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# CSIRO submission to Teacher Education Expert Panel

## Education & Outreach

CSIRO Submission 23/[822]

[April 2023]

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# Introduction

CSIRO welcomes the opportunity to provide feedback on the Teacher Education Expert Panel Discussion Paper.

CSIRO is a trusted leader in Science, Technology, Engineering, and Mathematics (STEM) education, and our programs aim to inspire the pursuit of further STEM education among students and the community, to equip the emerging workforce with tomorrow's skill sets, and to strengthen collaboration between industry and classrooms across Australia. CSIRO offer a variety of professional development programs and resources to assist educators as they deliver quality STEM education.

This response to the Discussion Paper will focus on two of the four reform areas:

- **Reform area 1:** strengthen initial teacher education (ITE) programs to deliver confident, effective, classroom ready graduates
- **Reform area 3:** improve the quality of practical experience in teaching

These are areas where CSIRO has over 40 years of experience and evidence of success, specifically in relation to supporting teachers to deliver high-quality STEM education. The other two reform areas are outside the scope of CSIRO's education experience.

CSIRO welcomes the opportunity to discuss these matters and our programs in more depth with the Department of Education. Please see contact details on the cover page.

# CSIRO response to the Discussion Paper

## 1.1 Current challenges in STEM education

Science, Technology, Engineering, and Mathematics (STEM) is an important consideration in initial teacher education for a range of reasons. Strengthening Australia's STEM talent 'pipeline' (the educational and career pathways of students and employees in the fields of STEM) is becoming increasingly important, as keeping pace with technological change can advance the economy and meet the needs of Australia's future workforce.<sup>1</sup> STEM and digital skills will play a vital role in realising Australia's innovation and productivity potential. STEM education complements the development of critical thinking, creativity, collaboration, and problem solving, which are demanded for future careers. Employment in STEM occupations is projected to grow by 12.9 per cent in the next 5 years, well above the average growth of all occupations (7.8 per cent) and more than twice as fast as non-STEM occupations (6.2 per cent).<sup>2</sup>

Having an increased number of specialised STEM teachers and primary level teachers able to teach STEM skills (or '21<sup>st</sup> Century skills') across the curriculum and subjects, will be vital to maintain and build the STEM talent pipeline. Teaching STEM in a cross-disciplinary and integrated way requires specialised training at the ITE stage<sup>3</sup>.

There is an ongoing decline in high school student enrolments in STEM subjects<sup>4</sup>, particularly higher mathematics<sup>5</sup>. Student performance in many STEM subjects is also declining, for example in mathematics<sup>6</sup> and science<sup>7</sup>. Teaching 'out-of-field' in STEM subjects is also a significant issue in Australia with an estimated 20 per cent of mathematics teachers teaching out of field<sup>8</sup> and it will be important to attract and retain more teachers into STEM specialisations to help boost student engagement and performance. Research has shown that high school students generally prefer

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<sup>1</sup> Office of the Chief Scientist. (2020). *Australia's STEM workforce: Science, technology, engineering and mathematics*. Retrieved from [https://www.chiefscientist.gov.au/sites/default/files/2020-07/australias\\_stem\\_workforce\\_-\\_final.pdf](https://www.chiefscientist.gov.au/sites/default/files/2020-07/australias_stem_workforce_-_final.pdf)

<sup>2</sup> Australian Government, National Skills Commission (2021) *State of Australia's Skills 2021: now and into the future*. Retrieved from [www.nationalskillscommission.gov.au/reports/state-of-australia-skills-2021](http://www.nationalskillscommission.gov.au/reports/state-of-australia-skills-2021)

<sup>3</sup> Kurup, P.M., Yang, Y., Li, X., & Dong, Y. (2021). Interdisciplinary and integrated STEM. *Encyclopedia of Social Science*, 1(4), 1192-1199. <https://doi.org/10.3390/encyclopedia1040090>

<sup>4</sup> ACARA (2022). *Year 12 subject enrolments*. Retrieved from [www.acara.edu.au/reporting/national-report-on-schooling-in-australia/national-report-on-schooling-in-australia-data-portal/year-12-subject-enrolments](http://www.acara.edu.au/reporting/national-report-on-schooling-in-australia/national-report-on-schooling-in-australia-data-portal/year-12-subject-enrolments)

<sup>5</sup> Wienk, M. (2022). *Year 12 Mathematics Participation Report Card: Mathematics enrolments reach all-time low*. Retrieved from <https://amsi.org.au/wp-content/uploads/2022/04/year-12-participation-2022.pdf>

