Women in Science, Technology, Engineering and Mathematics(STEM) in the Asia Pacific

(January 2024)

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List of acronyms and abbreviations

STEMinist A feminist who supports women in science, technology, engineering, and math. Someone who believes in gender equity in science, technology, engineering, and math.

STEMinism STEMinism is the practice of integrating feminism in STEM — supporting gender equity in both STEM practitioners/researchers and the research stakeholders.

STEMinism focuses on training women in science to advocate for themselves and to learn how to succeed within the meritocratic sySTEM of STEM.

Foreword

Proficiency in critical thinking, scientific research and data science, computer programming and technology applications plays a pivotal role in confronting the big challenges of our times. The climate crisis, fast-moving pandemics, growing economic disruptions, threats to food, energy and cybersecurity, and getting ahead of the waves of injustice and violence we see today, underlies the need for more STEM (Science, Technology, Engineering and Mathematics) capabilities, to address such global and local sustainable development challenges.

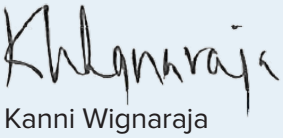
As countries push for progress, with increasing demands to mesh competitive economies with cohesive societies, the imperative for STEM skills continues to escalate. And while Asia stands out as a front runner in STEM domains, countries in the region grapple with hurdles in meeting the escalating demand for an agile workforce equipped with contemporary and adaptable skills; and an ecosystem to support them.

The evidence shows that investing in women and girls in STEM helps drive positive social norms and mitigates economic disparities, while fostering a more diverse and proficient STEM workforce. This we know. Yet, despite the increasing enrollment of women and girls in STEM education across the Asia region, this progress has yet to translate into the job market, with equal-pay and quality jobs for women in these fields. The ramifications of neglecting this pathway, from education attainment to the future of work, are considerable, including that of perpetuating gender gaps and reinforcing gender stereotypes in research and design.

This study, initiated by the UNDP Bangkok Regional Hub, Gender Team in collaboration with UNDP China, sheds light on the regional landscape of women in STEM across the Asia Pacific. UNDP teams in Indonesia, Malaysia, Maldives and Thailand have also been part of this research effort, to map the challenges and advancements made by the countries in the participation of women and girls in STEM fields.

It is by understanding and unpacking the factors that have enabled the underrepresentation, undervaluation, and unequal remuneration, that we can, together, chart a different way forward. And the perspectives and experiences of a diverse segment of those girls and women who have been left behind is essential to doing so.

This study serves as a foundational step toward dismantling barriers and fostering an inclusive approach to realizing the full potential of women and girls in STEM in the Asia Pacific region.



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Acknowledgement

Froniga Greig authored this research with the invaluable support and significant contributions of the UNDP focal points: Fei Zheng, Gender Specialist at UNDP China, Hanadi Abdelhalim, Gender Specialist at UNDP Thailand; Mohamed Nabeeh Asim, Program Officer and Gender Focal at UNDP Maldives; Yin Wei Chong, Head of Solutions Mapping at UNDP Malaysia; Agnes Gurning, Gender and Social Inclusivity Analayst and Asititi Sukatrilaksana, HR Analyst, both from UNDP Indonesia. Their unwavering dedication in data collection, identification of research participants, and analysis and review of draft reports is highly appreciated.

Heartful appreciation to the UNDP Asia Pacific Gender Team, Koh Miyaoi, Gender Team Leader and Tshering Choden, Regional Gender Specialist, for the invaluable feedback and edits across drafts, enriching the content and quality of this report. Furthermore, this report would not be possible without the valuable review, support and inputs from Malaysian Research Accelerator for Technology & Innovation (MRANTI), China Women's Association for Science and Technology (CWAST) and Zhaopin, an online recruitment platform in China.

Finally, deep appreciation for all the stakeholders who generously shared their insights and participated in interviews, lending depth and credibility to this research.

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Executive Summary

This research explores the trends and patterns currently unfolding in the region by providing a qualitative analysis of emerging issues facing women and girls in Science, Technology, Engineering, and Mathematics (STEM), as well as potential solutions, across five countries: China, Indonesia, Malaysia, Maldives, and Thailand.

The objectives of the research are to:

1. Map the key challenges and opportunities for women in STEM across the five countries by taking a life cycle approach (birth to retirement).
2. Capture best practices and examples that demonstrate effective approaches for promoting women in STEM.
3. Provide practical recommendations for how different stakeholders can promote women's participation in STEM

Key Findings

STEM has been recognized as a priority for all of the five countries included in this research, and significant efforts have been made to promote the participation of women and girls in STEM. As a result, there has been a gradual increase of women's participation in STEM education and careers, which is an encouraging development. However, it is important to acknowledge that despite these advancements, disparities still persist in certain disciplines, including maths, physics, engineering and computer science, where women continue to be underrepresented. Furthermore, one of the challenges in fully understanding the landscape of women and girls in STEM in this region is the lack of data on gender-specific data. This makes it difficult to paint a comprehensive picture of women and girls in STEM in the region in addition to applying an intersectional lens in further understanding this issue.

The study shows that key gender and development indicators, such as number of women in leadership roles, girls' education rates, labour force participation rates, and the gender pay gap, cannot serve as proxies, for increased representation of women in STEM. Instead, there is a need to gauge measures and national commitments that specifically target increasing opportunities, policies and programs to remove barriers facing women and girls in STEM and within specific sub-sectors. Additionally, the analysis identifies hidden factors, which are not fully captured by available data and are key to increasing women's effective representation and leadership in STEM.

Failing to promote the equal participation of women and girls in STEM has far-reaching social, ethical, and economic implications. Gender biases in the design and application of technologies, including artificial intelligence (AI), along side the skills deficit, pose significant eco-nomic implications and obstacles for both men and women, hindering the achievement of sus-tainable and equitable development outcomes across the region.

Throughout their childhood, education, and careers, women and girls in STEM face unique challenges. The findings demonstrate how traditional gender norms and roles shape boys' and girls' perceptions of STEM during childhood, influencing their educational choices and early career pathways. Once established in their STEM careers, women face barriers due to unrealistic expectations to prove themselves and the myth of meritocracy.

Early childhood and K-12 education

- **Boys and girls typically differ in their socialization experiences and acquire social norms and gender-role stereotypes along the way.** The biased belief that boys and men perform better than girls and women in science can lead to lower self-confidence and self-efficacy among girls, which could affect their attitudes towards pursuing STEM education and careers later in life.
- **This issue is further complicated by academic streaming in secondary school**. By funneling students into specific fields through academic streaming, the ability of women to pursue STEM-related education and careers is further affected. This perpetuates gender stereotypes and diminishes women's participation in STEM.
- **The teaching methods employed and the availability of resources in schools present significant barriers for girls in STEM subjects.** A research study conducted in Thailand discovered that teachers' belief that boys outperform girls in mathematics can have a negative effect on female students' performance in the subject.
- **In addition to students' learning achievements, individual interest levels, and the attitudes of teachers and parents, access to STEM-related career information is another key factor influencing students' career aspirations**. Besides, there are significant gaps observed in access to STEM education for students in rural communities. Alongside shortages of qualified mathematics and science teachers and STEM-related facilities and resources, rural schools often offer limited access to advanced coursework and extracurricular programs in STEM.

Higher education

- While in many countries women and girls are studying STEM majors in higher education in significant numbers, **women who graduate from STEM courses in higher education face a lower return on their education investment when they start working compared to men.** This acts as a disincentive for women to work in STEM fields.
- In addition, **women, and girls in general face a barrier when accessing information on diverse STEM opportunities and jobs and face barriers when accessing non-academic STEM educational pathways which tend to be dominated by men**. For girls and women in rural and remote areas, evidence from our research suggests that positive national statistics mask the small number of women and girls in rural and remote areas who can access to STEM courses at higher education levels due to cultural expectations that girls should study close to home.
- According to discussions in Malaysia, educational institutions in rural areas have the infrastructure to teach STEM but face a shortage of teachers with the requisite training. Culturally, families are also less likely to encourage their daughters to leave home and study in urban centres, where STEM courses are taught.

Careers of Women in STEM

- **Women's representation in STEM sectors experiences a significant decline during the transition from university to the workforce.** Various factors hinder women from entering the STEM workforce, including gender biases and stereotypes in recruitment, the sector's highly competitive nature, inadequate work-life balance, negative perceptions of STEM career prospects for women, as well as the pressure to conform to traditional gender roles.
- **Subconscious perceptions rooted in traditional gender stereotypes**, often lead to the notion that women are less suitable to pursue a STEM careers, suggesting that they have less aptitude to pursue STEM professions, have a greater need for a more equal work-life balance, or require additional flexibility to fulfill caregiving roles. **These implicit biases can influence recruitment, evaluation, and promotion decisions, posing challenges for women in STEM and limiting their career opportunities, despite advocating meritocracy**. Discussions with STEMinists in China and Malaysia reveal that many young, qualified female graduate opt for further higher-level education or undergraduate or school-level teaching assignments rather than enter research institutions or tech companies like their male peers due to a lower sense of self-efficacy, and perceived challenges in accessing recruitment and promotion opportunities in STEM sectors.
- Although the representation of women in STEM occupations has been increasing in recent years, **STEM sectors are still largely male-dominated, especially in leadership positions**. The lack of women role models in male-dominated workplaces can limit women's visibility and leave many junior female professionals without identifiable routes to pursue a career in STEM fields. Many women, whether in their early career or accomplished, experience a lack of self-confidence, and tend to have doubts about their long-term career prospects in STEM sectors.

  For example, in China, although the gender gaps in science research funding applications have gradually improved since 2011, thanks to affirmative measures adopted in recent years, significant gender gaps persist for top research projects and talent programmes.

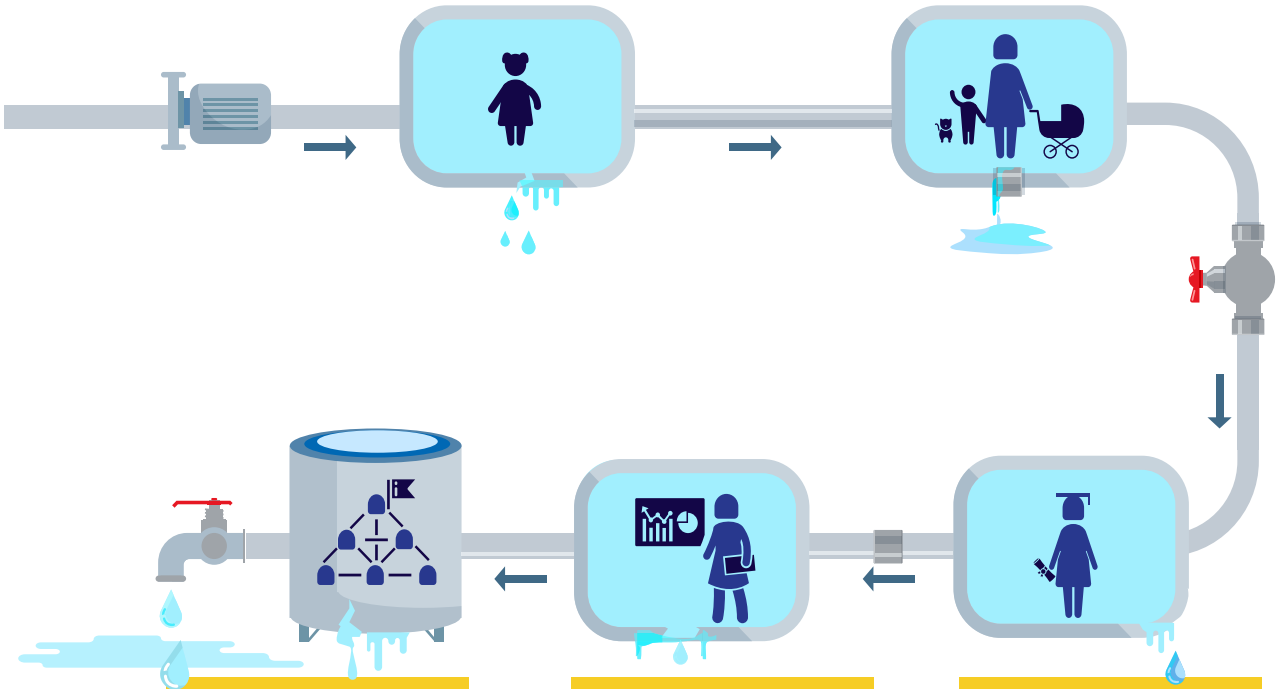
- In most traditional value systems, especially in the Asia Pacific region, gender norms and social expectations encourage women to prioritize family over their careers and education. As STEM careers are often work-intensive and offer little work-life balance, women may struggle to balance their professional and personal responsibilities, leading to limited career advancement opportunities and overall success. **The unequal impact of parenthood is considered one of the key reasons behind the productivity gaps between men and women.** For women, fewer publications would also mean fewer opportunities to be awarded research funding. According to the World Economic Forum, women are typically given smaller research grants and find it harder to obtain venture capital for tech startups.

Early Childhood and K-12 Education

The biased belief that boys and men perform better than girls and women in science can lead to lower self-confidence and self-efficacy among girls, which could affect their attitudes towards pursuing STEM education and careers later in life.

Family Responsibilities

In the Asia Pacific region, gender norms and social expectations encourage women to prioritize family over their careers and education. As STEM careers are often work-intensive and offer little work-life balance, women may struggle to balance their professional and personal responsibilities.



Lack of Social Capital

Despite the positive trends, the STEM sectors are still largely dominated by men, especially in leadership positions. In workplaces with fewer female role models and lower status for women on average, forming effective networks and acquiring social capital becomes more challenging for women.

Career Development

Various factors hinder women from entering and progressing in the STEM workforce, including gender biases and stereotypes in recruitment and promotion, the sector's highly competitive nature, inadequate work-life balance, as well as the pressure to conform to traditional gender roles.

Higher Education

While globally more women and girls are studying STEM majors in higher education, women tend to take longer time to land STEM jobs after graduation and have ower starting salaries compared to their male peers. This acts as a disincentive for women to study STEM majors.

Leaky Pipeline in the STEM Sector

1. Why study women and girls in STEM?

Background

The Fourth Industrial Revolution (Industry 4.0) is characterised by a fusion of technologies that is blurring the lines between the physical, digital, and biological spheres[1]. Skills in STEM (Science, Technology, Engineering and Maths) are now vital for tackling critical and urgent sustainable development problems, as diverse as the climate crisis and disaster risk reduction, health and education disparities, economic and food security, cyber security and even gender-based violence. Definitions and understanding of STEM skills along with careers in STEM are evolving and expanding to catch up with breakthroughs across all industries and at an unprecedented pace[2].

Navigating the next industrial revolution

Revolution		Year	Information
	1	1784	Steam, water, mechanical production equipment
	2	1870	Division of labour, electricity, mass production
	3	1969	Electricity, IT, automated production
	4	?	Cyber-physical sySTEMs

Figure 1 : Timeline of Industrial Revolutions.

