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Keynote Summary:

The Power of Partnerships to Promote Engagement of Young People in STEM: International and Local Perspectives

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ABSTRACT
Sarah Chapman was featured as a keynote speaker for the 2021 Network Gender & STEM Conference. She provided a passionate call-to-action based on her immersive educational experiences such as the Barbara Cail STEM International Fellowship (2016) and her 19 years as a secondary science teacher. The fellowship provided the opportunity to research and identify effective and innovative ways for promoting participation of young people, particularly girls, in science, technology, engineering and maths (STEM) fields during their education and subsequent careers. By visiting schools, businesses, universities, government departments and communities all over the world, she explored what OECD countries were doing that was having an impact on the rate of engagement in STEM education. Sarah also visited other countries that are high performing in STEM education to inform her professional practice. With a focus on best practice for engaging and sustaining young people, in particular girls, in STEM, this keynote summary offers important messages of connection, communication, and collaboration to consider for an effective STEM ecosystem that embeds four key strategies to empower and engage girls in STEM.

KEYWORDS
Gender & STEM; partnerships; student engagement

The Power of Partnerships to Promote Engagement of Young People in STEM: International and Local Perspectives

My keynote message for the international and local delegates of the 2021 Network Gender & STEM Conference was informed and inspired by broad research and teaching fellowships, professional experiences as founder of the Townsville STEM Hub and as Board Director of Women in STEMM Australia, and my own rich teaching and learning experiences through professional programs and as a secondary school science teacher in Australia. My most memorable and impactful experiences include the Australian Science Teachers Association and Sony Foundation's Australian-Japan Teacher Exchange (2014), the Chief Executive Women's Barbara Cail STEM Fellowship (2016), the International Google Education Conference (Singapore 2018), and the Commonwealth Bank and Australian Schools Plus Teaching Fellowship (Singapore 2019).

Partnerships and Perspectives

The Australian-Japan Teacher Exchange (2014) opened my eyes to a whole new world. Visiting Urawa Daiichi Girls School, a Super Science School, was certainly a highlight of my trip. This school was focused on enriching the student experience in science, geared to engage students in lifelong science careers. It was enriching to hear the extracurricular and additional subjects the school provided that helped students engage in a Super Science learning pathway. A Super Science School focusses on developing advanced science, mathematics, and technology skills for gifted students. This is achieved by providing students with international cooperative projects and collaborations with universities. The schools are very well resourced, and there is an extensive array of extracurricular experiences to extend student interest and capability. The girls at Urawa Daiichi Girls School were highly motivated and engaged to pursue a lifelong journey in a STEM-related field.

Two years later, through the Chief Executive Women's Barbara Cail STEM Fellowship (2016), I became involved with international research across five OECD countries: Singapore, Finland, England (UK), United States of America (USA) and New Zealand. Activities included investigating how government, business, industry, peak bodies, research, education, and community organisations were able to successfully engage young people in science, technology, engineering and maths (STEM). The results provided international examples of best practice for promoting the participation of young people, particularly girls, in STEM (Chapman & Vivian, 2017).

In 2018 and 2019 I was able to further investigate the practices of one OECD country: Singapore. First, as the invited keynote speaker at the International Google Education Conference, I encountered a range of innovative educational experiences from Social Enterprise Incubators to Makerspaces at the Singapore Centre for Social Enterprise, (raiSE), a sector developer focussed on raising support and awareness of social enterprises in Singapore (Singapore Centre for Social Enterprise, n.d.). Then, through a Commonwealth Bank and Australian Schools Plus Teaching Fellowship, I gained a complete perspective of Singapore's education landscape and how each component informs the other to ensure continual improvement for young people.

Partnerships were a prominent feature that informed and enhanced learning experiences for students at CREST Secondary School and the School of Science and Technology in Singapore. These schools incorporated vocational and entrepreneurial STEM pathways within their learning experiences. Partnerships were also used in this way at Urawa Daiichi Super Science Girls High School, Japan. These three schools were able to elevate their partnerships and authentic learning experiences to engage students in international experiences, thus assisting them in becoming global STEM citizens.
Based on the knowledge gained through these key experiences, and together with my 19 years of professional teaching experience in Australia, I propose a focus on the power of partnerships when promoting best practice for engaging and sustaining young people, in particular girls, in STEM. What follows is a reflection on understanding an effective STEM ecosystem and the importance of each stakeholder when embedding four key strategies within partnerships to engage and empower girls in STEM.

