

STEM Education Futures Research Centre Newsletter Issue # 4, December 2019

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Director's Message



Welcome to the 4th issue of the STEM Education Futures Research Centre newsletter!

In this issue, we report on Centre members' achievements in the last six months and their research on innovative projects such as the use of eye-tracking methods to understand how language background influence students' processing of mathematical world problems. Thank you to all Centre members for all their research contributions in 2019 and to the readership of the Centre's newsletter for their continued support! I wish everyone a very happy and safe Christmas and New Year!

Associate Professor Wan Ng



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Dr Tracey Ann-Palmer in *The Conversation*

THE CONVERSATION



Tracey-Ann Palmer

Lecturer, Initial Teacher Education, University of Technology Sydney

Dr Tracey-Ann Palmer published an [article](#) in the Conversation which was read by over five thousand people and picked up by major newspapers in Australia and overseas. Congratulations!



September 10, 2019

Keep your job options open and don't ditch science when choosing next year's school subjects

Tracey-Ann Palmer, University of Technology Sydney

Students picking their subjects for Years 11 and 12 need to understand that science can be useful in a wide range of future jobs.

The article describes Tracey-Ann's research to address the problem of low enrolments in post-compulsory school science. Her innovative research looks at how students see science compared to the other subjects they can choose. She discovered that students can perceive science as poor value in terms of time and effort to get marks, and as having limited use. She suggests that this can be addressed through good information and good experiences in science that help students value science as providing vital skills to help us to understand and participate in the world in which we live.

Click [here](#) to read the article.

Dr Mun Yee Lai's Eye-tracking Research on ESL Students' Processing of Mathematical Word Problems



Project title

The influence of the Chinese and English languages on students' processing of mathematics word problems

Students from East Asia have consistently out-performed their counterparts from Western countries in recent international studies of mathematics achievement such as TIMSS and PISA. Yet many different reasons have been studied but very few researchers have examined the issue from the perspective of the language used in the mathematics learning and assessment. Different cross-cultural studies have repeatedly indicated that the Chinese number-naming system is relatively more consistent and explicit than other languages such as English. The linguistic features of Chinese mathematical terms are also relatively straightforward and transparent. In the literature, discussion about how Chinese-character writing might affect students' mathematics ability and achievement has been made. This study investigates the relationship between the languages of the tests and their possible influence on students' mathematics achievement through analysing the linguistic components of the TIMSS mathematics assessment items in Chinese and English, and examining the behavioural differences of Chinese (Taipei, Taiwan) and



STEM: Government's 10 year plans

Generation STEM

Generation STEM is a new \$25 million, 10 year initiative to attract, support, retain and train NSW students in STEM and school, into further education and into employment. Website:

<https://www.csiro.au/en/Education/Programs/Generation-STEM>

Women in STEM Decadal Plan

Launched in April 2019, the Women in STEM Decadal Plan presented a framework and vision of the STEM ecosystem to attract, retain and progress girls and women in STEM careers and education. See:

<https://www.science.org.au/files/userfiles/support/reports-and-plans/2019/gender-diversity-stem/women-in-STEM-decadal-plan-final.pdf>

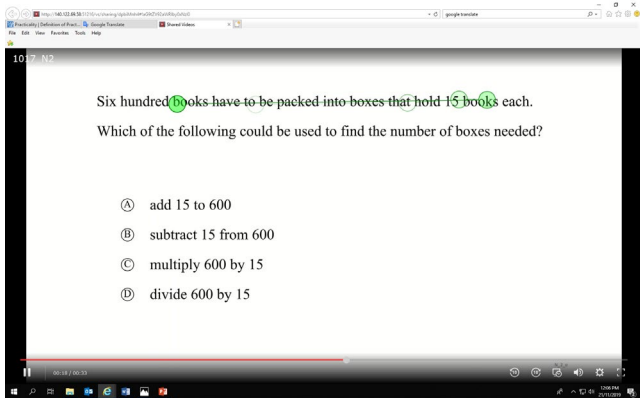
Indigenous Girls' STEM Academy

In July 2018, the Federal Government announced \$25 million for the Indigenous Girls' STEM Academy where over the next decade, the Academy will support 1000 Aboriginal and Torres Strait Islander girls and young women, from Year 8 right through to graduate employment. See:

<https://ministers.pmc.gov.au/scullion/2018/investing-25m-support-indigenous-girls-stem>

English (Adelaide, Australia) students when they process the items in their languages.