1 World Economic Forum, The Fourth Industrial Revolution: What it means? How to respond , January 2016 https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/

2 Ibid.

Definitions of STEM are constantly changing to include art, design, robotics, inventing and entrepreneurship. These changes are exciting and herald the transformation of entire systems of education, production, management,economics and governance and workforces. The Asia Pacific region is facing challenges in meeting the demand for suitably qualified workers in STEM. According to The World Economic Forum, by 2030, as many as 80 percent of jobs in Southeast Asia will require basic digital literacy, applied information, communication and technology (ICT) skills[3] . The labour shortage that the Asia Pacific will face by 2030 is estimated to rise from 12.3 million to 47 million at an annual opportunity cost of USD 4.238 trillion[4].

Despite the lack of comprehensive data, evidence suggests that the representation of women in STEM remains low across the Asia Pacific region. Women comprise around 23.9 percent of researchers, lower than the global average of 29.3 percent[5]. This percentage decreases at each stage of advancement throughout STEM careers. For example, an unprecedented number of women and girls are enrolled in academic STEM courses. However, women remain poorly represented in leadership roles in science research.[6] In a global survey conducted in 2015 of 69 national science academies, women comprised less than 10 percent of members in almost half of the countries. [7]

As we navigate Industry 4.0, it is essential to better understand the barriers to women's participation in STEM and the existing gender biases in STEM-related fields, resulting in women being underrepresented, undervalued, and underpaid.[8] Achieving women's equal participation in Industry 4.0 requires support to ensure their equal representation as professionals, leaders, and consumers. It is also vital to address the specific needs of various groups of women and girls, such as older women, women and girls with disabilities, rural women and girls, and ethnic minority women and girls. Their perspectives must be reflected in big data, social media data, and in the design and application of new products, systems, and opportunities.

Purpose of the study

This study scopes the landscape of women in STEM in the Asia Pacific and provides recommendations to diverse stakeholders, including governments, the private sector, and civil society. The study also showcases existing initiatives promoting women in STEM-related fields such as advocacy initiatives, partnerships, policies, and direct opportunities to address barriers and expand opportunities for women and girls to study and develop career pathways.[9]

This research builds on the momentum already underway in the region by providing a qualitative analysis of emerging issues and solutions facing women and girls in STEM across five countries China, Indonesia, Malaysia, Maldives, and Thailand. The research draws on literature, policies and legislation, and primary data collected in partnership with the related UNDP Country Offices.

3 World Economic Forum, *The Future of Jobs: Employment, Skills and Workforce Strategy for the Fourth Industrial Revolution*, 2016

4 Korn Ferry, *The Global Talent Crunch,* 2018

5 UNESCO, Science Report 2021: *To be smart, the Digital Revolution needs to be Inclusive,* 2021

6 Ibid.

7 Ibid.

8 Ibid.

9 These countries were pre-selected by UNDP regional office.

Objectives

The three objectives of this research are to:

1. Map the key challenges and opportunities for women in STEM across the five countries, by taking a life cycle approach (birth to retirement).
2. Capture best practices and examples that demonstrate effective approaches for promoting women in STEM.
3. Provide practical recommendations for how different stakeholders can promote women's participation in STEM.

This research includes examples of best practices and practical recommendations to address shared challenges and collaborate on delivering systematic changes in the region.

However, it should be noted that there are no one-size-fits-all solutions. This research does not claim to present issue-specific recommendations for STEM's sub-sectors. It is therefore, advised that all recommendations must be localized accordingly.

Approach

Primary data was collected using key informant interviews (KIIs) and Focus Group Discussions (FGDs). A total of 39 people (36 women and 3 men) participated in the research.

The research captures the voices of diverse stakeholders including:

- Policy makers working in the following areas: education, employment, and sector specific areas;
- Private sector employers in STEM related fields;
- Educational and research institutions;
- Civil society organisations representing the voices of women in STEM and women's rights;
- Women studying or working in STEM related fields.

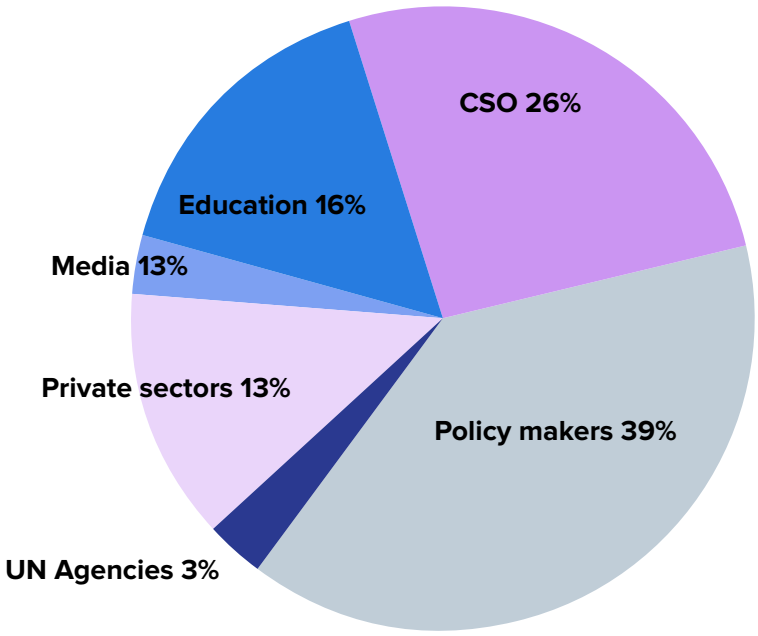


Figure 2. Overview of sectors represented in the interviewees

Key questions

The key questions guiding this research are:

1. What do we know about the representation of women and girls in STEM across the five countries (data and facts)?
2. What are the opportunity costs for countries in the Asia Pacific to leave women behind in scientific research in the Industry 4.0 era?
3. What existing policies and interventions promote women in science in the five countries?
4. What are the key barriers hindering the advancement of gender equality in scientific research in the region?
5. What are some recommendations/tools for different stakeholders to promote women and girls' participation in the science sector?
6. How could different stakeholders, including UN agencies, work together to create synergies and catalyse changes towards a more inclusive and sustainable future for the region?

Limitations and assumptions

- Significant data gaps exist across the countries included in the research, especially the Maldives. This analysis is based on available data and qualitative data.
- The research looks at common challenges across the STEM sectors generally and does not include specific challenges faced by sub-sectors of STEM, even though there is strong evidence to suggest that specific challenges exist and warrant further attention.
- This is essentially a qualitative study, and the sample is not meant to be representative of stakeholders working on women and STEM across the region.
- All stakeholders who participated in the research were identified by UNDP country offices. It is assumed that the selected participants understand the key issues and accurately represent the views and interests of women students and women employed in STEM.
- Due to time pressure and sampling methodology, most respondents come from capital cities. The nuances and interests of women at the sub-national level and women in rural and remote areas may not be adequately captured by the research.
- Although this research focuses on women in STEM education and employment, time and resource constraints limit their direct participation in the research. The research findings do not adequately capture the diverse identities of women in STEM and the impact that gender orientation, geography, ethnicity, disability, age, and other identities have on the barriers and opportunities women in STEM face.
- The research was carried out in English, and it is assumed that all respondents have a good working knowledge of English.
- The good practices highlighted in this research are self-proclaimed by countries and stakeholders involved in the research and were not selected based on specific criteria.

2. What is the Status of Women and Girls' Engagement in STEM in the Asia Pacific?

This section provides a profile of women and girls in STEM in the region, using existing data and contextual information to provide an overview and indication of cross cutting challenges. The analysis highlights significant gender data gaps in certain sub-sectors of STEM and among specific groups of women and girls. These data gaps make it difficult to paint a comprehensive picture of women and girls in STEM in the region including the importance of an intersectional lens in furthering understanding of the issues. Data from the five countries included in this research is used to demonstrate that key gender and development indicators, including the number of women in leadership roles, girls' education, labour force participation rates, and the gender pay gap cannot serve as proxies for increased representation of women in STEM. Additionally, the analysis identifies hidden factors that are key to further expanding women's effective representation and leadership in STEM but are not fully captured by available data.

Demographic trends and gender gaps in STEM and development

Gender gaps in STEM persist globally. Generally, women are overrepresented in studies related to arts and humanities, journalism and media, social sciences, and health and welfare, while being underrepresented in STEM-related subjects.[10] After completing their studies, young women tend to gravitate towards a career in healthcare, medicine, education, arts, and humanities, while young men tend to choose careers in engineering, computer science, math, and physics.[11] Even when women study STEM subjects, many do not enter STEM-related fields or exit the STEM sectors early in their careers.[12]

According to a 2021 report by UNESCO, women comprise around 23.9 percent of STEM researchers in the Asia Pacific region, lower than the global average of 29.3 percent[13]. It was also found that women's representation decreases in more senior research roles, such as in the national academies of science and science councils.[14]

10 UNESCO, Science Report 2021: To be smart, the Digital Revolution needs to be Inclusive, 202t

11 Stephenie Foster, Women in STEM: Critical to Innovation, Global Policy Journal, 2021

12 UNESCO, Cracking the code: girls' and women's education in science, technology, engineering and mathematics (STEM), 2017

13 UNESCO, Science Report 2021: To be smart, the Digital Revolution needs to be Inclusive, 2021

14 http://uis.unesco.org/sites/default/files/documents/fs51-women-in-science-2018-en.pdf

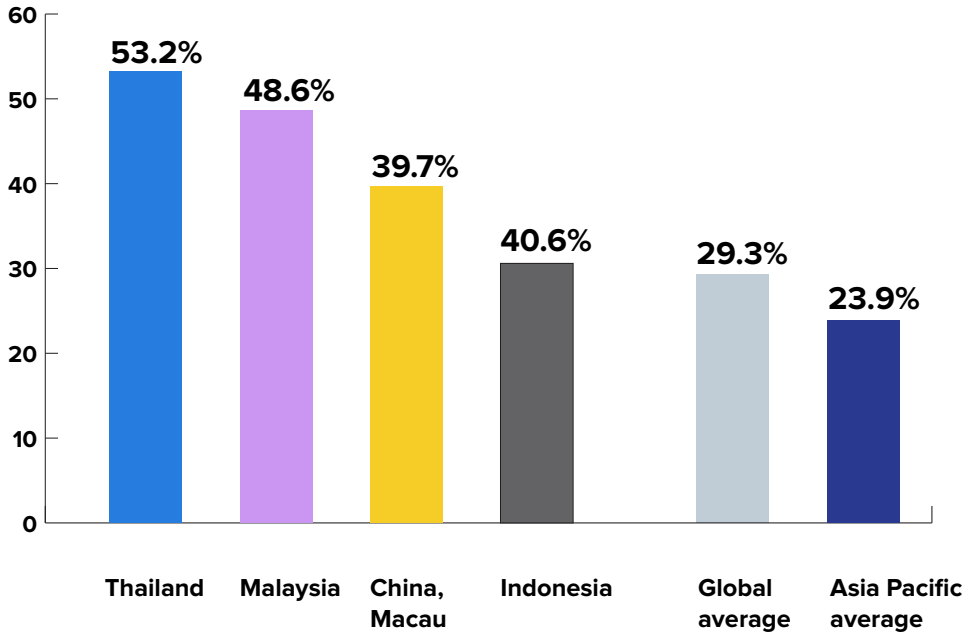


Figure 3 : Percentage of female researchers in Asia and the Pacific

Explaining gender gaps in STEM requires both an analysis of gender statistics and a close examination of complex social, cultural, economic, personal, political, and organisational barriers that contribute to these disparities.[15] Table 1 provides a summary of the human development index and gender development index for each of the countries included in this research. It reveals that although women's development is crucial for achieving comprehensive human development, the reduction of gender gaps does not always align proportionally with the overall pace of progress. Similarly, gender gaps in STEM do not automatically disappear with increased economic or human development.[16] Research found that in more gender-equal countries, the gender gap, favouring boys over girls, in science is greater, and the proportion of women graduating with a degree in STEM is smaller.[17]

15 International Science Council, A Global Approach to the Gender Gap in Mathematical, Computing, and Natural Sciences: How to Measure It, How to Reduce It?, 2022

16 UNESCO, Science Report 2021: To be smart, the Digital Revolution needs to be Inclusive, 2021

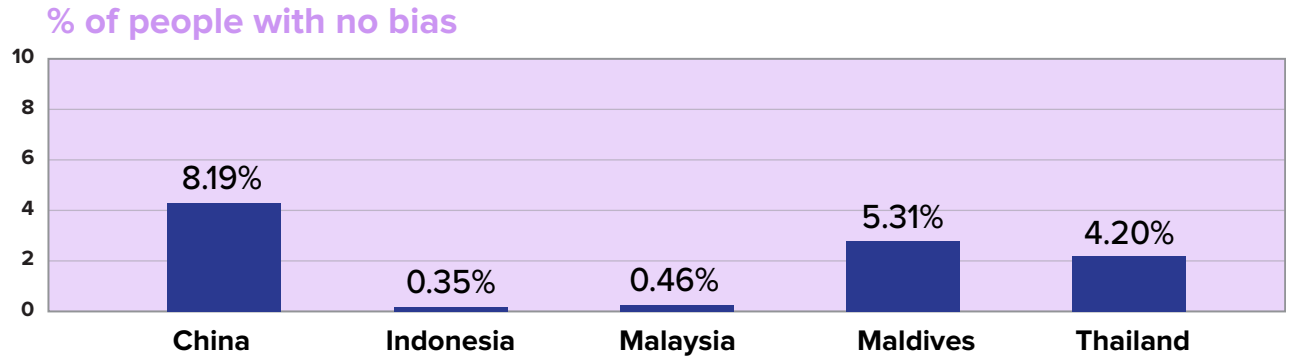
17 Stoet, G. and D.C. Geary, The Gender-Equality Paradox in Science, Technology, Engineering, and Mathematics Education, Psychological Science, 29/4, 581–593. 2018.

