everyone's family

Submission on the *Vision for a Science Nation: Responding to Science, Technology, Engineering and Mathematics: Australia's Future* Consultation Paper

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Introduction

As the Chief Scientist has noted, mathematics, engineering and science are "part of the essential path to a future that is broadly socially, culturally and economically prosperous" (Office of the Chief Scientist 2012: 12). The Smith Family welcomes an increased national focus on Science, Technology, Engineering and Mathematics (STEM) and the acknowledgement that a multi-pronged strategy, involving a diverse range of sectors and organisations will be required. Government, business and non-government sectors will all need to contribute, both individually and collectively.

Within the non-government arena there is a role for a range of institutions, including non-government organisations and charities, philanthropy, professional associations and the media. Unless an approach is taken which includes clear mechanisms and support for collaboration across sectors and organisations, it is unlikely that Australia will achieve its desired vision of a "nation in which science is an integral part of our society and our economy" (Foreword, Consultation paper).

Given The Smith Family's mission is to support the long-term participation in education of young Australians in need, this submission particularly focuses on the *Education and Training* section of the consultation paper.

Recommendations

1. That Australia's STEM strategy acknowledge the need for cross-sectoral and cross-institutional collaboration, involving government, business and non-government organisations and that the strategy explicitly develops mechanisms for supporting such collaboration.

2. That Australia's STEM education strategy includes a focus on the years prior to school, as well as school and post-school.

3. That cost-effective programs, with a strong evidence base for improving early mathematics, such as *Let's Count,* be further scaled, through investment from governments, business, philanthropy and the wider community, as part of a national response to improving STEM capability.

4. Efforts aimed at enhancing teacher capability, pedagogy and curriculum relating to STEM subjects should take particular account of those groups whose performance and participation is behind those of their peers. This includes students from low socioeconomic backgrounds and Aboriginal and Torres Strait Islander students.

5. Developing strong partnerships between parents, teachers and schools to enhance the STEM capability of Australian students must be an integral part of a national STEM strategy. Non-government organisations can help facilitate these partnerships, particularly with disadvantaged parents.

6. That a national STEM strategy take into account the more limited access that disadvantaged young people have to resources and opportunities that build STEM capability and engagement. The strategy should also build on existing successful initiatives.

The Smith Family

The Smith Family is Australia's largest education-oriented charity and delivers programs in 94 communities across all states and territories. In 2013 we supported over 134,000 disadvantaged children, young people and their families. This included over 15,500 from Aboriginal and Torres Strait Islander backgrounds.

Our programs begin in the early years and continue through to tertiary education. Our largest program, *Learning for Life,* is a long-term educational scholarship which supports around 34,000 children and young people each year. We are working to improve three key longer-term outcomes for the young people we support, namely: school attendance, Year 12 completion and post-school engagement in employment, education or training.

Improving the educational outcomes of disadvantaged children and young people is the most cost effective way of breaking the cycle of long-term disadvantage and welfare dependency. It also contributes to building Australia's human capital capability and is particularly important given the nation's ageing population and the increasing global competitiveness of our neighbours.

Education and training

Australia's performance in STEM

There is ample evidence of the challenge Australia is facing in regards to having a population which is highly capable and internationally competitive in the areas of STEM. Of particular concern to The Smith Family is the poor performance in these areas, of many children and young people from disadvantaged backgrounds. This begins early and continues throughout school and beyond:

- In the first year of school, one in four children who live in Australia's most disadvantaged communities do not have the mathematics skills needed for school. (Australian Government 2013)
- In Year 5, one in 10 students from low socio-economic backgrounds does not meet the minimum NAPLAN standards. For Aboriginal and Torres Strait Islander students it is one in four. (ACARA 2014)

- By age 15, students from low socio-economic backgrounds are, on average, around two and a half years behind students from high socio-economic backgrounds in mathematical, scientific and computer based literacies. (Thomson et al. 2013)

The impact of this poor performance is significant both for individual young people and the nation. Modelling of future jobs shows that 44 percent (5.1 million) of current Australian jobs are at high risk of being affected by computerisation and technology over the next 20 years. Those most likely to be affected include unskilled or low-skilled activities. Conversely, 75 percent of the fastest growing occupations now require STEM skills (PricewaterhouseCoopers 2015).