<sup>6</sup> OECD (2018). *PISA 2018 results: What students know and can do. Volume 1*. Retrieved from [www.oecd.org/education/pisa-2018-results-volume-i-5f07c754-en.htm](http://www.oecd.org/education/pisa-2018-results-volume-i-5f07c754-en.htm)

<sup>7</sup> OECD (2018). *PISA 2018 results: What students know and can do. Volume 1*. Retrieved from [www.oecd.org/education/pisa-2018-results-volume-i-5f07c754-en.htm](http://www.oecd.org/education/pisa-2018-results-volume-i-5f07c754-en.htm)

<sup>8</sup> Shah, C., Richardson, P. & Watt, H. (2020). *Teaching 'out of field' in STEM subjects in Australia: Evidence from PISA 2015*. GLO Discussion Paper Series 511, Global Labor Organization. Retrieved from <https://ideas.repec.org/p/zbw/glodps/511.html>

authentic inquiry-based learning experiences<sup>9</sup>, and partnering with STEM industry professionals and mentors can connect real-world STEM to the classroom<sup>10</sup>.

Under-representation of... in STEM is also a major issue. For example, the country's talent pool is limited by gender inequity in STEM education and careers.<sup>11</sup> Implementing Indigenous-led approaches to strengthening and sharing knowledge in the area of STEM, for example land and sea management, provides an opportunity for every classroom to be more inclusive of Indigenous-driven science<sup>12</sup>. Preparing educators to help address under-representation by creating inclusive STEM classroom environments is an important skill that could be addressed more effectively in ITE and beyond.

## 1.2 CSIRO education programs

CSIRO has a long history of applying inquiry-based learning approaches, including CREST, to deliver effective programs to STEM educators. Hands-on science using real world problems and contexts are an effective way to engage students in STEM<sup>13</sup>, which aligns with the 'effective pedagogical practices' referenced to in the Discussion Paper. CSIRO is uniquely positioned as Australia's national science agency to connect educators to cutting-edge science that CSIRO produces.<sup>14</sup> Although most of CSIRO's education programs are aimed at practising educators, many of the resources and approaches could be used to supplement ITE and/or can be directly accessed by pre-service teachers. CSIRO's educator-involved programs aim to increase confidence and capability in STEM education and provide the frameworks and resources to support the delivery of engaging and effective STEM education to students. These curriculum-aligned programs can supplement ITE programs (reform area 1) and provide approaches to improve the quality of practice experience in teaching (reform area 3). They comprise:

### Technology and computational thinking programs

- **Bebras** is an international initiative aiming to promote informatics and computational thinking among students in years 3 to 12. Bebras can be used by educators to integrate computing concepts into their teaching practice.<sup>15</sup>

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<sup>9</sup> Attard, C., Berger, N. & Mackenzie, E. (2021). The positive influence of inquiry-based learning teacher professional learning and industry partnerships on student engagement with STEM. *Frontiers in Education*, 6. <https://doi.org/10.3389/educ.2021.693221>

Murphy, S., MacDonald, A., Danaia, L. & Wang, C. (2019). An analysis of STEM education strategies. *Policy Futures in Education*, 17(2), 122-139. <https://doi.org/10.1177/147821031877419>

<sup>10</sup> Morris, J., Slater, E., Boston, J., Fitzgerald, M. & Lummis, G. (2021). Teachers in conversation with industry scientists: Implications for STEM education. *International Journal of Innovation in Science and Mathematics Education*, 29(1), 46-57.

<sup>11</sup> Consult Australia (2019). *Australia's STEM education challenges*. Retrieved from [www.consultaustralia.com.au/docs/default-source/people/people-page/australia's-stem-education-challenges-discussion-paper.pdf?sfvrsn=652a4ab9\\_2](http://www.consultaustralia.com.au/docs/default-source/people/people-page/australia's-stem-education-challenges-discussion-paper.pdf?sfvrsn=652a4ab9_2)

<sup>12</sup> CSIRO. (2023). *Indigenous science*. Retrieved from <https://www.csiro.au/en/research/indigenous-science>

<sup>13</sup> Cairns, D. & Areepattamannil, S. (2019). Exploring the relations of inquiry-based teaching to science achievement and dispositions in 54 countries. *Research in Science Education*, 49, 1-23. <https://doi.org/10.1007/s11165-017-9639-x>

<sup>14</sup> CSIRO. (2023). *Our achievements: Advancing Australia since 1916*. Retrieved from <https://www.csiro.au/en/about/achievements>

<sup>15</sup> Lonati, V. (2020). Getting inspired by Bebras tasks: How Italian teachers elaborate on computing topics. *Informatics in Education*, 19(4), 669-699. DOI: 10.15388/infedu.2020.29

- CyberTaipan is a cyber defence competition open to high school students and is based on a proven framework for educating and inspiring high school students towards further education and careers in cyber security and other STEM subjects. Educators can be involved as coaches.
- Digital Careers Teacher Professional Learning are free sessions suitable for primary and secondary educators teaching the Technologies, ICT or other related STEM classes.