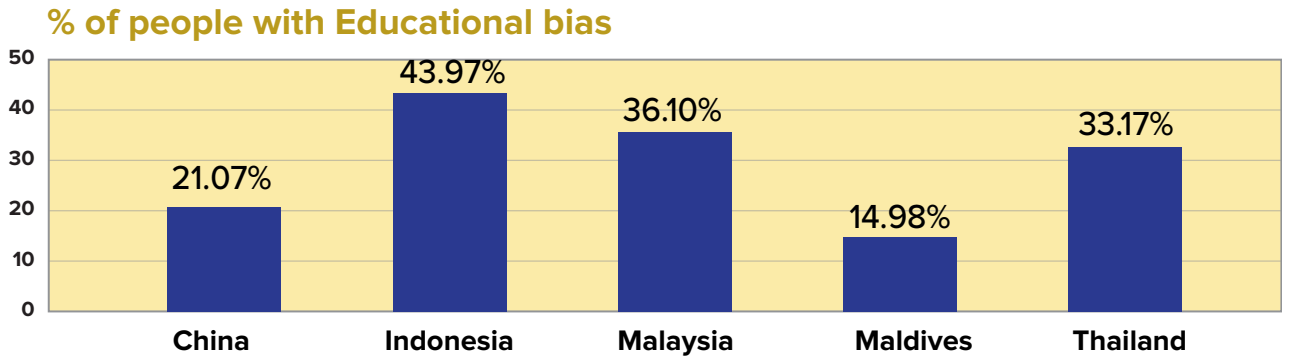
Figure 4. HDI and GDI by country 2022

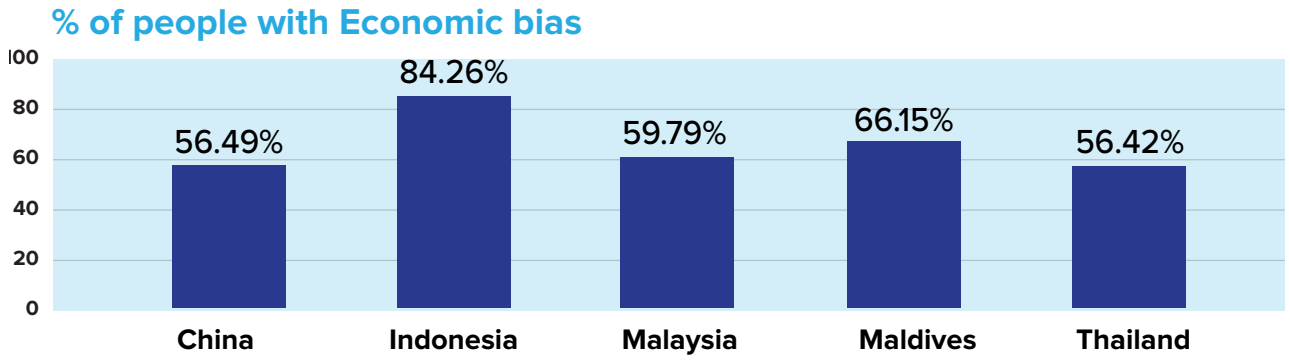
UNDP's Gender Social Norms Index provides further insights into biased attitudes against women's role in four dimensions: politics, education, economics and physical integrity. Biased gender social norms act as significant obstacles to achieving gender equality and empowering all women and girls. Table 2 reveals that most of the population in countries included in this research hold fundamental biases against women. These cultural and societal factors intersect with institutional and economic barriers, generating chronic gender gaps that could limit women's social and economic participation, creating a vicious circle.[18]

18 UN Women, Women in Science, Technology, Engineering and Mathematics (STEM) in the Latin America and the Caribbean Region, 2022

Table 1. Gender Social Norms Index, 2017-2022 (Countries displayed in alphabetical order)







Source: UNDP, 2023 Gender Social Norms Index: Breaking down gender biases: Shifting social norms towards gender equality, 2023

Progress and Challenges of Women's STEM Participation in the Asia Pacific Region

Women in STEM in education

Globally and within the Asia Pacific region, increasing numbers of women are enrolling in universities. According to a report by UNESCO (2021), globally, women have achieved parity at the bachelor (53%) and master's levels (55%) of study. At the doctorate level, women accounted for 44% of graduates.[19]

Many countries in the region are showing an upward trend of women and girls studying STEM related subjects. In China, a study conducted in 2022 by the National Science Library of the Chinese Academy of Science and Elsevier[20] shed light on the encouraging progress seen in women's engagement within STEM fields. Specifically, when comparing the timeframe of 2005 to 2009 with that of 2015 to 2019, there is a notable rise in the number of women pursuing STEM education. While it remains true that men continue to outnumber women in most STEM-related domains, there is an overall positive trend of an increased female presence in scientific research across various STEM disciplines.

However, this upward trend in women's participation in STEM subjects masks persistent and pervasive gender gaps in some STEM sub-sectors. Across the region, available data indicates that women graduates are outnumbering men in health and welfare and natural sciences while engineering remains a male dominated area of STEM (see Table 2)

Table 2. Percentage of female tertiary graduates by STEM field (Countries displayed in alphabetical order)

Country	Engineering	Health & Welfare	Natural Science	ICT
China				
Indonesia	24.9	78.0	74.3	34.7
Malaysia	27.1	72.4	70.7	46.0
Maldives				
Thailand	16.8	76.3	70.7	47.9

19 UNESCO, Science Report 2021: To be smart, the Digital Revolution needs to be Inclusive, 2021

20 National Science Library, Chinese Academy of Science, Elsevier, Gender in China Research Arena, 2022

Women in STEM in the labour market

The global labour force participation rate for women stands just above 50%, compared to 80% for men.[21] For most of the countries participating in this research, women's labour force participation rates are above the global average. However, high women's labour force participation rates have not automatically translated to an increase in the number of women in STEM (see table 3).

Table 3. Labour force participation rates by sex (Countries displayed in alphabetical order)

Country	Females	Males
China	61.1%	76.2%
Indonesia	52.7%	80.6%
Malaysia	42.6%	78%
Maldives	52.7%	78.7%
Thailand	58.7%	74.8%

Women in the Asia Pacific region continue to be underrepresented across the STEM sector jobs.[22] Although a recent study by UNESCO found that only three countries in Asia (South Korea, Malaysia and Thailand) have an equal or higher proportion women working in the STEM industry compared to men, with Thailand ranking first for the highest percentage of female workers in STEM (53 percent) this is not a trend across the countries included in this research.[23]

Women's representation in STEM employment decreases with each stage of advancement in their STEM careers. For example, although an unprecedented number of women and girls are enrolled in academic STEM courses, women remain underrepresented in leadership roles in science research. [24] According to the study conducted by National Science Library of Chinese Academy of Science and Elsevier[25], the ratio of men to women among researchers holding senior professional titles declined from 5.47 to 3.92 between 2008 and 2017. Similarly, those with deputy senior professional titles saw a decrease from 2.35 to 1.83, while individuals holding intermediate professional titles experienced a decrease from 1.94 to 1.55 during the same period.

Evidence underscores that women employed in science and technology are leaving the STEM sector as quickly as they are entering it. This phenomenon, known as the "leaky pipeline" is found in almost all countries in the world and is discussed in Section 4 of this report.

21 World Bank Gender Data Portal

22 UNESCO, Science Report 2021: To be smart, the Digital Revolution needs to be Inclusive, 2021

23 Nicha Jitkaew, Pathways: How Thai Culture And Gender Stereotypes Affect Female Career Experiences In STEM Occupations,Thammasat University, 2019

24 Ibid.

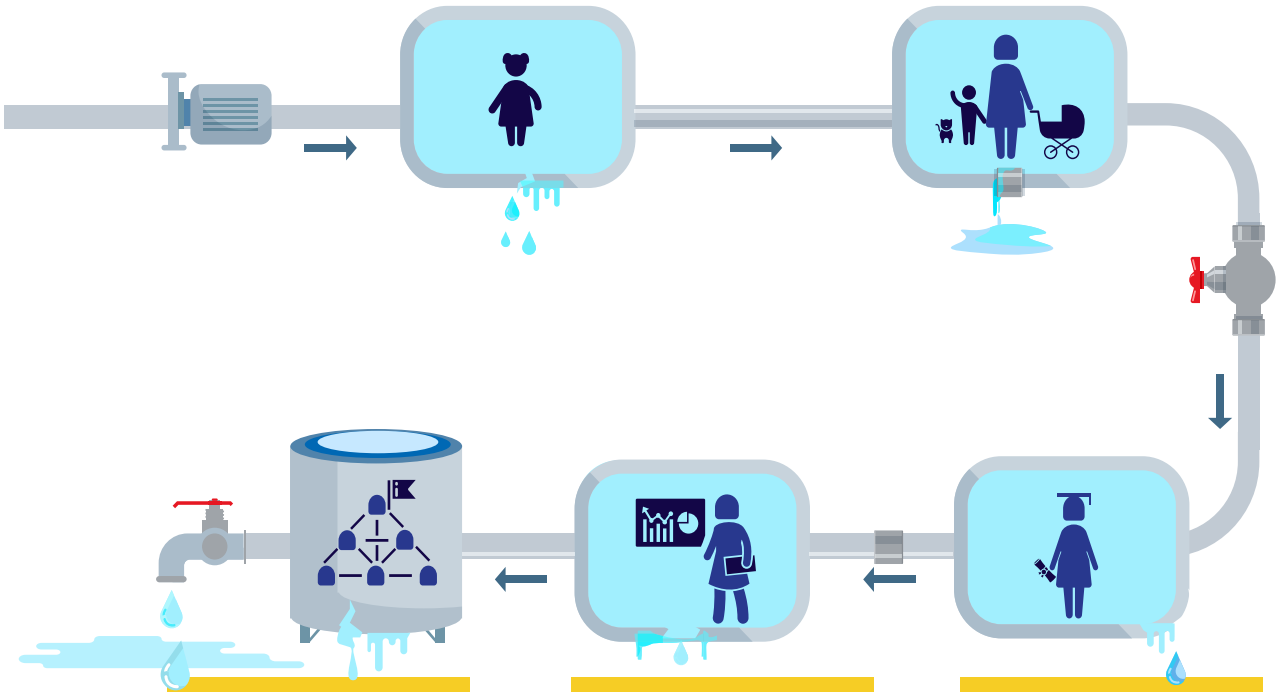
25 National Science Library, Chinese Academy of Science, Elsevier, Gender in China Research Arena, 2022

Early Childhood and K-12 Education

The biased belief that boys and men perform better than girls and women in science can lead to lower self-confidence and self-efficacy among girls, which could affect their attitudes towards pursuing STEM education and careers later in life.

Family Responsibilities

In the Asia Pacific region, gender norms and social expectations encourage women to prioritize family over their careers and education. As STEM careers are often work-intensive and offer little work-life balance, women may struggle to balance their professional and personal responsibilities.



Lack of Social Capital

Despite the positive trends, the STEM sectors are still largely dominated by men, especially in leadership positions. In workplaces with fewer female role models and lower status for women on average, forming effective networks and acquiring social capital becomes more challenging for women.

Career Development

Various factors hinder women from entering and progressing in the STEM workforce, including gender biases and stereotypes in recruitment and promotion, the sector's highly competitive nature, inadequate work-life balance, as well as the pressure to conform to traditional gender roles.

Higher Education

While globally more women and girls are studying STEM majors in higher education, women tend to take longer time to land STEM jobs after graduation and have ower starting salaries compared to their male peers. This acts as a disincentive for women to study STEM majors.

Figure 5 : Leaky Pipeline in the STEM sector

According to the China Association for Science and Technology, women account for around 40 percent of the workforce in STEM related jobs.[26] According to Zhilian Zhaopin, an online recruitment platform in China, in some sub-sectors, such as the pharmaceutical industry, women accounted for 48.9% of workforce in 2019, rising to 61% in 2022. However, women account for less than 20% of the most popular STEM positions in the field of technology, including machine learning, deep learning, image recognition, and architecture.[27] Women comprise only 5% of the members of the Chinese Academy of Engineering.[28]

In Malaysia, data from 2021 by Jobstreet shows that women make up around 35% of the technology workforce, and that only 23% of women are members of the Academy of Sciences Malaysia.[29] In fields like HealthTech, AgriTech, robotics and fintech, women are still held back by a glass ceiling and by cultural and societal constraints that lead women to lack confidence in themselves. The Malaysian Research Accelerator for Technology and Innovation (MRANTI) is seeking to address this imbalance. MRANTI has nurtured a growing number of female-led start-ups in AgriTech, food Tech, retail, and FinTech such as BloomThis, Batik Boutique, BoomGrow, and Data8.[30]

Gender pay gaps could contribute to the higher attrition rate of women in STEM careers compared to their male peers. Research from the USA, United Kingdom and Australia reveals that the gender pay gap in STEM is higher than the global average of 16%. [31] Unfortunately, STEM-related specific data regarding gender pay gaps in the countries under examination is unavailable. However, interviews conducted with key stakeholders in these countries indicate the presence of gender pay gaps in STEM fields across all of them, with many surpassing the average level of gender pay gap observed within their respective national contexts. (see table 4). [32]

Table 4. Gender pay gap as a percentage (Countries displayed in alphabetical order)

Country	Gender pay gap %
China	14.6%
Indonesia	23%
Malaysia	11%
Maldives	25%
Thailand	10.9%

26 Yuanxi Huang, Gejia Zhao, *The Development of Women Scientists in China and its Supporting Policy, National Academy of Innovation Strategy,* China Association for Science and Technology, 2018

27 Boss Zhiping, *2019 Report on Gender Differneces in the Workplace in China,* 2019

28 China National Bureau of Statistics, *China 2020 Statistical Yearbook on Science and Technolog,* 2020

29 Home – Official Portal Academy of Sciences Malaysia. Official Portal Academy of Sciences Malaysia

30 Dzuleira Abu Bakar, *Putting women at the heart of a DigitALL World,* The Edge Malaysia, March 7, 2023

31 Smith, Roger. Gender Pay Gap in the UK – Office for National Statistics. 3 Nov. 2020,; *Australian Department of Industry, Science and Resources, Gender pay gaps in STEM and other industries,* 2022. AAUW, *The STEM Gap: Women and Girls in Science, Technology, Engineering and Mathematics*, 29 Aug. 2023,

32 World Bank Gender Data Portal, genderdata.worldbank.org

National statistics usually do not provide data on specific populations such as ethnic minority women and girls, people living with disabilities, etc. The absence of this data on specific groups of women and girls potentially hides or obscures other gender gaps, which make it difficult to paint a comprehensive picture of women and girls in STEM across the Asia Pacific region.

Profiles of women in STEM in the Asia Pacific

> Becoming an engineer was never my dream. I wanted to be a doctor. I always dreamed of being a doctor. I failed the medical exam and I had to shift my dream and I ended up as an engineer. I studied a graduate program in information systems engineering (signalling and electrical engineering) where I was one of two women in a class of 30 students. I have worked for the railways for the last 12 years. I love my journey as an engineer. The discipline of engineering is quite like being a doctor because it is about keeping other people safe. In the railways you need to be safe. You need a safe design for the commuters, just as a doctor needs to save someone in the operating room. Although I use my STEM skills at work, my work also requires a lot of managerial skills. At work I am trying to give equal opportunities to women and men and right now my department is comprised of 40 percent women.
>
> **Tengku Alia Sandra, Department Head of Railway Engineering MRT Jakarta—39 years old**

> I have a computer science background and work as an information systems manager in a software team for an insurance company. In 2018, I partnered with two women to establish Women in Tech Maldives. This not-for-profit organisation recognises that technology is increasingly important given the geography and development context of the Maldives. Women in Tech provides a network for women already working in the field and raises awareness of the need for women's participation in diverse areas of STEM such as data collection and management, innovation, and cyber security in the future.
>
> **Aiesha Adnan, Co-founder of Women in Tech Maldives—35 years old.**

“I chose biology at undergraduate level because I read Darwin’s books. I was attracted to the experience of exploring alien territories and discovering new things that people have never seen before. But when I went to college, the biology department at Pekin University only had laboratory studies. I was a bit disappointed. However, in my third year, in undergraduate study, I was fortunate enough to meet this professor who was studying the giant panda in the field. So, I thought this is an opportunity. That is how I started my career. All the people around me voted against this decision, because it is considered typically a man's job to go to the field, to study animals and run around and climb mountains. But the one person that gave me courage was my mother. She said you must decide and take responsibility for it. If one day you regret it, you must be responsible for that too. I did not think twice. I told her that I will not regret it, which is true, I never regretted it.”

