



Quad technology workforce

Miah Hammond-Errey

Key points

- Maintaining a science, technology, engineering, and mathematics (STEM) workforce is a critical, but often overlooked, component of strengthening national critical technologies capabilities.
- Quad countries bring different and potentially complementary strengths to this challenge.
- The research relationships between Quad countries are under-developed, especially when compared to their research partnerships with China.

Policy recommendations

- Quad members should add cooperation on STEM workforce issues to their critical and emerging technologies agenda.
- They should create more incentives and infrastructure for joint research, especially on artificial intelligence (AI) and cybersecurity.
- This effort should focus on under-developed relationships between Australia, India and Japan, rather than these countries' already strong relationships with the United States.

A growing gap in talent

There is a global shortage of skilled workers, especially those with technological skills, and the pipeline for filling these positions is narrowing. One study finds that by 2030, there will be a global human talent shortage of more than 85 million people across all major industries, roughly equivalent to the population of Germany; by 2030 that shortage could result in about US\$8.5 trillion in unrealised annual revenues.¹ The problem seems acute in the technology sector, although measuring the technology pipeline and workforce is complicated, since not all technology graduates take jobs in the technology industry, and not all those working in the sector are technology graduates.²

India is an exception. It is the only country expected to have a surplus of highly skilled financial and business services labour by 2030.³ India produced a staggering 2.14 million STEM graduates in 2021, and an estimated 800,000 technology graduates across the fields of computer science, IT and mathematics at all tertiary education levels.⁴

Given their leading role in technology development, it is unsurprising that the US and Japan have an extensive talent pool of highly skilled and qualified technology workers in a range of fields – from AI to semiconductor manufacturing – and at various stages of technology company growth – from early-stage start-ups to multinational companies.

Australia will have difficulty finding suitably qualified workers, especially with specific technical skills, to meet its growing demand.^{5 6} Australia is predicted to need 1.2 million tech workers by 2030, while its tech workforce stood at 935,000 as at February 2023. In 2021, Australia produced 47,764 STEM graduates,⁷ of which 12,200 obtained bachelor-level degrees.⁸ However 4,800 of these graduates took jobs outside the technology industry.⁹ Australia needs

to diversify as well as grow its tech workforce, with one estimate suggesting that improving diversity in the technology workforce would grow Australia's economy by A\$3.1 billion on average every year over the first 20 years.¹⁰

Critical and emerging technologies in the Quad

Quad members should add cooperation on STEM workforce issues to their critical and emerging technologies agenda. That agenda recognises the transformative economic, social, and national security impact of these technologies and the need for like-minded countries to shape technological innovation.¹¹ Thus far, the Quad has focused on semiconductor supply chains, 5G communications and technical standards, such as those for AI¹² and its horizon-scanning areas such as biotechnology¹³ and quantum.¹⁴ Success will require enhanced cooperation on innovative technologies and international standards.¹⁵

The STEM workforce – and the pipeline for future workforce – is a critical, but often overlooked, component of this agenda. Quad countries bring different capabilities to this challenge. Australia has a robust, high-skilled and innovative workforce and a highly developed digital economy. Japan is a global leader in robotics, automation, and the commercialisation of technology breakthroughs. India has a massive technology talent pool, and the US is investing heavily in emerging technologies across the board – from the AI workforce to greater resources for research and development, as well as bolstering domestic chips production.¹⁶

Quad countries should combine their knowledge, equipment, and resources where possible. The STEM-focused Quad Fellowship program, announced in 2022, has seen the sponsorship and convening of 100 leading postgraduate students from the four countries.¹⁷

This is an excellent initiative, but Quad countries should build on it to strengthen people-to-people relationships and build trusted professional networks. They should also make policy and regulatory adjustments¹⁸ and align technology research and development. The Quad could serve as a natural incubator for cutting-edge innovation on a regional and global scale.

Potential for technology workforce collaboration on AI

AI provides one example of the benefits the Quad could accrue by cooperating on workforce issues. The four Quad countries are among the top 10 producers of AI research in the world, both by number of research publications and citations. Collectively, researchers in the Quad countries generated nearly 650,000 AI-related research papers between 2010 and 2020. This is more than the combined output of researchers from the European Union and the Association of Southeast Asian Nations.¹⁹ Japan stands out in simulation and human-computer interaction, India in data mining and data science, Australia in linguistics and theoretical computer science, and the US in machine learning and natural language processing.²⁰ These strengths could be leveraged by creating more incentives and infrastructure for joint research.

There is real potential to improve personal and institutional relationships and incentivise AI-related research between the Quad countries. The US collaborates extensively with Australia, India, and Japan on AI-related research; however, the latter three collaborate far less with one another.²¹ Meanwhile, China is the top research partner for the US and is the second leading partner for the rest of the Quad members. US research cooperation with China outweighs its research cooperation with the rest of its Quad partners taken together. Australia, India, and Japan each have more research partnerships with China than they do with one another.²² Improving institutional relationships, collaborative funding incentives and streamlining migration for various methods of study, research and collaboration across the Quad countries are a good early area of focus.

Georgetown University's Centre for Security and Emerging Technology has suggested several ways for government, universities, research institutions, and private sector partners to support AI-related research collaboration between Australia, India, and Japan. These include grants for joint research projects, scholarships and fellowships for visiting researchers and academic exchanges, competitions and prizes for jointly developed prototypes and solutions, as well as conferences and workshops.²³

The prospects for Quad success hinge on building stronger ties among the members beyond their bilateral linkages to the US. The Quad members each have something to offer – and have similar goals – when it comes to critical and emerging technologies and creating workforce solutions, innovation ecosystems and exchange between the four nations.