This means that disadvantaged students who do not acquire strong STEM skills at school are likely to be doubly disadvantaged in the employment market. There will be far fewer low skilled jobs which they can access and they will not be able to take advantage of new high skilled jobs, some of which do not even currently exist.

Beginning early

Given the foundational relationship between mathematics and the other STEM disciplines, The Smith Family has a particular interest in ensuring disadvantaged young people develop strong maths skills throughout their lives.

The development of mathematics and numeracy begins in infancy (Lipton & Spelke 2003) and can and should be strengthened through early childhood. Data from the Australian Early Development Census (AEDC) however, shows that many children are not acquiring appropriate mathematical skills prior to commencing school.

Mathematics is largely a cumulative discipline - the acquisition of higher order maths skills relies on the acquisition of foundational skills. Children who do not learn earlier skills are disadvantaged when they are asked to learn later skills (Bailey 2014). A consequence is that school-entry maths skills are predictive of later maths learning and achievement (Carmichael, MacDonald & McFarland-Piazza 2013; Duncan et al. 2007). Children who start ahead in maths tend to stay ahead; conversely, children who start behind tend to stay behind.

Recommendation

That Australia's STEM education strategy includes a focus on the years prior to school, as well as school and post-school.

Therefore, The Smith Family strongly urges that in developing a national STEM education strategy, it include not only the school and post-school arenas, but prior to school as well. Critical for children acquiring maths skills prior to school is the

home learning environment and the role of parents, who are children's first and most influential teachers (Australian Government 2009). Helping children to develop positive mathematical dispositions in the early years is also important for long-term success in this area. Children need to see maths as interesting, useful and fun if they're going to be engaged in it.

Despite the importance of developing early maths skills and positive dispositions, many parents spend less time engaging with their young children on maths activities compared to literacy. Many parents are uncertain about early maths learning, not knowing what their child could or should learn or how to help them to learn (Cannon & Ginsburg 2008).

Parents can also impact on a child's mathematical disposition and attitude – both positively and negatively. Nurturing and encouraging the capacity and confidence of parents to guide their child's maths development is very important. Providing support mechanisms for parents to take on this role is particularly vital for parents from low socioeconomic backgrounds (Ginsburg et al. 2008).

Let's Count – a scalable and cost-effective program for enhancing early mathematics skills

In response to AEDC data showing that significant proportions of children from disadvantaged backgrounds are behind in their maths when they start school, The Smith Family, in partnership with Professors Bob Perry and Ann Gervasoni, has developed and trialled the *Let's Count* program.

Let's Count assists educators in early childhood contexts, to work in partnership with parents and other family members, to promote positive mathematical experiences for young children, aged three to five. It fosters opportunities for children to engage with the maths they encounter as part of their everyday lives, and to talk about, document and explore it, in ways that are relevant and fun to them.

Since 2009, with the philanthropic support of the Origin Foundation, *Let's Count* has been implemented in 17 disadvantaged communities across all Australian states. It has supported, 8,000 children, 4,500 parents and 300 early years educators. The impact of the program has also been rigorously assessed through a three year longitudinal evaluation.

The evaluation showed that *Let's Count* impacted positively on the children, parents and educators who participated. All three groups had enhanced confidence and stronger interest regarding maths, as well as more positive dispositions towards it. The maths skills of the children grew significantly through their involvement and their skills were significantly greater than those of similar children who did not participate in the program. This is highlighted in Table 1.

Table 1: Percentage of children successful with mathematical tasks pre and post participation in *Let's Count* and comparison group of similar children who didn't participate in the program

Task	Percentage of children able to complete task prior to participation in *Let's Count* in Feb 2013	Percentage of the same children able to complete task after participation in *Let's Count* in late 2013	Percentage of similar children who did not participate in *Let's Count* able to complete task in late 2012
	Same children		Different children
Count a collection of at least 20	17	55*	37*
Order numeral cards 0 to 9	10	52*	31*
Order 4 candles shortest to longest	23	63	54
Make a collection of 7 when shown the number 7	27	84*	63*
Makes a set of 5 teddies when asked	63	90*	77*
Knows some triangles	81	95*	83*
Continue pattern	16	48*	34*

*The differences between these scores are statistically significant.