Students' processing of the TIMSS mathematics word problems were investigated through tracking their eye movements while reading the word problems. Eye-movements tracking (using the Tobii system) were employed to study students' processing of the items in their languages. In May 2019, twenty Grades 4 to 6 students with different mathematics abilities in Adelaide were invited to attend the eye tracking exercise. The Australian data set were collected and analysed by **Dr Mun Yee Lai**. This data set included the results of analysis of the language complexity of the TIMSS mathematics word problems in English, and video records of the parts of the word problems in English to which students paid more attention, as measured by the length of time the students fixed their eye-balls on those parts. As there is no existing framework that could assist the further analysis of how these two



The video showing the eye-ball movement

categories of data are interacting, Dr Lai developed a framework and in August, conducted research meetings in Taipei to discuss the practicability of the framework. Using this newly developed framework, the data identified five levels of attainment in solving the mathematics word problems. This study will move into its second stage of data analysis in 2020.



Dr Mun Yee Lai meeting with researchers in Taipei

Dr Damian Maher in University-School Partnership STEM Program Research

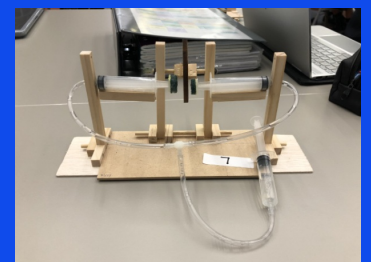


Project title
WANAGO: A University-School Partnership STEM Program

STEM education is crucial for the digitally-fluent, multidisciplinary careers of the future – the software developers, solar technicians, biotech engineers, data analysts and thousands more. But Australian high schools often do not have the teaching capabilities or resources to engage students in STEM subjects, or to offer these subjects at all. Hence students are missing out on their first stepping stone to the next generation of jobs. More than a stepping stone, the Wanago Program at UTS is a Faculty of Engineering and Information Technology (FEIT) initiative that provides new pathways connecting high school students and their teachers with higher education and future industries. The program combines the delivery of Australian curriculum electives in university-like settings, as well as initiatives to inspire students, mentor teachers and raise awareness in parents. The 2019 Wanago program offers *iSTEM* and *Engineering Studies* as pathways for Stage 5 and 6 students respectively to study STEM subjects in a university setting. The studies incorporate mechatronics, engineering, 3D computer-aided design and manufacturing, supported by cutting edge technologies such as 3D printers and



The Protospace classroom

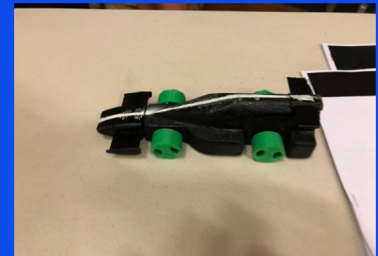


Brake model students created and presented

laser cutters. The *Engineering Studies* and *iSTEM* classes were conducted at UTS' building 10, the experimental learning studio and in the School of Biomedical Engineering lab.

Research into the impact of this innovative school-university-industry partnership program was conducted by **Dr Damian Maher** throughout the year. The research adopted a mixed methods approach whereby quantitative data from student and teacher questionnaires were triangulated with rich qualitative data from observations as well as student and teacher interviews. There were 18 Year 11 students from five different schools participating in the *Engineering Studies* elective and 31 Year 10 students in the *iSTEM* elective.

