Response to The Early Years Strategy Discussion Paper

April 2023

[redacted]

Introduction

Thank you for the opportunity to provide feedback on the Australia Government's development of an Early Years Strategy and to present ideas to address its objectives.

We agree that the early years are a unique window of opportunity with incredible potential to positively influence a child's development and provide a strong base for later success over their lifetime. As a nation, our future STEM capabilities depend on all young children having equal access to quality STEM education with opportunities to learn, develop, and thrive.

In this submission, we discuss the importance of high-quality education for young children and, in particular, how STEM education in the early years can translate to success in numeracy at school and lead to future STEM careers.

Australia's STEM-education challenge

The delivery of quality STEM education is a significant challenge for governments worldwide. There is an urgency to lift human capital so that nations, and their people, can be competitive and prosperous in a rapidly advancing global economy. This is particularly pertinent to Australia, given the current trajectory of STEM literacy.

Australian students' performance in maths and science is measured by the Programme for International Student Assessment (PISA), which assesses the ability of 15-year-olds to use their knowledge and skills to meet real-life challenges. In recent years, Australia's PISA results have continued to slip on international ranking tables. In fact, the latest report data shows, for the first time in the assessment's history, that Australia has fallen to the OECD average level in mathematics performance[1]. Studies also show that the number of senior school students engaged in STEM-related studies has flatlined at around 10 per cent[2]. And while STEM occupations are growing at twice the rate of non-STEM occupations[3], the hardest jobs to fill are in STEM-related fields (e.g., Skilled Trades, Engineers, Technicians, and IT)[4].

Australia's STEM-education position highlights the significant gap between the demand for STEM skills and the academic outcomes of Australian students.

[1] https://www.acer.org/au/discover/article/pisa-2018-australian-student-performance-in-long-term-decline
[2] Australia's skills and workforce development needs, Discussion Paper, Australian Workforce and Productivity Agency, July 2012.
[3] Australian Industry and Skills Committee (2022), National Report, https://nationalindustryinsights.aisc.net.au/national/stem-skills.
[4] The Manpower Group, (2022). The talent shortage, https://go.manpowergroup.com/talent-shortage

The need to start STEM education early

When considering the development of Australia's STEM workforce, it's natural to think about secondary school, vocational education, and university. However, starting quality STEM education in the early years builds a strong foundation for future school success in mathematics and STEM learning. Specifically, the development of spatial reasoning skills in the early years results in a significant boost to numeracy and STEM literacy[5].

In simple terms, spatial reasoning is the ability to manipulate objects in your mind, imagine objects from different viewpoints, rotate objects, and understand how objects relate to one another in space.

A sustained body of research has highlighted a strong association between spatial reasoning ability and mathematics performance. Individuals (young children and adults) with stronger spatial reasoning skills perform better at mathematics tasks. In part, this is because the cognitive processes involved in the spatial representations of objects, as well as their relationships and transformations, are inherently mathematical.

Importantly, spatial reasoning skills are malleable and can be taught[6]. This has been repeatedly demonstrated in successful interventions with spatial training in the early- and primary-years of schooling[7].

Spatial reasoning interventions are especially important for developing female confidence and participation in STEM[8], while also offering substantial learning benefits to students in disadvantaged areas[9]. This is important research, as we know that girls, Aboriginal and Torres Strait Islander students[10], and students from low socio-economic backgrounds have low STEM participation rates and are less likely to study or work in STEM after school. Students from remote, rural, and regional areas[11] are also falling behind in STEM education due to the limited resources available to them compared to metropolitan students.

---

[5] Hawes, Z. et al., (2022). Effects of spatial training on mathematics performance: A meta-analysis, Developmental Psychology, 58, 112-137

[6] Uttal, D., et al. (2013) The malleability of spatial skills: A meta-analysis of training studies, Psychological Bulletin, 139, 352–402

[7] Lowrie, T. et al. (2021). The impact of a spatial intervention program on students' spatial reasoning and mathematics performance, Journal of Experimental Education, 89, 259-277

[8] Sorby, S. (2007). Developing 3D spatial skills for engineering students, Australasian Journal of Engineering Education, 13, 1-11

[9] Lowrie, T. et al. (2019). The influence of spatial visualization training on students' spatial reasoning and mathematics performance, Journal of Cognition & Development, 20, 729-751

[10] https://www.education.gov.au/australian-curriculum/national-stem-education-resources-toolkit/i-want-know-about-stem-education/which-school-students-need-stem-education/aboriginal-and-torres-strait-islander-students

[11] https://www.education.gov.au/australian-curriculum/national-stem-education-resources-toolkit/i-want-know-about-stem-education/which-school-students-need-stem-education/remote-rural-and-regional-students

Australia has a world-leading STEM program for early years

In 2016, the Australian Government awarded $5.6 million to the University of Canberra's STEM Education Research Centre (SERC) team to develop the Early Learning STEM Australia (ELSA) Program. In the two years that followed, SERC received further funding to expand the Program and undertake research to evaluate the efficacy of the Program's learning and engagement, and the impact it had on children's STEM development.

