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INCLUSION IN AI: IS THERE A SINGAPORE MODEL?

Policy Report

March 2023

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Executive Summary

We are increasingly living in a digital ecosystem, where Artificial Intelligence (AI) research plays a significant part in exploring the potential interface between digitalisation and human lives. Yet, inclusivity, especially women's involvement, is still relatively insignificant in this arena. To ensure that AI can effectively serve and make sensitive decisions about the many aspects of people's lives, it would be important that the development and governance of AI involved individuals who are representative of the society it aims to transform and serve. Furthermore, the lack of female involvement in this field creates feedback loops that cause gender bias in AI and machine learning systems. If AI systems are not developed by diverse teams, their ability to cater to society's needs, align with the human rights, and protect the welfare of diverse users will be limited.

Inclusion in AI

According to the World Economic Forum,[1] only 22 percent of global AI professionals were female in 2018. Although the figure increased marginally to 26 percent in 2020, it is no match against the rapid growth in the field. For example, in the United States, the hiring of AI specialists increased by 74 percent annually over the past four years,[2] but few women were part of this growing sector.

The 4th Industrial Revolution introduced machine learning and AI to the forefront and very soon, AI may very well be embedded into almost all spheres of our lives. While AI technologies like Alexa, Cortana, and Siri have female names and voices, there are actually very few women involved in the development of AI products and services.

Inclusion in AI is a theme explored by the RSIS Future Issues and Technology (FIT) research programme, as well as in the research on gender and digital security in the RSIS Centre for Non-Traditional Security Studies.

This policy report is an extension of a commentary written by the author,[3] and inspired by a webinar[4] organised by the FIT programme with support from the RSIS Centre of Excellence for National Security (CENS) and the Singapore Computer Society on 20 October 2022. The theme was inclusion in AI development and use. This report focuses on women and their role in the AI industry, with special focus on the potential for Singapore's experience in inclusion in AI to serve as a global model.

[1] "Global Gender Gap Report 2020," World Economic Forum, December 2019. https://www.weforum.org/reports/gender-gap-2020-report-100-years-pay-equality/.

[2] *Women in AI*, Deloitte AI Institute, n.d., https://www2.deloitte.com/content/dam/Deloitte/us/Documents/deloitte-analytics/us-consulting-women-in-ai.pdf.

[3] Tamara Nair, "Women in AI: Is there a Singapore Model?" *RSIS Commentary* CO22015, 21 February 2022. https://www.rsis.edu.sg/rsis-publication/nts/women-in-ai-is-there-a-singapore-model/#.Y_eDYexBx-U

[4] "Inclusion in AI: Is there a Singapore Model?" RSIS Webinar, October 2022. https://www.rsis.edu.sg/event/rsis-webinar-inclusion-in-ai-is-there-a-singapore-model/#.Y-SZD-xBx-U

Women and Technology

Historically, technology-related jobs often involved the use of heavy machinery requiring physical strength. As a result, tech jobs were often seen as unattractive, or even unattainable employment options, for women. However, this argument against female employment in technology is no longer valid or relevant.[5] Today's technology is associated with intelligent systems and data analytics. In fact, the crux of today's technology is about "developing unbiased recommendation systems, more humane smart cities, robots that help take care of our seniors, and sustainable energy systems, as well as fully understanding biological data**".**[6] This certainly requires the inputs and involvement of women, who are just as creative and resourceful in these fields as their male colleagues.

Moreover, many of the challenges to be addressed by technological solutions will intersect with fields that are traditionally perceived as "women's work". These include roles in education, senior care, food production systems, physical and mental healthcare, caregiving, and humanitarianism — where the workforce is mainly comprised of women. These areas are also becoming more technologically advanced, especially in AI.

Undoubtedly, diverse perspectives on the technologies to address current and future challenges in these areas would need to be sought. Unfortunately, one of the biggest setbacks to the inclusion of women in AI can be traced back to early education, particularly in Science, Technology, Engineering and Mathematics or STEM subjects. Due to the limited female representation in STEM disciplines, the proportion of women professionals in AI is also reduced.

[5] Nuria Agell, "Women And Technology: A Major Challenge For The Future Of Work," *Forbes*, 8 March 2021, https://www.forbes.com/sites/esade/2021/03/08/women-and-technology-a-major-challenge-for-the-future-of-work/?sh=1557be2feeeb.

[6] Ibid.