The data showed the very positive responses of the students in being able to learn in real-world settings and access cutting-edge technologies as well as mentors and experts in the field. For example the students were able to work with staff in the School of Biomedical Engineering as well as FEIT's Rocketry and Formula 1 undergraduate teams to gain support for their design and production of rockets and F1 cars. Challenges identified differed between the Year 10 and Year 11 students with the former identifying the need to develop project management and the latter identifying a better balance between theory and practicals is required. The Wanago program will move into its second year of implementation in 2020 with an expansion in the number of classes.



F1 car after being milled and ready for competition

Associate Professor Wan Ng in Women in STEM Research



Project title ***Women in STEM: STEAMPunk Girls***

The Office of the Chief Scientist reported that the data continues to show that girls are less likely to engage with STEM education with males making up 84 per cent of the total number of people with STEM qualifications and only about 13% of all engineers in Australia are women. The STEAMPunk Girls project, funded (\$250,000) by the Australian Government/Business, incorporates the elements of STEAM (Science, Technology, Engineering, Arts and Maths), Project-Based Learning (PBL), and Design Thinking. The program was developed to help strengthen the pipeline of women in STEM by highlighting STEM study and career pathways for young women and equipping them with relevant skills and mindsets to prepare them to select and pursue these pathways. The program fosters the growth of a STEAM mindset that includes STEM knowledge and skills, as well as creativity and entrepreneurship. Showing students that they have the capacity to generate solutions to real-world problems enables them to see themselves as change-makers with the confidence to become informed and active citizens in the future.

The research, led by **Associate Professor Wan Ng**, aimed to provide evidence to inform future work in the use of STEAM as an interdisciplinary approach to foster interest and confidence in STEM fields among high-school girls in Australia. The research design made use of a mixed methods approach to investigate the impact of the program on the learning and teaching experiences of high school students



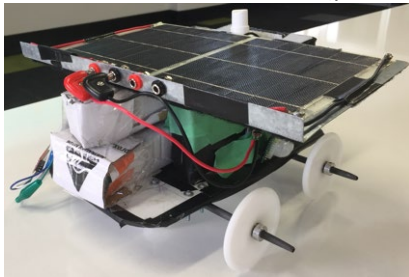
Girls and Virtual Reality

and teachers. Participants included 89 NSW teachers (51 metropolitan and 38 regional) and 352 students (189 metropolitan and 163 regional) across all the 3 school sectors. Nine school cases with innovative problems-solutions were studied in depth. Quantitative data showed that the strategies adopted in the project showed significance differences between pre-post program in teachers' understanding of PBL, Design Thinking, interdisciplinary STEAM and STEM careers. They perceived increase in students' engagement in STEM, confidence and motivation to study STEM. There was significant decrease in students' perception of barriers to women in STEM and increased self-efficacy in STEM and understanding of STEM careers.

Examples of two STEAMPunk case studies

1. ***How can we survive a drought?*** was the problem posed by a group of 22 Year 8 girls from a Catholic high school in Sydney. The 'drought' theme was incorporated into English, Maths, Science and Technology classes with an emphasis on coding Microbit, a handheld programmable microcomputer, to detect moisture and temperature. A range of innovative solutions was proposed by the girls e.g.

- The CowRing - a ring in a cow's ear that indicates rising body temperature to prevent livestock death by sending a warning to the farmer by text message.
- Water Wagon – a solar powered tanker vehicle with a sensor that detects soil moisture level and releases water from tank as necessary.
- Moisture Detector 101 (pictured below) - Microbit on a solar powered car senses



the amount of moisture in the soil and sends a text message to a phone with information about which parts of the farm require watering.

- MicroShower – device on a shower head which calculates how much water has been saved depending on how long the shower was, incorporating a reminder when the shower exceeds 5 minutes.

