TECH IN ED SUB 9
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Aboriginal and Torres Strait Islander Mathematics Alliance (ATSIMA) - *www.atsima.com*

Submission to the Education and Health Standing Committee

An inquiry into Digital Innovation in Secondary Education

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About ATSIMA

ATSIMA is an Indigenous led non-profit organisation that has the vision:

'All Aboriginal and Torres Strait Islander people will be succesful in mathematics'

To achieve this success, ATSIMA strives to create new ways of teaching mathematics that connects Aboriginal and Torres Strait Islander cultures to the teaching and learning of mathematics. ATSIMA aims to transform mathematics education for Aboriginal and Torres Strait Islander learners and, by doing so, transform mathematics education for all learners. ATSIMA is actively engaged in:

- Coordinating STEM and STEAM Camps annually for Aboriginal students in regional and remote NSW, in partnership with the NSW Department of Education and the NSW Aboriginal Education Consultative Group (AECG). ATSIMA prepares the academic and cultural programs for the NSW camps.
- Recruitment of Indigenous tertiary students, Cultural leaders, businesses and academics to deliver workshops for the NSW STEM and STEAM camps, creating a national network of Indigenous STEM professionals.
- Teacher professional development programs for individual schools and clusters of schools across Australia. To date ATSIMA has worked with schools in South Australia, New South Wales, Queensland, Northern Territory, and Western Australia;
- Working directly with Aboriginal and Torres Strait Islander students and their Communities through School and/or Government programs;
- Strategic Planning and Policy Advice for South Australian Government, Australian Curriculum, Assessment and Reporting Authority (ACARA) and Australian Mathematical Society (Equity and Diversity Committee);
- Working with Australian Curriculum, Assessment and Reporting Authority (ACARA) to embed Aboriginal and Torres Strait Islander perspectives in the mathematics curriculum;
- Working with Yirrkala Community School, North East Arnhem Land, NT on their Garma Mathematics program, a bilingual program that focuses on two-way learning; and

- Developing international relationships to learn from other Indigenous peoples from across the world. For example, we are in the process of developing professional development programs in Norway with Sami educators and extending an invitation to them for ATSIMA 2020 and other conferences.
- Organisation of a biennial conference that brings together educators, education researchers, research organisations, government officials and industry to explore ways of transforming mathematics education for Aboriginal and Torres Strait Islander people.

The points we raise in this submission will be from our breadth of experienced outlined above as well as member feedback. Note that one of our members, Bill Kerr, wrote a detailed response and we have included this at Attachment A without editing.

Technology and Education

ATSIMA's main point about technology in education for Indigenous students is that technology needs to:

1. **Promote creativity**, that is, allow students to be creative while investigating certain concepts. Creativity encompassess more than just creative thinking (only one aspect of creativity). Creativity we aspire to is the creativity of self-expression; allowing to express your own ideas while learning key mathematical concepts;
2. **Needs to compliment and support our culture** and not be a proxy for it;
3. **Aboriginal and Torres Strait Islander people are very quick to take up technology,** and have done so since colonisation started in 1788, particularly when it compliments cultural practice. For example, mobile phones and social media to keep connected with kinship groups, desert communities owned cars before non-Indigenous people to help travel large distance and drones to survey traditional lands.

From ATSIMA's experience in education, technology often does the thinking for the student thereby creating dependence. For example, we often find the black box approach to technology where a process is programmed into a device, the students plug the numbers in and, if done correctly, receives an answer. Students may be satisfied by getting an immediate answer however, students tend to have a poor understanding of the mathematical concept that is embedded in the device and, consequently, will find it difficult to determine whether the answer makes sense.

How digital innovation can assist secondary students to learn anything, anywhere, anytime

There is a huge potential for both ***Indigenous and non-Indigenous students to experience*** many aspects of our world, particularly the worldviews of many cultures, and to learn more about Aboriginal and Torres Strait Islander cultures. An excellent example of this is the "The Orb" which was developed by the Tasmanian Department of Education and the Aboriginal people of Tasmania. "The Orb" is effectively a teacher education resource that was developed on a multimedia platform and can be viewed via the internet (see https://www.theorb.tas.gov.au/). The main purpose of "The

Orb" is to teach the Aboriginal cultural of Tasmania as a living culture still practiced by many people today. It is about creating a compelling experience that overturns the mindset of Terra Nullius, create discussion and work towards reconciliation.