Scarce Female Representation in STEM

According to a UNESCO report in 2019, women comprised only 29.3 percent of scientific researchers in the world, representing less than a third of scientific researchers globally.[7] The rates were even lower in the Asia Pacific, where 18.5 percent of researchers in the south and west of the region, and 23.9 percent of researchers in East Asia and the Pacific, were women. Interestingly, 48.2 percent of Central Asia's researchers were women.[8] Although the number of women in science and engineering is growing, men continue to outnumber women, especially at the upper levels of these professions.[9] Of particular concern is the significant gender gap in fast-growing and high-paying jobs of the future, like computer science and engineering. The rapidly growing AI industry will compound the disparity further.

Women face a variety of systemic barriers that often discourage them from pursuing a STEM education or career. Predominant gender stereotypes in STEM fields, such as boys are better at mathematics and science, and that science and engineering careers are masculine domains, deter girls from participating in STEM-related studies.[10]

Others offer alternative explanations. In a study of 300,000 students in 64 countries, female students who scored well in mathematics were found to have scored better in reading tests than their male peers. Their comparative advantage in reading is believed to have influenced their decisions to pursue professions in the humanities.[11] At the same time, the cultural factors that deterred the girls from learning or pursuing STEM subjects could also have contributed to their advantage in reading.[12]

[7] Clementine Collett, Livia Gouvea Gomes, and Gina Neff, *The Effects of AI on the Working Lives of Women* (Paris: UNESCO, 2022).
[8] Ibid.
[9] Catherine Hill, Christianne Corbett, and Andresse St Rose, *Why so few? Women in science, technology, engineering, and mathematics* (Washington D.C.: American Association of University Women, 2010).
[10] UNESCO, *STEM Education for Girls and Women: Breaking Barriers and Exploring Gender Inequality in Asia* (Paris: UNESCO, 2020).
[11] Thomas Breda and Clotilde Napp, "Girls' comparative advantage in reading can largely explain the gender gap in math-related fields," *Proceedings of the National Academy of Sciences* 116, no. 31 (2019): 15435–15440.
[12] Ibid.

Therefore, the claim that the gender gap in STEM is due to men's innate aptitude for science rather than socialisation or discrimination[13] or biological differences rather than sociological factors,[14] is unfounded. Instead, data proves[15] that inherent bias and negative stereotyping are the likely factors behind the inequality.

Women's under-representation in the field of STEM has far-reaching implications on the future of work and national economies, as well as the achievement of the UN Sustainable Development Goals (SDGs). In the Southeast Asia region alone, about 80 percent of jobs will require basic literacy and applied ICT skills by 2030. Without equal access to technology and ICT learning in schools, women would be unqualified for these jobs. UNESCO, which leads the global education 2030 agenda, emphasises the importance of STEM education for all by making gender equality a global priority across all sectors.[16] According to UNESCO's report on STEM education for girls and women, the STEM field lags behind in terms of Sustainable Development Goal (SDG) 4 (i.e. ensuring inclusive and equitable quality education and promoting lifelong learning opportunities for all) and SDG 5 (i.e. achieving gender equality and empowering all women and girls).[17]

Inclusion and diversity in policy-making holds underrated power. While experts may possess collective intelligence, the lack of cognitive diversity (especially when the experts comprise mostly men) could lead to blind spots in the decision-making process. This could be a serious oversight — a dangerous one even — when it comes to national security. To foster more sophisticated solutions, "rebel ideas"[18] that drive divergent thinking would be required. By moving out of comfort zones and challenging collective thinking/bias on a topic, more innovative and practical solutions may be arrived at.

Although thinking differently can be a distraction, the logic flips with complex issues.[19] AI itself is no longer about single algorithms. It is now a sophisticated field that involves "ensembles of algorithms that 'think' differently,

[13] Scott Jaschik, "What Larry Summers Said," *Inside Higher Ed*, 18 February 2005, https://www.insidehighered.com/news/2005/02/18/what-larry-summers-said.
[14] Ibid.
[15] UNESCO, *STEM Education for Girls and Women*.
[16] Ibid.
[17] Ibid.
[18] Mathew Syed, *Rebel Ideas: The Power of Diverse Thinking* (UK: John Murray, 2019).
[19] Ibid.

search differently, and encode problems in diverse ways."[20] Therefore, it would be imperative to adopt more diverse thinking and approaches in order to design and govern this form of machine intelligence.

Data, design choices, and societal context in which algorithmic decision making is used should be assessed through a gender lens to maximise the benefits of these systems for *all* users.[21] For example, speech-to-text technology does not work very well for women if it is built based on the characteristic of male voices, so varied combinations are required for its smooth operation. To capture fresh perspectives, a diverse workforce comprising both men and women would be better equipped to identify and remove AI biases and inaccuracies that can cost companies heavily.