The STEM Ecosystem: Connections, Communication, and Collaboration
To effectively engage with young people in STEM, understanding benchmarks for high performing STEM engagement programs is not sufficient. An in-depth understanding of the complex interconnected landscape or ecosystem and the role each component plays are essential. As displayed through Figure 1, the STEM Ecosystem is a dynamic network that consists of key stakeholders who can enable STEM engagement of young people and their families. Each stakeholder has an important part to play, as one stakeholder cannot achieve all the roles meaningfully. For example, Level 1 stakeholders enable STEM engagement through funding, policy work and research. Level 2 stakeholders are the core drivers of STEM engagement, connecting with young people and their families (Level 3) at their point of need. Level 2 stakeholders provide targeted STEM opportunities to sustain engagement. Each level relies on connection, communication, and collaboration to strengthen and sustain effective STEM engagement. Understanding the STEM Ecosystem also allows for the identification of gaps that need to be addressed.

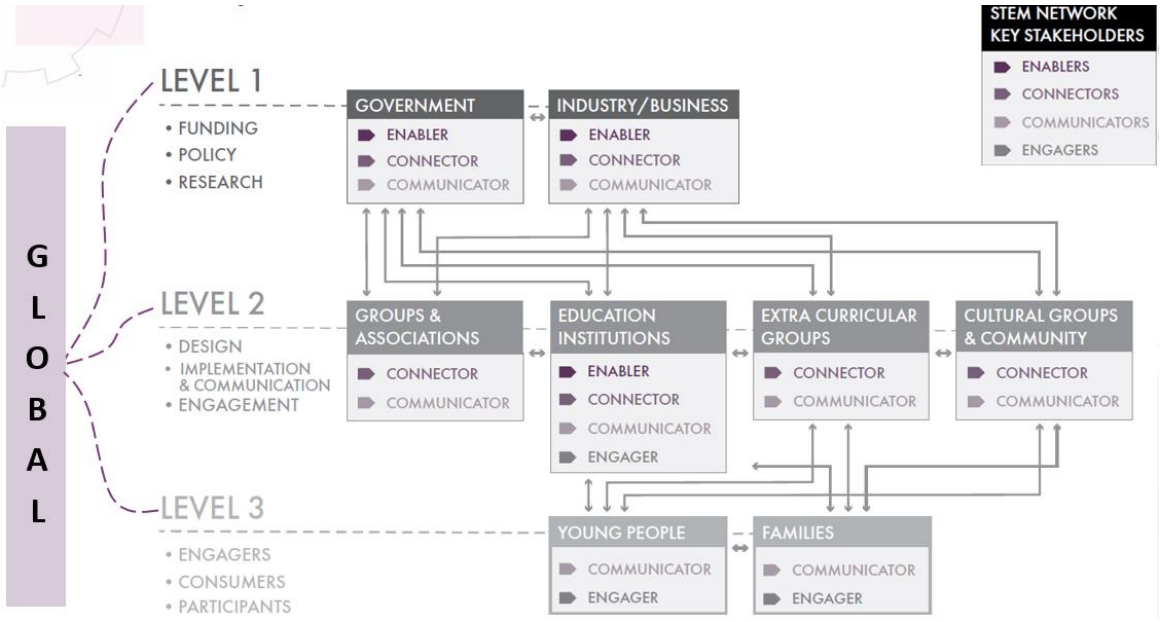

Figure 1. STEM Ecosystem map modified from Chapman and Vivian (2017).

My professional experience as an educator engaging young people has highlighted to me the importance of partnerships to make the unknown visible for students. Young people are attracted to and look up to people who are visible. Extensive partnerships with the STEM ecosystem allow students to be inspired by new possibilities, to be challenged by new problems and learn from new ways of thinking. Diversity in learning experiences allows young people, especially girls, to see possibility for themselves. These experiences can include engagement with technologies used in current scientific research to illustrate the relevance and extension of classroom learning. For example, students in my senior biology class have engaged in fieldwork at our local estuary. They collaborated with researchers at James Cook University, utilising their expertise and technologies to enhance their research. Students used a submersible to study life below the water's surface. As North Queensland is home to estuarine crocodiles, the submersible vehicle provided a glimpse into a habitat that would otherwise be inaccessible for students. Through this collaboration, students have learnt the importance technology has in research. Students also influenced the research direction of the researchers by providing suggestions around the analysis of the underwater data. Use of emerging technologies has led to students initiating a project with others across the world and working to solve a community concern through their own research project. Partnerships provide an authentic platform to catalyse student empowerment and agency.