Lu Zhi, Professor, School of Life Sciences; Executive Director, Center for Nature and Society, Peking University—58 years old

“I faced difficulties with maths at primary school which led to low self-esteem in science and maths. Once I got to secondary school maths became easier, but I wanted to be a lawyer. I did well in my exams and was streamed into sciences. I studied at an all-girls school and not many of us went into STEM. Although I am in the biotechnology field, I often sit on panel discussions, and I am surrounded by men. My family supported me to be a doctor. Today my daughters are in science as well. One is doing surveying in construction. The other daughter is doing chemical engineering. My husband is also supportive of my daughters having careers in science. He supports us to be ambitious.”

Mahaletchumy Arujanan, Director of Petri Dish Malaysia science communication journal— 53 years old

3. What are the implications of the gender gap in STEM?

This section delves into the extensive social, ethical, and economic ramifications that stem from the persistent underrepresentation of women in STEM fields within the region. Failing to address this gender gap can lead to biases in the design and implementation of critical technologies, including artificial intelligence (AI). Moreover, it can result in a shortage of talent and skills, giving rise to substantial economic consequences. Additionally, it poses obstacles to achieving sustainable and equitable development outcomes throughout the region.

Bias in the design and application of technologies

Global estimates indicate that women hold around 22% of jobs in artificial intelligence (AI).[33] Across the countries that participated in this research, the technology sector is experiencing significant growth and gender gaps will widen if women are not actively involved in emerging areas like designing artificial intelligence or digital finance. In addition, if hidden gender biases in technology design are not addressed, innovative technologies may reinforce such biases. For instance, many AI models used for recruitment purposes have been found to target listings for better-paid jobs towards male-candidates.[34] A study of 133 AI sySTEMs revealed that 44% exhibited gender bias.[35] As technology plays a crucial role in the design of transport, smart cities and disaster risk reduction and is critical for the future, ensuring that women participate in designing the world we live in will guarantee that their needs are understood and reflected.[36]

33 Stanford Social Innovation Review, *When algorithms go sexist: Why and How to Advance AI Gender Equity*, 2021

34 EY, *Why we need to solve the issue of gender bias before AI makes it worse,* 2021

35 Ibid.

36 World Economic Forum. *Cities aren't designed for women. Here's what's needed next,* 2022

Box 1: Think City Malaysia — Understanding Women's Perception and Experience of Safety in Downtown Kuala Lumpur

In 2017, Think City began exploring a Safe City programme, which was later called Safe Communities to stress the people-centric focus, as part of a larger effort to revitalise downtown Kuala Lumpur. The programme engages women as a key target group in formulating better strategies towards a safer city for all. Recognizing the importance of women's perspectives and experiences, Think City actively engaged women as a key target group in formulating strategies for a safer urban environment. To address safety concerns and validate the experiences of women, Think City deployed various technologies as part of the program. Smart lighting sySTEMs were implemented to enhance visibility and create well-lit public spaces, promoting a sense of security for women navigating the city. Surveillance sySTEMs were strategically placed to deter criminal activities and provide an additional layer of safety. Furthermore, pedestrian-friendly infrastructure improvements were introduced to ensure ease of movement and accessibility, particularly for women.

Through these technological interventions, Think City aimed to foster an urban environment where women feel empowered to navigate and utilize public spaces confidently. By acknowledging and addressing safety concerns, Think City's Safe Communities program contributes to creating a more inclusive and supportive city for women, enabling them to actively participate in the social, economic, and cultural aspects of urban life.

Human resource and skills deficit impacting development

The demand for STEM skills is steadily increasing across various industries, including the gig economy, entrepreneurship, and sustainable development, particularly in areas related to climate, environment, and energy sectors. Moreover, STEM skills are now essential for certain STEM-adjacent roles in science communications, education, management, and business. However, studies indicate that women are more susceptible to job loss as a result of the widespread adoption of recent technologies.[37] Although women continue to be well-represented in occupations that are less likely to be automated, such as childcare and nursing, they also dominate in positions that are the most likely to be automated, such as administrative assistants, office clerks, bookkeepers, and cashiers. Equipping women with STEM skills can help mitigate the risk of them being left behind in the job market. Additionally, the COVID-19 pandemic has further emphasized the importance of women pursuing STEM fields, as technology has played a crucial role in sustaining economies during the crisis.

37 World Economic Forum, *Working women are more at risk of job automation than men,* 2022.

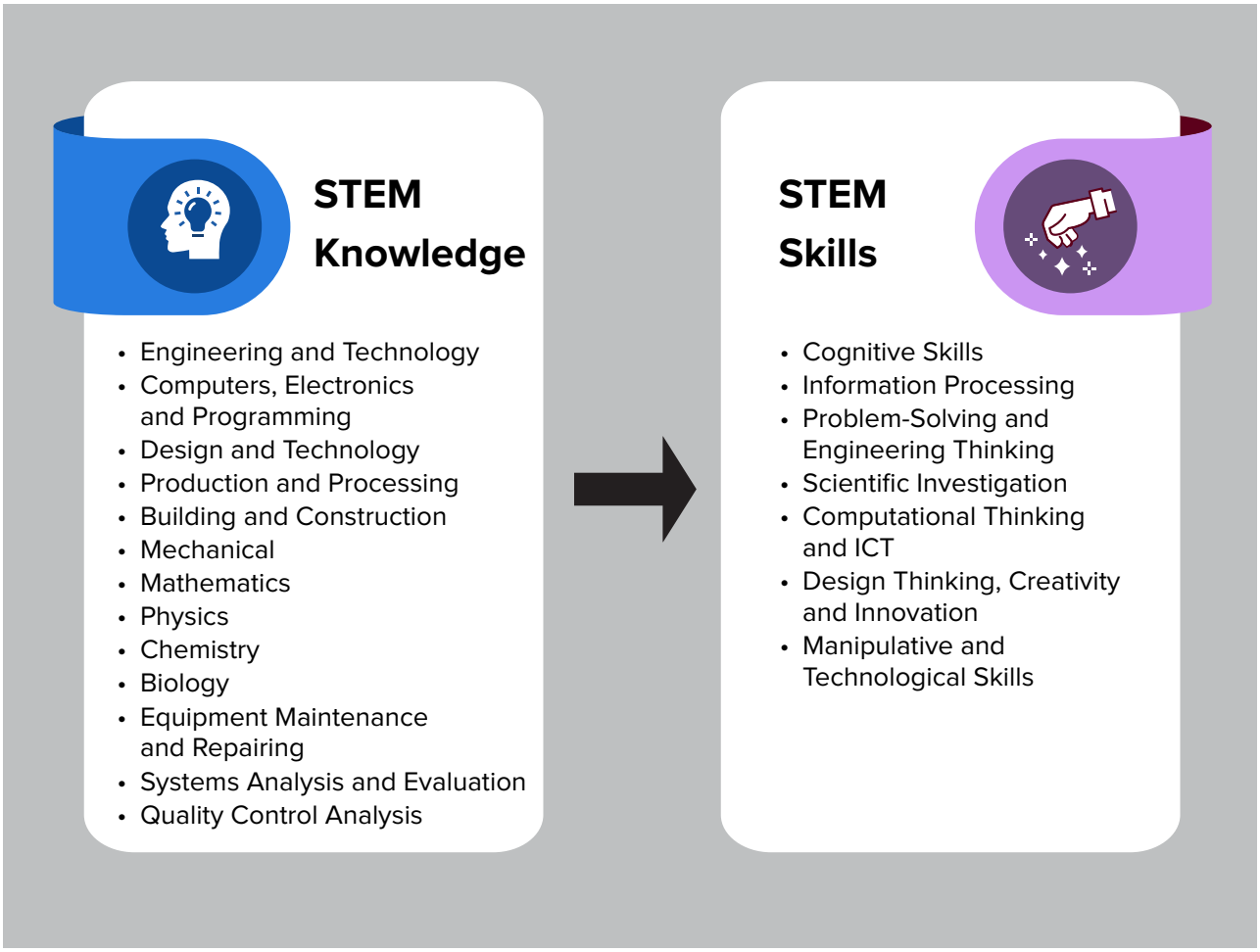


Figure 6. Definition of STEM knowledge and STEM skills

Source: Exploring STEM Competences for the 21st Century, UNESCO, 2019

In the Asia Pacific region, there is a significant shortage of appropriately skilled human resources in STEM fields, despite the increasing demand for these competencies. [38] Projections indicate that by 2030, 80 percent of jobs in Southeast Asia alone will necessitate fundamental digital literacy and applied information, communication, and technology (ICT) proficiencies.[39] However, the region is poised to experience a significant labor shortage, with estimates indicating a rise from 12.3 million to 47 million workers by 2030 at an annual opportunity cost of USD 4.238 trillion.[40] According to a recent report by Boston Consulting Group (BCG) on taking a gender focus in climate action, women are underrepresented in sectors where major green reskilling efforts will take place. An illustrative example lies within the energy sector, specifically the oil and gas segment, where approximately six million jobs are anticipated to undergo reskilling efforts. However, projections suggest that only 22% of reskilled workers will be women.[41]

38 Korn Ferry, *The Global Talent Crunch,* 2018

39 The Diplomat, *STEM Gender Bias Cripples Asia-Pacific Region,* 2020

40 Ibid.

41 The Boston Consulting, *Why Climate Action Needs a Gender Focus,* October 2021

Improving women's labor participation in high-productivity sectors, particularly in science and technology, could lead to a substantial boost in the collective annual GDP of Asia Pacific countries. Mckinsey estimates that by 2025, this improvement could add USD 4.5 trillion to the collective GDP of countries in the Asia Pacific, representing a 12 percent increase compared to the business-as-usual trajectory.[42] China has the largest growth opportunity, with a potential increase of USD 2.6 trillion, followed by Indonesia (USD 135 billion), Thailand (USD 70 billion), and Malaysia (USD 50 billion). The growth opportunity for the Maldives is limited, but the World Bank estimates a potential increase of 6.5 billion in 2023, or around 6.6%.[43]

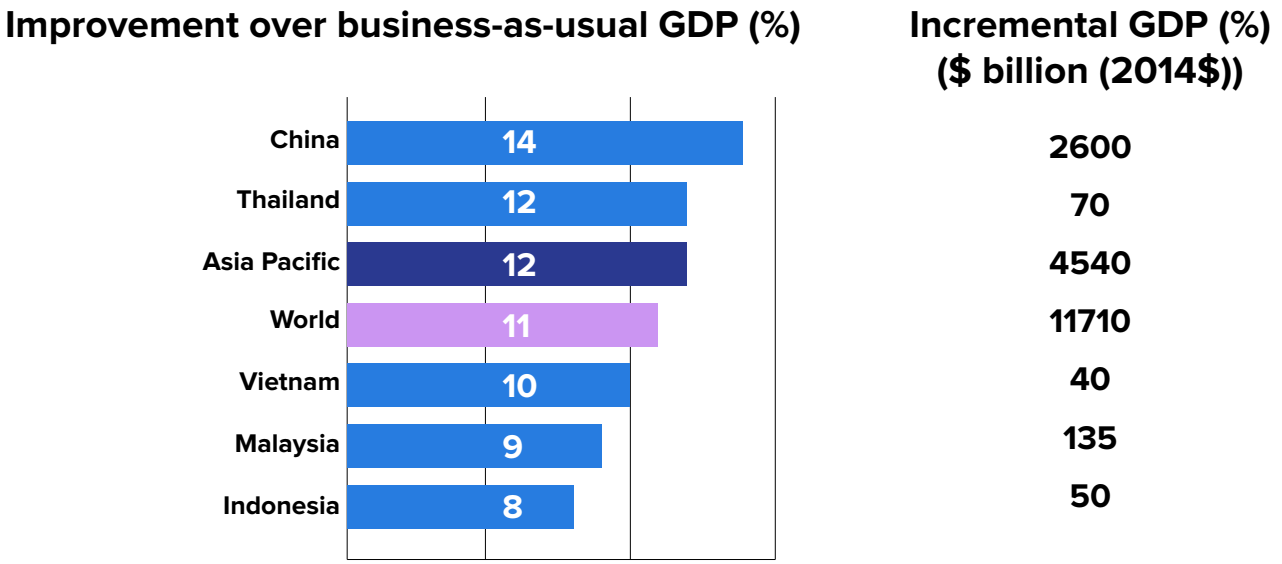


Figure 7. Incremental 2025 GDP from improving Gender Equality at the best-in-region rate

Source: ILO World Output Database, Oxford Economics HIS National Statistical agencies, Mc Kinsey Global Growth Model, McKinsey Global Institute Analysis.

Obstacles to Sustainable Development

Increasing the participation of girls and women in STEM could empower them economically and build a more diverse and talented STEM workforce. Moreover, it could help ensure that diverse groups of girls and women would influence, benefit from and shape the world we live in as technology users, entrepreneurs and innovators. Gaining access to technologies and digital skills is one of the crucial ways for women to participate in political, economic, and social affairs. However, present currently only 54% of women and girls in the Asia Pacific region have digital access.[44]

Technology solutions, such as digital banking, mobile money, mobile-point-of-sale devices, and online lending, provide opportunities for women to pay, save, borrow, and manage cash. Technology can be used by lenders to assess credit worthiness based on alternative data, such as cash flows through mobile wallets or behaviour patterns on e-commerce platforms. The more women who use these platforms, the more their data can influence credit decisions, products, services and innovations offered by

42 *McKinsey Global Institute,* The power of parity: Advancing women's equality in Asia Pacific, April 23 2023

43 The World Bank, *Maldives Needs More Robust Fiscal Reforms to Sustain Strong Recovery,* April 2023

44 The International Telecommunication Union, *Facts and Figure 2022,* 2023

"Women offer unique viewpoints and ways of thinking that are conducive to technological innovation, progress and development."

— Wang Hongyang, President of the China Women's Association for Science and Technology

"Unless women are equally represented in such areas, their needs are at risk of being overlooked in how our future is designed."

— Kanni Wignaraja , UN Assistant

financial institutions.[45]

By creating more and better opportunities for women in STEM, we can build a more inclusive and equitable society. This will not only benefit women but also contribute to overall economic growth and prosperity.

45 Development Asia, *Is Digital Finance the Answer to Giving Women–Owned MSMEs Access to Credit?*, January 2023, development.asia/insight/digital-finance-answer-giving-women-owned-msmes-access-credit.

4. What Challenges do Women in STEM Face throughout their Lives?

This section describes key challenges gathered from interviews and discussions with women choosing to study or pursue careers in STEM across the five selected countries. The challenges have been organised using a life-cycle approach, highlighting specific issues during a woman's childhood, education, and career. The findings demonstrate how traditional gender norms and roles shape boys' and girls' perceptions of STEM during childhood, therefore influencing their educational choices and early career pathways later. Once established in their STEM careers, the explicit and implicit barriers that women in STEM face can have a significant impact on their professional opportunities and experiences during their mid to senior careers.