[20] Ibid. (p 15)
[21] Lynette Yarger, Fay Cobb Payton, and Bikalpa Neupane, "Algorithmic equity in the hiring of underrepresented IT job candidates," *Online Information Review* 44, no. 2 (2020): 383–395.

The Singapore Experience

Singapore presents a different scenario from that mapped out for other countries in the Asia-Pacific region. Firstly, Singapore is among the global leaders in terms of gender equality in the tech industry, particularly in the AI field. On average, 28 percent of Singapore's AI talent pool is female.[22] Additionally, Singapore seems to have embraced a gender-neutral stance towards STEM education and careers. Such a stance in education and training is possibly a result of earlier policies on maximising human resource development as a way forward for a young nation.

Both boys and girls are given opportunities to engage in information and communication technology (ICT) within the formal curricula as well as in extra-curricular activities. Mathematics and the sciences are also areas of studies that are open and accepting of students based on their capabilities regardless of their gender. Girls and boys are equally encouraged by parents and teachers to enrol in coding and other ICT classes. One possible reason for this could be a greater awareness of future opportunities in higher education and careers stemming from ICT/AI amongst parents and educators. Nonetheless, Singapore has yet to achieve adequate gender representation in the AI sector.

Women are still under-represented when we consider jobs of the future and how Singapore might retain a competitive edge in hiring the best talent. This could be harmful because gender inequality would impact how and who can assess and use these new technologies.

A 2018 study by Mastercard on female participation in STEM across six countries – Australia, China, India, Indonesia, Malaysia and Singapore – presented some interesting findings.[23] Enthusiasm for STEM subjects started early in girls and 68 percent found the field interesting. The study also identified 15 as the critical age when girls decide whether or not to pursue STEM, and older girls on a STEM track are more likely to commit to it.[24] Perceptions of difficulty, and low numbers of women in the field could also cloud their views about STEM-related careers. As the research was a cross-country study with cumulative data, it is difficult to pinpoint the exact factors impacting the numbers or perceptions of

[22] A. Bello, T. Blowers, S. Schneegans, and T. Straza, "To be smart, the digital revolution will need to be inclusive," excerpt from the *UNESCO Science Report*, UNESCO, 2021, https://unesdoc.unesco.org/ark:/48223/pf0000375429; and "The Gender Gap in Science and Technology in Numbers," World Economic Forum, 2021, https://www.weforum.org/agenda/2021/07/science-technology-gender-gap/.

[23] "Enthusiasm for STEM Sparks Early Amongst Girls in Asia Pacific: Mastercard Research," Mastercard, 2018. https://www.mastercard.com/news/ap/en/newsroom/press-releases/en/2018/february/enthusiasm-for-stem-sparks-early-amongst-girls-in-asia-pacific-mastercard-research/

[24] Ibid.

STEM subjects in Singapore. Moreover, there appears to be a lack of specific comparative data on female participation in AI in the region, highlighting the need for greater disaggregated evidence.

The lack of gender disaggregated data is also a policy blind spot that needs to be addressed, given Singapore's reputation as an equal-opportunity work environment and apparent lack of a *machismo*-culture[25] in the field which is allegedly present in other "Silicon Valley-type" work environments elsewhere.[26] How can Singapore leverage on this strength?

[25] It should not be assumed that there are no cultural barriers for women in STEM/AI in Singapore. Possibilities of an unconscious bias borne out by a gender-based upbringing may exist, exhibiting clear gender distinctions in education and careers.

[26] Karen Englander, Carmen Yáñez, and Xochitl Barney, "Doing Science Within a Culture of Machismo and Marianismo," *Journal of International Women's Studies* 13, no. 3 (2012): 65-85; Angela C. Johnson, *Women, Race, and Science: The Academic Experiences of Twenty Women of Color with a Passion for Science"* (PhD diss., University of Colorado at Boulder, 2001).

Conclusion

Singapore offers a supportive environment that encourages both boys and girls to pursue STEM education and develop careers in the field. Initiatives like Women@NTU, which "unites the NTU community for diversity, equity, inclusion and excellence", has established the Promotion of Women in Engineering, Research and Science (POWERS) programme with support from the Ministry of Education (MOE).[27] The programme empowers women by creating an ecosystem with a "long-term goal of increasing gender diversity in STEM".[28] Such initiatives help negate, to some extent, the disadvantages women face in the tech industry, particularly in the field of AI. Although there is much to learn from the Singapore model, more can be done to boost diversity in the sector.