The *Let's Count* program is cost-effective and scalable. For example, around 30,000 children are able to be supported over a 12 month period for an investment of around $1.5 million. *Let's Count* helps children, particularly disadvantaged children, to start school on track in their mathematics development and with the essential positive attitude to the subject which will set them up for future success.

Recommendation

That cost-effective programs, with a strong evidence base for improving early mathematics, such as *Let's Count,* be further scaled, through investment from governments, business, philanthropy and the wider community, as part of a national response to improving STEM capability.

Across the school years

Data from NAPLAN, PISA and the Australian Council of Learned Academies (Marginson et al. 2013) highlight both performance and participation issues regarding STEM for young Australians in the school years. While an increasing proportion of young Australians are completing Year 12, there is a decline in the proportion undertaking science and maths at the higher levels. This has consequences for their subsequent employability and the human capital pipeline that industry will be able to utilise in subsequent decades.

As highlighted in the early years section of this submission, students' valuing and liking of maths (and science) matters for their long term engagement in the subject. They are important contributors to the probability of them undertaking these subjects in the later years of high school.

Data from the 2011 Trends in International Mathematics and Science Study (TIMSS) (Table 2) shows that significant proportions of Australian students indicate that they do not like maths and science. This 'dislike' starts early and these proportions are generally higher than for their international peers.

Table 2: Comparison of Australian and international students who like maths and science

	Australian students %	International students %
Like maths, Year 4	45	48
Like maths, Year 8	16	26
Like science, Year 4	55	53
Like science, Year 8	25	35

Enhancing the curriculum, teacher capability and pedagogical approaches to maths and science in schools can contribute to addressing some of the STEM performance and participation issues flagged by national and international data.

Young people need to receive maths and science education which is engaging, inspiring and expert. As the UK 21st Century Science and Learning Group has noted: "Specialist knowledge and experience enables teachers to explore and illuminate their subject bringing it alive for students through personal experience and knowledge of current research and debate. Deep and inspiring subject knowledge also allows teachers to respond knowledgeably to students' interests and provide stretch and challenge for the most able students" (Science and Learning Expert Group 2010: 27).

The Smith Family would urge that efforts to enhance teacher capability, pedagogy and curriculum, take account of those groups whose performance and participation is particularly behind those of their peers. This includes students from low SES and Aboriginal and Torres Strait Islander students.

Recommendation

Efforts aimed at enhancing teacher capability, pedagogy and curriculum relating to STEM subjects should take particular account of those groups whose performance and participation is behind those of their peers. This includes students from low socioeconomic backgrounds and Aboriginal and Torres Strait Islander students.

Enhancing the learning environments outside of school

The learning environments outside of school, including in the home and wider community, are important influences on young people's participation and performance in STEM subjects, both from the early years and through school and beyond. Included in this are parents' attitudes to these subjects, their engagement in their child's learning and their understanding of the relevance of STEM for future employment.

Recent longitudinal research shows that students who reported having parents with more positive attitudes towards science tended to have higher educational and occupational science aspirations (De Witt et al. 2013). More positive parental attitudes towards science create more favourable attitudes among children, which in turn, leads to higher science achievement. Parental attitudes towards science therefore have a positive effect on children's science test scores. (Perera et al. 2014: 21)

Importantly, given the gap in achievement between low SES and high SES students, analysis of PISA data shows that children from disadvantaged backgrounds may be able to improve their science performance as much as students from more wealthy families if their parents have more positive attitudes towards science (Perera et al. 2014: 22). Engagement in their child's learning matters more to the educational outcomes children achieve, than their parents' socioeconomic background (Fox & Olsen 2014). Supporting parents, especially those from disadvantaged backgrounds to be engaged in their child's STEM learning is critical.