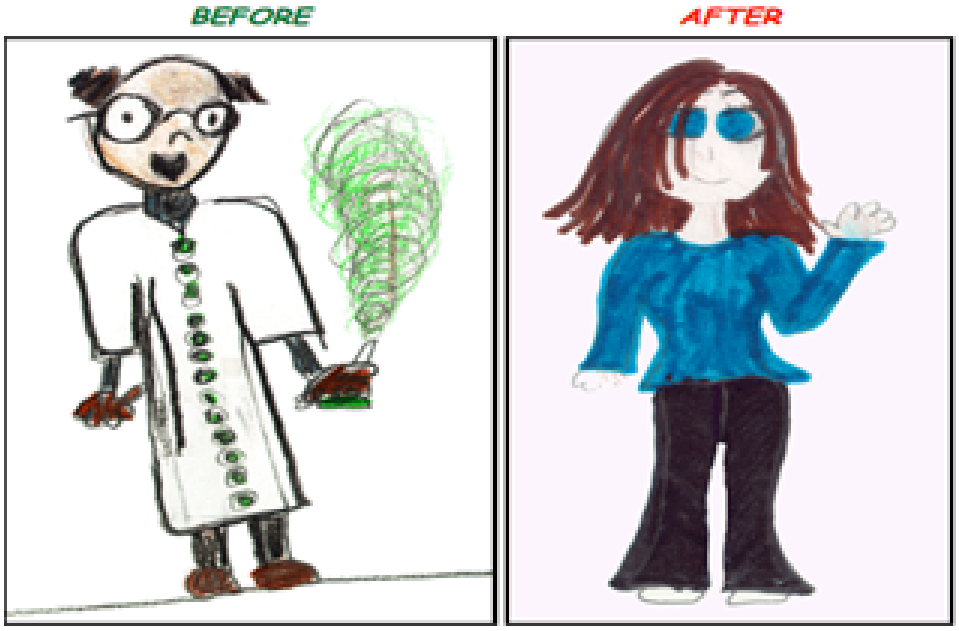


Figure 8 : What does a scientist look like?

Note: The figure illustrates the 'What Does a Scientist Look Like?' educational exercise, designed to confront stereotypes and broaden students' understanding of scientists' societal roles. It features student drawings before and after their interactions with real scientists, highlighting shifts in perception.

Source: coolmomtech.com, accessed on March 14, 2023

Early childhood and K-12 education

Pervasive social and gender norms, as well as biases perpetuate the idea that boys are better at science and maths. Consequently, these beliefs influence the perspective of girls, boys, educators, and caregivers, leading to adverse effects on the way STEM subjects are taught. This, in turn, diminishes the confidence and inclination of girls to pursue STEM-related studies. In 2018, the Program for International Student Assessment (PISA) found that among the assessed students, boys' average scores in mathematics were only 5 points higher than girls', and girls' science scores were 2 points higher than boys', however, twice as many boys go on to become engineers than girls.[46]

Biased belief about boys' and girls' aptitude

Gender differences in science and mathematics at different levels of education have gained increasing attention. Evidence shows that the gender differences are often small and vary based on national-level differences in gender-role stereotyping. For example, in OECD countries, boys report more favourable attitudes towards science and mathematics, while girls reported lower level of self-confidence and self-efficacy.[47] However, in some Middle Eastern and Central Asian countries, this pattern is reversed, with girls reporting greater interest, self-efficacy, and achieving higher mathematics and science scores.[48] Such findings indicate that gender differences in STEM education outcomes may be influenced more by the external environment than innate ability differences.

Boys and girls typically differ in their socialization experiences and acquire social norms and gender-role stereotypes along the way. The biased belief that boys and men perform better than girls and women in science can lead to lower self-confidence and self-efficacy among girls, which could affect their attitudes towards pursuing STEM education and careers later in life. During our discussions, women in all five countries confirmed the persistence of a common belief that boys are naturally better at maths and science, while girls need to work harder to achieve superior results:

> Even if a girl is good at sciences, she will be perceived as hard working, not naturally gifted, and there will be questions about whether she can continue.
>
> STEMinist Indonesia

> Girls would be told sometimes that even if a girl is good in science in junior high school, it will be more challenging for them to keep the advantage in high school; but if a boy has poor grades, it is forgiven as he is just young, and he will be fine when he reaches high school. Although things are improving in urban areas, in counties and towns, the inherent label and biased culture still has an impact on girls.
>
> STEMinist China

46 OECD, PISA 2018 Results (Volume II) : *Where All Students Can Succeed,Paris: OECD Publishing,* 2019

47 Reilly, D., Neumann, D. L. & Andrews, *Investigating gender differences in mathematics and science: Results from the 2011 Trends in Mathematics and Science Survey.* Research in Science Education, 1-26

48 Gopalan, Maithreyi, *Understanding the Linkages Between Racial/Ethnic Discipline Gaps and Racial/Ethnic Achievement Gaps in the United States, Education Policy Analysis Archives,* vol. 27, Mary Lou Fulton Teacher College, Dec. 2019, p. 154. Crossref, https://doi.org/10.14507/epaa.27.4469

Research indicates that parental and teacher beliefs about gender stereotypes in STEM can affect female students' attitudes and achievements in STEM, reducing their motivation to pursue STEM education later on.[49] These biases erode girls' confidence and limit their exposure to STEM subjects and opportunities, which may decrease their interest in pursuing STEM pathways. Despite a decline in overt gender bias, evidence suggests that that less-conscious beliefs underlying negative stereotypes continue to influence assumptions and choices in early education. [50] Therefore, to increase the female pipeline in STEM education and industries, it is critical to start inclusive education at an early stage.

> Gender prejudice is still pervasive in society, both in rural and urban areas and even at the leadership level. Women's capacities in STEM are not adequately recognised and women participation in STEM might not be fully supported by their families and the society, thus limiting women's opportunities to participate in STEM subjects.
>
> STEMinist Thailand

Academic Streaming

This issue is further complicated by academic streaming in secondary school.[51] In some countries, high school students are given the choice to select an academic stream between liberal arts and the sciences, with the sciences often being favored by the top-performing students.

Based on our survey findings, we observed that during the transition to high school, girls tend to have lower self-confidence in their STEM abilities, which in turn influences their choice of academic stream. The popularity of science subjects makes entry into the science stream increasingly competitive for boys and girls. Girls who are not encouraged to be competitive face a disadvantage. Moreover, girls (and boys) who do not demonstrate aptitude across all science and maths subjects may overlook potential STEM pathways as early young as 15 years old.

By funneling students into specific fields through academic streaming, the ability of women to pursue STEM-related education and careers is further affected. This perpetuates gender stereotypes and diminishes women's participation in STEM. In the Maldives, caregivers, peers, and educators play a crucial role in influencing students' choice of academic stream. However, their advice may be influenced by outdated notions of STEM or gender stereotypes regarding the suitability of certain careers for women and men.

> When parents do not know and do not have the opportunity to learn about careers in STEM they may not be able to advise girls. Parents may choose streams associated with high paying jobs, but in communities they cannot see the diversity of jobs in STEM and so may prefer to direct their girls to business stream instead.
>
> STEMinist Maldives

Similar situations are found in China. A 2020 esearch conducted in 2019 analysed high school students' composition in an unnamed province and found that girls accounted for around 40% of high school stu-

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49 Reilly, D., Neumann, D. L. & Andrews, Investigating gender differences in mathematics and science: Results from the 2011 Trends in Mathematics and Science Survey. Research in Science Education, 1-26

50 AAUW, *Why So Few: Women in STEM,* 2020

51 'Streaming' (also known as 'tracking' in some countries) usually involves grouping pupils into classes for all or most of their lessons, so that a pupil is in the same group regardless of the subject being taught.

dents streaming into sciences and 73% of those streaming into liberal arts.[52] Choosing not to pursue a STEM track denies opportunities for girls to seek education and career opportunities later on. These findings demonstrate the significant role educators and caregivers play in positively reinforcing girls' early participation in STEM:

> My parents were not highly educated. They knew education was important but really it was the mathematics teacher who encouraged me. My maths teacher would give us a problem and we would discuss it. After we tried to solve the problem, he would teach the class.
>
> STEMinist Malaysia

Teaching Methods and Teachers' Perception

The teaching methods employed and the availability of resources in schools present significant barriers for girls in STEM subjects. Furthermore, the attitudes and perceptions of teachers regarding gender equality directly impact the academic performance of their female students in mathematics and sciences.[53]

A research study conducted in Thailand discovered that teachers' belief that boys outperform girls in mathematics can have a negative effect on female students' performance in the subject.[54] Similarly, a 2021 study conducted in Beijing involving 1,150 primary and middle school students and their teachers revealed that teachers who hold gender misconceptions and biases tend to expect students to show traits and behaviours consistent with their gender stereotypes. In particular, it was found that teachers tend to exhibit stereotypical educational behaviours such as treating boys and girls differently in classroom management and encouraging boys and girls to engage in different activities, etc[55]. For example, teachers often encourage boys to participate in science competitions, such as science or mathematics Olympics, more than girls.

When girls do not receive the same level of direct or indirect encouragement and support compared to their male peers, they are less likely to pursue STEM-related courses or activities, which will further limit their opportunities in pursuing STEM careers. In addition, the lack of diverse role models was identified as a key issue for STEMinists in Thailand:

> In Thailand, there are people with diverse gender orientations who face bullying and discrimination. When I studied microbiology, we did not have any diverse teachers in our labs. We did not see ourselves. We need diverse representation, and we need to be present.
>
> STEMinist Thailand

52 Dai Li, Yizhen Wang, *Female students in science majors: Gender differences in higher education opportunities and major choices*, Social Development Research, 2019

53 Zulich J, *Sex role attitudes among high school students and their teachers, Free Inquiry of Creative Sociology,* 1986, 14: 207-211

54 Jitkaew, N. I. C. H. A, STEM Pathways: *How Thai Culture and Gender Stereotypes affect female career experiences in STEM occupations.* Retrieved November 29, 2022

55 Chaoqun Li, Liangyuan Xu, and Yanfang Li, *The effects of teachers' gender stereotypes on primary and secondary school students' gender stereotypes: the mediating role of teachers' gender education behaviors*, China Special Education, Vol. 4, No. 4, 2021

Accessing Information on STEM Careers

In addition to students' learning achievements, individual interest levels, and the attitudes of teachers and parents, access to STEM-related career information is another key factor influencing students' career aspirations[56] . Evidence shows that due to the lack of proper guidance, many boys and girls have a limited understanding of STEM-related occupational choices. Girls may also struggle to access information about all types of possibilities within STEM and female role models who have succeeded in those careers, which impacts their subject choices.[57] Girls may be less likely to pursue studies in STEM fields if they are not aware of the real-world applications of these subjects.

> Secondary school education showed a startling lack of information for students about how diverse and far-reaching opportunities are in an engineering career. The confusion around what an engineer is meant that many female students were not aware of what options are available in engineering.
>
> STEMinist Malaysia

Besides, there are significant gaps observed in access to STEM education for students in rural communities. Alongside shortages of qualified mathematics and science teachers and STEM-related facilities and resources, rural schools often offer limited access to advanced coursework and extracurricular programs in STEM. Consequently, girls from rural communities face an additional barrier, as they are less likely to be exposed to diverse STEM educational programmes or opportunities and have less access to resources, such as laboratories or technology, that are necessary for an effective STEM education. Additionally, acceptance of a STEM curriculum in rural areas may be lower when parents and students fail to see its relevance to the local context [58].

> We do not know what STEM jobs exist because we cannot see them. Advice on education options and career guidance is very much needed for secondary students to demonstrate the diversity of new jobs in STEM. For this to be effective, there is a need to involve the parents because they can influence a student's choice.
>
> STEMinist Maldives

In summary, girls often lack exposure and encouragement to pursue studies in STEM from early childhood, kindergarten, to year 12. How STEM is taught and by whom can also impact girls' confidence in STEM. Addressing these challenges will require a multifaceted approach that involves working with parents and educators to challenge harmful gender norms and biases and designing and using gender-responsive curriculum and teaching methods. In rural areas, this extends to promoting diverse role models, and improving the way that STEM subjects are taught in schools to increase their local relevancy.

56 Karen Murcia, Coral Pepper, John Williams, *Youth STEM career choices: What's influencing secondary students' decision making, Issues in Educational Research*, Vol. 30, No. 2, May 2020: 593-61

57 National Institute of Education Sciences STEM Education Research Center, *Report on STEM Education in China*, 2019

58 Stelmach, B. L, *A synthesis of international rural education issues and responses, Rural Educator*, 2019, 32(2), 32–42.

Higher education

While in many countries women and girls are studying STEM majors in higher education in significant numbers, women who graduate from STEM courses in higher education face a lower return on their education investment when they start working compared to men. This acts as a disincentive for women to work in STEM fields. In addition, women, and girls in general face a barrier when accessing information on diverse STEM opportunities and jobs and face barriers when accessing non-academic STEM educational pathways which tend to be dominated by men. For girls and women in rural and remote areas, evidence from our research suggests that positive national statistics mask the small number of women and girls in rural and remote areas who can access to STEM courses at higher education levels due to cultural expectations that girls should study close to home.

Technical and Vocational Education

STEM educational pathways usually require a post-graduate degree, however, associate degrees, or technical education and vocational programs, offer a faster and more inclusive track towards a career in STEM. Careers in programming, application development and e-commerce provide a different career pathway than the more traditional post graduate courses. However, gender stereotypes limit girls' access to these courses. Similarly, researchers, laboratory technicians or engineering technicians are also increasingly hired in agriculture and manufacturing sectors. Women and girls may not be aware of alternative STEM pathways, such as vocational or apprenticeship programs, which could expand their opportunities for learning and accessing careers in STEM.

> STEM is considered in vocational colleges which have courses in technology, robotics, coding, automotive engineering, agriculture, food technology, however, the students are mostly boys. There are 86 vocational colleges all over the country, but girls are not attending them.
>
> STEMinist Malaysia

> Vocational schools are divided. In vocational training courses the fees are lower. Entrance into these courses is easier. The opportunities include engineering, mechanics, IT, and are traditionally separated for boys and girls. For example, girls go to secretarial schools.
>
> STEMinist Thailand

> Girls often get good support and encouragement at schools, but it is often the parents that treat boys and girls differently, especially when the girls are in vocational colleges. Parents tend to encourage their daughters to study accounting, or early education, those "softer" majors that are considered "feminine" in vocational colleges, instead of encouraging them to study more "masculine" subjects such as STEM subjects.
>
> STEMinist China

Rural and Urban Divide

STEM pathways are traditionally academic and highly competitive which negatively impact girls and women in rural areas where there are fewer universities.