Led by internationally acclaimed mathematics and STEM education researcher, Centenary Professor Tom Lowrie, the ELSA Program[12] was created by an expert team of STEM-education specialists, learning scientists, developmental psychologists, data scientists, and digital creators.

ELSA is informed by ground-breaking research, making the Program pedagogically sound with strong links to both the Early Years Learning Framework (EYLF) and the STEM-related content of the Australian Curriculum for Foundation. Indeed, Professor Lowrie was a co-creator of the EYLF.

Designed for four and five-year olds, the ELSA Program engages children in STEM Practices[13]—the ideas, methods and values that underpin STEM—and focusses on building spatial reasoning and logical reasoning. It builds this reasoning through play-based STEM activities.

Engagement in spatial reasoning activities is critical in the first five years, because spatial reasoning is the best predictor of whether children will end up in a STEM-related career[14].

Teachers and educators deliver the ELSA Program in early learning centres and preschools. The Program features 16 digital apps for children, an Educator app, a Families web-app, 100+ hands-on activity ideas, pedagogical frameworks that support intentional teaching[15], as well as physical resources such as picture books and STEM games that reinforce concepts developed in the Program.

The ELSA apps have been designed so that children can direct their own play while building capacity in spatial and logical reasoning in STEM. Importantly, the apps collect children's STEM literacy data, and reports this data back to educators, without time-consuming formal assessments.

Underpinning the ELSA Program is a comprehensive professional development course that is designed to increase STEM knowledge, teaching capacity, and confidence in teaching STEM.

The ELSA Program was designed to make STEM available to all

The ELSA Program was designed to support the Australian Government's 'Inspiring all Australians in digital literacy and STEM' strategy, which sought to increase the participation of Australian children in STEM and improve their digital literacy.

[12] http://www.elsaprogram.com.au
[13] Lowrie, T., Leonard, S., & Fitzgerald, R. (2018). STEM Practices: A translational framework for large-scale STEM education design. EDeR - Educational Design Research, 2(1), 1-20.
[14] https://www.gwern.net/docs/iq/smpy/2009-wai.pdf
[15] Lowrie, T., & Larkin, K. (2020). Experience, Represent, Apply (ERA): A Heuristic for Digital Engagement in the Early Years. British Journal of Educational Technology, 51(1), 131-147. https://doi.org/https://doi.org/10.1111/bjet.12789

A key objective of the ELSA Program was to provide equal access to STEM for all children and make sure it is accessible to every child—regardless of gender, cultural heritage, socio-economic status (SES) or experience of disability. This objective is embodied in ELSA's philosophy of 'STEM for all' and the design of ELSA was guided by academics with expertise in the areas of inclusion, and rural and remote education.

The development Pilot for ELSA included children in vulnerable, geographically isolated, and non-traditional learning communities who have often been excluded from STEM education opportunities.

The ELSA Program gives teachers and educators the framework, resources, and confidence they need to create intentional STEM teaching moments within their specific contexts and cultures.

In addition, the Program's innovative approach to technology minimises the challenges of most educational technology programs that need high-speed internet connectivity and high child-to-device ratios, whilst minimising concerns about screen time. Specifically, centres and schools can successfully deliver the ELSA Program using one device, and internet connectivity is not needed to use the children's apps.

The ELSA Program features four digital characters who guide children through the apps. ELSA's philosophy of inclusiveness (STEM for all) is also embodied by these heroes of the apps. There are two girls and two boys: Elliot is an Indigenous Australian boy, Piper is a girl who needs a wheelchair to move, Remy is an Asian-Australian boy, and Amy is an Anglo-Australian girl. The presence of these characters, as companions of the children as they engage in STEM activities, sends a clear message to children taking part in ELSA that STEM is for everybody.

By representing people who have historically felt excluded from STEM—girls, Aboriginal and Torres Strait Islander Australians, and people with disabilities—these characters help make all children feel welcome, included, and equal.

Making families a part of STEM learning

The ELSA Program also includes a Families web-app to provide simple and fun opportunities for families to engage in STEM activities with their children as they go about their daily lives. For example, when shopping for groceries, driving in the car, visiting the beach or park, or doing the laundry.

It gives teachers, educators, and families a common STEM language. It also helps parents understand the importance of positive experiences of STEM in the early years for their child's learning and development.

