Female family members, mothers in particular, played a significant role and were named as the most influential role models. Two participants referred to their mothers' adverse past experiences as a reason to unconditionally support their daughters. For instance, one participant's mother was held back from studying medicine due to her parents' differential treatment of girls and boys in her family. Another participant who was forced to escape her abusive father was immediately sheltered by her godmother who facilitated the participant's entry to the university. On the other hand, male family members' emotional, psychological and financial support helped these women further their studies and careers in STEM "If my husband hadn't paused his STEM career for a few years to look after our children while I did my PhD and postdoc research, I don't know how I would have pulled it off!", "In Mexico, girls usually look after the elderly, but my brother does more for my grandmother than I ever have," said two participants.

Research supervisors were the participants' biggest support during their academic studies. "I wouldn't have accomplished so much if it weren't for my female supervisors' wholehearted support in the past eight years. They helped me endure graduate school difficulties and broadened my research prospects," said the recent PhD graduate. Another older participant had a very positive experience with her post-doc supervisor in the USA "I was so scared to tell him I was pregnant, but when he found out, he immediately started looking into insurance for me and the baby," she reiterated.

Building alliances in academic and STEM events with other female STEM scientists is considered a tool that can advance the gender equality agenda in families, schools, and society, in general. These alliances are observed in science communicators' collaborations as well as female faculty's support for victims of sexual violence in STEM departments in 2019, "I accompanied a victim to the dean's office after she had taken shelter in my office. These young women's narratives are hardly heard by those in higher academic positions, mostly men, if not accompanied by someone in a position of power," mentioned an older participant.

The participants emphasize the importance of positive female representation and role modeling in movies, TV, and social media as well as schools and STEM events in ratifying their future prospects both as STEM researchers and science communicators. For instance, NASA female scientists on TV and Julieta Fierro, the renowned Mexican astrophysicist and science communicator, were one participant's role models as a child. STEM events in schools and in public are also referred to as an opportune occasion to build a positive role model image, "when young girls see us, they feel more comfortable to ask their questions and these interactions boost their confidence and interest," a participant adds. Role modeling in low-income communities where resources are scarce is also important. One participant actively attempts to motivate young girls in rural spaces, where she and her team conduct research, by setting herself and her female students as examples of women being capable of doing fieldwork. She reiterates that believing in girls' cognitive abilities is not enough and pragmatic actions must take place to increase girls' participation in STEM. Another participant highlights the importance of including STEM women's biographies in textbooks to improve female representation in the curricula.

Finally, legislation, and financial incentives from universities or the government help steer more women into STEM and ensure that they remain in these fields. "I have seen several classmates quit their studies because they could not afford their own and their children's education expenses, and their husbands or families were either unable to help or simply asked those women to give up their studies," a participant mentioned.

Hindering Factors: Gender stereotypes in STEM, biased or discriminatory treatment, and sexual harassment, were central to the participants' experiences with male professors, classmates, colleagues, and supervisors in STEM education and careers career choices. It is difficult to separate the participants' narratives of discrimination and sexual harassment from those involving gender stereotypes or gender-biased treatment due to their overlapping nature.

Male professors played a central negative role in the participants' pathway to STEM. The scope of these experiences ranges from biased treatment and assessment to sexual discrimination and harassment. One participant claims that male professors usually refer to fieldwork as a masculine domain and warn female students about what they call 'realities on the field,'. She believes such unequal treatment discourage female students from doing

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fieldwork, resulting in less training and preparation for the labor market. Having graduated early with honors, a participant was told “It’s a pity you had to work so hard to graduate. All you would’ve needed was to translate some lab results for me to graduate in a month”, followed by his criticism of her decision to get a diploma in Management Development assuming that her objective of doing so was to ‘find a man to marry and get pregnant’. The same participant was asked by a male professor at her masters’ admission interview “What can you offer me during your graduate studies? We both know you’ll either end up getting married or pregnant before dropping out,” One older participant’s PhD. supervisor refused to read her completed dissertation and instead reviewed a male student’s work just so she would not graduate first in her class. As the only woman of her class to finish her doctoral studies, she was treated with aggression and insulted on the day of her thesis defense, “When I finished my defense, she threw my dissertation in the trash can and yelled ‘Go back to the kitchen and nursing your son!”

Gender stereotypes are used to harass female students and professors, including ‘STEM women’s lack of seriousness and aspiration in their studies’. Three participants recall hearing their male professors and classmates refer to female students as MMCs (‘*mientras me case’* or ‘until I marry’) which means female students’ only purpose of studying STEM in university is to ‘find husbands’. On the first day of undergrad classes, a male professor addressed the few female engineering students by asking “what are you doing here if your destiny is to serve coffee to your husbands in a few years?” mentioned one of the younger participants. An older participant remembers hearing this phrase from her male classmates mocking the other few female students a few decades ago. Both participants refer to an old tradition of catcalling female students and professors on campus, “When a woman was heard crossing the corridor, male professors would incite male students to go to the door and whistle at her!”

Male classmates’ gender-biased beliefs and stereotypes can negatively influence their female counterparts’ motivation to continue their studies as well. For example, STEM female engineering students are treated as inferior, incapable and incompetent by their fellow male classmates, “male classmates think that girls get ‘easy credit’ from male professors. Our opinions and ideas are not taken seriously in team projects by the rest of the group who are majority men. If we object, we're called bossy and aggressive. They accuse us of flirting or having sexual relations with male professors to get high grades," she adds.