> Higher education institutions are concentrated in urban areas in Indonesia. Culturally, families do not encourage girls to leave home and go to the big universities, which disadvantages girls in rural areas who want to study STEM.
>
> STEMinist Indonesia

> Our society is not awake to the opportunities of women working in STEM, or women from rural areas or marginalised women. STEM is perceived as something from the centre, from Bangkok.
>
> STEMinist Thailand

In areas across the region with high populations of ethnic minority women, educational performance among girls is weak which makes it difficult for these girls to pass the entry requirements for university. This issue is compounded for ethnic minority girls who are stateless:

> In Thailand we had an ethnic minority girl who was stateless, and bi-sexual who wanted to be a scientist. She wanted to study nanotechnology. She fought against barriers for 20 years. She has now completed her doctorate, just after she received her Thai citizenship.
>
> STEMinist Thailand

According to discussions with STEMinists in Malaysia, educational institutions in rural areas have the infrastructure to teach STEM but they face a shortage of teachers with the requisite training. Culturally, families are also less likely to encourage their daughters to leave home and study in urban centres, where STEM courses are taught.

> In rural areas the facilities and labs are not great. There are not enough science teachers in rural areas. Students can't see the practical application of STEM knowledge and the investment to move to urban areas is high.
>
> STEMinist Malaysia

Women from Thailand explained that studying STEM courses costs more, and that the cost is prohibitive for women in rural areas.

> In rural areas there is still a push for people to get a job with the government. The government does not pay a higher salary for people with a STEM background, so it is easier to just get a cheaper degree and a job.
>
> STEMinist Thailand

Economic Barriers

Although the economic investment required to pursue higher education is not a barrier that only impacts women, cultural and gendered attitudes regarding the appropriate levels of investment in women's education may pose a barrier for some women. This is particularly the case for those in areas where studying would require them to leave home.

> Although education is free in Malaysia, when you are studying, you lose the opportunity to make money. In Malaysia you cannot just work part time at Starbucks or McDonalds and expect to survive.
>
> STEMinist Malaysia

> Industrial college is cheaper than mainstream education. This provides a pathway for rural and stateless people. When these people graduate, they do not get the certificate which makes it more difficult to get a job.
>
> STEMinist Thailand

Economic barriers facing women become more obvious for women studying at the post graduate level:

> I let women bring their children to my classes. I felt that as a woman, I need to make it possible for women to learn. I educate the men in the class, explaining that it is their right to learn. We need to support these people.
>
> STEMinist Malaysia

Economic Return on STEM Education

For some women pursuing higher degrees in STEM, the economic return on their education investment becomes a key consideration. In Malaysia, entry-level engineering or science jobs no longer attract high salaries, leading some women to start their own businesses or transition into different fields. Similarly, in China, research indicates a lower rate of return on women's higher education. Despite outnumbering men across all levels of higher education, women tend to take longer to land jobs after graduation and have lower starting salaries compared to their male peers[59]

While higher education scholarships provide a solution for women wishing to study STEM, there are few scholarships that specifically target women candidates.

> Higher education scholarships and government loan schemes provide opportunities for boys and girls. All opportunities are for all Maldives people. We do not have targeted programs or initiatives for women. We use a training needs analysis to determine labour shortages and then offer scholarships based on that. We do not even collect or use sex disaggregated data to make the decisions. However, women comprise most successful applicants.
>
> STEMinist Maldives

59 Changan Li, Zhijiao Yang, *Exploring the Evolution of Gender Structural Differences and Gender Equality in Higher Education*, 2020

> Scholarships and awards that are created specifically for female students would sometimes be deemed discriminatory towards men. This is not the case. In fact, promoting gender equality requires such compensation for women, who are disadvantaged in the STEM sector. Those people need to understand that female scholarships and awards are not tokenism or consolation prizes; rather they are meant to show support and recognition for the achievements of women in STEM.
>
> STEMinist China

Scholarship programe in countries like the Maldives and Malaysia, where women are well represented in STEM studies, can be tailored to target underrepresented groups, including older women, rural women, and ethnic minority women.

Sexual Exploitation, Abuse and Harassment

Although there are a lack of official statistics and evidence, sexual exploitation, abuse and harassment of women in higher education was highlighted by some as an issue facing women in male dominated fields such as STEM:

> People who are affected (graduate students) do not want to complain. They do not want to be a black sheep. If they are complaining, they will miss out on certain chances. This is what happens in a male dominated culture. This culture sees feminism as aggressive. Women in STEM have had to fight to get where they are, now they are less inclined to speak up.
>
> STEMinist Thailand

> There is sexual harassment in the classroom. Teachers will comment on the girls' appearance. In universities and workplaces, there is a weak understanding of these issues, and as a result — no anti-sexual harassment or anti-discrimination policies are put in place.
>
> STEMinist Thailand

Scientific research should not be done in a vacuum. For scientific research, we need to abide by basic ethics and morals. We absolutely cannot tolerate issues such as sexual harassment and sexual assault. It is our code of conduct for scientific researchers. It must be eliminated, so that the public can trust the scientific community. The best way to do this is to build our ethical system. A major feature of this ethical system is that it has a very diverse social representation, and all members of society can participate in.

— Carole Mundell, Head of Astrophysics, Professor of Extragalactic Astronomy, Head of Astrophysics, University of Bath

There are invisible and visible obstacles that women often encounter in STEM sectors. While a lot of research would focus on the absence of women in STEM, other important issues, such as sexual harassment, sexual assault, and violence against women, including violence against women scientists, also requires our attention. Many studies conducted by UN Women have shed light on this issue. For example, 104 countries have enacted legislation on sexual harassment and sex discrimination in the workplace and mandated that the private sector take tough measures to combat sexual harassment.

— Norul Mohamed Rashid, Policy Advisor on Governance and Peace and Security, UN Women Regional Office for Asia and the Pacific

Despite high national statistics on the numbers of women studying STEM-related courses in higher education, these figures mask geographic gender gaps between rural and urban areas, and the potential barriers faced by specific groups of women, such as those living in rural and remote areas or those living with disabilities. Addressing the shared challenges facing women in STEM higher education will require a comprehensive approach that involves raising awareness of different STEM opportunities, providing alternative non-academic educational pathways, and continuing to challenge gender stereotypes.

Careers of Women in STEM

Women's representation in STEM sectors experiences a significant decline during the transition from university to the workforce. Various factors hinder women from entering the STEM workforce, including gender biases and stereotypes in recruitment, the sector's highly competitive nature, inadequate work-life balance, negative perceptions of STEM career prospects for women, as well as the pressure to conform to traditional gender roles.[60]

60 International Labour Organization, *The Gender Gap in Employment: What's Holding Women Back?*, Published in December 2017, Updated in February 2022

Factors	Description
Personal Interest	Women's individual preferences, curiosity, and inclination towards STEM subjects or fields.
Self-efficacy	Women's belief in their own abilities and confidence to succeed in STEM careers, influenced by experiences, encouragement, and perceived competence.
Social and Cultural Influence	External factors such as family, peers, role models, and societal expectations that shape women's perceptions of STEM careers and their sense of belonging.
Economic Considerations	Practical factors like salary prospects, job security, and the perception of opportunities and rewards in STEM professions.

Figure 9. Conceptual Framework of STEM Women's Career Choice

Cultural Stereotype and Career Motivation

Gender biases and stereotypes about whether women should or can pursue STEM careers comprise one of the key challenges faced by women in STEM throughout their life. Subconscious perceptions rooted in traditional gender stereotypes, often lead to the notion that women are less suitable to pursue a STEM careers, suggesting that they have less aptitude to pursue STEM professions, have a greater need for a more equal work-life balance, or require additional flexibility to fulfil caregiving roles. These implicit biases can influence recruitment, evaluation, and promotion decisions, posing challenges for women in STEM and limiting their career opportunities, despite[61] advocating meritocracy. For example, in China, a survey by Zhilian Zhaopin in 2022, revealed that over 60% of women were questioned about their marital status and plans to have children during job interviews.[62]

> A male-dominated work culture is a deterrent for women. There may not be discrimination in accessing the opportunity, but the job is labelled as men's work. Women and families of women are concerned about their safety in the workplace, especially on the islands, in rural or remote areas.
>
> STEMinist Maldives

61 María Paz Espinosa, Eva Ferreira, *Gender implicit bias and glass ceiling effects,* Journal of Applied Economics, 2022, 25:1, 37-57

62 Zhilian Zhaopin, 2022 *Survey Report on Women in the Workplace* (2022中国女性职场现状调查报告), 2023

Discussions on women in STEM found that the work of a consultant, technical designer and design reviewer in construction corporations are considered stable choices for careers in STEM and are deemed suitable for women because these roles do not require travel or working on construction sites. Similar views were also expressed by an interviewee in China:

> There is some flexibility for women in science, but for engineering, employers are often more reluctant to hire women, as women would face some practical challenges. For example, employers will need to send an extra male employee to accompany the female employee to conduct a site visit, which is considered potentially unsafe for women.
>
> STEMinist China

These biases not only affect employers' perceptions of women, but also profoundly influence the way women in STEM see themselves and their potential to achieve success in the STEM profession. Research found that under male-dominated environments, women are more likely to hold themselves to a higher standard than male colleagues. A woman may estimate her chances of success more conservatively than her male peers, leading her to drop out halfway, or choosing not to enter the profession altogether.

Discussions with STEMinists in China and Malaysia reveal that many young, qualified female graduate opt for further higher-level education or undergraduate or school-level teaching assignments rather than enter research institutions or tech companies like their male peers due to a lower sense of self-efficacy, and perceived challenges in accessing recruitment and promotion opportunities in STEM sectors.

> Some argue that the reason more girls enter masters and PhDs is that they do not have opportunities to enter the job market, so they continue their education instead. I have interviewed some female PhD candidates in engineering and science in top universities. They are very good students, but they feel a lack of confidence for their future careers with lots of potential barriers. The confidence issue is important here. And when we are comparing the data on higher education enrolment, we need to consider the deeper reasons behind it. Many girls want to be a teacher upon graduation because they do not feel as competitive to work in the top tech companies as their male peers. Boys want to be entrepreneurs, but girls only want to be teachers.
>
> STEMinist China

> A lot of good female engineers become teachers. But this is a waste of skills. God has given us the ability to have children, but this means at least 9 months we are out of work. But we should be helping women during this time. We need to make allowances for women, especially when going to the field.
>
> STEMinist Malaysia

Motherhood and Limited Work Flexibility

For women who enter the STEM sectors, their attrition rate is found to be significantly higher along their career ladder. One explanation for why women are leaving their careers is that STEM workplaces often emphasize an ideal worker who is continuously available and has no domestic responsibilities. [63] [64] [65]

In most traditional value systems, especially in the Asia Pacific region, gender norms and social expectations encourage women to prioritize family over their careers and education. As STEM careers are often work-intensive and offer little work-life balance, women may struggle to balance their professional and personal responsibilities, leading to limited career advancement opportunities and overall success. The intense competition between work and family responsibilities can also compel women in STEM to compromise their career ambitions. A female scientist in China shared her feelings of guilt for not being able to take care of her child as much as she wanted, while also feeling guilty about taking care of her child during weekends, when her male colleagues were working overtime in the labs. A STEMinist in Indonesia voiced similar concerns:

> Some women in STEM prioritize care work, which slows down their progress at work, while their male counterparts focus on what is happening in the office. For example, during the COVID-19 pandemic, women had to learn to juggle double or triple the amount of care duties at home, especially when paid childcare services were not available during the lockdowns. Over the last three years, women in the Institute of Electrical and Electronics Engineers have formed a larger support group across the Asia Pacific region, so we can support and learn from each other on how to balance work and family.
>
> STEMinist Indonesia

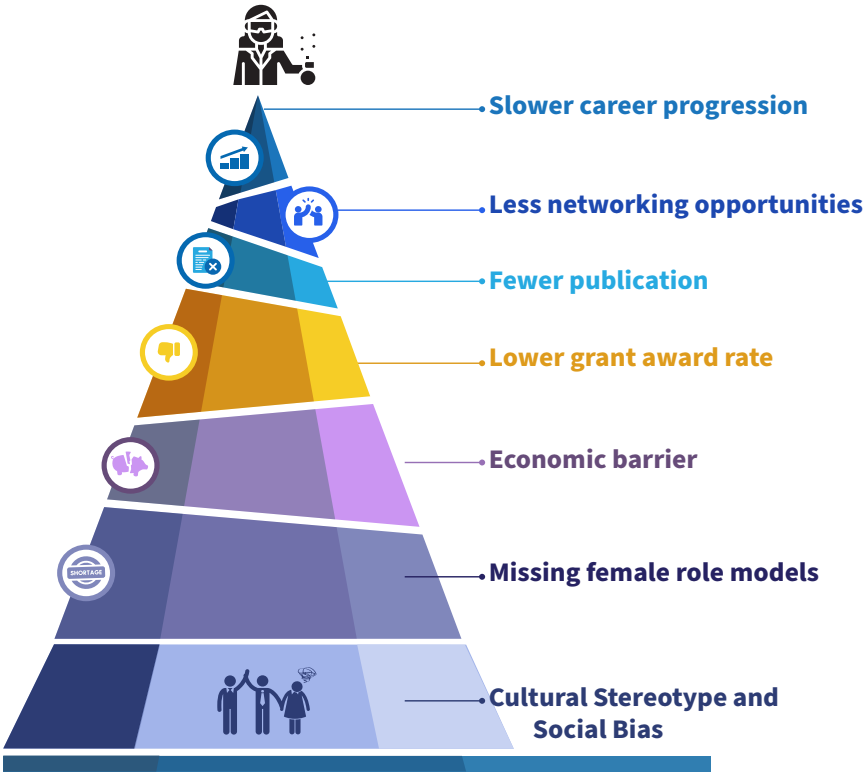

Figure 10. A mountain of invisible barriers for women in science

63 Acker Joan, Hierarchies, jobs and bodies: *A theory of gendered organizations, Gender & Society 4* (2): 139–58, 1990

64 Britton Dana M, *Beyond the chilly climate: The salience of gender in women's academic careers,* Gender & Society 31 (1): 5–27, 2017

65 Stone Pamela, *Opting out? Why women really quit careers and head home,* Berkeley: University of California Press, 2007

Cultural expectations of mothers to be intensive care takers while men are not, often stand in conflict with the intensive work culture in STEM sectors, creating challenges for mothers in STEM to be recognized as dedicated workers[66][67]. This is particularly challenging for women in STEM who work in engineering or construction, and are required to travel for their work for extended periods. A renowned female scientist shared her firsthand experiences of being rejected for a promotion after having her first child, as her employer believed that she would need to spend more time on childcare. She was therefore considered to be unsuitable for leadership roles, despite her exceptional performance record. Although she received the promotion the following year, she was surprised by some senior men around her perceiving her to be less than qualified because she took a career break to have a child. In addition, the work-life balance policies also played an important role in shaping the division of household labour. Parameters of such policies, including eligibility criteria, duration and compensation levels of leave could help promote equal sharing of household labour to retain more women in the STEM sectors.[68]

> In Malaysia, men treat women very well. Female engineers are often protected from doing field work or working late at night. This can also be discriminatory. Female engineers are not being harassed, but they are restricted from taking on roles and going to the field. If the woman insists on doing it, they will be allowed. In academia, women who are mothers are not given the 8 o'clock lectures because they need to care for the family.
>
> STEMinist Malaysia

Male-dominated workplaces and women's lack of social capital

Although the representation of women in STEM occupations has been increasing in recent years, STEM sectors are still largely male-dominated, especially in leadership positions. The lack of women role models in male-dominated workplaces can limit women's visibility and leave many junior female professionals without identifiable routes to pursue a career in STEM fields. Many women, whether in their early career or accomplished, experience a lack of self-confidence, and tend to have doubts about their long-term career prospects in STEM sectors.