Notes

¹ Y Binvel, M Franzino, A Guarino, J-M Laouchez and W Penk, *The \$8.5 Trillion Talent Shortage*, Korn Ferry, 2018, accessed 2 July 2023, <https://www.kornferry.com/insights/this-week-in-leadership/talent-crunch-future-of-work>

² TCA, *Getting to 1.2 million: Our roadmap to create a thriving Australian tech workforce*, TCA, 1 August 2023, accessed 30 July 2023, <https://techcouncil.com.au/wp-content/uploads/2022/08/2022-Getting-to-1.2-million-report.pdf>

³ Binvel et al., *The \$8.5 Trillion Talent Shortage*, p. 10.

⁴ Nasscom, *India's Tech Industry Talent*, Nasscom, February 2022, accessed 30 July 2023, <https://community.nasscom.in/communities/emerging-tech/indias-tech-industry-talent-demand-supply-analysis>

⁵ ACS and Deloitte Access Economics, *ACS Australia's Digital Pulse 2022*.

⁶ Australian Computer Society (ACS) and Deloitte Access Economics, *ACS Australia's Digital Pulse 2022*, ACS, 2022, accessed 17 July 2023, <https://www.acs.org.au/insightsandpublications/reports-publications/digital-pulse2022.html>; Tech Council of Australia (TCA), *Tech Jobs Update*, TCA, May 2023, accessed 2 July 2023, https://techcouncil.com.au/wp-content/uploads/2023/05/TechCouncil-Tech-Jobs-Update-May-2023_final-1.pdf

⁷ Department of Education, *University enrolment and completion in STEM and other fields*, Department of Industry, Science and Resources (DISR), 2023, accessed 20 July 2023, <https://www.industry.gov.au/publications/stem-equity-monitor/higher-education-data/university-enrolment-and-completion-stem-and-other-fields>

⁸ TCA, *Getting to 1.2 million*, p. 19. Note: This includes graduates from 'Information Technology' related fields, but not Mathematics – which are included in the Nasscom figure.

⁹ TCA, *Getting to 1.2 million*, p. 19.

¹⁰ ACS and Deloitte Access Economics, *ACS Australia's Digital Pulse 2022*, p. 23.

¹¹ The White House Briefing Room, *Quad Principles on Technology Design, Development, Governance, and Use* [media release], The White House, 24 September 2021, accessed 3 July 2023, <https://www.whitehouse.gov/briefing-room/statements-releases/2021/09/24/quad-principles-on-technology-design-development-governance-and-use/>

¹² Prime Minister of Australia, *QUAD JOINT LEADERS' STATEMENT*; Prime Minister of Australia, *QUAD LEADERS' JOINT STATEMENT* [media release], Prime Minister of Australia, 20 May 2023, accessed 6 July 2023, <https://www.pm.gov.au/media/quad-leaders-joint-statement>

¹³ The White House Briefing Room, *Fact Sheet: Quad Leaders' Summit* [media release], The White House, 24 September 2021, accessed 3 July 2023, <https://www.whitehouse.gov/briefing-room/statements-releases/2021/09/24/fact-sheet-quad-leaders-summit/>

¹⁴ Prime Minister of Australia, *QUAD JOINT LEADERS' STATEMENT*.

¹⁵ S Abdulla, H Chahal, M Konaev and N Luong, *Quad AI: Assessing AI-related Collaboration between the United States, Australia, India, and Japan*, Centre for Security and Emerging

Technology (CSET), May 2022, accessed 4 July 2023, <https://cset.georgetown.edu/wp-content/uploads/Quad-AI.pdf>

¹⁶ Abdulla et al., *Quad AI*.

¹⁷ Prime Minister of Australia, *QUAD JOINT LEADERS' STATEMENT* [media release], Prime Minister of Australia, 24 May 2022, accessed 6 July 2023, <https://www.pm.gov.au/media/quad-joint-leaders-statement>

¹⁸ G Boekenstein, 'The Quad's role in tech diplomacy', *The Strategist*, 15 February 2023, accessed 4 July 2023,

<https://www.aspistrategist.org.au/the-quads-role-in-tech-diplomacy/>

¹⁹ Abdulla et al., *Quad AI*.

²⁰ Abdulla et al., *Quad AI*, p. 1.

²¹ Abdulla et al., *Quad AI*.

²² Abdulla et al., *Quad AI*.

²³ Abdulla et al., *Quad AI*, p. 13.



About the author

Dr Miah Hammond-Errey is the Director of the Emerging Technology for the United States Studies Centre at the University of Sydney and host of the Technology & Security podcast.

About this paper

The ANU National Security College (NSC) is a joint initiative of The Australian National University and the Commonwealth Government. NSC is independent in its activities, research and editorial judgment and does not take institutional positions on policy issues. Accordingly, the authors are solely responsible for the views expressed in this publication, which should not be taken as reflecting the views of any government or organisation. NSC's publications comprise peer-reviewed research and analysis concerning national security issues at the forefront of academic and policy inquiry. This paper has been written for the Quad Tech Network Dialogue, held in September 2023 as part of the Quad Tech Network initiative.

About the Quad Tech Network

The Quad Tech Network (QTN) is an initiative of the NSC, delivered with support from the Australian Government. It aims to establish and deepen academic and official networks linking the Quad nations – Australia, India, Japan, and the United States – in relation to the most pressing technology issues affecting the future security and prosperity of the Indo-Pacific.

Contact

national.security.college@anu.edu.au

nsc.anu.edu.au



NSC_ANU



ANU National Security College

CRICOS Provider #00120C

TEQSA Provider ID: PRV12002 (Australian University)