Engagement: Embedding Key Strategies

Four key strategies can promote increased and sustained engagement of girls in STEM (Figure 2; modified from Chapman & Vivian, (2017)): messaging, girls-only opportunities, authentic connections, and family involvement. What follows is examples of how each strategy has been embedded successfully.

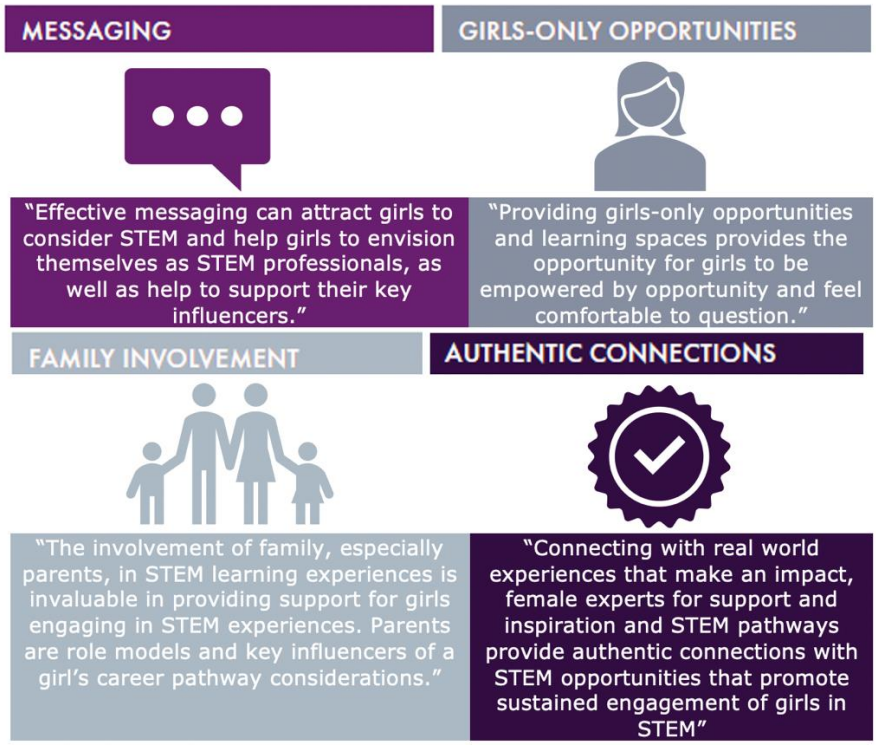

Figure 2. Key strategies for engaging girls modified from Chapman and Vivian (2017).

Strategy 1: Messaging
Effective messaging is imperative to engage young people, especially girls, and provide opportunities for them to connect to the possibilities STEM. Ineffective messaging has the potential to derail other significant efforts employed to engage young people. Effective messaging needs to clearly show the 'real' face of STEM to dispel the stereotype. I have developed a messaging protocol of IMPACT instead of LABEL (Chapman, 2020), shown in Figure 3. This ensures a STEM expert communicates their WHY or the IMPACT they make before giving their LABEL. Many students have misconceptions around STEM occupations, so heading a presentation with a label can be a barrier for engagement. As an experienced educator, I have found that students respond more positively and engage with communicators who use this messaging protocol. This protocol coupled with coaching students on how to engage with STEM experts, leads to students engaging beyond the initial experience in both informal conversations and formal mentoring or work experience.