This research emphasises the collaboration which must be an essential part of improving Australia's STEM capability. A national STEM strategy must see parents as having a key role in partnership with teachers and schools. For parents from disadvantaged backgrounds, who may lack confidence or be unaware that their attitude and engagement in their child's STEM engagement is critical, additional efforts will be required to support them to engage in their child's learning. Non-government organisations who already have relationships with disadvantaged parents can be critical brokers in facilitating them to be more engaged in their child's learning.

Recommendation

Developing strong partnerships between parents, teachers and schools to enhance the STEM capability of Australian students must be an integral part of a national STEM strategy. Non-government organisations can help facilitate these partnerships, particularly with disadvantaged parents.

Access to technology

In addition to parents' attitude and engagement in their child's learning, a number of other home or outside school factors can influence young people's performance and engagement in STEM. These include their access to the internet at home, ability to visit museums and similar institutions and their access to opportunities that emphasise the relevance and applicability of STEM.

Analysis of the Australian Bureau of Statistics' (ABS) 2012 *Children's Participation Survey,* shows that in Australia's most disadvantaged communities only two third of children aged 5 to 14 years accessed the internet at home over a 12 month period. This compares with 90.5% of children in the most advantaged communities. Other research by the ABS, shows that 85% of children in this age range who used the internet at home, did so for educational purposes. Curriculum, schools, teachers and educational systems now tend to assume that all children and young people consistently have access to resources such as computers and the internet, but for disadvantaged families this is not the case. This can impact on young people's engagement in STEM.

Science, in particular, is an area where home access to the internet can significantly add to a young person's engagement in the subject. For example, the capacity for a young person to log on to the NASA website at home and follow the New Horizons mission to Pluto or to explore a multitude of science related interests, can build engagement, curiosity and self-directed learning.

Outside school learning opportunities

The more limited access to the internet at home for disadvantaged young people is exacerbated by them being less likely, than their more affluent peers, to visit museums and other places of exploration and discovery. These places offer opportunities for informal and self-directed learning in all STEM areas (Henderson & Atencio 2007). Out-of-school, informal learning experiences are important for cultivating children's interest and understanding of science (Perera et al. 2014: 8).

Despite the importance of these types of experiences, two fifths of children aged 5 to 14 years from Australia's most disadvantaged communities did not attend any cultural venues or events such as museums, art galleries and libraries over a 12 month period. This compares to less than one in five children from Australia's most affluent communities (Australian Bureau of Statistics 2012).

Initiatives which help promote understanding of the value of, and address access issues to out of school engagement in STEM, can play a part in a national strategy aimed at enhancing capability in this area, particularly for those children and young people at most risk of being left behind.

Learning clubs

Learning clubs are an example of an initiative which takes place outside of school, complements what happens in school and can contribute to enhancing the capability of students, particularly those from disadvantaged backgrounds. *Learning clubs* provide a safe and supportive learning environment where students can participate in activities that develop their academic skills. The Smith Family runs many such clubs across Australia, including 130 that focus on supporting students with their homework and eight which specifically work on mathematics. Participants are able to access trained local volunteer tutors, including university students who are training to be teachers.

The *Learning Clubs* run for a minimum of two terms each year and students attend once or twice a week at no cost. This ensures that there's consistent support and engagement over a significant part of the school year. They take place in a range of venues, with around 60 percent occurring on school premises. This can also help build parental engagement in their child's learning. Students whose parents are engaged in their learning are more likely to do well as school, complete Year 12 and go on to higher education. This holds true for all young people, regardless of their parents' socioeconomic background (Fox & Olsen, 2014).

The Smith Family collects a range of data from both the students who participate in *Learning Clubs* and their parents. This is across the areas of academic engagement, self-management, sense of belonging and interpersonal skills. The 2014 outcomes data for students who participated in *Learning Clubs* includes:

- 89% said it helped them finish their homework
- 87% said it helped them do better in class
- 93% said it taught them to ask for help when they don't understand
- 88% said it taught them they can do well if they try
- 95% of students felt welcome and that they belong
- 96% indicated tutors were easy to talk to.

More than 80 percent of parents also reported on the positive impacts on their child of participation in *Learning Clubs,* including increasing their confidence with school work and ability to finish homework on their own.