#### Programs connecting STEM industry (including CSIRO) and the classroom

- STEM Professionals in Schools is a national volunteer program that facilitates partnerships between schools and industry to bring STEM into the classroom. The program individually matches teachers and STEM professionals so they can work together to increase teachers' STEM skills, knowledge, and confidence through a range of activities. The program has a substantial proportion of volunteers from CSIRO, who can connect CSIRO's cutting-edge science to the classroom.
- Generation STEM Community Partnerships Program (in New South Wales) creates strong partnerships between local schools and industry, with the goal of highlighting local STEM careers and opportunities and providing avenues for students to develop their STEM skills in an engaging and rewarding way. Teachers are paired with local STEM professionals to mentor them through the projects and they increase their skills and knowledge through exposure to contemporary STEM practices.

Cultural competency in teaching STEM to Aboriginal and/or Torres Strait Islander students, and demonstrating links between the knowledges of Australia's First Nations Peoples and the science curriculum (which aligns with Enabling factors for learning in the discussion paper)

- The former Indigenous STEM Education Project comprised a number of programs aiming to increase interest and academic achievement among Aboriginal and/or Torres Strait Islander student in STEM, including several focusing on building the capacity and confidence of educators. Many of the evaluation reports<sup>16</sup> and a 'what works'<sup>17</sup> summary identified teacher engagement and practice, the ability to embed Indigenous knowledges in the curriculum, and employing two-way science as success factors.

#### Inquiry-based learning

- Creativity in Research, Engineering, Science and Technology (CREST) is non-competitive awards program that supports both primary and secondary students in the design and implementation of their own open-ended science investigation or technology project. CREST supports teachers to facilitate inquiry learning in the classroom and provides scaffolded resources to enable all students to achieve an award.

#### Supporting under-represented students

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<sup>16</sup> CSIRO (2023). *Monitoring and evaluation*. Retrieved from <https://www.csiro.au/en/education/Programs/Indigenous-STEM-Education-Project/Monitoring-and-evaluation>

<sup>17</sup> Banks, C. (2021). *'What works' in Indigenous STEM education*. Canberra, Australia, CSIRO. Retrieved from [https://www.csiro.au/-/media/Education-media/Files/Indigenous-STEM/Evaluation/21-00120\\_SER-EDU\\_FACTSHEET\\_WhatWorksIndigenousSTEMEducation\\_WEB\\_210414.pdf](https://www.csiro.au/-/media/Education-media/Files/Indigenous-STEM/Evaluation/21-00120_SER-EDU_FACTSHEET_WhatWorksIndigenousSTEMEducation_WEB_210414.pdf)

- **STEM Together**, helps curious Year 5 to 10 students strengthen their confidence, capability, and connection with STEM, including professional learning and tools for educators. STEM Together prioritises opportunities for students that identify as Aboriginal and/or Torres Strait Islander, female, and from schools in regional or lower opportunity areas.