2. ***How can we, as concerned community members, improve the quality of life and sense of connection for our local senior citizens?*** was the problem posed by a group of 19 Year 9 girls from a regional



government school in NSW. The 'senior citizen' and 'quality of life and connection' themes involved understanding the brain and researching about ageing and its effect on the brain and coming up with a variety of ways of using STEAM in their project to improve the lives of the elderly residents. The girls continued to visit the care home each week during their lunch breaks and encouraged the residents to talk to

them about their life experiences. The girls also tested their ideas during the visits, including playing games with the residents, introducing them to virtual reality (VR), music and drama performances, and making ice cream for them using liquid nitrogen. The students conducted research into the effects of all their proposed interventions and cited evidence of the ways in which the activities would be beneficial for the aged care residents. They then observed the effects on the residents of their participation in each of the activities. During the project, the students also conducted a Skype interview with a female scientist, who told them about macular degeneration and its effects on the elderly.



Making ice-cream for senior citizens using liquid nitrogen.



Senior citizens experiencing virtual reality.

Update on the WAFTUS Science Challenge Research

A/Professor Mary Coupland; Dr Kimberley Pressick-Kilborn; Dr Tracey-Ann Palmer & Dr Marco Angelini

The WAFTUS Science Challenge is now in its fourth year. WAFTUS is from the schools involved – Wilkins, Ashfield, Fort St, Tempe, and Summer Hill, with U for UTS. Year 10 students from Fort Street and Tempe High Schools are given training in mentoring and meet once a week during school term 2 with small groups of Year 4/5/6 primary school students, to mentor them in carrying out a scientific investigation.

The scheme was launched this year with a brilliant presentation to the mentors from UTS Scientist Dr Nural Cokcetin, who spoke about her own research in honey and antibiotics. There was a lot of interest in microbiology as a result! The primary school groups brought their projects to Fort St High School for judging on Wednesday July 3 by eight scientists/ science educators from UTS. On September 12 and 15, all school students involved visited UTS for a tour of the science facilities.

In 2019, UTS staff involved with WAFTUS proposed to lead a collaborative project to research the program, its impacts, and make recommendations for the future of the program including expansion to other schools. Our proposed research questions are:

1. What do primary and secondary students, and their teachers, see as the benefits of participation in the WAFTUS Science Challenge?
2. How has involvement in the WAFTUS Science Challenge contributed to the professional learning of the participating teachers and UTS academics?
3. What recommendations for future iterations and/or expansion of the WAFTUS Science Challenge can be made?

Principals and teachers involved in the project have been invited to be collaborators in this research venture, and in principle agreement has been given. Currently the research team has achieved UTS Ethics approval and is awaiting SERAP permission to proceed with data collection in the form of interviews with students and staff in the relevant schools.

New Research Project

Dr Kimberley Pressick-Kilborn, in collaboration with Ange Fitzgerald (University of Southern Queensland) and Reece Mills (Queensland University of Technology), is conducting a national survey of primary science teacher educators, to investigate the diversity of approaches taken in primary science education during initial teacher education degrees. The survey will be open throughout November 2019 with interviews over the summer, and the research findings will be shared at the ASERA conference in June 2020.

Visiting Scholars to the STEM Education Futures Research Centre

Key Technology Partnerships (KTP) visiting scholars

- Visiting scholar Associate Professor Ruurd Taconis from Eindhoven University of Technology was at UTS in August. He presented a research seminar and worked with Centre researchers on an online teaching/learning project, as well as discussed collaborative research along STEM that embraces technology and engineering. **Associate Professor John Buchannan** hosted Ruurd's visit.
- Dr Sue Cranmer from Lancaster University visited UTS in November to work with Centre members on collaborative projects in the area of Technology-enabled Learning, particularly in the Special Needs area of Education. **Dr Kirsty Young** hosted Dr Cranmer's visit.

Visiting Professor from Slovenia

- Professor Robert Repnik from the Faculty of Natural Sciences and Mathematics and the Faculty of Education, University of Maribor, Slovenia, visited the STEM Ed Centre in October to exchange research knowledge in Physics education. He is Head of Department for Physics, and his travel was funded by the *Innovative Learning and Teaching for Quality Careers of Graduates and Excellent Higher Education Initiative*. **Associate Professor Wan Ng** hosted Professor Repnik's visit.