Learning Clubs are locally facilitated learning environments which harness a range of resources, in ways that are particularly beneficial to disadvantaged students. They can be an important complement to both the school and home learning environment, and contribute to improving the capability, especially in the area of maths, of disadvantaged students.

Real world STEM opportunities for young people

As identified earlier in this submission, 75 percent of the fastest growing occupations require STEM skills. Many of these roles would be unfamiliar to young people, especially to those from disadvantaged backgrounds who are less likely to have parents and others in their network who are familiar with these newer occupations. Providing opportunities for young people, especially those from disadvantaged backgrounds, to gain insights and experience in STEM occupations can contribute to the goals of a national strategy.

One example of such opportunities is the *Work Inspiration* program, and in particular an initiative which is being organised by the multinational enterprise software business SAP, in partnership with The Smith Family.

Work Inspiration is a business-led initiative that provides young people with opportunities to experience the world of work first hand in a meaningful and inspiring way. *Work Inspiration* allows students to explore career journeys, connect with business and meet and talk to staff who are employed in a range of roles. It helps students broaden their perspectives and develop aspirations. *Work Inspiration* also allows businesses to showcase their employment opportunities, engage with the future workforce and support their local community. *Work Inspiration* originated in the UK and The Smith Family is working with the Foundation for Young Australians and the National Australia Bank to replicate and adapt the program for Australian employers.

SAP has been involved in *Work Inspiration* in partnership with The Smith Family since 2014. Ninety three percent of students attending the SAP program conducted in Melbourne in that year agreed that doing *Work Inspiration* encouraged them to develop aspirations and set goals for their future. All students indicated that they had been inspired by the range of career options in ICT following their participation in the SAP *Work Inspiration* program.

Of particular relevance to a national STEM strategy is a *Work Inspiration* SAP program which will be run in Sydney over three days in August 2015. The program will involve 20 students from an all-girls government school in western Sydney. The school is very culturally diverse and the students are in Years 9 and 10 and studying Information Systems and Robotics subjects. The program will be delivered at SAP's headquarters in North Sydney. It will be the fourth program SAP has led.

Over the three days the girls will experience a highly interactive and engaging agenda, focused on STEM, which will see them engage with volunteer employees from across different teams at SAP, as well as one of their global customers. The students will also spend one of the three days of the program at the head office of SAP's global customer.

The program will include an overview of SAP and the depth of career possibilities, an exploration of the students' strengths, the role of Facebook and Twitter in the company's marketing strategy, the use of data and business analytics, a design thinking workshop, interaction with the Business Women's Network, tips on preparing a resume and video conference with the Asia Pacific Team on the upcoming Social Media Campaign for International Youth Day.

The program will not only highlight the huge range of employment opportunities in STEM, but will also provide wonderful role models for the students in an area where there is significant under-representation of girls, especially those from disadvantaged backgrounds. The program is made possible because of the strong partnerships developed between industry, schools and not-for-profits. SAP's partnership with The Smith Family was determined by employees, with the purpose of making a difference in people's lives. Partnerships are key to the success of the program.

There is significant opportunity to expand such STEM initiatives with a direct benefit to the nation and *Work Inspiration* is highly regarded by corporates. SAP employees, for example have provided feedback on the volunteering opportunity, indicating that they enjoy the connection with students and appreciate the opportunity to work with disadvantaged students. From the students' perspective, such opportunities give a unique insight into the possibilities of STEM, creating engagement in the area and identifying real pathways for employment.

Recommendation

That a national STEM strategy take into account the more limited access that disadvantaged young people have to resources and opportunities that build STEM capability and engagement. The strategy should also build on existing successful initiatives.

Conclusion

STEM is critical for the future of both individual Australians and the nation as a whole. Significant numbers of Australians, particularly young Australians from disadvantaged backgrounds, are not acquiring the capability in this area which is critical in the 21st century. A national STEM strategy, which is developed and implemented through cross-sectoral collaboration between governments, industry and the non-government sector, is essential for the future economic and social wellbeing of Australia. While a range of new initiatives will be required, there are currently available and proven approaches which could readily be scaled in a cost-effective way. The cost-effectiveness of these approaches is in part a function of the collaborations which underpin them.

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