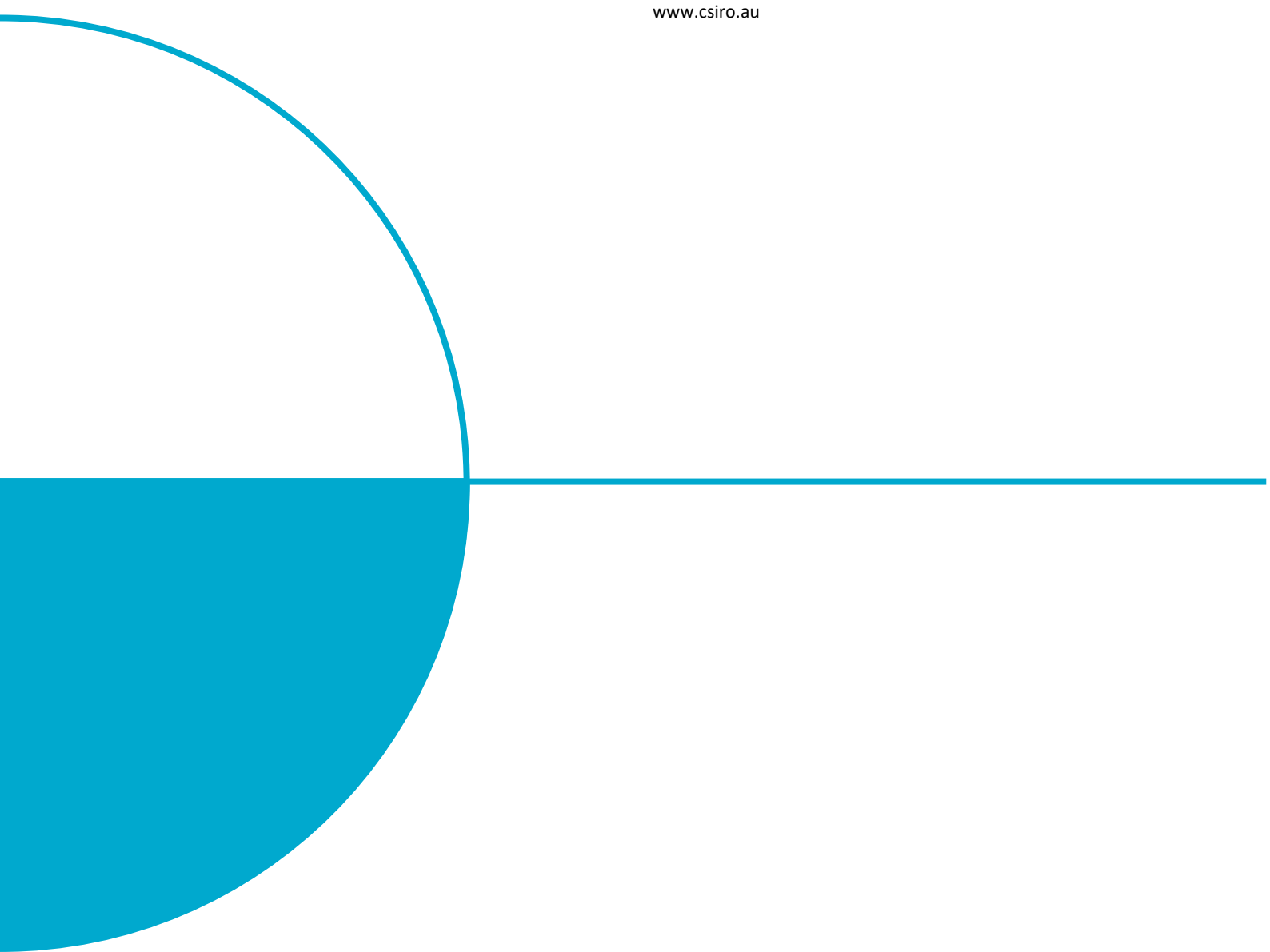
#### Resources and citizen science

- **Your Diet and Your DNA** is a simulation that centres on the food choices of two students and how these choices might be impacting their performance and health. Educators can use the inquiry model to investigate in the laboratory how healthy and unhealthy diets can impact health and disease. The program includes an Australian Curriculum linked teacher guide.
- **The Global Learning and Observations to Benefit the Environment (GLOBE) Program** is a NASA-sponsored science and education program that provides opportunities to participate in data collection and the scientific process. GLOBE can be used by educators to integrate the initiative's protocols into a class project.
- **Sustainable Futures** is designed to support primary and secondary teachers working with students in Years 3 to 10. Teachers who register with the program receive free access to digital teaching resources which includes a variety of ideas and activities to support the teaching of sustainability and the environment in Australian schools.

### 1.3

In summary, STEM comprises an interdisciplinary learning approach for students and a critical set of skills necessary for Australia's future workforce. There is a growing need to ensure Australia has educators skilled and confident in teaching STEM. CSIRO suggests it is important to consider whether ITE and practical teaching experience can be supplemented by specialised STEM education programs where relevant. Universities providing ITE could promote CSIRO's and other providers' programs to their students and graduates, which will provide opportunities to build STEM education skills and make valuable connections to STEM industries. Many of CSIRO's educator-focused STEM programs can assist pre-service and practicing teachers to:

- apply practical, inquiry-based, real world learning
- connect the classroom to the STEM industry
- increase technology and computational skills
- support under-represented students to engage in STEM.



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