Conference Presentations

Pressick-Kilborn, K., Buchanan, J., & Maher, D. (2019). Engaging children in citizen science and sustainability education through digital technologies: Bridges or barriers? Paper presented at the Annual Conference of the Australasian Science Education Research Association, Queenstown, NZ, July 2-5.

Palmer, T.A., Aubusson, P., Burke, P., & Pressick-Kilborn, K. (2019). *Primary Connections* Professional Learning: What do teachers really want? Paper presented at the Annual Conference of the Australasian Science Education Research Association, Queenstown, NZ, July 2-5.

Pressick-Kilborn, K. (2019). Pedagogical practices that catch and hold primary students' interest in science: (Re) Examining the importance of connectedness. Paper presented in the Symposium, *Catching and holding students' interest in science learning*, at the Biennial Conference of the European Science Education Research Association, Bologna, Italy, August 26-30.



Left: (from L to R) Dr Tracey-Ann Palmer, Professor Peter Aubusson, Dr Kimberley Pressick-Kilborn
Right: Dr Kimberley Pressick-Kilborn (centre front) with fellow Symposium presenters from Denmark, Germany and USA at the ESERA Conference in Bologna, Italy.

Latest Publications

- Apps, T., Beckman, K., Bennett, S., Dalgarno, B., Kennedy, G., & **Lockyer, L.** (2019). The role of social cues in supporting students to overcome challenges in online multi-stage assignments. *The Internet and Higher Education*, 42, 25-33.
- Arguel, A., **Lockyer, L.**, Kennedy, G., Lodge, J. M., & Pachman, M. (2019). Seeking optimal confusion: a review on epistemic emotion management in interactive digital learning environments. *Interactive Learning Environments*, 27(2), 200-210.
- Burden, K., **Kearney, M.**, **Schuck, S.**, & Burke, P. (2019). Principles underpinning innovative mobile learning: Stakeholders' priorities. *TechTrends*, 1-10.
- Kearney, M.** & **Maher, D.** (2019), Mobile learning in pre-service teacher education: Examining the use of professional learning networks. *Australasian Journal of Educational Technology*, 35(1). <https://doi.org/10.14742/ajet.4073>
- Maher, D.** (2020). Altered Realities: How virtual and augmented realities are supporting learning. In Keengwa, J (ed), *Handbook of Research on Innovative Pedagogies and Best Practices in Teacher Education*, IGI Global, pp. 34-51.
- Kitto, K., & **Knigh, S.** (2019). Practical ethics for building learning analytics. *British Journal of Educational Technology*, 50(6), 2855-2870.
- Ng, W.** (2020). Affective Profiles of Year 9/10 Australian and South East Asian Students in Science and Science Education. *Eurasia Journal of Mathematics, Science and Technology Education*, 16(1). DOI: <https://doi.org/10.29333/ejmste/110782>
- Nicholas, H., & **Ng, W.** (2019). Mobile Digital Literacy of Australian Adolescent Students. *International Journal of Digital Literacy and Digital Competence (IJDLDC)*, 10(3), 32-48.
- Palmer, TA.** (in press). Student subject choice in the final years of school: Why science is perceived to be of poor value. *Australian Educational Researcher*. DOI: 10.1007/s13384-019-00357-9
- Pressick-Kilborn, K.**, & **Prescott, A.** (in press). School-university partnerships as rich STEM learning contexts for pre-service teachers working with primary students. In A. Fitzgerald, C. Haeusler & L. Pfeiffer (Eds.) *More than coding: Unraveling contemporary approaches to STEM education in primary classrooms*. NY: Routledge.
- Yaseen, Z & **Aubusson, P.** (2019). Exploring Student-Generated Animations, Combined with a Representational Pedagogy, as a Tool for Learning in Chemistry. *Research in Science Education*, pp. 1-20. <https://doi.org/10.1007/s11165-018-9700-4>
- Yasukawa, K.**, & Evans, J. (2019). Adults' numeracy practices in fluid and unstable contexts—An agenda for education, policy and research?. *Zeitschrift für Weiterbildungsforschung*, 42(3), 343-356