In these male dominated workplaces, women may feel isolated, excluded or unable to participate in networking and professional development opportunities. They may also be hesitant to report incidences of sexual exploitation and harassment, aggravated by the lack of women colleagues and a unified voice.

A survey conducted in the USA in 2018 on improving the retention of women in the IT sector, revealed that women in male-dominant working environments can experience feelings of isolation and alienation. [69] This finding is supported by our interviews with STEMinists in the Asia Pacific. Without effective diversity and inclusion strategies, male-dominant workplaces can foster unwelcome practices, lower work satisfaction, and limit opportunities for retention and promotion.

> As a civil engineer, I worked on civil designs and in my department, there were 19 men and 1 woman. I faced real obstacles when working. When travelling to the field site my personal safety was at risk. Male staff would need to accompany me.
>
> STEMinist China

66 Blair-Loy Mary, *Competing devotions: Career and family among women executives.* Cambridge, MA: Harvard University Press, 2003

67 Hays Sharon, *The cultural contradictions of motherhood,* Yale University Press, 1996

68 European Commission, *Gender Equality and Work-Life Balance Policies during and after the COVID-19 crisis*: Thematic Review, 2022

69 Hala Annabi, Sarah Lebovitz, *Improving the retention of women in the IT workforce: An investigation of gender diversity interventions in the USA,* 2018

The lack of role models can also contribute to a lack of networking opportunities. An extensive body of empirical studies has demonstrated the connection between a social network and career development success[70] . Researchers found that a social network provides social capital, which could be defined as resources available to an individual based on group membership, relationships, networks of influence, and support[71]. When we consider this in the context of STEM careers, social capital can include gender-relevant formal and informal job-related information, mentorship, professional development and job opportunities, etc. Access to social capital could help women tackle employment challenges in male-dominant workplaces[72]. However, in environments with few female role models and lower status for women on average, forming effective networks and acquiring social capital becomes more challenging.

A survey by Zhilian Zhaopin of 39,000 women from China found that 66% of women perceived the barriers they encounter in the workplace as personal rather than institutional or structural[73]. Consequently, many women are working to resolve these barriers themselves. However, their efforts to promote women and girls in STEM often go unrecognized and unremunerated, further hindering their career advancement.

To address these challenges, it is important to avoid creating an echo chamber and to engage men and other change-makers to facilitate conversations on barriers facing women in STEM.

Publication and Grant Funding

The number and influence of publications in high-profile academic journals is considered one of the key matrixes to assess a researcher's overall competence and is closely linked to recruitment, promotion, awards, and funding opportunities. The pressure to "publish or perish" is a common phenomenon in the STEM community. Some countries have implemented policies like "promote or leave", which grant scientists permanent positions only after passing evaluations during a probationary period. While this intends to promote job security, it can also disadvantage women hoping to have children, as the probationary period coincides with a woman's childbearing years.

Research published in 2020 found that across all STEM disciplines, only 27 percent of research publications over the past 60 years were authored by women[74]. A similar trend is also evident in the Asia Pacific. A 2022 report by the Chinese Academy of Science found that from 2005 to 2009, the average number of papers published by male researchers in STEM was 5.76, compared to 4.34 by female researchers. From 2015 to2019, men published an average number of 10.02 papers, whereas women published an average of 6.87. This indicates that men were not only more productive in both time periods, but it also shows how the gender disparity in favor of male researchers over women researchers has further intensified with time[75].

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70 McDonald, S, Network effects across the earnings distribution: *Payoffs to visible and invisible job finding assistance,* Social Science Research, 49, 299– 313, 2015

71 Bourdieu P, *Handbook of theory and research for the sociology of education* (pp. 241–258), Greenwood Press, 1986

72 Yang Yang, Nitesh V. Chawla, and Brian Uzzi, *A network's gender composition and communication pattern predict women's leadership success* , 2019

73 Zhilian Zhaopin, *2022 Survey Report on Women in the Workplace* (2022中国女性职场现状调查报告), 2023

74 Huang, J., Gates, A. J., Sinatra, R., & Barabási, A. L., *Historical comparison of genderinequality in scientific careers across countries and disciplines*, 2020

75 National Science Library, *Chinese Academy of Sciences,* Gender in the China Research Arena, 2022

The unequal impact of parenthood is considered one of the key reasons behind the productivity gaps between men and women[76]. For women, fewer publications would also mean fewer opportunities to be awarded research funding. According to the World Economic Forum, women are typically given smaller research grants and find it harder to obtain venture capital for tech startups. In China, although the gender gaps in science research funding applications have gradually improved, thanks to measures adopted by the National Natural Science Foundation of China since 2011, significant gender gaps persist for top research projects and talent programmes[77] .

In conclusion, women in STEM face several challenges during their careers that can limit their opportunities for advancement and success. These challenges are rooted in gender biases, stereotypes and hidden discrimination at work. Solutions for addressing barriers facing women in STEM should focus on implementing equal opportunity policies, creating a more inclusive workplace culture, providing flexible work arrangements, promoting work-life balance, increasing the visibility of women role-models, addressing practical barriers, and supporting women's care responsibilities. By addressing these challenges, we can help women achieve their potential and make significant contributions to the STEM sector.

76 Allison C, Morgan et al, *The unequal impact of parenthood in academia,* 1996

77 National Science Library, *Chinese Academy of Sciences,* Gender in the China Research Arena, 2022

5. What Promising Pathways Exist to Promote Women and Girls in STEM?

This section provides examples of existing initiatives across the region that promote the participation of women and girls in STEM, including advocacy, education, policy, partnerships, and direct opportunities.

Advocacy

Advocacy initiatives play a vital role in promoting women and girls in STEM fields through awareness-raising initiatives. These initiatives highlight careers and opportunities in STEM sectors and seek to address the challenges faced by women and girls. Some inspiring women and STEM advocacy initiatives in the region include:

- **Parent and educator awareness-raising programs:** These successful initiatives challenge social and gender norms that hinder girls and women from studying or entering STEM careers. They aim to educate parents and educators on the importance of STEM education for girls and women and the value they can bring to STEM fields. Non-government organizations are also working to create a more equitable ecosystem. By raising awareness among parents and educators, female students can be further supported and encouraged to study STEM.
- **Role models:** Promoting women in STEM as role models is essential in increasing the visibility of women in STEM fields. Media campaigns, school visits, and other outreach activities can highlight successful women working in STEM fields and inspire young girls to pursue their own interests and passions in STEM.

  Women working in STEM play a crucial role in this area. Many women in the region have co-founded charities and networks, sat on boards, spoken at forums, and conducted outreach in rural areas. These women invest massive amounts of time and commitment to promoting women and girls in STEM. Women in Tech Maldives has launched a series of women in STEM posters that highlight women in the Maldives working in different STEM careers. The posters are available for schools and workplaces and can be downloaded on social media.

Figure 11. Maldives Women in Tech MV poster

- **Communication campaigns:** These can be an effective contribution to STEM advocacy initiatives. For instance, the Vietnam Women's Union (VWU) promotes women in STEM through its communication campaign Women actively studying, creatively working, and building happy families. The campaign is designed to prepare Vietnamese women for the new era by promoting attributes such as knowledge, good health, responsibility for themselves, and their potential to contribute to their families, society, and the country.
- **International forums:** Events and forums which highlight barriers and key issues facing women in STEM are effective advocacy tools. The 2022 and 2023 Women in Science Policy Dialogues, organised in China by UNDP with China Women's Association for Science and Technology (CWAST) and UN Women, provided an opportunity to bring together experts, policymakers, and practitioners to share knowledge, experiences, and ideas for promoting women and girls in STEM. Bridging the gap between gender and technology provides valuable case studies for other organisations to learn from and replicate.

Box 2: China Women's Association for Science and Technology

The China Women's Association for Science and Technology (CWAST) is a non-profit organization established in 1993. Its mission is to support and advance women in STEM fields within China. CWAST actively works to unite and mobilize women scientists and technologists, aligning their contributions with the nation's strategic development goals, focusing on science and education, talent development, and sustainable growth.

Education

Promising education initiatives that promote women and girls in STEM range from interventions that challenge social and gender norms and biases, offering scholarships, promoting curriculum revisions and development initiatives, teacher training and expanding non-academic or vocational STEM education opportunities for women and girls. Some of the education initiatives in the region include:

- **Challenging social and gender norms and biases in education.** Challenging entrenched and biases limiting women and girls' participation in STEM is a critical first step to promote girls and women in STEM. This can be achieved through changes to the curriculum, teacher training, and the use of role models. For example, some schools and programs are actively promoting girls' participation in STEM subjects by introducing them to female scientists, engineers, and mathematicians who serve as role models. One successful program being implemented across the region is Hour of Code[78]. The Hour of Code is a one-hour introduction to computer science, using fun tutorials to show that anybody can learn the basics. This grassroots campaign has benefited over 70 million students with the support of over 400 partners and 200,000 educators worldwide. Although the program does not just target girls, this initiative can help to increase interest and engagement in STEM fields among girls and underrepresented groups.

78 "Hour of Code – *What Will You Create?*" Code.org, hourofcode.com/en

- **Scholarships to promote girls and women in STEM.** The British Council has doubled the number of scholarships in its Global Women in STEM program, supporting women to pursue their studies in science, technology, engineering, or math at a UK university[79]. Awardees will gain academic support in tuition fees, stipends, travel costs, visas, health coverage fees, and even support for mothers and other awardees with dependents. There are now 29 scholarships available for women from Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Thailand, and Vietnam. All the scholarships will cover the funding for over 21 master's degrees and eight PhDs or fellowships.
- **Flexible higher education opportunities and subsidies.** In Vietnam, at the Hanoi University of Civil Engineering, female students can choose a four-year bachelor's degree in engineering instead of five years. A newly structured scholarship program for female students at the Lac Hong University awards a 30% tuition subsidy to female students studying technology and engineering. These incentives have increased the enrolment of female students and helped them to overcome difficulties preventing them from choosing to study engineering.

Box 3: . WiSci Camp

Three U.S. embassies coordinated on the **WiSci Camp for female secondary-school students in Southeast Asia.** Private grants made the program accessible to girls from Indigenous communities and lower-income households. Seventy participants from Indonesia, Malaysia and the Philippines met at seven American Spaces locations in July. Fourteen women counsellors recently graduated from university paired off to lead groups of 10 girls. .

- **Teacher training and curriculum development on STEM.** In Thailand, Indonesia and Malaysia teachers have been trained on how to make STEM more accessible to girls in the classroom. Teachers learn novel approaches and are provided a range of resources to encourage girls' participation and interest in STEM. Training teachers provides new methods for teaching maths and sciences and provides practical ways to take STEM out of the classroom. For example, in Malaysia, the STEM garden initiative provides practical hands-on applications of STEM to livelihoods through planting gardens and developing entrepreneurship skills[80]. Thailand's Fostering Teacher Competency Towards a New Way of Learning project provided training on STEM-based curriculum for primary school teachers from 16 schools under the Office of the Basic Education Commission and the Department of Local Administration. The training aimed to prepare teachers for a new way of teaching, where technology and innovation are integrated into the basic curriculum, allowing students to be the centre of a practical learning experience that aligns with their local context[81].

79 The Jakarta Post, *British Council Scholarships Support More Women to Study STEM Subjects in Asia*, 16 Feb. 2022
Southeast Asian Digital STEM Platform, *Why STEM – 21st Century Skills in Southeast Asia's Education Syste*m, 2020

80 The Jakarta Post, *British Council Scholarships Support More Women to Study STEM Subjects in Asia,* 16 Feb. 2022
Southeast Asian Digital STEM Platform, *Why STEM – 21st Century Skills in Southeast Asia's Education System*, 2020

81 Global Power Synergy Public Company Limited (GPSC), *GPSC and OBEC team up in an effort to enhance teacher competence by providing professional development training on STEM–based curriculum for primary school teachers from 16 institutes*, 2021

- Expanding non-academic STEM education opportunities. Expanding non-academic STEM education opportunities for women and girls can be an effective way to promote their participation in STEM. This can include after-school programs, summer camps, incubators, bootcamps and extracurricular activities that expose girls to STEM subjects and encourage their interest and participation. By offering a range of STEM education opportunities outside of traditional academic settings, girls and women have more opportunities to observe different spectrums of STEM career, explore their interests, and build their skills in STEM fields. In Thailand, students are learning at an Innovation Camp under the Thai Teachers TryScience (TTS) Project, implemented by the Kenan Foundation Asia to improve STEM education in Thailand[82]. To date, Kenan trainers using Thai TTS have built the capacity of 30 head teachers and provided training to 450 teachers from 10 schools in Bangkok and Samut Prakarn. These efforts will benefit over 2,000 teachers and 45,000 students within the TTS school network.

In Malaysia, the Ministry of Education, MDEC, and the National STEM Association have supported several education initiatives[83]. Since 2013, the Ministry of Education engaged local terrestrial and satellite television stations to develop options for televising events like science fairs and robotics competitions. Since 2014, the Ministry has been collaborating with television stations to improve Science and Mathematics programmes, for instance, by injecting more critical-thinking elements into existing educational programmes and developing new and engaging educational programmes. Additionally, the Ministry's pusat sains bergerak (Science On Wheels) programme intends to expand to schools in rural and remote areas.

Box 4: Her Digital Future Bootcamp

Under the Digital X initiative by UNDP's Chief Digital Office, UNDP has launched "HER Digital Future" in 2023, a program designed to increase girls' engagement in STEM. The program is conceived to furnish Chinese adolescent girls with comprehensive training and guidance in digital proficiencies. It further endeavors to deepen their comprehension of the Sustainable Development Goals (SDGs), while nurturing innovative thinking and cultivating their interests for STEM study and careers. So far, it has successfully conducted 20 offline bootcamps, leading to the submission of over 30 Tech4SDG student proposals. Its outreach has impacted approximately 1,134 young girls from rural backgrounds.