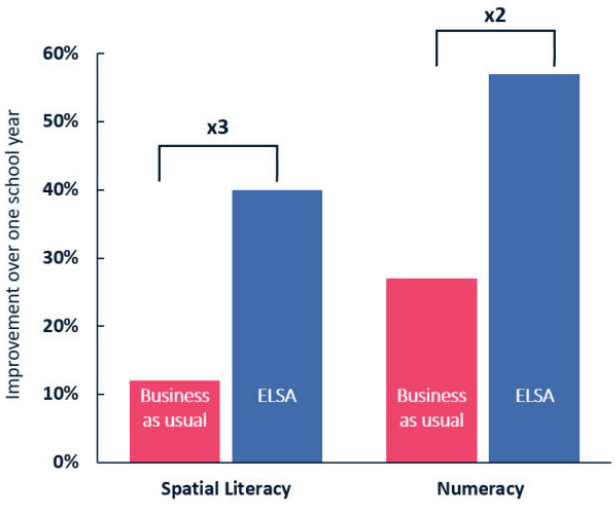
The ELSA Program significantly boosts numeracy and STEM literacy skills

More than 400 early learning centres and preschools around Australia have used the ELSA Program, and the evidence shows that students achieve considerable STEM outcomes.

The ELSA Program has been developed within a strong evidence base, including a randomised control trial (RCT) with more than 1,200 children across Australia.

The results of the trial showed significant performance gains in both STEM learning and numeracy for the children who participated in the ELSA Program for one year.

For STEM literacy skills, children improved at a rate three times higher (x3) than children not involved in the Program.



For numeracy, the children improved at a rate twice (x2) that of the business-as-usual cohort.

The ELSA Program helped those most at-risk for lower mathematics understanding (because they also had lower spatial reasoning) achieve the largest gains in numeracy performance, closing the gap between children with low and high spatial reasoning.

ELSA also delivered significant outcomes for the educators, with data showing the Program:

- improves educators' understanding, interest, and confidence in teaching STEM content
- transfers to increased engagement in leadership roles for educators.

Why does the ELSA Program work?

The ELSA Program gives all children access to high-quality STEM education, regardless of gender, cultural heritage, socio-economic status (SES), or experience of disability.

The significant learning outcomes achieved by the ELSA Program can be summarised into six high-level attributes:

1. **The pedagogy:** All learning activities and lessons are embedded within a pedagogically rich learning environment with a strong evidence base.
2. **The training:** Children practise STEM skills through carefully developed activities and learning progressions.
3. **Adaptability for context and culture:** Program flexibility allows teachers and educators to deliver STEM learning that applies to different contexts and cultures.
4. **STEM Practices unit:** Challenging problem solving is structured in ways that build children's confidence.
5. **The professional development:** PD that promotes teacher confidence and develops their content knowledge.
6. **Research and evidence:** Research demonstrates that the ELSA Program boosts numeracy and STEM skills.

Development starts on an ELSA Program for Foundation to Year 2

In 2021, the Department of Education awarded the University of Canberra a further $5.7 million in funding to develop the ELSA Program for the early years of formal schooling (Foundation to Year 2). A pilot of this program will begin in schools during 2024.

Conclusion

Today's preschool children will use STEM practices in jobs that haven't yet been imagined, and it is critical that they develop the STEM mindset and skills needed for these future jobs, and the technologically advanced world in which they'll live.

Australia needs a nation-wide approach to the development of foundational skills critical for educational success and prolonged STEM engagement.

Early Years Strategy – start quality STEM education early

We thank you for the opportunity to provide feedback on the Australian Government's development of an Early Years Strategy and look forward to seeing the Strategy's development progress.

We ask that the expert Advisory Panel make it a priority to include (in the Early Year Strategy) the delivery of an evidence-based, high-quality STEM education program for early years, which focusses on the development of spatial reasoning skills.

We also suggest that the expert Advisory Panel prioritise the needs of rural, regional, and disadvantaged communities by giving them priority access to such a program so that Australia can start to close the educational gap.

About SPLAT-maths

The ELSA Program received substantial support from the Australian Government Department of Education. This support enabled the ELSA Program to become fully sustainable and continue beyond its initial pilot.

The Department of Education provided the site licence to a commercial entity that was spun off from the University of Canberra, called SPLAT-maths.

The ELSA Program is now available to purchase by all Australian early learning centres and preschools through SPLAT-maths.

SPLAT-maths' proven outcomes in maths and science developmental skills have attracted significant interest from governments or educational jurisdictions in several countries—including Ireland, Scotland, the USA, and Indonesia. Discussions and negotiations are currently underway in multiple regions to implement the ELSA Program into various educational frameworks and curricula.