To support changes in Indigenous Communities and to strengthen connection with technologies, there are two significant organisations: Indigenous Digital Excellence and Ngakkan Nyaagu.

The Indigenous Digital Excellence (IDX) program at the National Centre for Indigenous Excellence (https://ncie.org.au/idx/) aims to strengthen Indigenous participation, practice and entrepreneurship in the digital economy. IDX has laid out a roadmap which involves the inclusion of more digital technologies in education.

Ngakkan Nyaagu (NGNY) is 100% Aboriginal owned and operated end-to-end digital agency founded in 2014 by Liam Ridgeway and John Saulo. NGNY wants to make an impact on our community. NGNY coined a term Indigenous Digital Economy which aims to identify and build on the ways in which technology can positively impact on Aboriginal & Torres Strait Islander culture and community sustainability. For NGNY this is a journey of how technology can play a pivotal role in preserving culture and using these tools to teach culture across Aboriginal & Torres Strait Islander communities as well as non-Indigenous communities nationally and internationally. As a business, NGNY are impacting Indigenous Digital Economy through educational and employment opportunities and through the growth of an online business marketplace that offers a pathway into economic participation for Indigenous owned and operated businesses.

The role of digital technology in addressing secondary student engagement and retention

From ATSIMA's experience, increase engagement and improving retention is centred on developing a positive strong identity of the student. Therefore, make connections between mathematics and the culture of the students that promotes deep learning is essential. Technology can play an important role by allowing students to explore concepts and use technology to record and communicate their understanding and ideas. For example, many complex mathematical concepts can be taught by understanding how the concepts connect to patterns including patterns that exist in the environment. Students could use a range of technology to record patterns on their traditional country and explore why those patterns exist through a combination of traditional knowledge and mathematical knowledge. Patterns could also be animated to show how they change over time pulling together the understandings of the pattern from the two knowledge systems.

In summary, technology could be an important vehicle that allows students to be creative while learning important concepts and while reinforcing the students' cultural identity. ATSIMA would also contend that such an approach (i.e. an education based on creativity and cultural identity) would improve equity in education, assist at-risk students and cater for high performing students.

Challenges to implementation, including provision of digital infrastructure, resources and technical support

There would be varying sets of challenges for different Indigenous Communities across Australia, which would probably centre more on connectivity. For example, many Aboriginal students are transient student moving between different Communities and homelands during the year. The way the education system has traditionally dealt with this perceived problem is to say, “when you are not at school, you are missing out on your education.” This situation only occurs because 1) the school system does not understand why the students are transient; and 2) the school system does not value the cultural education of the student.

ATSIMA understands that some States and Territories are already using technology to track students and have the students work and assessment available to teachers via a digital platform, which is a positive step in the right direction. However, students may be moving to advance their tradition cultural education. If the education system valued this aspect of the student’s education, the student could be using technology to record and develop a story around their educational journey in partnership with an Elder. This will give teachers a better understanding as well as allow connections to be drawn to the curriculum.

Attachment A

Bill Kerr's response

Overarching statement:
Computers can be both *instrumental and epistemological vehicles* for certain *powerful ideas / dispositions and hands on practices* which can be delivered to *those who have missed out (aka the digital divide)*

1) Rapid but twisted evolution of the computer revolution

Although computers are everywhere, the hardware, software, applications, programming languages and the practices and theories of educational computing continue to evolve rapidly which makes it hard to keep up to date.

Experts and movements (the new Coding Movement, the Maker Movement) do exist and are very helpful but they don't always agree. The existence of the vigorous Coding and Maker Movements outside of schools indicates that often schools are not doing the job and also that these movement are highly engaging for many students.

2) The powerful ideas and dispositions

Seymour Papert's original concept (1) was about using computers to transform the way knowledge developed in the learner's mind. The subject domain of geometry could be restructured to make it more accessible, meaningful and fun for the learner (aka "hard fun").

Some powerful ideas can be clearly identified
eg. debugging of code or working to improve a prototype through repeated iterations requires persistence and is a form of looking at mistakes. There is general agreement of the educational importance of that.