82 Kenan Foundation Asia, STEM education in Thailand: Thai students and teachers learn how STEM education and technology can solve real world challenges. Kenan Foundation Asia, September 30, 2022

83 The Edge Malaysia, *Putting Women at the Heart of a DigitALL World,* 7 Mar. 2023

Policy initiatives to create an enabling environment for women

Policy initiatives that remove barriers facing women and girls in STEM and support their career progression create an enabling environment. Positive policy initiatives in the region include:

- **Affirmative action policies and progressive human resource policies.** All countries included in this research have labour laws and policies designed to eliminate discrimination in the recruitment, promotion, and retention of women at work. Quotas for women on boards and in leadership roles can be used to increase the participation of women in leadership roles in STEM. Vietnam has a 30% quota for the number of women in leadership roles across all government institutions and agencies. In Indonesia, it is illegal to specify the sex of applicants in job advertisements. Overall, a combination of affirmative action policies and quotas can promote gender equality and create more opportunities for women and girls in STEM-related fields.
- **Policies to promote the upskilling of women in STEM.** In 2021, China's thirteen departments, including the Ministry of Science and Technology, the All-China Women's Federation and the China Association for Science and Technology (CAST), jointly issued the 'Measures to support female professionals in science, technology and innovation'[84]. These measures include:
    - Understanding the importance of supporting female scientific and technological talent to play a greater role in technological innovation
    - Cultivating high-level female scientific and technological talent
    - Supporting the innovation and entrepreneurship of female scientific and technological talent
    - Improving the evaluation and incentive mechanism for female scientific and technological talent
    - Supporting the scientific research work of female scientific and technological talents during pregnancy and nursing
    - Strengthening the training of female reserve talent in science and technology
    - Strengthening the basic work of female scientific and technological talents

Box 5: . Checklist for employers to promote women in STEM

- O Require balanced interviewing for all talent pools
- O Identify sponsors and mentors
- O Ensure equitable and flexible work policies, part time roles, equal pay and equitable leave provisions
- O Make leaders accountable for gender-balanced promotion and retention through performance objectives
- O Create and promote transparent career pathways to draw talent
- O Reflect on women's lived experiences in tailoring initiatives or working conditions to your business – listen to women
- O Measure, evaluate and report on gender data to inform the right interventions in the right areas.

84 Wang, Hongwei, et al, The Development of Female Science and Technology Workers in China: Achievements, Problems and Suggestions, Cultures of Science, vol. 6, no. 1, SAGE Publications, Mar. 2023, pp. 34–50.

Thailand has responded to the unequal impact of automation on women in the workforce by implementing the Thailand 4.0 Development Plan. This plan aims to invest in women's capabilities and improve their access to decent and productive employment. The initiative aligns with the objectives of the Decent Work Country Program, which was signed by the Ministry of Labour, employers, and workers organizations in early 2019. The program specifically targets women in entry-level jobs with low STEM skills and supports their development of knowledge, competencies, and skills necessary for collecting, analysing, and visually presenting manufacturing-related data for decision-making. To date, 1,050 women workers at the Seagate Technology plant in Korat, Sung Noen District, Nakhon Ratchasima province, have successfully completed the training program [85].

Box 6: STEM4ALL

STEM4ALL is a UNDP and UNICEF platform dedicated to accelerating gender equality and the representation of women and girls in STEM to meet the demands of the future of work in Europe and Central Asia. STEM4ALL bridges the gender divide in education and careers and seeks to promote equality in infrastructure, services and solutions that work for people everywhere. The platform brings STEMinists together, provides resources, job and mentoring opportunities, career and training information and opportunities and online learning.

Source: https://stem4alleurasia.org/about/about-stem4all

Partnerships

Bringing together different stakeholders and leveraging resources and expertise can be an effective way to promote women and girls in STEM. Promising partnerships promoting women and girls in STEM in the region include:

- **Networks and platforms for women in STEM.** In the Maldives, there are various networks and platforms that provide support and resources for women in STEM. These include the Women in Tech Maldives network, which provides training, mentorship, and networking opportunities for women in technology. Other countries such as Malaysia and Indonesia are collaborating with international women in STEM networks to develop national chapters.
- **Industry briefings and training sessions.** Governments across the region are partnering with industry and academic institutions to provide career exhibitions, webinars and events to align academic programs, private sector needs and government priorities. In Vietnam, USAID BUILD-IT conducted the “Women in STEM Webinar: Why We Need More Women in STEM”, drawing more than 100 university leaders, faculty, and student participants[86]. The webinar is the first in a series to explore the need for more women in STEM and how industry and academia can work together to meet this critical need.

85 International Labour Organization, ILO and Thailand enhance women's access to technical skills in Electronics Industry, September 26, 2019

86 U.S. Agency For International Development, Building University-Industry Learning and Development Through Innovation and Technology (BUILD-IT), 11 Sept. 2023

- **Private sector and academic partnerships.** Private companies are increasingly working with academic institutions to provide information on industry needs and careers. This may involve analysing workforce data, conducting surveys or focus groups with students and educators, and collaborating with industry partners to identify skill gaps and emerging job opportunities. Chevron Thailand Exploration and Production Ltd. has launched several initiatives to promote STEM education and careers for women in Thailand, including scholarships, internships, and mentoring programs[87]. The company also partners with universities and government agencies to promote STEM education and careers for women. The University of Danang–University of Science and Technology launched the "STEM Career Academies in Central Vietnam Project" in collaboration with Chevron and SEAMEO STEM-ED at the University of Danang[88].
- **Civil society initiatives**. Non-government organisations (NGO) and civil society are working to address the systemic barriers preventing women and girls from participating in STEM fields. In China, a local NGO, One Kilo Box, is an umbrella organisation focusing on rural education. One Kilo Box works with other civil society organisations to provide primary, early childhood education and vocation education and supports the continued education of students in both primary and high school. One Kilo Box has developed a STEM education curriculum, currently being rolled out with assistance from local partner organisations.

Direct opportunities

The promotion of women and girls in STEM can be aided through various direct opportunities in the region, such as awards and prizes, grants and competitive innovation funds for women owned start-ups or researchers, online directories of women in STEM and capacity development initiatives that provide training and skills development. These direct opportunities can create an enabling environment for women and girls to enter and thrive in STEM fields.

- **Awards and prizes**. Awards such as the Prize for Vietnamese Women, including the Women in Digital Transformation and Sustainable Development Award 2021 with Ministry of Foreign Affairs, can encourage women's participation in STEM. Westlake University in China also established the Westlake Women in Science Initiative in 2022, which aims to cultivate high-level talent in natural sciences, engineering, medical sciences, and other subjects. It plans to raise RMB 50 million to support female science talent with funding awards, fellowships, research funds and other resources.
- **Capacity development initiatives.** Capacity development initiatives provide women an opportunity to upskill or launch their own startups. In Vietnam, the Women's Union has been supporting women's startups since 2017. To date, it has invested in 1 million women, equipping them with information technology skills in diverse areas such as e-government and the digital economy. Vietnam also organised a Women's Innovation & Start-up Day to encourage and support women's innovative ideas. Women owned startups are also being promoted through accelerators and ecosystem development initiatives in Malaysia. The Malaysia Digital Economy Corporation (MDEC) is an agency under the Ministry of Communications and Digital that has been leading the digital transformation of the economy for 26 years. They aim to enable a progressive and innovation-led digital economy and have been training women in entrepreneurship, to retain women in the sector. Additionally, the Malaysian Research Accelerator for Technology & Innovation centre (MRANTI) is providing inclusive programs to promote women in STEM. MRANTI offers accelerator programs, an innovation centre, mentoring and coaching, links with venture capital investors and grants for research and development. In addition, MRANTI provides a physical space where investors can

87 Chevron Thailand Exploration and Production Ltd., *Thailand Partnership initiative: Project Overview | Enjoy Science,* November 29, 2022

88 Bangkok Post, *First Regional STEM Education Collaboration in ASEAN,* 26 July 2022

create startups, including a landbank at its technology park. MRANTI's approach supports women at every stage, from sandboxing ideas to product testing and evaluation, to promotion and exposure, both locally

- **Online directories of women in STEM.** Online directories of women in STEM or women-owned businesses, like STEM Women Asia, can increase visibility and recognition of women in STEM. STEM Women Asia provides an online directory of women in Asia and Oceania working in STEM. Led by the Australian Academy of Science (the Academy), STEM Women Asia has been developed in partnership with the Association of Academies and Societies of Sciences in Asia (AASSA) and the InterAcademy Partnership (IAP).
- **Sponsorship and mentorship programs.** These programs can provide guidance and support to women in STEM, while digital bootcamps can equip them with relevant skills over a short three-month period[89].

89 Ellen Boccuzzi, Paula Uniacke, *Accelerating women's advancement in STEM: Emerging lessons on network strategies and approaches,* The Asia Foundation, June 28, 2021

6. What Can Stakeholders do to Promote Women and Girls in STEM?

This section provides a list of practical ways that different stakeholders can do to promote women and girls' participation in STEM.

Policy makers

- **Promote the collection and analysis of data on women in STEM is crucial to develop effective strategies and policies to promote women's particiaption and leadership in STEM sector.** This should include data on women's enrolment rate in STEM education programs at different level, women's representation and retention rate in STEM careers at different levels and positions. Adopt an intersectional lens that considers various identities such as age, geography, socioeconomic status and ethnicity can provide a more nuanced understanding of the data on and barriers facing women in STEM.
- **Support research initiatives exploring gender dynamics in STEM to gain insights into the challenges faced by women, and evaluate existing STEM policies to discern their potential impact on gender inequality within the sector.** Based on the research findings, integrate a gender lens into STEM policies, ensuring a more inclusive approach. Establish clear and measurable indicators to monitor progress, foster partnerships, and provide direct opportunities for the advancement of women and girls in STEM.
- **Facilitate the inclusion and progress of women in STEM by actively involving them in national research and development programs.** This includes measures like relaxing age limits for female applicants, boosting women's representation in evaluation panels, and establishing specialized research programs for women. In the mean time, elevate women's involvement in national STEM decision-making and consultation processes.
- **Ensure the adequate provision of public services, such as childcare, elderly care, and domestic care facilities and services** to help both men and women to balance work and household responsibilities. Additionally, review and promote policies and initiatives that encourage equal sharing of unpaid care responsibilities between genders.
- **Establish certification programs to acknowledge and reward exceptional gender-friendly workplace policies and equal opportunity initiatives in the STEM sector**. Recognize institutions and companies excelling in these aspects by granting certifications based on comprehensive data, action plans, and assessments related to women's participation. Consider prioritizing these certifiedinstitutions and companies in public procurement.

Civil society organisations and the media

- **Conduct awareness campaigns targeting students, parents, the public, policy makers, and employers to emphasize the significance of promoting more women to join STEM education** in shaping the future of work and driving economic and social development. Engage with key stakeholders, including educational institutions and industry leaders, to foster collaboration and build a more inclusive and forward-thinking community.
- **Implement STEM education programs outside traditional classrooms to cultivate interest in both girls and boys, especially those with rural background.** Ensure equitable access to STEM-related education through initiatives such as bootcamps, summer activities, and other extracurricular programs to create an inclusive learning environment that encourages diverse participation in STEM fields.
- **Utilize various media outlets to highlight inspirational stories of women role models in STEM, providing diverse narratives that showcase their achievements and contributions.** By amplifying these voices and narratives, the goal is to inspire and empower more women and girls to break barriers and pursue successful careers in STEM fields.
- **Enhance, interconnect, and broaden the network of women's associations across diverse STEM fields to amplify the voices and representation of women's needs and interests.** By fostering stronger collaboration and inclusivity within these networks, the aim is to create a more unified and influential platform that advocates for the diverse perspectives and requirements of women in STEM.

Educators

- **Expand scholarship opportunities specifically for women and girls in STEM, offering targeted support to encourage their participation in underrepresented areas**. Also complement the scholarship with mentorship components, internships, and research opportunities to provide hands-on experience and networking opportunities, which are crucial for career development in STEM.
- **Encourage girls' participation in STEM clubs, competitions, and fairs at schools and universities, with a focus on female-led teams.** Invite women who are successful in STEM fields to mentor club members and offer guidance and inspiration to female students, building their confidence, teamwork skills, and a sense of community.
- **Promote gender-responsive STEM pedagogies across all levels of education, from early childhood to vocational education, is crucial for boosting women and girls' confidence and problem-solving skills using STEM skills**. This also involves training teachers, especially in primary and secondary education, to understand and address unconscious bias in teaching practices and assessments, thereby engaging all students equally.
- **Partner with government, private sectors and civil society to provide a comprehensive supportpackage** to enable female students to develop and sustain career in STEM sectors through measures including mentorship programme, employment counseling, vocational training, job matching and follow-up care after employment.
- **Expand vocational education opportunities within STEM to increase access to non-traditional STEM pathways**, such as coding and website design, as well as emerging technologies such as robotics, biotechnology, and renewable energy systems.

Private sector

- **Embrace gender equality as one of the core values of the instutional culture and develop a corporate gender equality strategy**, which include a female talent management strategy that seeks to identify female talent from the interview process and also offer equal opportunity to female talent in their career development with specific, measureable and timebound tartget and indicators. Allocate resources to monitor and evaluate the progress against these tartgets.
- **Adopt structured and skill-based hiring practices to support promotion and pay transparency and avoid unconscious gender bias**. This should be combined with other measures that include setting transparent career paths and salary structures, implementing family-friendly work practices, building awareness among managers and providing development and leadership trainings.
- **Identify and develop women leaders to sustain organizational growth and improve team and organization effectiveness**. Provide upsklling program, leadership workshops and professional network for them with a community approach to facilitate in-depth learning and development solutions for female employees.
- **Promote the implementation of family-friendly workplace policies for men and women** that help address the needs of parents and families for adequate time and resources for childbearing, while fulfilling their work responsibilities. Consider leveraging the technologies and internal communication to change the organizational culture and work style.
- **Partner with secondary and higher education institutions to provide systematic support to female students** through career fairs, bootcamps and intiatives to encourage them to pursue their STEM dreams and to provide practical support to help female students majoring in STEM successfully transit from school to the workplace.
- **Engage boys and men for gender equality** so they could have a better understanding of conscious and unconscious bias on women as well as take up the responsibility to promote gender equality.

6. Next Steps for UNDP to advance Women and Girls in STEM?

UNDP is well-positioned to build on the existing momentum within the organisation globally and the region to promote women and girls in STEM. Practical next steps for UNDP to take include:

- **Contribute new knowledge on women in STEM** through research on key issues, such as the establishment of national or city-level indexes to assess and rank the advancement of women's participation and leadership in the STEM sectors.
- **Support data initiatives that seek to build an evidence base or conduct analyses** on the barriers and opportunities facing women and girls in STEM.
- **Mainstream STEM skills into existing programs** focusing on women's entrepreneurship, agriculture and livelihoods, and climate change adaptation.
- **Collaborate with governments, academic institutions, and the private sector within the STEM fields to implement incentive measures**, such as certification programs, designed to encourage and recognize exemplary gender equality practices within STEM sectors.
- **Explore the expansion of e-collaboration and e-cooperation among women freelancers and gig workers**. This approach can promote cooperative ownership of computing platforms, offering its users, including workers, better negotiating positions, recognition of their digital labour, and democratic control over resources.
- **Identify and support direct opportunities** that provide competitive grants and funds towards the innovation and promotion of women and girls in STEM.
- **Organize regional forums and collaborations with existing global and local platforms** to establish partnerships, markets and direct opportunities for women in STEM within the region.
- **Develop key advocacy messages and identify role models** to champion women and girls in STEM and share them across networks and institutions.
- **Support countries to join existing global networks of women in STEM**. These global connections lead to better understanding, commitment to targets, and improved practices and policies.

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