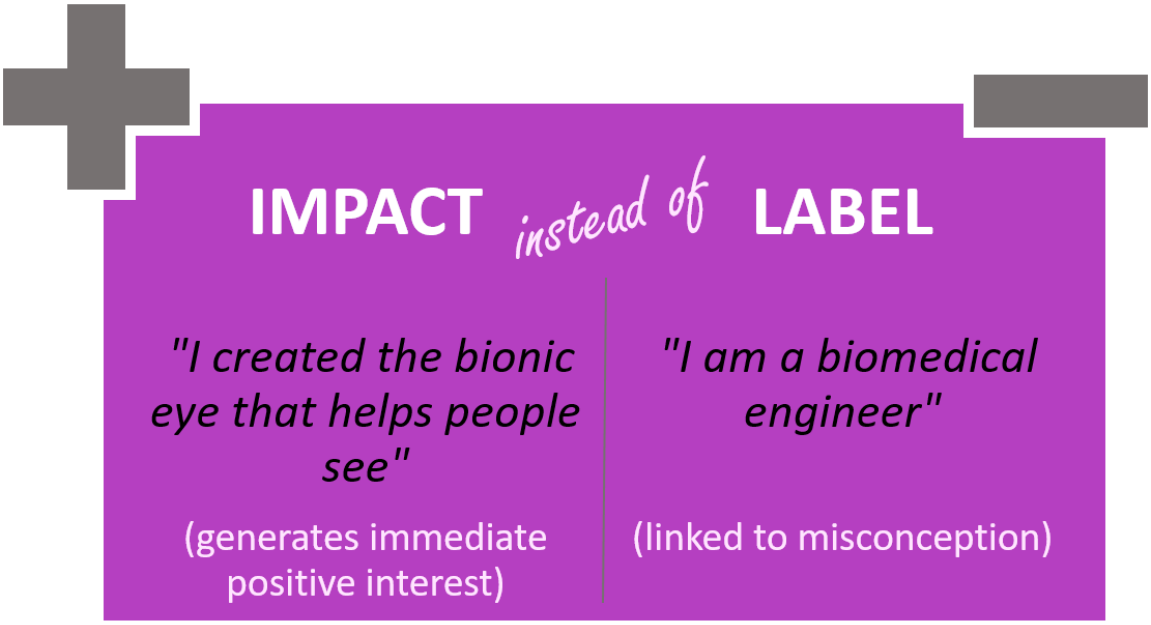

Figure 3. Messaging protocol IMPACT instead of LABEL when communicating with young people (Chapman, 2020).

Techbridge Girls USA, established in 2000, is an organisation that challenges bias in STEM opportunities through messaging. This organisation develops and delivers gender responsive and culturally relevant experiences embedded in the community. Their success has come from developing strong messaging through their STEM communication and unconscious bias training for all their mentors. Ensuring quality messaging with their partnerships ensure girls feel empowered. Their other key strategy was the involvement of parents/guardians and family in the STEM journey. The involvement coupled with resources informed family members about the importance of STEM and possible pathways. These key strategies have led to Techbridge Girls being a successful and sustainable organisation for STEM engagement.

Strategy 2: Girls-only Opportunities
Stemettes UK, established in 2013, is a girls-only STEM engagement organisation. It builds on the social aspects of connection, growing girls' connection with others that are likeminded. The connection with STEM is also

grown with a range of girls-only experiences that have been built from strong partnerships and mentors from industry. These partnerships provide authentic STEM connections and involve girls in solving real world problems. Parent/guardian involvement is also a key component in ensuring girls remain engaged in the Stemette's programs.

Strategy 3: Family Involvement
Thomas Jefferson High School for Science and Mathematics USA is a public school that harnesses family involvement from fundraising to sourcing authentic contexts and collaborations with research and industry to elevate their STEM programs. One of the programs this school has that sets them apart dedicates half of the timetable (2.5 days per week) for senior students to work in industry or research to complete a research project that contributes to their final grade. This allows them to engage authentically in STEM, preview STEM occupations and see their learning as relevant to industry. It also allows students and their families to build authentic connections and confidence in their chosen STEM pathway in high school. These experiences are shared with families to reaffirm the impact and importance of STEM. For example:

> *Brandon wanted to study Medical Engineering, however he was unsure if a STEM pathway was for him. He engaged in medical research around glioblastoma, a fatal brain cancer. This experience had cemented his STEM pathway choice. Along with this Brandon was articulate and confident, contributed by his external experiences with the research industry.*

Strategy 4: Authentic Connections
High Technology High School USA is a pre-engineering public school that has project-based learning targeting engineering design, a research practicum, computer programming, data analysis, engineering, and technology. Students learn advanced STEM skills through a program developed by industry that promotes strong problem solving and enhances critical thinking skills, along with computer programming and advanced mathematics. In grade 10 until the completion of high school, every student conducts their own yearly research projects. Students engage fully with these opportunities, collaborating with local business and industry, working on authentic projects of their own interests. For example:

> *Ana and Rachael worked with industry and their local university to develop the SunScream app. In their work they had to learn advanced mathematics and coding, in order to develop their product. "Sun exposure can result in sunburn, premature skin aging, skin cancer and damage. The app will determine the requisite SPF value for a given UV index and remind users to reapply" explain Ana and Rachael.*

The ability to choose a relevant topic provided these girls with the motivation to learn the advanced skills required to create their application. High engagement of all girls in this school is attributed to the authentic contexts for learning and the partnerships that enable this form of learning.

Conclusion

We make visible what we value. To effectively engage with young people, particularly girls, partnerships across the STEM ecosystem are essential. Engaging young people through empowering messaging, involving the family unit, enabling girls-only experiences and authenticity will ensure girls can adapt and succeed in the ever-changing world we live in.

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