Other powerful ideas arising from computer science can be identified and ways found for them to be taught. However, what history has shown is that the most important thing here is setting up learning environments where an invitation to develop powerful ideas will emerge naturally, rather than being forced. See next section.

Although there has been exaggeration, historically by some, of what can be achieved with computer based learning environments, nevertheless, the practices in most schools falls well short of what could be achieved.

ACARA's Digital Technology curriculum (2) does outline some of the powerful ideas (as outcomes) but doesn't explain how to achieve them. Effective teacher training exists through the CSER MOOCs site (3).

The history since computers entered schools shows there are widely different claims and approaches about the best way for them to be used. Some authors have done a good job of sorting through this. To do a thorough review of this literature is an arduous but possible task.

Three game changers have been identified by Sylvia Martinez and Gary Stager: coding, physical computing and fabrication. (4)

Collaboration has been identified as part of the desirable culture (Yasmin Kafai/ Quinn Burke (5)) and some software and learning sites have built that into their workings (eg. Collabrify software (6), Scratch3.0 website with their Remix feature(7))

Various names have been assigned to summarise the powerful ideas. These include computational thinking, computer science, computational literacy, computational participation. This theorising is an ongoing process in a relatively new curriculum area. Consensus has not yet been achieved. It is an important discussion which does need to be further analysed and understood.

3) Learning environments

Experience shows that for most students powerful ideas are not learned by force. A more effective approach is to make them conspicuous in the learning environment (by good choice of hardware, software and learning environment) so that their development is encouraged.

For most students, the powerful ideas will only arise from thoughtfully constructed learning environments, a powerful curriculum delivered by teachers who understand the issues.

Such environments have been developed and trialled in the past (eg. Turtle geomety, "Instructional Software Design Project" (8)) and this is ongoing.

Some excellent modern curricula have been developed, eg. Scratch 3.0 curriculum by the Harvard School of Education (9). Some general principles of what works and what should be encouraged can be stated, eg. collaborative work, project work which is personally and socially meaningful with long time slots.

Whole school change / integrated curriculum (STEM / STEAM) is difficult for a variety of reasons, (a) School leadership may not understand the issues deeply (b) Teacher training has not kept up with the computer revolution. Nevertheless, focused change based on teacher enthusiasts is possible. The structural reform which works well involves personally and socially meaningful projects (preferably an integrated STEAM curriculum), sufficient time to develop them with teachers trained who understand the issues (learning environment, hardware, software, child psychology and cultural issues for indigenous students)

4) Cultural focus

Learning environment can be enhanced meaningfully for indigenous learners using *Culturally Situated Design Tools*. Some exemplary work has been done by the group led by Ron Eglash in the USA over a long time frame (10)

I have developed a few exemplars along similar lines (11)

Much more could be done along these lines. The conditions for success have been outlined in the publications of Eglash et al.(12)

5) Hardware and software

The growing list of hardware to choose from highlights the need for informed evaluation: includes Makey Makey, Arduino, Little Bits, Ozobot, Micro:bit, Chibi Chip, Circuit Playground Express, Lilypad, Bee-Bot, Dash and Dot, Sphero, Edison, Drones, etc.

Some of the important principles have been articulated by those who have developed the best construction kits (13). They include:

- Design for designers – use kits that encourage building and tinkering (iterate, iterate and iterate again)
- Low floor (easy to begin use), wide walls (diversity of possible projects including multimedia) and open windows (collaboration)
- Make powerful ideas obvious but not forced
- Minimalism often works better than feature creep
- You can do quite a lot with a little bit of programming
- Eat your own dogfood (don't ask students to use software and hardware you don't like using yourself)

With these principles in mind some of the hardware and software I recommend are Scratch3.0, Turtle Art, Makey Makey, the micro:bit, MakeCode, the Hummingbird:bit and App Inventor (not a prescriptive list)

6) Nuts and bolts

Computers in schools and related hardware is a significant budget item. Many schools have difficulty acquiring sufficient network managers / maintenance staff. Teacher training lags behind the potential of what can be achieved.

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a) Turtle Art design: https://billkerr2.blogspot.com/2019/07/skills-and-dispositions-utilised-in.html
b) Indigenous icons: https://billkerr2.blogspot.com/2018/12/indigenous-icons-activity.html
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Kind regards

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