In 2019, the author served as an expert-mentor to a team of secondary school students examining female students' interest in ICT/AI and tech careers as part of the MOE Humanities and Social Studies Research Project (HSSRP)[29]. While the research findings were focused on the level of interest in ICT/AI in co-ed and single-sex schools in Singapore, they do reveal a deeper interest among younger Singaporeans in examining the barriers and opportunities for girls in ICT and AI careers.

Nevertheless, it appears that the motivation for girls to pursue a higher education and careers in AI is connected to these factors: (i) removing gender stereotypes in education/training, (ii) seeing successful female role models in STEM/AI fields, and (iii) availability of opportunities to participate in mentoring programmes during secondary school. Therefore, the following recommendations are proposed:

1. Publicise and showcase women in STEM and AI research and careers

Women's disinterest in STEM education/careers is linked to their under-representation in the field. As such, Singapore's female AI trailblazers should be more prominently showcased through school visits and mentorships/internships programmes where they are trained to take on leadership/mentoring roles. In

[27] "Women@NTU: Empowering Women at NTU and Beyond," Nanyang Technological University, accessed 2023, https://www.ntu.edu.sg/women.
[28] Ibid.
[29] "GEB Special Programmes," Ministry of Education, accessed 2023, https://www.moe.gov.sg/education-in-sg/our-programmes/geb-special-programmes.

addition, the career and education fairs promoting STEM and AI in tertiary institutions should feature diverse genders, ages, and racial backgrounds. This should also be the case with all AI publicity and promotions, including in the private sector. Such initiatives should be spearheaded by government agencies tasked with AI development and governance.

2. Collect gender disaggregated data

Unless we are aware of a policy blind spot, it cannot be addressed. Thus, collecting data on female enrolment and participation in AI operations, both in education and industry, would be vital. This is best led by government agencies overseeing tech/AI/ICT development. At present there is a dearth of such information in Singapore because of the gender-neutral stance. And unless disaggregated data that considers intersectional elements like race and age are available, the ability to come up with targeted and effective policies to attract more female talent to the AI industry will be limited.

3. Link AI to humanities/social sciences education

AI is still rooted in the STEM sector, even though AI systems have already infiltrated the humanities and social sciences field, dominated by women. A good example would be ChatGPT. Thus, linking AI to humanities and social sciences education could be a powerful way to attract more women into the AI sector. Moreover, cognitive diversity through more inclusive policies would be necessary as we begin to face new and somewhat "threatening" AI systems. There should be a smooth transition between "hard" (design and implementation) and "soft" (creation and use) areas of AI, so that all can contribute, learn and benefit from this technology.

4. Identify problem areas and remote concerns through community consultation

With the introduction of new AI technologies, greater inclusion of women in community consultations would help to highlight a broader range of potential pitfalls. Such actions would also minimise gender and cultural bias by raising the profile and usefulness of AI, increasing interest in AI and making it (seemingly) less "intimidating"[30] to women.

[30] It would be prudent to investigate why such "intimidation", if indeed it does present itself, exists in the first place.

There is an urgent need to increase the number of women in AI, data science and software engineering teams globally, and to educate men in the tech/AI sector on gender bias that work against women (and ultimately everyone) in the field. To identify and remove biases inherent in AI systems, a more diverse team of designers and AI specialists is required for assessing the data, design choices and societal context within which algorithmic decision making is used. The real risk to society is not knowing what we are missing out by *not* including women. Thus, the need to collect data, especially gender disaggregated data to help map out possible weaknesses.

Singapore presents great potential to stand out internationally in this field, especially in its ability to attract relatively high numbers of women. With greater interest in expanding the reach and pull of AI expertise, Singapore can serve as a model for inclusivity in AI systems and in its governance.

About the Author

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She graduated from the National University of Singapore (NUS) with a Bachelor's Degree in Political Science and Geography and went on to train at the National Institute of Education (NIE). She obtained a Masters in Environmental Management, a Graduate Diploma in Arts Research and a PhD in Development Studies from the University of New South Wales in Sydney, Australia. She also possesses a Professional Certificate in Project Management by the Institute of Engineers, Singapore and Temasek Polytechnic. She is also the coordinator of centre publications and Research Integrity Officer for RSIS, as well as the Head of the Research Integrity and Data Management Unit of the School.

Dr Nair's current research focuses on issues of power and the biopolitics of labour and technology, and the Women, Peace and Security (WPS) agenda in the region. She is Singapore's representative of the ASEAN Women for Peace Registry and is also the representative for Nanyang Technological University for the ASEAN University Network on Human Rights and Peace Education. She has published in Development Studies journals, writing on marginalised communities and sustainable development, issues of gender, and power and subject creation.

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