All the women interviewed have been subject to sexual harassment by male teachers, classmates, and colleagues in a variety of spaces including university campuses, STEM conferences, STEM events and festivals, and online. To name a few, one older participant was harassed by fellow male researchers during international conferences abroad. "At nights, they kept calling my hotel room to say they were waiting for me in their rooms," she mentioned. According to other participants, girls tend to find STEM classrooms and laboratories hostile environments where they do not feel safe around male professors, classmates or colleagues, especially if the professor has a reputation for harassing female students. One participant has observed female students skip laboratory sessions or classes given by professors with a notorious history of sexual harassment. As science communicators, two participants have suffered a great deal of online sexual harassment, through offensive or discriminatory sexual language, name calling, unwelcome sexual requests, 'jokes' of a sexual nature, etc. Other instances of sexual harassment include catcalling on campus, which is a decades-long tradition in the science departments of UNAM, although it has diminished due to the pressure from Feminist student groups in the STEM departments of UNAM. "When I started my studies, I was told not to ever cross a bridge that connects several science buildings in fear of getting catcalled. A female professor would tell us about the time when male professors would incite male students to run to the door to whistle at female students and even professors walking in the hallway". Some participants claim that the tradition persists in UNAM affiliated programs on other campuses.

The oldest participant claimed that she had only endured discrimination in the first decades of her career while a well-known STEM professor and researcher (1970s to late 1990s), particularly on her academic trips to Asia. These include being barred from staying at hotels as a single woman, being forced to sit separate from male fellow researchers on the bus, not being allowed to sit with men at lunch, and also being excluded from parties. In India, she was even denied the prize money and the awarded trip by the male organizers due to her gender. The same participant spoke about the trauma of growing up with an abusive father. "My father was a medical doctor. He would take medical books from the shelves to show my sister and I how science had proved women's brains were inferior to men's," This participant had a hard time speaking about her experiences of violence and harassment by her father and other male family members and therefore, refused to elaborate. She was also tormented by her ex-husband and ex-father-in-law during the first years of her career as a faculty, "they used to mock my salary and tell me a woman's place was at home. They didn't think I was a good mother!"

Discussion

The results indicate that family- and school-level factors influenced the participants' pursuit and progression in STEM studies and careers with many commonalities with the UNESCO's ecological framework. Parents, particularly mothers, and the wider family encouraged the participants' interest in STEM subjects since early childhood and had a positive influence on the participants' STEM career choices. With school level, female professors and supervisors played a significant role in cultivating these women's engagement and achievement in STEM through role-modeling, dispelling myths about sex-based innate abilities in STEM and providing mentorship. In contrast, gender stereotypes in STEM and stereotyped ideas about gender roles together with lack of safe, inclusive spaces for women appeared to be the hindering factors in the participants' progress in STEM studies and career development. At school level, the participants reported interactions and experiences with biased male professors, classmates and colleagues, which negatively affected these women's learning and career opportunities as well as development. In the face of data scarcity on the factors facilitating and hindering Mexican women's engagement and progression in STEM studies, this article aims highlight the importance of recording and analyzing STEM women's narratives and experiences to provide some insight into the factors hindering or facilitating gender equal STEM education in Mexico and contribute to the 2030 agenda. There were several limitations to my study, including the small pool of participants from one university, not taking into account the participants' STEM discipline, number and type of questions asked, my bias in the selection of the participants from UNAM, and not including STEM male participants in the study. The number of participants in this study is narrow, so the interviewed women are not necessarily representative of all girls and women engaged in STEM studies or careers in the country. By raising the number of participants and selecting them from a wider range of STEM disciplines and taking STEM men's perspectives and experiences into account, a broader panorama of the factors influencing gender disparity in Mexico could be achieved. In furthering my study, I will reach out to participants from several states in order to address the location bias in the study. The interviews, as the main tool for this study, were beneficial in collecting a large amount of qualitative data and made it possible for me to build rapport and confidence with the participants so that they could share their narratives, particularly those with a more sensitive nature. However, the use of a survey with questions targeting the four levels in UNESCO's ecological framework could provide more precision in the analysis of the collected data.

Conclusion

Despite recent improvements in expanding access to STEM education in the world, many countries, including Mexico, are concerned about gender disparity in STEM studies and career. Gender-based discrimination, social and cultural norms, and other factors prevent Mexican girls and women from having equal opportunities to contribute to, and benefit from, STEM. Equal and high-quality STEM education for these girls and women would equip them with the knowledge, skills, attitudes, and behaviors required to address the 2030 Agenda for Sustainable Development.

Using UNESCO's ecological framework, I tried to explore the factors that influenced some Mexican female STEM professionals' pathway to STEM studies and careers. The results of this study found multiple and overlapping factors at family, school and societal level which have been critical to creating more pathways for these women in STEM education as well as careers. Combating gender disparity in STEM education and careers in Mexico requires holistic and integrated responses at all levels. In accordance with the ecological model presented in this study, there is no single factor that alone has influenced these women's participation, achievement and progression in STEM, but interactions among factors at the individual, family, school and societal levels.

Further research should understand and assess the particular obstacles that keep Mexican female students away from studying and pursuing careers in all STEM fields throughout the country. There is a great need for data collection and analysis of the factors that affect Mexican girls' and women's decision to pursue university STEM studies and careers. Although some efforts have attempted to improve Mexican girls' engagement in STEN education, there are not adequate sources, especially in Spanish, that can give us a holistic understanding of these factors influencing female students, professors, and research in STEM fields in higher education, which this study hopes to encourage.

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